Traumatic Brain Injuries (TBI)

Section 1: Introduction

Traumatic brain injuries are a commonly encountered condition by nurses in all settings. Even when the patient has long passed the acute injury stage of a brain injury, the effects can be long-lasting. Therefore, nurses in all settings should understand traumatic brain injuries, including different types of traumatic brain injuries, populations who are at risk, necessary assessments, signs and symptoms, treatments, nursing interventions, and prevention strategies.

Traumatic brain injury (TBI) occurs when a force impacts the brain and causes injury that disrupts normal brain function (FDA, 2021). TBI is the most commonly occurring neurological disorder (Maas et al., 2022) and is the leading cause of death, disability, and seizure disorders for people around the world. A 2020 literature review estimated that approximately 2.8 million people in the United States experience a TBI each year (Zrelak et al., 2020). In the US in 2021, there were approximately 214,110 hospitalizations related to TBI and 69,473 recorded deaths (CDC, 2024e). The estimated global cost burden of traumatic brain injury is $400 billion each year (Maas et al., 2022). It is difficult to accurately assess the number of people who experience a traumatic brain injury because those who suffer a mild injury often do not seek medical care. Those who are discharged from the emergency department are frequently not included in the statistics (Zrelak et al., 2020). In some areas of the world, identification of TBI and post-TBI care varies, and accurate data is inconsistent (Maas et al., 2022). In a study that relied on self-reporting, it was found that almost 10 million Americans reported having suffered a traumatic brain injury in the previous year, which includes 2.2% of children and 3.3% of adults (Waltzman et al., 2025). Though the exact number of people who experience a TBI each year is difficult to ascertain, experts agree that this injury presents a significant burden on the US healthcare system and the individuals directly affected (Maas et al., 2022).

TBIs can occur in any situation where there is an impact to the head, but there are some events that commonly lead to head injuries. Falls are the cause of almost half of all hospitalizations related to TBI. Suicide by firearm is the most common cause of death due to TBI in the United States. TBIs also commonly occur due to motor vehicle collisions and assaults (CDC, 2024d). In 56% of cases, when a patient experiences a TBI, they have alcohol in their system (Zrelak et al., 2020). In children, 55% of TBIs are due to a fall, and 24% are due to an unintentional blunt force injury (like being hit with a baseball bat). In children over the age of 5, motor vehicle accidents are the leading cause of death due to TBI, while in children under the age of 5, the leading cause of TBI-related death is assault, most commonly by child abuse. Explosions and blasts are the most common causes of TBI for military service members during conflicts (NICHHD, 2020).

Nurses in many workplace settings interact with patients who have experienced TBI. These nurses are integral to the multidisciplinary team by using finely honed assessment skills and intervening appropriately to support favorable outcomes. Nurses must have specialized knowledge to be effective interdisciplinary team members when caring for individuals with TBI. They should understand how TBIs can be categorized and what the different types of injury entail. Nurses should be knowledgeable regarding the populations at highest risk for TBI and must be able to identify signs and symptoms of TBI when they occur or when there is a status change in their patient. Nurses caring for these patients must also be aware of current evidence-based nursing interventions and treatments to promote optimal outcomes and reduce complications (Figueiredo et al., 2024).

Section 2: Types of Traumatic Brain Injuries

Not all injuries to the head result in a TBI, and not all TBIs are the same. This distinction is essential when discussing TBI signs, symptoms, interventions, and treatments. The categorization of TBIs depends on the context of the discussion. In a broad context, TBIs can be classified as either penetrating or non-penetrating, based on the manner in which the injury occurs. Most commonly, however, TBIs are categorized by severity, either mild, moderate, or severe. They can be classified by symptom progression as either primary or secondary. Sometimes it can be beneficial to categorize TBIs by symptom presentation as either concussive or subconcussive. TBIs can also be discussed in terms of the type of injury, like diffuse axonal injury, or long-term effects, such as chronic traumatic encephalopathy. An initial evaluation of neurological function must occur to diagnose and categorize a TBI. If there is altered neurological function, imaging scans, such as magnetic resonance imaging (MRI) and computed tomography (CT), will be ordered to examine for changes in the brain. The provider may also order blood work and toxicology screens to determine if other factors could contribute to the altered neurological function. Based on the information gathered, the provider can determine the type and severity of the TBI (Bell, 2024). Nurses must understand the terminology that describes and defines different types of TBI to better care for their patients.

Penetrating TBI

A penetrating TBI occurs when an object penetrates the brain tissue, often called an open TBI (Cleveland Clinic, 2024). Most penetrating TBIs are the result of a gunshot wound (Bell, 2024). Mortality rates are highest for this type of injury—deaths due to penetrating TBI account for 34.8% of all TBI-related deaths (Zrelak et al., 2020).

Non-Penetrating TBI

Non-penetrating TBI is the most common type of TBI and is caused by a blunt force impact to the head that injures the brain. It is often referred to as a closed head injury. It is important to remember that even though nothing has penetrated the brain, the brain can still have structural damage due to bleeding (Bell, 2024).

Subconcussive Brain Injury

This type of injury occurs when there has been an impact to the head, but there are no notable symptoms following the injury. Individuals with this type of injury may not realize they have been injured. Even though the patient may not have symptoms, subconcussive injuries can cause complications when they occur repetitively, such as sports injuries. An example of this type of injury may be a soccer player who frequently hits the ball with their head (Bell, 2024).

Mild TBI

Mild TBIs account for 90% of all TBIs that present at the hospital (Maas et al., 2022). A mild TBI is often the result of an external blunt force, where the individual may or may not lose consciousness. They may report feeling "dazed" following impact (Bell, 2024). A mild TBI can also occur when an impact on the body causes the brain to move back and forth within the skull. When this occurs, there can be chemical changes within the brain, as well as stretching and damage to individual brain cells (CDC, 2024a). People often use the terms "mild TBI" and "concussion" interchangeably (Cleveland Clinic, 2024), though concussion is technically a type of mild TBI (Development, 2020). This type of injury is typically not considered life-threatening, though symptoms can linger (CDC, 2024a).

Moderate TBI

Like a mild TBI, moderate TBIs are caused by an impact or jolt to the head or a penetrating injury (CDC, 2024b). Moderate TBIs are categorized as a loss of consciousness for more than 15 minutes but for less than 24 hours (Cleveland Clinic, 2024). Patients with a moderate TBI typically have a mix of injury severity and have the potential to have worsening neurological symptoms. Moderate TBIs are challenging to diagnose and define because they are often lumped into broader categories, such as mild-to-moderate TBI and moderate-to-severe TBI, rather than being clearly defined as a single category (Godoy et al., 2024).

Severe TBI

Falls, firearm-related suicides, and motor vehicle crashes most often cause severe TBIs. Most individuals who experience a severe TBI will have ongoing medical complications as a result of their injury (CDC, 2024b). Those who are diagnosed with a severe TBI will have significantly lower neurological function and loss of consciousness or meet two of the following criteria: over age 40, hypotensive, and displaying abnormal posturing (Ginsburg & Smith, 2025). Severe TBI involves significant structural and metabolic brain dysfunction and is the leading cause of morbidity and mortality around the globe, especially for the younger population. While only 6-8% of all TBI cases are considered severe, nurses must understand the implications of this diagnosis and work to prevent further injury (Zrelak et al., 2020). When a severe TBI occurs, the patient may require emergency surgery to avoid complications or death (NICHHD, 2020). Severe TBIs occur in two phases, the first being the primary TBI, followed by the secondary injuries (Zrelak et al., 2020).

Primary TBI

A primary TBI occurs when structural damage to the brain results from a penetrating or non-penetrating impact to the head (Bell, 2024). Different types of primary TBIs occur with injuries, including diffuse axonal injury (DAI), hemorrhages, hematomas, contusions, and skull fractures. The damage caused by a primary TBI is considered to be generally completed as soon as the injury occurs (Johns Hopkins Medicine, 2025b).

Secondary TBI

A secondary TBI occurs in the hours or days after the primary injury happens and results from chemical and physical changes in the brain that cause further damage (Johns Hopkins Medicine, 2025b). These changes are due to the initial inflammatory process after the primary injury (Figueiredo et al., 2024). Secondary TBI can occur when there is increased intracranial pressure, progressive brain swelling, arterial damage within the brain triggering a stroke or seizure, or hypoxic injury due to respiratory arrest or hypotensive crisis (Bell, 2024). Secondary TBI can also occur when the blood-brain barrier is compromised. Blood, plasma proteins, and other foreign substances, usually kept out of the brain by the blood-brain barrier, can enter the brain tissue and cause significant brain swelling. Swelling of the brain can lead to poor circulation within the brain, causing hypoxic injury. Inflammatory processes can also damage nerve cells (NICHHD, 2020). Electrolyte imbalances, especially altered sodium levels, can affect neurological changes by causing fluid shifts (Figueiredo et al., 2024). Nursing care of TBIs focuses on preventing secondary TBI injuries (Zrelak et al., 2020).

Diffuse Axonal Injury (DAI)

Diffuse axonal injury is a common primary brain injury and is described as widespread damage to the white matter of the brain (NICHHD, 2020). It occurs when the axons, or nerve fibers, are torn and stretched as the brain shifts within the skull. DAI can cause damage to multiple areas of the brain and can result in a coma. The damage that occurs with diffuse axonal brain injuries is typically microscopic and may not be visualized on an MRI or CT scan (Johns Hopkins Medicine, 2025b). This type of injury most often occurs due to motor vehicle crashes, falls, or sports-related injuries. DAI can inhibit the communication ability of nerve cells in the brain. It can also trigger chemical cascades that lead to secondary brain injury. Damage from DAI can be temporary or permanent, and recovery is often a lengthy process (NICHHD, 2020).

Concussion

A concussion is a type of mild TBI. It is a temporary injury, but healing can take several months. Concussions are most often caused by a blunt impact to the head, such as sports injuries, falls, motor vehicle accidents, or rapid brain movement within the skull, which occurs when a baby is shaken. After the injury, the individual may or may not lose consciousness, but they do tend to have a sudden change in their level of awareness. “Second hit phenomenon” can occur when the individual experiences two concussions close together, which can lead to worsening symptoms and secondary injury. After someone experiences a concussion, the symptoms can linger for weeks or months (NICHHD, 2020).

Hematomas

A hematoma occurs when there is bleeding due to a ruptured blood vessel. there are different types of hematomas. The dura mater is the outermost protective membrane surrounding the brain. Bleeding between this membrane and the skull is called an epidural hematoma. This type of injury can occur immediately following the impact injury or take hours to form (NICHHD, 2020). Epidural hemorrhages, or hematomas, typically occur after blunt trauma to the temporal region and can be the result of an arterial or venous bleed (Tenny et al., 2024). Epidural hematomas are particularly dangerous because they exert pressure on the brain. The arachnoid mater is the mid-layer protective membrane of the brain. When the blood vessel rupture is located between the dura mater and arachnoid mater, the injury is classified as a subdural hematoma. This injury is common in older adults after a fall and is dangerous due to the pressure exerted on the brain. The pia mater is the innermost protective membrane of the brain. When bleeding occurs between the arachnoid mater and pia mater, the injury is classified as a subarachnoid hemorrhage. Intracerebral hematomas occur when there is bleeding within the functional brain matter, which is particularly damaging to the surrounding brain tissue (NICHHD, 2020).

Contusion

This type of injury occurs when tiny blood vessels bleed into the brain tissue. A coup injury describes a contusion that occurs directly at the site of impact to the head. More commonly, people suffer from a countercoup injury, which causes a contusion on the opposite side of the brain from the impact injury. They typically result from rapid deceleration, which causes the brain to bounce back and forth within the skull. Contusions may take hours to a day to become apparent. This type of injury can be found in someone who has experienced a motor vehicle crash or in an infant who has been shaken. A new or larger lesion can occur when a contusion continues to bleed, resulting in further damage to brain tissues. This process is called hemorrhagic progression of contusion and can worsen the patient’s clinical status (NICHHD, 2020).

Skull Fracture

A skull fracture is defined as a break or crack in the bones of the skull. It typically occurs after a blunt force injury, and damage to the brain may be noted at the site of injury, under the fracture. Skull fractures can cause damage to blood vessels, membranes, and functional brain tissue (NICHHD, 2020). Skull fractures occur most commonly with motor vehicle crashes, sports injuries, violence, and falls. There are different types of skull fractures, though the most common is a linear skull fracture, which occurs when there is a break, but no movement of the bone. A depressed skull fracture occurs when there is a sunken break in the skull. A diastatic skull fracture occurs along the natural suture lines of the skull and is observed as widening of the suture lines. This type of skull fracture is most common in infants. A basilar skull fracture is considered the most serious type of skull fracture and occurs when the break is in the base of the skull. This can cause cerebrospinal fluid leaks and damage to the brain (Johns Hopkins Medicine, 2025a).

Post-concussive Syndrome

Post-concussive syndrome is defined as concussion symptoms that last more than three months after a mild TBI. These symptoms can last up to a year after injury (Mayo Clinic, 2024). Post-concussive syndrome affects 80% of patients who experience a mild TBI (Ginsburg & Smith, 2025). Risk factors for post-concussive syndrome include age 20-30, female sex assigned at birth, history of anxiety, prior headaches, and prior brain injury (Mayo Clinic, 2024). These patients are also at risk for second impact syndrome, which is a rare condition where the brain swells rapidly, often resulting in death. They can experience posttraumatic epilepsy or chronic traumatic encephalopathy (Ginsburg & Smith, 2025). Older adults who experience post-concussive syndrome tend to have more serious and persistent symptoms (Mayo Clinic, 2024).

Chronic Traumatic Encephalopathy

Technically, chronic traumatic encephalopathy (CTE) is not the result of a single brain injury. It occurs when there are repeated brain injuries that lead to this rare degenerative brain condition (Bell, 2024). CTE can result in problems with thinking, understanding, and communicating. Those with CTE may exhibit movement disorders. They may experience poor impulse control, depression, confusion, and irritability (NICHHD, 2020). This type of brain injury is associated with high-contact sports where impacts to the head are common, like boxing, soccer, and football (Bell, 2024). CTE takes years to develop and, until recently, could only be diagnosed via autopsy. Research continues in order to establish consistent diagnostic criteria for this condition (NICHHD, 2020).

Post-traumatic Dementia

This condition can occur when there has been a single, severe TBI. It can present similarly to CTE. Research has found that moderate and severe TBIs that occur in early or midlife can increase the individual's risk for dementia later in life (NICHHD, 2020).

Section 2 Personal Reflection

How do providers determine the type of TBI? What are the different ways to classify TBI? How do mild, moderate, and severe TBIs differ? In what ways are they similar? What are the long-term conditions associated with TBI?

Section 3: Populations at Increased Risk for TBI

Specific populations are at higher risk of experiencing a traumatic brain injury. Most traumatic brain injuries occur in adults aged 65 and older, and injury in this population most commonly occurs due to a fall (NICHHD, 2020). Children under age four and young adults ages 15-24 are also at increased risk for TBI (Mayo Clinic, 2021). In any age group, males are more likely to experience a severe TBI than females (NICHHD, 2020). In low- and middle-income countries, the most common cause of TBI is any road traffic incident, which may involve cars, motorcyclists, and pedestrians. In high-income countries, falls are the most common cause of TBI (Maas et al., 2022). Communities that are affected by conflict, such as migrants and refugees, as well as indigenous communities, are at increased risk for TBI (Maas et al., 2022). Exposure to violence is a risk factor for TBI. The prevalence of TBI among incarcerated individuals is high, with 64% of male inmates and 78% of female inmates having a history of TBI. This population is at particularly high risk because a history of TBI can predispose someone to violence, and violence can cause further TBI (NICHHD, 2020).

Older adults (aged greater than 65 years) are most frequently hospitalized for TBI. In the United States, this population accounts for over 43% of hospital admissions due to TBI. In some countries, the rate of TBI in older adults is rising. Older adults tend to experience more severe cognitive and functional impairments following TBI. They are also at higher risk for functional decline (Maas et al., 2022).

In children, TBI leads to more than 500,000 emergency department visits and approximately 60,000 hospitalizations in the United States each year. Most children experience TBI due to sports-related injuries, falls, and motor vehicle crashes. Falls resulting in TBI are more common in younger children due to their emerging ambulatory skills and the fact that they have anatomically disproportionately large heads. They also have a shifted center of gravity and immature neck muscles. Non-accidental trauma, or child abuse, can also contribute to TBI in this age group. Like other age groups, pediatric males are more likely to experience TBI than pediatric females. Most pediatric TBIs are mild, but in the United States, there are over 3,000 TBI-related deaths in the pediatric population each year (Haydel et al., 2024).

Section 3 Personal Reflection

What populations are at increased risk for TBI? Why do you think older adults are at increased risk for TBI? What are some causes of increased risk for children ages 0-4 years?

Section 4: Assessment

When a head injury occurs, the patient should be assessed immediately by someone trained to evaluate TBI (NICHHD, 2020). The ABCDE Trauma Assessment is a commonly used tool for the initial assessment of patients with traumatic brain injuries. This tool helps to maintain assessment priorities and allows the healthcare worker to focus on key assessment findings. ABCDE stands for airway, breathing, circulation, disability neurologic exam, and exposure and environment (or systemic injuries). The nurse should report any concerning findings to the appropriate healthcare provider (Zrelak et al., 2020).

When assessing the airway, the healthcare team must check for consciousness, evaluate if the airway is clear, assess for security of the airway, and then monitor the airway while maintaining spinal stabilization. Patients who have a rapidly declining mental status or are at significant risk for deterioration may become unable to oxygenate appropriately, so they should be intubated and placed on assistive ventilation. Since traumatic brain injuries are acquired through a traumatic event, the cervical spine must be stabilized until spinal injury can be ruled out through imaging. Ten percent of trauma patients experience associated cervical spine injuries, so protecting the spinal cord is a high priority (Zrelak et al., 2020).

Next, breathing must be assessed. Pulse oximetry should be used to assess oxygenation, and the goal SpO2 is greater than 90%. Episodes of hypoxia are associated with increased risk of mortality and should be avoided. The patient's ability to maintain appropriate carbon dioxide levels depends on their capability for normal breathing patterns. Hyperventilation should be avoided, and end-tidal CO2 (ETCO2) should be monitored with a goal of 35-40 mmHg. The patient's respiratory pattern should be observed. Irregular respirations can indicate neurological dysfunction, increased intracranial pressure (ICP), or injuries to the chest (Zrelak et al., 2020).

Circulation is evaluated following the respiratory assessment. The patient should be examined for life-threatening hemorrhage, and the blood pressure should be measured with a mean arterial pressure (MAP) goal of at least 60 mmHg. Hypotensive patients are at higher risk of mortality, and their neurological exam may not be reliable. Until ICP monitoring can be established, maintaining a MAP of at least 60 mmHg ensures cerebral perfusion pressure is maintained. Signs of herniation should be evaluated by assessing for Cushing's triad, which includes hypertension, bradycardia, and irregular respirations (Zrelak et al., 2020). Identified in 1901 by Dr. Harvey Cushing, this triad of symptoms is ominous and indicates that brain stem herniation is imminent (Dinallo & Waseem, 2023). A widening pulse pressure is also a concerning finding, and the combination of these signs can indicate a late compensatory mechanism to maintain cerebral perfusion pressure when intracranial pressure is increased. Bradycardia is associated with increased ICP but can also indicate cervical spine injury.

Tachycardia may indicate hypovolemic shock or be an autonomic response to injury of the hypothalamus, indicating a terminal injury (Zrelak et al., 2020).

The disability neurologic exam helps to evaluate the level of immediate neurological injury. Once it is established that the patient's airway, breathing, and circulation are intact, the patient should be evaluated using the Glasgow Coma Scale (GCS) (Ginsburg & Smith, 2025). This scale was first introduced in 1974 by Graham Teasdale and Bryan Jennett to aid in assessing the level of consciousness for patients who have experienced an acute head injury. Today, the GCS scoring system is also commonly used to document and monitor trends in the neurological assessment following a TBI (Zrelak et al., 2020). The GCS utilizes eye-opening, verbal, and motor responses to determine the level of consciousness. To use this tool, the patient receives a score in each area assessed. These numbers are then added together to determine the GCS score. The minimum and most grave score is a 3, while the highest and most reassuring score is a 15 (Ginsburg & Smith, 2025).

Glasgow Coma Scale

Eye-opening response

- Spontaneous (4)
- Opens to verbal stimuli (3)
- Opens to pain (2)
- No response (1)

Verbal Response

- Oriented (5)

- Confused (4)
- Inappropriate words (3)
- Incomprehensible speech (2)
- No Response (1)

Motor Response

- Obeys commands for movement (6)
- Purposeful movement to painful stimuli (5)
- Withdraws to painful stimuli (4)
- Flexion response to painful stimuli (decorticate posturing) (3)
- Extension response to painful stimuli (decerebrate posturing) (2)
- No response (1)

To ensure a standardized GCS exam, nurses should understand basic guidelines regarding the techniques used during the exam. Eye-opening does not have to coincide with alertness or awareness of the situation. If opening eyes to speech stimuli, the patient does not have to follow directions or acknowledge what is spoken. Graded pressure should be used to elicit a response to a pain or pressure stimulus. This involves only using a level of pressure that would elicit a response in someone who is neurologically intact and no more or less. If factors affect eye opening, such as periorbital trauma, the nurse should document NT, or not testable, for this exam section. An oriented verbal response requires a correct answer from the patient when assessing their awareness of person, place, and time. Even if the communication is coherent, the patient should be scored as confused if any of the answers are incorrect. If the response lacks structured phrases, the patient should score a three in verbal response. If the patient cannot respond verbally due to an endotracheal tube or physical injury, the nurse should document NT, or not testable. A patient who is classified as able to obey commands must be able to complete a specific response that is not associated with a reflexive action. The instructions should include a two-step process, such as “squeeze and release my fingers”. For a localized response, there must be a connection between the stimulus's location and the patient's movement in response. For example, if sternal pressure is applied, the patient who can localize the sensory input would attempt to push the examiner’s hands away from their sternum. If the patient only crosses their hand over their body, this does not qualify as a localized response. Normal elbow flexion would indicate a normal flexion response, unless the movement mimics an abnormal response. Abnormal flexion may include slow movement, repetition of the response, arms moving across the chest, rotating the forearm with a clenched thumb, and leg extension. Straightening of the elbow in response to a stimulus is considered an extension response. Some injuries or medications may limit the patient’s ability to engage in a motor response. In these cases, the nurse should document that the motor response exam is not testable (Zrelak et al., 2020).

When the GCS exam cannot be conducted due to injuries or medical interventions, modified versions of the scale can be used. Evidence supports the use of a motor response-based tool. However, it has not been widely implemented due to concerns about inter-rater reliability and how to communicate exam findings effectively. The Full Outline of UnResponsiviness, or FOUR score, is an assessment tool that can be used when the GCS exam is limited. This assessment tool uses a similar scoring system. However, eye response, motor response, brain stem reflexes, and respiration scores are given equal weight, so a deficit in one area does not skew results. This tool is not used as often as GCS because there can be variability in how healthcare team members assess the score (Zrelak et al., 2020). The pediatric GCS tool is similar to the adult tool, though it includes some changes in the scoring for verbal response for infants and young children. These differences account for developmentally appropriate behavior, such as crying, cooing, and babbling, though for children older than five, the adult GCS tool is valid for assessing neurological status (Haydel et al., 2024).

As the GCS score declines, the risk of secondary injury increases. It is important to remember that the GCS score should be obtained following resuscitation and before administering any paralytic or sedating agents. These medications can mimic or mask a neurologic deficit. Pupil size and functioning should be evaluated as part of the neurological exam, as it is a valuable indicator of increasing injury or herniation. Asymmetric pupils are present when there is more than one millimeter difference in the diameter when the pupils are compared. This finding should prompt a neurosurgical evaluation. A fixed pupil is present when there is less than a one mm response to light stimuli. When both pupils are dilated and do not react to changes in light stimuli, it is often an ominous sign of anoxic brain injury and brain death. The nurse should note any injuries around the eyes, as orbital injury can mimic or mask signs of brain herniation. The patient should be assessed for seizure activity, and the healthcare team should determine if there was a witnessed seizure at the scene immediately after the injury occurred. Any seizure activity warrants a neurosurgical consultation. If the seizure occurred prior to the head injury, postictal signs, such as decreased level of consciousness, could complicate the neurological exam (Zrelak et al., 2020).

If the patient can cooperate with the neurological exam, the cranial nerves should be assessed (Ginsburg & Smith, 2025). A TBI that affects the base of the skull can cause cranial nerve damage. As a result, the patient may experience paralysis of facial muscles, loss of sensation, an altered sense of smell or taste, dizziness, vision changes, swallowing problems, tinnitus, and hearing loss (Mayo Clinic, 2021).

Finally, exposure and environment, also known as systemic injury, should be assessed. Other potential causes of decreased level of consciousness should be evaluated. These include airway obstruction, hypoxia, hypoglycemia, opiate overdose, or a neurologic event such as spontaneous intracerebral hemorrhage, seizure, or stroke. These factors can confuse the neurological exam findings and impact the patient's management plan. Drug or alcohol intoxication should be assessed, as these can impact exam findings. The patient should be assessed for severe extracranial trauma. If this type of injury is present, regardless of the GCS score, the patient should be transferred to a trauma center where they can receive a neurosurgical evaluation (Zrelak et al., 2020).

The assessment of a patient with a TBI should be individualized and also include a complete physical assessment (Zrelak et al., 2020). A detailed history should be obtained from the patient and those who witnessed the injury. Information gathered should include the mechanism of the injury and whether the patient lost consciousness. If they did experience a loss of consciousness, the length of time should be noted (Ginsburg & Smith, 2025). The witness should be asked if there were any other changes in alertness or difficulty with speaking or coordination immediately after the injury. It is important to know where the patient's head was struck and if other parts of the body were impacted (Mayo Clinic, 2021). Past medical history is also necessary to understand potential risk factors. If the patient has been taking anticoagulants, they will be at increased risk for intracranial bleeding. A review of symptoms should be obtained (Ginsburg & Smith, 2025).

In some cases, laboratory studies may be ordered when evaluating a traumatic brain injury, though they are not always necessary. If a patient experiences a minor head injury and has a contusion, they may only require imaging studies. If the patient experiences a more traumatic injury, such as a motor vehicle crash or gunshot wound, they will likely require common labs. Orders may include a complete blood count (CBC), complete metabolic panel (CMP), coagulation profile

(PT and PTT), and a type and screen. Patients who experience a head injury and are taking anticoagulants will likely also have blood work ordered (Ginsburg & Smith, 2025).

Imaging studies are commonly used when diagnosing a TBI. Typically, the first study is a computed tomography (CT) scan without contrast, especially for individuals who are suspected of having a moderate to severe head injury (Ginsburg & Smith, 2025). A CT scan uses sequential X-rays to create a detailed image of the brain that is used to assess for skull fractures, hemorrhage, hematomas, or contusions (Mayo Clinic, 2021). This imaging study is available in most hospitals and is generally considered to be quickly accessible. A CT may be repeated, or a magnetic resonance imaging (MRI) may be ordered if diffuse axonal injury is suspected (Ginsburg & Smith, 2025). MRI technology uses strong magnets and radio waves to create a detailed image of the brain (Mayo Clinic, 2021). MRI is more difficult to obtain than a CT scan, so this imaging study is more likely to be utilized for follow-up care (Ginsburg & Smith, 2025). Advanced MRI, such as diffuse tensor imaging and volumetric analysis, can help to identify subtle injuries that cannot be visualized using standard MRI. It is important to remember that the absence of injury on a CT scan does not necessarily mean there has not been an injury, especially if symptoms persist (Maas et al., 2022). Skull x-rays may be used to assess the presence of a foreign body, but they are not typically used for diagnostic purposes (Ginsburg & Smith, 2025).

Individuals with mild TBI are not likely to have intracranial injuries, so providers will use algorithms, such as the New Orleans Criteria (NOC) and Canadian CT Head Injury/Trauma Rules (CCHR), to determine the need for a CT scan. The PECARN tool is used for pediatric patient screening to determine the necessity of a CT scan. All of these screening tools have been externally validated. The New Orleans Criteria suggests a CT may be warranted after a head injury if there is reported headache, any amount of vomiting, the patient is older than 60 years, is under the influence of drugs or alcohol, experienced a seizure, has trauma visible above the clavicles, or is experiencing short-term memory deficits. The Canadian CT Head Injury/Trauma Rule recommends a CT scan when a patient who has experienced a head injury reports a dangerous mechanism of injury (pedestrian struck by a vehicle, ejection from a motor vehicle, a fall from more than three feet high, or a fall down more than five stairs. This tool also recommends CT for those who have experienced a head injury with vomiting more than once, are older than 65 years, have a GCS of less than 15 at two hours post-injury, have a seizure, show any signs of a basal skull fracture, have an open or depressed skull fracture, or who experience amnesia of the events 30 minutes prior to the injury (Ginsburg & Smith, 2025).

The Pediatric Emergency Care Applied Research Network (PECARN) head trauma algorithm is used for patients younger than 16 years who have experienced a head injury to help determine if a CT scan is necessary. For children younger than 2 years, the presence of a scalp hematoma (especially when not a frontal injury), loss of consciousness for five seconds or more, severe mechanism of injury, abnormal behavior, or a palpable skull fracture should undergo a CT scan. Children older than two years should have a CT scan if there has been a loss of consciousness, vomiting, severe headache, severe mechanism of injury, signs of a basal skull fracture, or altered mental status after experiencing a head injury. For children, a severe mechanism of injury includes events like a motor vehicle crash, a fall from greater than three feet, or injury by a high-impact object (Ginsburg & Smith, 2025).

When the injury occurs in an athletic setting, coaches and athletic trainers can utilize screening tools to identify head injuries that warrant further evaluation by a healthcare provider (NICHHD, 2020). The implementation of safe-play protocols varies among different team sports. More research is needed to create consensus statements to help guide sports-related TBI management and to develop consistent sideline assessments and return-to-play protocols (Maas et al., 2022).

Section 4 Personal Reflection

What is the ABCDE Trauma Assessment tool? What are the benefits of this type of tool? What are the necessary elements of a post-TBI neurological exam? How can establishing a GCS score upon admission and then reassessing the score regularly improve outcomes? When would it be appropriate to use a modified GCS scale? What types of imaging studies are used when evaluating TBI? Why do providers use screening tools to determine if imaging is necessary?

Section 5: Signs and Symptoms

Symptoms of TBI can vary and depend on the type of TBI. Patients with mild TBI may complain of headache, nausea, vomiting, fatigue, speech difficulties, challenges with balance, dizziness, blurred vision, tinnitus, changes in taste or smell, light or sound sensitivity, brief loss of consciousness, feeling confused or disoriented, memory and concentration issues, mood changes, anxiety, depression, insomnia, and increased sleeping (Mayo Clinic, 2021). Symptoms of mild TBI are different for each patient. Some symptoms may appear immediately, while others may take hours or days to become evident. They may also change during the course of recovery (CDC, 2024a).

Prolonged symptoms due to TBI may include cognitive problems, like memory, learning, reasoning, and judgment issues, or executive functioning problems, such as difficulty with problem-solving, multitasking, organization, planning, decision-making, and beginning or completing tasks. The patient may also experience language and communication challenges, which can be frustrating. They may have problems with understanding speech, decreased reading comprehension, difficulty with speaking or writing, inability to organize their thoughts or ideas to communicate, or trouble participating in conversations. Symptoms can affect social interactions as the patient may struggle with interpreting nonverbal cues and have difficulty with conversations. Behavioral changes may include a decline in self-control, lack of awareness of abilities, participation in risky behavior, and verbal or physical outbursts. Emotional changes can include depression, anxiety, mood swings, irritability, lack of empathy, anger, and insomnia. Sensory problems may also be present, including persistent ringing in the ears, difficulty interpreting visual input, impaired hand-eye coordination, skin tingling, pain, itching, changes in taste, and balance problems (Mayo Clinic, 2021).

Those with moderate to severe TBI may report symptoms of mild TBI, as well as longer loss of consciousness, persistent or worsening headache, repeated nausea or vomiting, seizures, dilated pupils, cerebrospinal fluid (CSF) leaks from the nose or ears, coma, weakness or numbness in the extremities, and coordination difficulties. They may exhibit profound confusion, agitation, combativeness, and slurred speech (Mayo Clinic, 2021).

Assessing symptoms can be difficult for infants and young children who have experienced TBI. They likely cannot communicate the presence of headaches, sensory changes, and confusion. Still, caregivers may observe changes in eating/nursing habits, irritability, inconsolability, changes in ability to focus, changes in sleep patterns, seizures, depressed mood, drowsiness, and loss of interest in preferred toys or activities (Mayo Clinic, 2021). In infants who have not yet had closure of the fontanelle, a full or tense anterior fontanelle can indicate increased ICP. Non-accidental trauma should be considered for children with multiple injuries in various locations with differing stages of healing, retinal hemorrhage, bilateral chronic subdural hematomas, and significant neurological injury with minimal external signs of trauma (Haydel et al., 2024).

Certain physical exam findings can alert the healthcare team to potential traumatic brain injury. Battle's sign, or bruising behind the ears, usually indicates a basilar skull fracture. Bruising beneath the eyes, bleeding from the ear, or CSF leaking from the ear or nostril can also indicate the presence of a basilar skull fracture. This injury is highly associated with intracranial hemorrhage (Ginsburg & Smith, 2025).

Traumatic brain injury symptoms, especially for mild injuries, may be overlooked by the patients, as they can often be attributed to other health problems. An individual may not recognize that the symptoms result from a brain injury or understand how they affect their daily life (CDC, 2024a).

Some symptoms of TBI warrant seeking emergency medical care. Patients who have experienced a head injury should be educated regarding these symptoms and when to seek emergency care. Alarming symptoms can include worsening or persistent headache, weakness, numbness, decreased coordination, seizures, repeated vomiting, slurred speech, unusual behavior, pupil changes, confusion, restlessness, agitation, loss of consciousness, extreme drowsiness, or inability to wake from sleep. In children, caregivers should monitor for any alarming symptoms found in adults, as well as inconsolability or persistent crying despite interventions that usually calm the child, and refusal or inability to eat or nurse (CDC, 2024a). Instructions to monitor for these precautions should be emphasized when there has not been imaging of the head prior to discharge (Ginsburg & Smith, 2025).

Section 5 Personal Reflection

What are the symptoms of a mild TBI? What are the symptoms of a severe TBI? What symptoms may be present in young children after TBI? When providing discharge education, what symptoms should the nurse tell the patient to watch for that warrant seeking emergency care?

Section 6: Treatment

When a traumatic brain injury occurs, the primary goal is to prevent further damage from secondary injuries (Ginsburg & Smith, 2025). Multiple factors determine how a traumatic brain injury will be treated, including the size, severity, and location of the injury (NICHHD, 2020).

Many members of the multidisciplinary team are involved in the treatment of TBI. Case managers and social workers can help to coordinate follow-up appointments, assist with discharge planning, provide information on resources, and communicate with insurance companies. Occupational therapists can help patients improve functional status related to activities of daily living and provide recommendations for accommodations to help the patient recover independence. Physical therapists can help patients regain strength, endurance, and coordination. They can also recommend and educate patients and caregivers regarding assistive devices to help them maintain safety as they regain their abilities. Speech-language pathologists are necessary to evaluate and treat communication and swallowing challenges that can result from a TBI (Ginsburg & Smith, 2025). They can also help the patient learn how to use communication devices. If the patient requires inpatient rehabilitation, a physiatrist, a physician trained in physical medicine and rehabilitation, will supervise the process and determine the patient's needs (Mayo Clinic, 2021). Neurologists diagnose and manage nervous system conditions and follow the long-term care of post-TBI patients. Neurosurgeons evaluate the patient and decide, based on clinical findings, if surgical interventions are necessary. Neuropsychologists can help evaluate cognitive abilities and determine if the patient is capable of managing their own finances and medical decisions after a TBI (Ginsburg & Smith, 2025). They can also help the patient gain coping skills and strategies to manage behaviors and provide psychotherapy as needed (Mayo Clinic, 2021). Pharmacists are essential in ensuring that prescribed medications are dosed correctly and that the patient understands how to take them (Ginsburg & Smith, 2025). Rehabilitation nurses are also vital team members who provide ongoing care and assist with discharge planning. A traumatic brain injury nurse specialist may be available to coordinate care and educate the patient and family regarding what to expect through the recovery process. Recreational therapists can assist the patient as they learn time management skills and begin to participate in leisure activities. A vocational counselor can assess the patient's ability to return to work and suggest accommodations to decrease challenges in the workplace after the injury (Mayo Clinic, 2021).

Most TBIs are mild and do not require complex interventions. Typically, these patients are discharged after a satisfactory routine neurological exam if they are at minimal risk for developing intracranial problems. When a screening tool suggests a CT scan be completed but no CT is available, the patient may be observed for several hours to monitor for symptoms (Ginsburg & Smith, 2025). Treatment following a mild TBI includes rest and over-the-counter analgesics to treat headaches. "Brain rest" is typically prescribed after a mild TBI (NICHHD, 2020).

"Brain rest" means avoiding activities requiring concentration or attention (NICHHD, 2020). The provider will determine when it is appropriate for the patient to return to school, work, and recreational activities. The patient should limit physical and cognitive activities, such as concentrating on tasks, for at least the first few days after injury. Cognitive and physical activities should be resumed gradually (Mayo Clinic, 2021). When the brain is not allowed to rest, even following a mild TBI, there is an increased risk for second-impact syndrome. This life-threatening condition is a secondary injury that causes sudden brain swelling and possible herniation (Cleveland Clinic, 2024). Instructions regarding returning to work, school, and activities should be customized to account for the patient's symptoms (CDC, 2024c).

A specific protocol must be followed when a head injury occurs while playing sports before the participant can return to play. The patient should stop playing immediately. They should only be allowed to return to play after being evaluated and approved for play by someone trained to evaluate concussions (NICHHD, 2020). For most sports-related mild TBIs, symptoms typically resolve within 3-14 days, and return to normal functioning is typically expected after four weeks (Ginsburg & Smith, 2025).

Follow-up care is essential after mild TBI. Nurses should advise patients to maintain follow-up appointments to evaluate their progress and assess for complications. At these appointments, any new or ongoing symptoms should be discussed. Sometimes, cognitive changes, such as mood swings or irritability, may occur several weeks after the initial injury. Medications that may be used to treat symptoms of TBI include pain medications, either over-the-counter or prescribed, anticonvulsants to treat or prevent seizures, anticoagulants to prevent blood clots, diuretics to reduce intracranial pressure by preventing fluid accumulation, stimulants to increase alertness, and antidepressants and anti-anxiety medications to treat feelings of depression, fear, and excessive nervousness (NICHHD, 2020).

When a severe TBI occurs, the patient must be stabilized to protect their spinal cord and vital organs. The priority in treating a serious head injury is to assess the patient's airway, and if it is compromised, to secure it and maintain ventilation. Adequate cerebral perfusion pressure must be maintained. Next steps focus on preventing hypoxia, hypercapnia, or hypocapnia, evaluating and managing increased intracranial pressure, obtaining a neurosurgical consult, and then identifying and treating any other serious injuries that may be present (Ginsburg

& Smith, 2025). Patients with a severe TBI may require surgery to relieve increased intracranial pressure or to remove foreign objects, such as debris or bullet fragments. The surgeon may need to remove necrotic brain tissue, evacuate hematomas, or repair a skull fracture (NICHHD, 2020).

Intracranial pressure (ICP) monitoring is necessary in some cases of moderate and severe TBI. The goal of ICP monitoring is to prevent secondary injury. A ventricular catheter, a thin, flexible tube inserted into the brain's ventricle and drained externally, is the gold standard of ICP monitoring and can be used to drain cerebrospinal fluid to reduce pressure. Parenchymal monitors are also an invasive ICP monitoring tool, but they can only be used to evaluate the pressure in a particular area of the brain. Non-invasive techniques for monitoring ICP include pulsatility index using a transcranial Doppler, tympanic membrane displacement, near-infrared spectroscopy, and optic nerve sheath diameter assessments. These non-invasive tools tend to be inaccurate, subject to variability, and are not widely used as long-term monitoring tools. The Brain Trauma Foundation recommends ICP monitoring for patients with a severe TBI and abnormal CT scan results or if they have two of the following criteria: over age 40, systolic blood pressure less than 90 mm HG, or abnormal posturing. Patients who initially have a reassuring CT scan and later have worsening results on subsequent scans, evidence of brain swelling, and extensive bilateral contusions on the brain should also have their ICP monitored. When interrupting sedation to check neurological function is not possible or when the neurological exam is not reliable, like in cases of spinal cord injury, ICP monitoring is also recommended (Ginsburg & Smith, 2025).

The prognosis for recovery after a TBI varies and depends on many factors (Cleveland Clinic, 2024). It is estimated that 50% of adults who experience a TBI do not regain their pre-injury health level by six months post-injury. In some areas of the world, follow-up after mild TBI can be as low as 10%, which reduces the likelihood of favorable outcomes and increases the likelihood of incomplete recovery (Maas et al., 2022). In the US, the outcome five years post-injury of patients who experienced TBI resulted in 22% deaths, 30% worsened health status, 22% unchanged health status, and 26% improved health status (CDC, 2024b).

Genetics may contribute to outcomes, as studies have found that those with a genetic variant that predisposes them to Alzheimer's disease tend to have less favorable outcomes after a TBI. The patient's age and number of previous head injuries also influence recovery. Brain swelling develops more quickly in infants and adolescents than in older adults. Adults ages 20-40 tend to experience more behavioral and mood changes following a TBI, and those who are over age 50 typically experience more cognitive challenges. Older adults are less likely to have long-term symptoms. However, they may have a more complicated course because they are more likely to be taking multiple medications, including anticoagulants, which can increase the risk of bleeding (NICHHD, 2020). Older adults tend to have better psychological outcomes than younger adults. This may be due to their ability to develop coping skills and the fact that they have had time to achieve personal goals. They also tend to have less societal pressure to resume economically productive work (Maas et al., 2022).

Patients who experience a severe TBI are often admitted to an inpatient rehabilitation facility following hospital discharge. In this setting, a multidisciplinary team works together to improve the patient's ability to perform self-care tasks. They work to treat any cognitive, physical, occupational, and emotional challenges that result from the injury. The time spent in rehabilitation depends on the patient's needs. Some patients will receive cognitive rehabilitation therapy, which focuses on regaining normal brain function through an individualized program. This therapy helps patients learn coping strategies for cognitive deficits they may experience post-injury (NICHHD, 2020).

There is ongoing research to discover improved ways to identify and treat traumatic brain injuries to improve outcomes. Currently, research explores methods to help the brain heal itself through neuroplasticity, which occurs when the brain can adapt and repair itself. Researchers are working to refine diagnostic criteria for chronic traumatic encephalopathy (CTE). They are also researching biomarkers that can help identify risk, aid in diagnosing TBI, and help identify CTE (NICHHD, 2020). The identification of biomarkers could help reduce radiation exposure for patients who receive a CT scan after a head injury, but do not need one. Biomarkers are also being studied to help determine prognosis after injury (Maas et al., 2022). Scientists at the Food and Drug Administration are investigating diagnostic tools and portable imaging devices that may aid in diagnosing mild TBI (FDA, 2021).

Section 6 Personal Reflection

What is the primary goal of TBI treatment? What are the different roles of the multidisciplinary team when treating TBI? What are the treatment and monitoring needs of mild TBI? What are the treatment and monitoring needs of severe TBI? What factors affect outcomes? How can inpatient rehabilitation be beneficial for the patient? How do you think current research will change the diagnosis and treatment of TBIs in the future?

Section 7: Nursing Interventions

Nurses are involved in every stage of care for patients with TBI. They provide the monitoring and care needed post-injury and vital patient education (Ginsburg & Smith, 2025). The nurse must have knowledge of current TBI information, have professional expertise, be competent in performing procedures, be able to prioritize effectively, and make evidence-based decisions. Nurses are also critical in supporting the patient's family as they deal with the uncertainty surrounding a TBI (Figueiredo et al., 2024). Patient education regarding preventative measures for TBI is vital (Ginsburg & Smith, 2025).

Neuromonitoring is a critical aspect of nursing care following a TBI. Ongoing neurological assessments should occur at regular intervals. Nurses are essential in identifying neurological deficits and recognizing changes in clinical status. The timely identification of status deterioration can directly impact the patient's outcome. The patient may experience more drastic complications if subtle changes are not identified (Figueiredo et al., 2024).

Monitoring intracranial pressure (ICP) is often critical to post-TBI care (Figueiredo et al., 2024). Early signs of increased intracranial pressure include headache, increasing confusion, decreased mental status, non-purposeful movement, nausea, vomiting, double vision, blurred vision, nystagmus, eye deviation, facial twitching, weakness, fatigue, intractable yawning, hiccupping, and air hunger. Late signs of increased ICP include seizures, unequal or unreactive pupils, loss of consciousness, impairment of brain stem reflexes, extensor posturing, and Cushing's triad (Zrelak et al., 2020). Nurses should report the presence of these symptoms.

Nurses may be required to calculate cerebral perfusion pressure as an aspect of neuromonitoring (Figueiredo et al., 2024). Cerebral perfusion pressure determines the ability of the brain tissue to receive oxygen. It is calculated by subtracting the intracranial pressure value from the mean arterial pressure (MAP) value (Mount & Das, 2023). As a reminder, MAP is the average blood pressure during one cardiac cycle and is calculated by adding the systolic blood pressure and two times the diastolic blood pressure divided by three. MAP should be 70 to 100 mm Hg and is usually directly measured with invasive hemodynamic and ICP monitoring (Mount & Das, 2023). Cerebral perfusion in the presence of increased intracranial pressure may be improved by administering barbiturates, draining CSF, or performing a craniotomy (Figueiredo et al., 2024).

Cerebral blood flow and oxygenation of the brain can also be evaluated using Licox PbtO2, or the partial pressure of oxygen, as well as monitoring brain temperature and hypothermia. These values are monitored via a probe placed in the intracranial space. PbtO2 values can be a marker for secondary brain injury and can indicate hypoxic events more quickly than ICP and CPP monitoring. PbtO2 should be greater than 20 mmHg, but 30 mmHg is the ideal value for cerebral oxygenation. Lower values are associated with poor neurological outcomes (Figueiredo et al., 2024).

Neuromonitoring is important as increased ICP can affect not only the brain and neurological system but also other vital organs. Nurses are essential in identifying increases in ICP and decreases in CPP and PbtO2, identifying the potential causes of these changes, and initiating interventions that can help reduce the occurrence of secondary injuries (Figueiredo et al., 2024).

Patients experiencing increased intracranial pressure are often sedated and mechanically ventilated to protect the airway and optimize oxygenation and ventilation. Noninvasive mechanical ventilation is not recommended for patients with TBI, and orotracheal intubation is preferred to ventilate and oxygenate these patients. Nurses must be careful when suctioning secretions from these patients' airways, as coughing or gagging can increase intracranial pressure and contribute to secondary injury. Appropriate mechanical ventilator and airway care should be implemented to prevent complications (Figueiredo et al., 2024).

Nurses may use or assist in using certain types of technology that can help monitor neurostatus. A pupillometer is a device that can monitor neurostatus by measuring the constriction velocity of pupils. Constriction velocity of less than 0.8 mm/second and less than 10% reactivity following exposure to light can suggest increased intracranial pressure. Transcranial Doppler may be used to assess hemodynamic changes in the brain after a TBI. Electroencephalography (EEG) may help detect subclinical seizures after a TBI. Early intervention for seizure activity can aid in preventing adverse outcomes. Brain temperature monitoring is often integrated into the catheters used for ICP monitoring. Maintaining hypothermia can be a protective measure nurses can use to lower the brain's metabolic demands and prevent secondary brain injuries (Figueiredo et al., 2024). There is no evidence to support the use of intentional hypothermia in children with TBI, though hyperthermia should be avoided (Haydel et al., 2024).

Nurses may implement interventions to control ICP. These may include fluid therapy, blood pressure regulation, administering antiepileptic medications, positioning, and titrating sedation medications. Changes in fluid volume can contribute to complications, so nurses usually monitor fluid status. Fluid therapy aims to maintain normovolemia, or normal fluid volume. Isotonic crystalloid fluids, such as 0.9% sodium chloride or Lactated Ringer's solution, are preferred for hydration, with hyperosmolar fluids, like hypertonic saline or mannitol, used as occasional boluses to help manage ICP (Figueiredo et al., 2024). Mannitol is typically dosed at 0.5-1g/kg, and an inline filter should be used with administration, as this medication can crystallize. Hypertonic saline (2%-23.4%) may also be administered, typically in intermittent boluses. A central line should be used to infuse saline when the concentration is 3%-7.5%. Low sodium levels should be corrected slowly to prevent neurological damage. Nurses should monitor for complications of these medications, including renal failure when high doses of mannitol are used and volume overload with hypertonic saline. Hypokalemia and hypochloremia can occur with the use of either fluid (Zrelak et al., 2020).

Elevating the head of the bed and positioning the head in a midline position can facilitate venous drainage and decrease ICP. Head elevation should be at least 30 degrees, and changes in ICP should be noted during repositioning. Cervical spine immobilization should be implemented prehospital; if not, the spine should be immobilized until imaging confirms the spine is stable. Nurses should utilize correctly sized cervical collars, since collars that are too small can increase ICP by impeding venous blood flow. Cervical collars and other neck braces can cause problems, such as skin breakdown. The collar should be removed and reapplied to assess the skin, provide skin care, clean the collar, and change the pads on the collar, but the patient's head should be held in a neutral position during this process (Zrelak et al., 2020).

Externalized ventriculostomy drains (EVDs) are commonly used to help control ICP in patients with severe TBI. Healthcare-associated ventriculitis occurs at a rate of 22% and is associated with increased morbidity and mortality. Microorganisms may be introduced during catheter insertion, but may also be introduced during routine care. Nursing interventions can prevent infections by assisting providers in adhering to the evidence-based insertion protocols and implementing evidence-based care protocols. These protocols vary by facility, so the nurse should know their facility's guidelines. Some protocols utilize a topical antimicrobial or a particular dressing at the insertion site. There may be specific guidelines for site care and dressing changes. Various methods are also used to access the EVD to obtain a cerebrospinal fluid sample. More research is needed to establish universal guidelines for these procedures (Zrelak et al., 2020).

Cerebral microdialysis is a new technology that can assess metabolic markers like glucose, pyruvate, lactate, and glycerol. It involves monitoring via a semipermeable catheter placed in the brain tissue via craniotomy. Using this technology, nurses can monitor metabolic balance and prevent secondary injuries by intervening as changes occur. This technology can also guide early nutritional support to prevent hypoglycemia and blood glucose fluctuations (Figueiredo et al., 2024).

In the acute stages of severe TBI, issues with sodium balance are expected. Most commonly, hyponatremia can result from the inappropriate secretion of antidiuretic hormones, cerebral salt-wasting syndrome, or a side-effect of medications used to reduce ICP. Inappropriate salt-wasting syndrome will present with symptoms of water reabsorption, concentrated urine, and hyponatremia. Labs will show low sodium levels, serum osmolarity, and urine osmolality. Cerebral salt-wasting syndrome will present with hyponatremia, low serum osmolarity, and high urine osmolarity. Cerebral salt-wasting syndrome can be challenging to distinguish from inappropriate secretion of antidiuretic hormones, but it is important for nurses to understand the difference, as they require different interventions. In cases where there is inappropriate secretion of antidiuretic hormone, nurses restrict fluids and slowly correct the sodium levels using hypertonic saline solution. In cases of cerebral salt-wasting syndrome, fluid volume is replaced using saline solution and 3% hypertonic sodium chloride. Hypernatremia can result from central diabetes insipidus or mannitol use. In central diabetes insipidus, there is a decrease in antidiuretic hormone secretion, which leads to severe dehydration and electrolyte imbalances. Symptoms include polyuria, low urine osmolarity, high serum osmolarity, and hypernatremia. Treatment involves the administration of antidiuretic hormone, typically desmopressin or vasopressin, administering fluids if possible, encouraging enteric intake of water, or elevating hypotonic fluid administration. Nurses must be vigilant in monitoring lab values and understand the different sodium imbalances that can affect the patient's outcome (Figueiredo et al., 2024).

Nurses should be familiar with medications that may be prescribed for patients who have experienced TBI. Oral nimodipine may be given in cases of subarachnoid hemorrhage to reduce neurological deterioration. Statins may be given for their anti-inflammatory properties, which can help preserve the integrity of the blood-brain barrier. Sedation and analgesic medications are often used for severe TBI to protect the patient from increased ICP. Antipyretics may be used to limit fevers, but they act upon the hypothalamus, which may be disrupted in cases of severe brain injury. Nurses may use cooling blankets to maintain hypothermia, though they can cause shivering, increase metabolic demand, and reduce cerebral oxygenation. As a result, cooling blankets are typically only used with continuous sedation to limit these side effects (Figueiredo et al., 2024).

Nurses can use family member involvement to improve the patient's prognosis. The patient and family should be included in rounding, and family visitation should be encouraged. A family member should be present during resuscitation efforts if possible and safe. The family should be involved in decision-making, especially when discussing goals and making end-of-life decisions, if necessary. The family should receive daily updates and participate in daily goal setting (Zrelak et al., 2020).

It is critical that patients with TBI have reduced agitation levels, and the use of medications and physical restraints may be counterproductive. Research has found that sensory input can reduce agitation through tactile and auditory stimulation. One study found that when family members administer these interventions, the effects are greater than when completed by nursing staff. In the study, auditory input included the family member speaking to the patient near both ears by introducing themselves, saying the patient's name, informing them of the time and place, and telling them positive shared memories. Tactile stimulation used in the study included palpation of the patient's wrist and palm from the wrist to the fingernails (Sedghi et al., 2020). This technique can also be helpful in relieving stress for the family member (Figueiredo et al., 2024).

Another way nurses can involve family members in patient care is to elicit their help in maintaining an environment with limited noxious stimuli. There has not been conclusive research on the effect of room environment on ICP, but nurses commonly implement these interventions to reduce fluctuations in ICP for patients with severe TBI. Nurses can minimize uncomfortable or painful stimuli, such as preventing a full bladder by ensuring the Foley catheter is draining, repositioning the patient very gently, and limiting sounds from bedside equipment. Nurses can avoid equipment alarms by anticipating when a medication will be completed or when a bag of fluids needs to be replaced. Nurses can educate families that they can help in this effort by avoiding bumping into or jarring the hospital bed, speaking in quiet tones, avoiding loud noises, keeping the room lights dim, and educating visitors about the necessity of keeping the room calm and quiet. Nurses should also educate families and visitors to assume the patient's hearing is intact and avoid having conversations that could be upsetting in the patient's presence. Individual responses to stimuli and the effects on ICP should be noted, and the patient's care should be personalized to reflect their responses (Zrelak et al., 2020).

In addition to interventions that specifically aim at reducing the risk of secondary brain injury. Other nursing interventions are necessary to reduce hospital-acquired complications. Mechanical DVT prophylaxis should be implemented immediately, and pharmacologic prophylaxis can be implemented once any intracranial bleeding is stabilized. Adequate nutrition should be maintained, with feedings initiated within the first 72 hours post-injury and full caloric intake achieved by day 7. Continuous feedings are preferred over bolus feedings, and a PEG tube may be necessary. If tracheal intubation is needed, trans-jejunal feedings are preferred to prevent aspiration. Mobility should be considered to avoid deconditioning. It is recommended that a tracheostomy be placed within eight days to allow for greater mobility. Range of motion exercises should be completed to prevent contractures and spasticity. Bowel and bladder training may be necessary. Early therapies and progressive mobility are essential in identifying deficits and preventing decline. To support neuropsychiatric outcomes, good sleep hygiene should be promoted while avoiding overmedicating and overfatiguing. Adequate pain management and social support are also necessary for positive outcomes. Nurses should assess for depression and anxiety, as well as screen for any changes in cognition. Nurses must be mindful of good antibiotic and culture stewardship. Nosocomial infections can be avoided by removing lines as soon as possible and only placing invasive lines when absolutely necessary. Nurses must practice good hand hygiene and implement typical care bundles to prevent hospital-acquired complications, such as bloodstream infections, urinary tract infections, ventilator-associated pneumonia, and falls (Zrelak et al., 2020).

Nurses are critical in implementing evidence-based interventions to improve outcomes, but some may not know how interventions can affect the patient. Implementing clinical pathways and protocol-based guidelines in caring for patients with severe TBI, especially in the ICU setting, can increase nurses' autonomy, improve patient outcomes, reduce complications, reduce the length of intensive care unit stay and readmission, and enhance patient satisfaction. Nurses who are knowledgeable in the care of critically ill TBI patients can reduce complications and secondary injuries in this population (Figueiredo et al., 2024).

Psychological trauma can result from experiencing a TBI. The recovery from TBI is challenging and can cause neurologic and psychiatric complications. Nurses should educate patients and caregivers to be aware of feelings of hopelessness or suicidal ideation. They should be encouraged to seek help if they experience these feelings (Ginsburg & Smith, 2025). Nurses can suggest coping strategies, including joining a support group, writing things down that may be difficult to remember, following a routine, taking breaks, adjusting expectations regarding the time it takes to complete tasks, breaking tasks into small steps, avoiding distractions when trying to focus, and limiting multitasking (Mayo Clinic, 2021).

Section 7 Personal Reflection

What methods do nurses use to monitor intracranial pressure and cerebral perfusion? Why should nurses monitor for sodium imbalances after severe TBI? What are some ways nurses can involve the family in patient care? Why are usual patient care tasks important, in addition to the TBI-related care tasks? Why are evidence-based care protocols beneficial? Why do you think TBI can cause psychological trauma?

Section 8: Health Disparities Related to TBI

There are health disparities associated with TBI. Some groups are more likely to have poor outcomes, including racial and ethnic minorities, military service members, veterans, people experiencing homelessness, people who are incarcerated, survivors of intimate partner violence, and people who live in rural areas (Prevention, 2024d).

American Indian/Alaska Native adults and children have higher rates of TBI-related hospitalization and death than other racial or ethnic groups. This may be due to increased rates of motor vehicle crashes, substance use, and suicide in this population. Individuals in this group often have difficulty accessing healthcare. Non-Hispanic Black and Hispanic patients experience a lower rate of appropriate follow-up care and rehabilitation after experiencing a TBI, compared to non-Hispanic white individuals. Patients of racial and ethnic minority groups are also at higher risk of poor psychosocial, functional, and employment-related outcomes following a TBI than non-Hispanic white patients (CDC, 2025).

Between 2000 and 2021, over 450,000 US military personnel were diagnosed with TBI, and these injuries most commonly occur outside of a deployment situation. Military service members and Veterans who have experienced a TBI are more likely to have long-term symptoms, experience post-traumatic stress disorder (PTSD) and depression, have difficulty accessing mental healthcare services, and suffer from suicidal ideation (CDC, 2025).

Research has found that almost half of all incarcerated individuals have a history of TBI. Those with a history of TBI are more likely to experience mental health problems, like severe depression and anxiety, substance use disorders, anger control difficulties, and suicidal ideation. These individuals are less likely to be screened for TBI and experience more difficulty accessing appropriate care (CDC, 2025).

Individuals experiencing homelessness are 2-4 times more likely than those who have not experienced homelessness to have a TBI. They are up to ten times more likely to have experienced a moderate or severe TBI. Individuals in this population who have a history of TBI often have worse physical and mental health than those without a history of TBI (CDC, 2025).

One in three women experiences intimate partner violence in their lifetime, and of those, 75% experience a TBI as a result (Toccalino et al., 2022). Survivors of intimate partner violence who experienced a TBI due to an assault by an intimate partner are more likely to have PTSD, insomnia, and depression (CDC, 2025).

Individuals who have experienced TBI and who have a lower income or are uninsured often encounter barriers in accessing care compared to those who have private health insurance. They are less likely to receive surgical interventions related to TBI, less likely to qualify for inpatient rehabilitation services, and are more likely to die while in the hospital (CDC, 2025).

Those who live in rural areas are also at increased risk for poor outcomes related to TBI. This is often due to the distance from emergency medical care services, lack of access to a Level I trauma center, and lack of access to specialized TBI care.

Children in rural areas are more likely to experience a TBI and are more likely to die as a result of their injury (Prevention, 2025). Patients who are not able to rapidly access appropriate care are at increased risk for secondary brain injuries and death (Zrelak et al., 2020).

Section 8 Personal Reflection

What are some health disparities related to TBI? Why do you think these disparities exist? How can knowing about TBI-related health disparities improve how you advocate for patients?

Section 9: TBI Prevention Strategies

Patient education for injury prevention is a critical aspect of nursing care. Most TBIs occur due to an accidental injury that could have been prevented. While some accidents, like a motor vehicle crash, may not be preventable, some measures can reduce the risk of TBI when the collision occurs. Healthcare workers can educate patients and families on ways to reduce the risk of TBI. Seatbelts should always be used in a motor vehicle, and small children should always sit in the vehicle's back seat. They must also utilize a child safety or booster seat, as indicated by their age, height, and weight. Individuals should not drive while impaired by alcohol or other drugs. Healthcare workers can educate patients about medications that may impair their ability to drive safely (Ginsburg & Smith, 2025).

Education regarding the use of helmets should be provided to both children and adults (Ginsburg & Smith, 2025). Helmets should always be worn when participating in activities with a high risk of head injury, such as using a bicycle, skateboard, motorcycle, scooter, snowmobile, or all-terrain vehicle. Helmets should also be used while participating in certain sports, such as baseball, contact sports, skiing, skating, snowboarding, and horse riding (Mayo Clinic, 2021). Helmets should be appropriate for the activity and fit the participant properly (NICHHD, 2020). Patients can also reduce their risk for TBI by being mindful of their surroundings. They should not utilize a phone or tablet while driving, walking, or crossing the street. These devices can be distracting and lead to accidents or falls (Mayo Clinic, 2021).

Fall prevention strategies are imperative in preventing traumatic brain injury, especially for adults older than age 65. Strategies may include installing handrails in bathrooms, utilizing a nonslip mat in the bathtub or shower, removing area rugs, mounting handrails on both sides of staircases, improving lighting in the home, and ensuring there is no clutter on the stairs or floors. Falls can also be prevented through regular vision assessments to determine if an issue may impair eyesight and lead to a fall. Regular exercise is a preventative measure for falls that lead to head injuries (Mayo Clinic, 2021). The Centers for Disease Control and Prevention has introduced a STEADI (Stopping Elderly Accidents, Deaths, and Injuries) initiative for healthcare workers that includes guidelines for screening patients for fall risk, assessing modifiable risk factors, and intervening to reduce risk by implementing evidence-based strategies (Maas et al., 2022).

There are strategies that can be implemented to reduce the risk of TBIs in children. Safety gates can be installed at both the top and bottom of stairs, keeping stairs clear of clutter, installing window guards to prevent falls, utilizing nonslip mats in the shower and bathtub, and securing area rugs can help reduce falls. Playgrounds that have shock-absorbing materials on the ground can prevent serious injuries. Children should never play on fire escapes or balconies, as falls can lead to severe injuries (Mayo Clinic, 2021). Nurses must educate athletes about returning to sports after they have experienced a TBI. These patients and caregivers should be advised that returning to sports too soon after the injury can put the patient at risk for lifelong symptoms and cumulative effects of subsequent injuries (Ginsburg & Smith, 2025). Some athletic organizations require a baseline brain function test before the beginning of the sports season. This test can include items to test memory, attention, ability to concentrate, and problem-solving skills. A baseline test can help identify when there has been a change in mental status (Mayo Clinic, 2021).

Section 9 Personal Reflection

What are TBI-prevention strategies related to vehicle use? Who should be educated regarding helmets, and what information should be shared? Why are fall prevention strategies most necessary for older adults? What are interventions that can prevent TBIs in children?

Section 10: Conclusion

In 2017, the Lancet Neurology Commission on TBI estimated that traumatic brain injuries will likely continue as one of the top three causes of death and disability due to injury up to 2030. Long-term studies also indicate that TBI should be treated as a chronic condition (Maas et al., 2022). This means that nurses and other healthcare workers will continue to encounter patients with TBI in healthcare settings frequently. Nurses who understand the different types of TBI, populations at risk, assessment needs, signs and symptoms, treatments, nursing interventions, and prevention strategies are better equipped to meet the needs of people in their community who experience a traumatic brain injury.

References

Bell, A. (2024). *Types of Traumatic Brain Injury-Meet Dr. Paul Vespa*. Retrieved 6-5-25, from https://medschool.ucla.edu/news-article/types-of-traumatic-brain-injury

Centers for Disease Control and Prevention (CDC). (2024a, May 16). *About Mild TBI and Concussion*. Retrieved 6-14-25 from https://www.cdc.gov/traumatic-brain-injury/about/index.html

Centers for Disease Control and Prevention (CDC). (2024b, May 16). *About Moderate and Severe TBI*. Retrieved 6-28-25 from https://www.cdc.gov/traumatic-brain-injury/about/moderate-severe-tbi.html

Centers for Disease Control and Prevention (CDC). (2024c, May 16). *Clinical Guidance for Pediatric Mild TBI*. Retrieved 6-29-25 from https://www.cdc.gov/traumatic-brain-injury/hcp/clinical-guidance/index.html

Centers for Disease Control and Prevention (CDC). (2024d, April 29). *Facts About TBI*. Retrieved 6-7-25 from https://www.cdc.gov/traumatic-brain-injury/data-research/facts-stats/index.html

Centers for Disease Control and Prevention (CDC). (2024e, October 19). *TBI Data*. Retrieved 6-2-25 from https://www.cdc.gov/traumatic-brain-injury/data-research/index.html

Centers for Disease Control and Prevention (CDC). (2025, January 30). *Health Disparities and TBI*. Retrieved 6-29-25 from https://www.cdc.gov/traumatic-brain-injury/health-equity/index.html

Cleveland Clinic. (2024, January 25). *Traumatic Brain Injury*. Retrieved 6-5-25 from https://my.clevelandclinic.org/health/diseases/8874-traumatic-brain-injury

Dinallo, S., & Waseem, M. (2023, March 20). *Cushing Reflex*. StatPearls Publishing. Retrieved 6-29-25 from https://www.ncbi.nlm.nih.gov/books/NBK549801/

Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHHD). (2020, November 24). *Traumatic Brain Injury (TBI)*. National Institutes of Health. Retrieved 6-7-25 from https://www.nichd.nih.gov/health/topics/tbi

Figueiredo, R., Castro, C., & Fernandes, J. B. (2024). Nursing Interventions to Prevent Secondary Injury in Critically Ill Patients with Traumatic Brain Injury: A Scoping Review. *Journal of Clinical Medicine*,*13*(8), 2396. https://www.mdpi.com/2077-0383/13/8/2396

Ginsburg, J., & Smith, T. (2025, February 17). *Traumatic Brain Injury*. StatPearls Publishing. Retrieved 6-5-25 from https://www.ncbi.nlm.nih.gov/books/NBK557861/

Godoy, D. A., Rubiano, A. M., Aguilera, S., Jibaja, M., Videtta, W., Rovegno, M., Paranhos, J., Paranhos, E., de Amorim, R. L. O., Castro Monteiro da Silva Filho, R., Paiva, W., Flecha, J., Faleiro, R. M., Almanza, D., Rodriguez, E., Carrizosa, J., Hawryluk, G. W. J., & Rabinstein, A. (2024). Moderate Traumatic Brain Injury in Adult Population: The Latin American Brain Injury Consortium Consensus for Definition and Categorization. *Neurosurgery*, *95*(3), e57-e70. https://doi.org/10.1227/neu.0000000000002912

Haydel, M. J., Weisbrod, L. J., & Saeed, W. (2024, February 16). *Pediatric Head Trauma*. StatPearls Publishing. Retrieved 6-29-25 from https://www.ncbi.nlm.nih.gov/books/NBK537029/

Johns Hopkins Medicine. (2025a). *Head Injury*. Retrieved 6-28-25 from https://www.hopkinsmedicine.org/health/conditions-and-diseases/head-injury

Johns Hopkins Medicine. (2025b). *Traumatic Brain Injury*. Retrieved 6-28-25 from https://www.hopkinsmedicine.org/health/conditions-and-diseases/traumatic-brain-injury

Maas, A. I. R., Menon, D. K., Manley, G. T., Abrams, M., Åkerlund, C., Andelic, N., Aries, M., Bashford, T., Bell, M. J., Bodien, Y. G., Brett, B. L., Büki, A., Chesnut, R. M., Citerio, G., Clark, D., Clasby, B., Cooper, D. J., Czeiter, E., Czosnyka, M., & Zemek, R. (2022). Traumatic brain injury: progress and challenges in prevention, clinical care, and research. *The Lancet Neurology*, *21*(11), 1004–1060. https://doi.org/10.1016/S1474-4422(22)00309-X

Mayo Clinic. (2021, February 4). *Traumatic Brain Injury*. Retrieved 6-29-25 from https://www.mayoclinic.org/diseases-conditions/traumatic-brain-injury/symptoms-causes/syc-20378557

Mayo Clinic. (2024, October 30). *Persistent post-concussive symptoms (Post-concussion syndrome)*. Retrieved 6-30-25 from https://www.mayoclinic.org/diseases-conditions/post-concussion-syndrome/symptoms-causes/syc-20353352

Mount, C. A., & Das, J. M. (2023, April 3). *Cerebral Perfusion Pressure*. StatPearls Publishing. Retrieved 6-20-25 from https://www.ncbi.nlm.nih.gov/books/NBK537271/

Sedghi, T., Ghaljeh, M., Faghihi, H., & Sarani, H. (2020). The Effect of Auditory and Tactile Stimulation by a Family Member on the Level of Agitation in Patients with Traumatic Brain Injury and Decreased Consciousness: A Quasi-Experimental Study. *Medical-Surgical Nursing Journal*, *9*(2).

Tenny, S., Das, J. M., & Thorell, W. (2024, February 17). *Intracranial Hemorrhage*. StatPearls Publishing. Retrieved 6-28-25 from https://www.ncbi.nlm.nih.gov/books/NBK470242/

Toccalino, D., Haag, H. L., Estrella, M. J., Cowle, S., Fuselli, P., Ellis, M. J., Gargaro, J., & Colantonio, A. (2022). The Intersection of Intimate Partner Violence and Traumatic Brain Injury: Findings From an Emergency Summit Addressing System-Level Changes to Better Support Women Survivors. *J Head Trauma Rehabil*, *37*(1), E20-e29. https://doi.org/10.1097/htr.0000000000000743

United States Food and Drug Administration (FDA) (2021, August 23). *Traumatic Brain Injury: What to Know About Symptoms, Diagnosis, and Treatment*. Retrieved 6-5-25 from https://www.fda.gov/consumers/consumer-updates/traumatic-brain-injury-what-know-about-symptoms-diagnosis-and-treatment

Waltzman, D., Black, L. I., Daugherty, J., Peterson, A. B., & Zablotsky, B. (2025). Prevalence of traumatic brain injury among adults and children. *Annals of Epidemiology*, *103*, 40–47. https://doi.org/https://doi.org/10.1016/j.annepidem.2025.02.005

Zrelak, P. A., Eigsti, J., Fetzick, A., Gebhardt, A., Moran, C., Moyer, M., & Yahya, G. (2020). Evidence-based review: nursing care of adults with severe traumatic brain injury. *American Association of Neuroscience Nurses*, *42*, 1-42.