FOSTER YOUTH, CHILD ABUSE, AND HEAD TRAUMA: NAVIGATING THE TREATMENT GAP FOR VICTIMS OF ABUSE-RELATED TRAUMATIC BRAIN INJURIES IN THE FOSTER CARE SYSTEM

by

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Abuse-related traumatic brain injuries (TBIs) are a leading cause of death for children in the United States. Foster youth are particularly vulnerable to abuse and significantly more likely to experience an abuse-related TBI than their non-foster peers. TBIs can worsen over time and prompt medical attention produces the best outcomes. However, children in the foster care system may face significant challenges in receiving medical care during the optimal time frame, preventing proper treatment. This thesis examines the specific barriers that foster youth face in accessing care and identifies new protocols and procedures that have the potential to overcome these obstacles. Psychological barriers, including fear, guilt, denial, and loyalty, combined with environmental factors such as ignorance, neglect, limited resources, and lack of awareness, can impede proper treatment and follow-up care for abuse-related TBIs. By implementing more accurate identification processes, treatments that are effective in the subacute and chronic phases of TBI, and a comprehensive rehabilitation approach, flexible avenues of treatment can be pursued to enhance long-term outcomes and support the recovery of foster youth affected by abuse-related TBIs.

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Introduction

Childhood Head Trauma

Due to the extreme vulnerability of the brain, blunt-force head trauma is one of the leading causes of death and severe disability in children. The brain is a soft organ which consists of fat, water, proteins, carbohydrates, and salts, and contains an intricate network of nerves and blood vessels. Given its fragility, even the mildest brain injury has the potential to impair an individual's cognitive, physical, and psychosocial functions. Brain injuries can be particularly devastating in children because the brain is still maturing and injuries can have a greater impact on their future development and overall quality of life. Therefore, health-care professionals have spent a considerable amount of time refining diagnostic, surgical, and rehabilitative methods in order to minimize the lasting impacts of pediatric brain injuries.

Upon sustaining a head injury, a child needs to be medically examined so that a treatment plan that properly accounts for the severity of the injury and any presenting symptoms can be implemented. Due to the progressive nature of brain injuries, it is crucial that a child be examined and treated as soon as possible otherwise the injuries can worsen over time (Narayana Health, 2017; Urban, 2016). In more severe head injuries, trauma can cause swelling, oxygen deprivation, and nerve damage in the brain which can be detrimental if left unaddressed. Although the brain will attempt to heal itself, failing to receive acute treatment when it is needed can result in cognitive and functional deficits that are difficult to correct.

In the weeks following a head injury, ample rest and follow-up care adherence are essential for ensuring an optimal recovery (Cleveland Clinic, 2021; Seabury et al., 2018). Ongoing therapy and medications may also be necessary depending on the severity of the injury. These standard treatment protocols acknowledge that prompt medical attention produces the best outcomes for pediatric brain injuries. However, there are circumstances that may prevent a child from receiving immediate care which current treatment procedures conflict with. One instance where children may face barriers to seeking medical attention is in cases of child abuse which is currently one of the leading causes of severe or fatal brain injury in children.

On average, roughly five children die from abuse every day, and at least three of these deaths will be associated with head trauma (*Child Abuse and Neglect Fatalities 2019: Statistics and Interventions*, 2021; *Head Injury in Children*, 2022; Christian, 2022). Although child abuse is a pervasive issue affecting children globally, certain populations of children are more vulnerable due to unique circumstances such as increased exposure to trauma, a lack of stable support systems, and dependency on caregivers who may not prioritize their safety and well-being. Foster youth in the United States represent a particularly vulnerable population in this regard, as these characteristic risk factors make them more susceptible to abuse and impose challenges in reporting injuries and receiving appropriate interventions. Thus, not only are foster youth especially vulnerable to abuse, but in the event of head trauma, they may lack the necessary resources to receive proper care.

Abuse in the Foster Care System

This thesis emphasizes that brain injuries caused by abuse are common in the foster care system, but often go unreported and unaddressed due to unparalleled circumstances. In medicine, damage to brain tissue caused by a physical assault is called a traumatic brain injury (TBI) and can result in cognitive, emotional, and physical impairments. While neither child abuse nor TBI is idiosyncratic to the foster care system, research has demonstrated that foster youth are significantly more likely to experience a TBI than their non-foster peers, and physical abuse accounts for more than 25 percent of TBIs that occur in this population (Cusimano et al., 2020;

Cusimano, Lamont, et al., 2021; Cusimano, Zhang, et al., 2021; Guinn et al., 2019). Interestingly, although neglect is commonly considered alongside abuse, researchers found that TBIs caused by neglect are far less common (Cusimano, Lamont, et al., 2021).

The high prevalence of TBIs in the foster care system reflects the fact that foster youth are disproportionately susceptible to child abuse (Cusimano, Lamont, et al., 2021; Guinn et al., 2019). A study in Oregon and Washington determined that almost one-third of foster children have reported abuse or neglect by a foster parent or another adult in the home (White et al., 2005). Meanwhile, researchers studying abuse in New Jersey foster homes concluded that no child was assuredly safe in the foster care system (Kaufman & Jones, 2003). Currently, there are nearly 424,000 children in the United States foster care system making them one of the largest populations who are at an increased risk for physical abuse (Steele & Gargaro, 2022). As abuse-related head trauma remains a leading cause of death and severe disability in children and young adults, the documented frequency of physical abuse among foster youth warrants considerable attention toward addressing TBIs in the foster care system.

The foster care system poses unique and overwhelming barriers that can prevent foster youth from receiving treatment for a TBI. Whereas patient outcomes are positively associated with earlier treatment, it is necessary to acknowledge that victims of child abuse in the foster care system face significant challenges in seeking medical care during the optimal time frame. Victims of abuse-related TBIs in the foster care system may not have access to the appropriate environment and support system they need to meet the recommended standards for immediate medical attention and follow-up care adherence (*Head Injury in Children*, 2021; *Head Injury in Children*, 2022). These challenges may be compounded by the complexity of navigating the foster care system and the potential for abuse to go unreported, leading to delays in identifying and treating injuries. Accordingly, this thesis examines possible alternatives to typical TBI treatment protocols to address these barriers and effectively relieve long-lasting symptoms months to years after an injury is sustained.

Thesis Scope

This thesis does not claim that treatment methods as a whole for pediatric TBI are poorly established, nor that health care is not already a priority within the foster care system. Pediatric neuroscience is a highly advanced field and physicians and scientists have dedicated decades of research toward finding the best treatments possible for brain injuries in children. Moreover, countless additional health-care professionals such as speech pathologists, physical therapists, and pharmacists are highly skilled at rehabilitating an individual's quality of life post-injury. Likewise, recent provisions in the Affordable Care Act and Family First Prevention Services Act have increased the affordability of health care within the foster care system and made the screening evaluation process of foster youth before and shortly after placement a priority (Children's Bureau, 2022; Steele & Gargaro, 2022).

However, despite advancements in the field of pediatric head trauma and federal provisions mandating states to offer health services to foster youth, the unique challenges faced by this population can impede their access to optimal forms of care for abuse-related injuries. Missed cases of abuse-related TBIs have been shown to result in fatality that might have been prevented had the inflicted neurological damage been recognized and treated accordingly (Christian, 2022). Thus, the improvements proposed in this thesis are not to be in lieu of current methods or systems, but rather in addition so as to widen the inclusivity of blunt-force head trauma treatments.

Furthermore, while there are many domains that influence the health and wellbeing of foster youth, this thesis remains narrowly focused on brain trauma fatalities and disabilities that originate from physical abuse rather than neglect or emotional trauma. Abuse-related TBIs often involve intentional acts of violence, which can lead to severe mechanical and chemical injuries to the brain. In contrast, neglect may result in long-term developmental issues but does not always involve immediate physical harm. It is, of course, still possible for neglect-related TBIs to occur as a result of unsafe living conditions or a lack of supervision, however, these injuries involve a different set of factors and mechanisms that may not align directly with the scope of this research.

Additionally, it is well established that foster care experiences can considerably impact the social and emotional health of foster youth (Simms et al., 2000). However, while recent literature suggests that emotional trauma could potentially cause physical brain damage, the mechanisms underlying such effects are not as well understood, and studying them differs significantly from investigating physically inflicted TBI. By solely delving into TBIs originating from physical abuse, this research aims to provide a more precise examination of blunt-force head trauma within the foster system. This specificity allows for a deeper understanding of the unique impact that child abuse has on brain injuries in this context. However, neglect and emotional trauma are significant barriers that can prevent a foster youth from receiving care for a TBI, and will be explored later in this thesis from this perspective.

Research Questions

Using an array of literature, I explore the impacts that abuse-related TBIs can have on current and former foster youth as evidence for the importance of treating these injuries. Parts I and II of this thesis survey what is currently known about brain injury in children, while Parts III and IV ask two essential questions: First, “What circumstances can prevent foster youth from accessing standard brain injury treatment and rehabilitation?”; Next, “When the identification or treatment of pediatric brain injuries are delayed, what alternative methods of care can maintain the potential for positive patient outcomes?”. In order for TBI research to progress, health professionals and advocates for foster youth will need to identify the barriers that delay TBI identification and treatment within this population, and introduce more feasible avenues of care.

This thesis broadly identifies many of these barriers, and highlights how a child’s physical, cognitive, and emotional abilities suffer when abuse-related TBIs are not cared for. Additionally, this thesis explores how the health care and foster care systems can better address the circumstances of abuse-related TBIs by providing new methods of detecting and treating these injuries in current and former foster youth. For each section of my thesis, I created a database of existing academic and government media sources representing original data on my topic of interest. Sources were found through internet search engines such as Google, Google Scholar, PubMed, and UO Libraries, and selected based on their relevance and reliability. I structured my analysis as a narrative that connects research that is not commonly considered together, but that can be found to explain or strengthen each other's findings. To properly address my research questions, I referenced various sources of media ranging from government websites to scientific journals, and analyzed the existing literature to identify areas of agreement and disagreement. I used many resources to provide an informed analysis of each topic, and considered saturation point to be when no additional data could be found whereby further arguments could be derived.

Chapter I: Definition of Traumatic Brain Injury

Blunt force head trauma is acquired from a bump, blow, jolt, or penetration and can result in various degrees of injury. The most devastating level of injury causes neuronal deficits which can permanently or temporarily impair cognitive, physical, and psychosocial functions. This alteration of brain function caused by an external mechanical force is described as a traumatic brain injury (TBI) (*Brain Injury Overview*, 2022; Dawodu, 2021).

Every year, an estimated 1.5 million Americans sustain a TBI. Of these 1.5 million, 230,000 are hospitalized and survive, 50,000 die, and roughly 90,000 incur a long-term disability. Today, roughly 5.3 million children and adults are estimated to be living with a permanent TBI-related disability in the United States (*Report to Congress*, 2019). While TBI impacts all age groups, children and young adults are at a significantly higher risk (*Report to Congress*, 2019). Furthermore, the functional impacts of TBI are considered more severe in children compared to adults because the pediatric brain is still developing and many symptoms continue to change and unfold over time (*Pediatric Traumatic Brain Injury*, 2021).

This section seeks to define TBI and explain the mechanisms underlying these injuries. These details will provide foundational knowledge that is helpful for comprehending the rationale behind existing treatment protocols and identifying how emerging processes and procedures could potentially work.

Broadly speaking, TBI may result in nervous cell death, inflammation, scar formation within the brain, and damage from oxygen reacting with nervous cells (Popernack et al., 2015; Sophie Su et al., 2016). The central nervous system (CNS), which includes the brain and spinal cord, is composed of several cell types. Each of these cell types uniquely contributes to the functions of the brain and can lead to severe impairment when damaged. Damages of these cells manifest as symptoms commonly associated with TBI such as bleeding and swelling. The primary cell type are neurons, cells which transmit electrical impulses to other neurons and translate the impulses they receive into chemical signals. Through the transmission and translation of electrical messages, neurons can communicate with other parts of the nervous system.

Neurons are accompanied in the nervous system by four types of glial cells which play both structural and supportive roles. First, astrocytes are cells that nourish neurons and maintain the blood brain barrier which controls the transmission of molecules from the bloodstream into nervous tissue. Second, ependymal cells line the ventricles of the brain as well as produce cerebrospinal fluid which supports and protects the brain. Third, microglia keep the CNS clean by eliminating waste products and pathogens. Finally, oligodendrocytes produce myelin in the axons of the CNS.

Damages of neuronal tissues associated with TBI are described by two categories: primary injury and secondary injury. Primary injuries are directly caused by mechanical forces at the moment of initial trauma. Secondary injuries are the subsequent tissue and cellular damages as an indirect result of the insult. While primary and secondary injuries consist of damage to the various nervous cell types, it is through secondary injuries that scar formation, oxygen-related damage, and inflammation will occur (Popernack et al., 2015; Sophie Su et al., 2016). The mechanisms of primary and secondary injuries provide the necessary background information for understanding how a blunt-force impact to the brain manifests as physical and emotional symptoms. Reviewing the specifics of these injuries will be helpful for understanding how the emerging treatment methods described later in this thesis could someday become the standard for treating TBIs beyond the acute period, and how this would change the lives of abuse-related TBI victims in the foster care system.

Primary Injuries. Primary injuries associated with TBI reflect the fragility of the brain at a neuronal level. Focal injuries, those that are contained to a specific location, typically occur within a restrained head and result in deformation such as skull fracture and contusions at the location of impact (*Common Classifications of TBI*, 2021; Popernack et al., 2015). Death of neuronal and glial cells due to blunt-force injury, called traumatic necrosis, can compromise blood vessels and lead to bruising (hematomas) and bleeding (hemorrhages) in the brain (Ng & Lee, 2019).

Meanwhile, diffuse injuries, those that occur over a more widespread area, result from the movement of the brain within an unrestrained head where the soft brain tissue and the rough interior of the skull interact mechanically. Diffuse axonal injury accounts for approximately seventy percent of TBI cases and is the tearing of axons when the brain is injured as it shifts and rotates inside the skull (Ng & Lee, 2019). Tears in brain tissue or blood vessels, called lacerations, also occur— especially when the brain rebounds and strikes the skull (*Common Classifications of TBI*, 2021; Popernack et al., 2015). Extensive damage of axons is the hallmark feature of diffuse TBI and predominantly occurs in the tissues of the brainstem and corpus callosum which leaves neurons unable to properly communicate (*Axons*, 2017; *Common Classifications of TBI*, 2021; Ng & Lee, 2019). The degree of axonal injury and neuronal degeneration determines the severity of TBI.

Secondary Injuries. Secondary injuries are the tissue and cellular damages that occur after the primary insult. These injuries can be more destructive than primary injuries and have a greater impact on a patient's recovery. Within the first few hours following a blunt force head injury, the brain becomes compromised in several chemical and mechanical ways.

On a chemical level, the initial cellular response to physical brain injuries is an increase in intracellular calcium levels and an overexcitation of neurons. This results in an excessive activation of neurons, glial cells, and vascular (blood vessel) cells (Hinson et al., 2015; Kaur & Sharma, 2018; Weber, 2012). Neurotransmitter release is a normal component of neuronal communication, but over releasing neurotransmitters (excitotoxicity) can lead to additional injuries. In this case, there is an overproduction and release of glutamate, which over activates glutamate receptors. The result is a massive influx of sodium ions, chloride ions, and water into the neurons causing them to swell and ultimately burst (Hinson et al., 2015; Luo et al., 2011; Ng & Lee, 2019; Weber, 2012). Additionally, excess calcium can disrupt brain function by compromising proteins, mitochondria, enzymes, and other fundamental cellular structures causing the cells to malfunction or die (Hinson et al., 2015; Ng & Lee, 2019). The brain also releases chemical signals that trigger an inflammatory response to TBI. However, as the brain recruits immune cells to the site of injury, the consequential inflammation causes swelling and increases pressure within the skull (intracranial pressure) which can also cause necrosis (*Common Classifications of TBI*, 2021; Kokiko-Cochran & Godbout, 2018; Ng & Lee, 2019; Postolache et al., 2020).

On the other hand, when the force of impact causes mechanical injuries, bleeding and clotting can occur, which prevents other areas from receiving the blood and nutrients needed for the cells to function. Consequential injuries such as insufficient blood flow (ischemia) and insufficient oxygen in the brain (hypoxia) can both cause widespread necrosis (*Common Classifications of TBI*, 2021; Rahaman & Del Bigio, 2018). Abnormal accumulation of fluid also occurs within the brain tissue (edema) and results from leakage from broken blood vessels, breakdown of the blood-brain barrier due to the necrosis of astrocytes, groupings of damaged tissues such as hematomas, and other injuries to the brain's tissues (*Common Classifications of TBI*, 2021; Jha et al., 2019; Roybal, 2022; Siracusa et al., 2019). Edema leads to increased intracranial pressure and further mechanical damage of tissue as the brain presses against the rigid skull.

Because of the interrelated nature of these immediate injuries, the patient's condition can exacerbate until treated. As intracranial pressure increases, swelling can also increase, which will worsen the mechanical damage to cells. More chemical and mechanical cell death will cause more inflammation due to the immune system's continued attempt to address the injuries. This inflammation will further constrict the blood vessels and the brain will be even more deprived of blood and oxygen. Without either, the brain begins to lose function which can lead to neurological symptoms such as confusion, disorientation, difficulty communicating, visual disturbances, weakness, seizures, and loss of consciousness (Bauer & Fritz, 2004; *Common Classifications of TBI*, 2021; Kaur & Sharma, 2018; McKee & Daneshvar, 2015; Popernack et al., 2015). Loss of function in the brain stem can hinder the brain's regulation of the body resulting in high or low blood pressure (hyper/hypotension) and excessive carbon dioxide levels in the blood (hypercapnia), both of which can cause cardiac issues (*Common Classifications of TBI*, 2021; Gregory & Smith, 2012).

Secondary injuries can continue to occur weeks to months after a TBI is sustained depending on the severity of the injury, the patient's overall health and medical history, and the quality of the initial treatment and ongoing care (Bramlett & Dietrich, 2015). If a patient is treated but secondary injuries still continue, this does not necessarily mean that the initial treatment did not work, but rather that the injury is still ongoing and evolving. Some effects of TBI, such as inflammation and bleeding, can continue to occur long after the initial injury (Bramlett & Dietrich, 2015; Mayo Clinic, 2021a; Novack & Bushnik, 2002).

After the first few hours to days after the initial injury, bleeding can continue to produce hematomas and also blood clots, especially if a patient is imobile during recovery. Prolonged inflammation can further necrosis and result in cerebral atrophy which is the loss of brain tissue due to the excessive death of brain cells (Ng & Lee, 2019). The amount of cell death sustained due to inflammation and other secondary injuries can also induce an abnormal increase in muscle tone, or spasticity which causes stiffness, spasms, and difficulty moving (*Spasticity*, 2023; *Spasticity After Brain Injury*, 2023). Cell death that impacts the ability to breathe and swallow can result in pneumonia (P. J. Hu et al., 2017). Additionally, inflammation can disrupt the drainage of cerebrospinal fluid in the brain and cause hydrocephalus, with increases in intracranial pressure (Chen et al., 2019).

In the days and weeks after the initial injury, the patient is also at risk of infection if there are any fractions or penetrations in the skull (Kourbeti et al., 2012; Sharma et al., 2019). A patient may also experience epileptic seizures if the brain injury was severe enough to alter the electrical activity of the brain (Ding et al., 2016; Fordington & Manford, 2020). Finally, individuals who sustain TBI can experience neurological changes that result in cognitive and behavioral problems such as memory loss, difficulty with attention and concentration, and changes in mood or personality (Benedictus et al., 2010; Li & Liu, 2013).

Secondary injuries comprise the cellular, chemical, tissue, and blood vessel changes in the brain which can occur hours, days, and even weeks after the initial injury. These injuries are largely responsible for the development of TBI symptoms such as cognitive and behavioral problems, increased intracranial pressure, and cerebral edema. Untreated, these injuries are sure to impact the brain's ability to properly function and alter an individual's cognitive, physical, and behavioral wellbeing. Therefore, it is important for someone who has sustained a TBI to receive prompt medical care to minimize the risk of secondary injury and optimize their chances of recovery. By reducing the risk of further injury and promoting a healthy brain environment, medical professionals can help support the healing process and improve outcomes for patients with TBI.

Chapter II: Diagnosis and Treatment of Pediatric Traumatic Brain Injury

Given the progressive and destructive nature of TBI, prompt diagnosis and treatment are critical for reducing the risk of secondary injuries and optimizing patient outcomes. Current treatment approaches for TBI involve addressing the underlying cause of injury and managing symptoms such as inflammation, bleeding, and infection. Additionally, patients may experience neurological changes resulting in cognitive and behavioral problems that require a multidisciplinary approach to treatment. This section reviews current methods for the diagnosis and treatment of pediatric TBI to establish a foundational knowledge of traditional TBI care plans. Later sections will build on this foundation to explain how barriers can prevent victims of abuse-related TBIs from accessing some or all of these standard diagnosis and treatment procedures, and why emerging methods with different approaches are necessary.

The Golden Hours of Care

The American Academy of Pediatrics dicates that children who have sustained a head injury need to be evaluated by a health care provider if any of the following symptoms occur: vomiting, seizure, loss of consciousness, severe or worsening headache, altered behavior, lack of coordination, confused or slurred speech, dizziness, water or blood oozing from the nose or ears, or bleeding that will not stop (Schutzman, 2021). Additionally, children should be examined if they are younger than six months of age, fell from a height greater than five feet, were hit with a high speed object or a great force, or if the caregiver has concerns over how the child is acting (Schutzman, 2021). The purpose of these guidelines is to ensure a prompt medical evaluation so that in the event of a TBI, health care professionals may slow the progressing brain damage as quickly as possible and administer treatment during an optimal window.

The ‘golden hour’ in medicine describes a limited one-hour timeframe for treating an injury that has caused potentially irreparable harm, after which the chances of morbidity and mortality steeply increase (Hoemeke et al., 2021; Narayana Health, 2017; Prabhakar Abhilash & Sivanandan, 2020). This concept is particularly applicable to severe head injury patients, as current research finds that earlier arrival to a hospital is associated with greater survival and improved functional outcomes; however, in these cases the timeframe may stretch beyond 60 minutes (Dinh et al., 2013; Hedges et al., 2009; Narayana Health, 2017; Newgard et al., 2015). Still, despite debate over the exact range of the ‘golden hour,’ there is concrete evidence that delaying treatment for a severe head injury increases the development of secondary injuries (Narayana Health, 2017; Urban, 2016).

Prompt medical evaluation and treatment for a child who has sustained a head injury is essential for the best possible outcomes (Dang et al., 2017). Because the symptoms of a TBI can be subtle, it is especially important to recognize them and seek medical attention as soon as possible. Based on the principles of the ‘golden hour’ the sooner the patient is treated, the greater their chances of survival and improved functional outcomes. By being aware of the importance of prompt evaluation and treatment, caregivers can help ensure the best possible outcomes for children who have sustained head injuries.

Initial Injury Evaluation

Health professionals use different tests and measures to assess for TBI and often, multiple measures are used together to determine a path for treatment and recovery. During the immediate assessment, health professionals commonly use the Glasgow Coma Scale (GCS) to categorize the severity of a TBI as mild, moderate, or severe (Centers for Disease Control and Prevention, 2022). The official GCS can be used in children older than five years without modification, whereas there have been several modifications to create versions applicable for younger children and infants. In a short exercise, patients are prompted for an eye opening response, verbal response, and motor response. Below is a table describing possible reactions and their corresponding scores:

Response Type	**Ages 5-21 Response**	**Ages 0-5 Response**	**Score**
Eye Response	No response	No response	1
	Eyes open to pain	Eyes open to pain	2
	Eyes open to sound	Eyes open to sound	3
	Eyes open spontaneously	Eyes open spontaneously	4
Verbal Response	No response	No response	1
	Incomprehensible sounds	Moans in response to pain	2
	Inappropriate words	Cries in response to pain	3
	Confusion	Cries in irritation	4
	Oriented response	Coos and babbles	5
Motor Response	No response	No response	1
	Abnormal extension to pain	Abnormal extension to pain	2
	Abnormal flexion to pain	Abnormal flexion to pain	3
	Withdrawal from pain	Withdrawal from pain	4
	Purposeful movement to painful stimulus	Withdrawal from touch	5
	Obeys commands	Moves purposefully	6

Table 1: The Glasgow Coma Scale (Jain & Iverson, 2022)

Patients are given a score in each category and the final GCS score is the sum of these numbers. In general, brain injuries are classified as mild if a patient scores between 13 and 15, moderate if they score between 9 and 12, and severe if they score less than 8 (*Pediatric Traumatic Brain Injury*, 2021).

Additionally, health professionals will use neuroimaging tests such as computerized tomography (CT) and magnetic resonance imaging (MRI) scans to better understand the extent of the injury. CT scans are the primary neuroimaging test used during initial assessment as they are much quicker than MRI scans (*How Do Healthcare Providers Diagnose Traumatic Brain Injury (TBI)?*, 2020). CT scans provide x-ray images from multiple angles which result in a complete picture of the brain. These scans will quickly reveal damage such as bleeding or bruising. Meanwhile, MRI scans use magnets and radio waves which also produce images of the brain but with more detail than CT scans. However, MRI scans take significantly longer to complete and are used more during follow-up examinations (*How Do Healthcare Providers Diagnose Traumatic Brain Injury (TBI)?*, 2020; *What's the Difference Between an MRI and a CT?*, 2016). If scans reveal any abnormalities, TBI is immediately classified as either moderate or severe (Brasure et al., 2012).

The remaining three components health professionals use to classify the severity of TBI are all dependent on a reliable narrative of events from someone accompanying the patient. Health professionals will ask if the patient lost consciousness at any time, if the patient's mental state seemed impaired following the incident, and if the patient seemed to experience any memory loss. Although health professionals can determine some of this information themselves, a reliable source other than the patient is often needed to gain a complete picture. Classifications for these criteria, and a review of the aforementioned structural imaging results and GCS scores are summarized below:

Criteria	Mild TBI	Moderate TBI	Severe TBI
Neuroimaging	Normal	Normal or Abnormal	Normal or Abnormal
Loss of Consciousness	0 - 30 Minutes	30 Minutes - 24 Hours	> 24 Hours
Alteration of Mental State	1 Minute - 24 Hours	> 24 Hours	> 24 Hours
Memory Loss	0 - 1 Day	1 - 7 Days	> 7 Days
GCS Score	13-15	9-12	3-8

Table 2: Criteria Used to Classify TBI Severity (Brasure et al., 2012)

Once a health professional has determined the severity of a TBI, this information is used to determine how to proceed with treatment. Throughout the treatment process, some health professionals may use other tests for TBI to gain a better understanding of how a patient's brain functions have been impacted. These tests may include speech and language tests, swallowing tests, and breathing tests to assess for any functional impacts, social communication skills tests to assess changes in social competency, cognition tests to see how a patient's higher levels of thinking have been impacted, and additional neuropsychological assessments that can depict a patient's behavior and actions. Results from these tests do not directly play into the differentiation between a mild, moderate, and severe TBI diagnosis, but they can provide valuable information about the damages that took place.

In cases of mild TBI, sometimes called concussions, injuries caused the brain to bounce around or twist inside the skull. The results of this movement can include chemical changes in the brain and slight stretching or damage to brain cells (*Concussion: Causes, Symptoms, Diagnosis, Treatments, Prevention*, 2020). Despite this, mild TBI is relatively easy to treat and does not require much professional intervention. Once a physician confirms that the CT or MRI scans are normal, most mild injuries require no treatment other than rest and over-the-counter pain relievers to treat headaches (Carney et al., 2017). Still, it is of utmost importance that a patient follows their healthcare provider's instructions for complete rest and a slow return to normal activities, otherwise the healing process may take much longer.

On the other hand, moderate or severe TBI requires significantly more involved treatment as these injuries can potentially lead to long-term health problems. Thus, a fast diagnosis and treatment is most critical for this level of injury in order to optimize patient outcomes. The first step in treating moderate or severe TBI is ensuring the patient has enough oxygen and an adequate blood supply, maintaining blood pressure, and preventing any further injuries to the head or neck (Carney et al., 2017). For some cases this can be done with medication, while in more extreme circumstances, surgery may be needed to remove blood clots or pools, repair skull fractures, or relieve pressure inside the skull (called intracranial pressure) (*What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020).

Current Acute Care Treatments

Emergency treatment for TBI aims to prevent secondary injuries and manage adverse conditions. When physicians deem an invasive surgical procedure unnecessary, several classes of medications can be used in an attempt to alleviate TBI symptoms (Davis, 2021; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020). Diuretics are used to drain excess cerebrospinal fluid which can reduce intracranial pressure. Magnesium and anticoagulants are prescribed to improve blood flow while anticonvulsants can be used to prevent seizures. Lastly, sedative agents such as barbiturates can reduce intracranial pressure or induce a medical coma when necessary (Davis, 2021; *Medications*, 2023; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020).

Surgical treatments are required for TBI when injuries compromise the structural and physiological capacities of the nervous system, its cells, structure, and function. When these injuries occur, the resulting damage progresses rapidly, thus surgical measures are the quickest route to preserving proper brain functions. Through various methods, surgical treatments center around reducing pressure and carbon dioxide levels and increasing oxygen levels in the brain. Currently, there are five surgical treatments recommended for addressing injuries associated with traumatic brain injuries: craniotomies, ventriculoperitoneal shunt surgeries, endoscopic third ventriculostomies, decompressive craniotomies, and cranioplasties (Valle et al., 2022; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020). Each of these surgical procedures involves close monitoring for complications such as infections, seizures, and changes in intracranial pressure, and diligent follow-up to ensure that recovery is progressing as expected and to address any complications or ongoing symptoms.

Craniotomy. Craniotomies are the surgical removal of part of the skull called the cranium to expose the brain. This procedure can be used to remove large collections of blood that pool outside of blood vessels called hematomas and to treat swelling of the brain. For large hematomas, neurosurgeons will remove a section of the cranium and drain the excess blood. Once the hematoma has been drained, the physician can directly repair the broken blood vessels to stop further bleeding and swelling (Johns Hopkins Medicine, 2022c; Mayfield Brain & Spine, 2021).

By removing part of the cranium, a craniotomy also relieves intracranial pressure (ICP). Increases in ICP after a TBI are often associated with intracerebral hemorrhages which occur when arteries in the brain burst causing bleeding in the brain tissue and subsequent swelling (*Increased Intracranial Pressure (ICP) Headache*, 2021; Johns Hopkins Medicine, 2022c).

When ICP is elevated, the brain is severely at risk of further damage as the pressure build up causes the brain to press up against the skull and disrupts the high flow, low pressure circulatory system of oxygen, carbon dioxide, and blood in the brain (Markus, 2004; Popernack et al., 2015). Removing part of the cranium can allow a swollen brain to bulge out and reduce this pressure to avoid inciting further damage. After the surgery, the bone flap is replaced or covered with plates and screws.

For hematomas smaller than a centimeter, physicians typically opt for a far less invasive surgery than a craniotomy called an aspiration procedure. During this procedure, a physician drills a small hole into the cranium called a burr hole before placing rubber tubes inside these holes to allow the blood from the hematoma to drain out (Mayfield Brain & Spine, 2021; "Types of Surgery for Head Injury," 2020).

Ventriculoperitoneal shunt surgery. Hydrocephalus is another injury associated with TBI and refers to the accumulation of excess cerebrospinal fluid (CSF) in the ventricles, cavities of the brain where CSF is produced. CSF is a clear fluid that flows through what is called the subarachnoid space as it surrounds the brain and spinal cord to provide nutrients and cushion the delicate tissues. Severe injuries during TBI can create blockages in the ventricular system or the subarachnoid space as well as inhibit the absorption of CSF into the tissues. CSF accumulates in the ventricles as a result, and the resulting hydrocephalus increases the brain's ICP. There are two forms of hydrocephalus: communicating and noncommunicating.

Communicating hydrocephalus occurs when the flow of CSF is blocked after it leaves the ventricles and can be treated by ventriculoperitoneal shunt surgery. The term "communicating" refers to the fact that CSF can still flow between the ventricles, however, the fluid is blocked from reaching the spine and other areas of the brain, depriving them of nutrients and protection

(Johns Hopkins Medicine, 2022a; Mayo Clinic, 2021). Communicating hydrocephalus is the most common form following TBI and surgery involves the insertion of a drainage system (*Hydrocephalus and Treatment*, 2009; Pangillinan et al., 2022).

This system, known as a shunt, usually has two small, thin tubes connected by a valve. Through surgery, a small hole is made in the cranium and one end of one tube is placed inside the brain into the ventricles. The end of the other tube is placed in the peritoneal cavity which is in the abdomen. When the shunt is in place, the tubing travels under the skin down the neck and into the stomach. (Minagar et al., 2019; Piatt, 2019; *Ventriculoperitoneal Shunt*, 2015).
The spinal fluid then drains at a constant rate into this part of the body where it can be absorbed.

Recovery from this procedure takes three to four days, and most patients are able to leave the hospital within a week. In cases of severe hydrocephalus, most patients will require a shunt system for the rest of their lives and need to be monitored regularly. During hospitalization, health professionals ensure the shunt is working properly before the patient is discharged (*Ventriculoperitoneal Shunt*, 2015).

Endoscopic third ventriculostomy. The second form of hydrocephalus is non-communicating or obstructive hydrocephalus. This occurs when the flow of CSF is blocked along the passages connecting the ventricles causing buildup and an increase in ICP with subsequent damage to brain tissues (Johns Hopkins Medicine, 2022a; Mayo Clinic, 2021). Although less common than communicating hydrocephalus, non-communicating hydrocephalus is also associated with TBI and can have detrimental effects.

Endoscopic third ventriculostomy is the most used procedure for non-communicating hydrocephalus in which a bypass is created to allow the accumulating CSF to drain (Cincinnati Children's Hospital, 2018). In cases where hematomas form in the ventricles, endoscopic ventriculostomy can also be used in lieu of a craniotomy to remove them ("Types of Surgery for Head Injury," 2020).

During this procedure, a surgeon makes a burr hole in the cranium to allow a small video camera, called an endoscope, and miniaturized surgical instruments inside the brain to access the third ventricle and drill a hole in the bottom. This hole allows the CSF to drain from the brain (Eminence Neurosurgery, 2018; Yadav et al., 2012). Following the operation, patients are closely monitored to evaluate neurological functions such as the movement of limbs, pupil dilation, and answering simple questions such as "What is your name?" (Memorial Sloan Kettering Cancer Center, 2021). Upon release, long-term follow-ups are crucial for monitoring the development of complications.

Decompressive craniectomy. A decompressive craniectomy is the last resort for relieving ICP. If ICP is persistent after various other methods such as craniotomies and medications are attempted, a physician will fall back on a craniectomy (Guo et al., 2022). As in the aforementioned craniotomy, a segment of the cranium is removed allowing the swollen brain to extend out of the skull in order to alleviate some ICP (Popernack et al., 2015; Schirmer et al., 2008). This operation differs, however, in that the resected portion of the cranium is not replaced (Mayfield Brain & Spine, 2021).

Part of the reason physicians consider this procedure a last resort is its significant association with several complications despite the progress and development of surgical techniques and hospital technology over the past few years (Gopalakrishnan et al., 2018). Therefore, a few recent studies have proposed modifications to this surgical method which might decrease both acute and long-lasting complications that are associated with TBI (Burger et al., 2009; de Andrade et al., 2020; Lambride et al., 2020). Currently, these findings are still developing, but over the next few years, these advancements in decompressive craniectomy surgical techniques could lead to higher success and fewer complications when used to treat elevated ICP.

Cranioplasty. Lastly, TBI can cause skull fractures and damage to the cranium. These injuries not only leave the brain vulnerable to internal tears and external impact, but they can also allow bacteria and air into the brain which increases the risk of infection (Johns Hopkins Medicine, 2022b).

Reconstructive surgery of the cranium is known as a cranioplasty, and these surgeries primarily occur after a patient recovers from a craniectomy (Iaccarino et al., 2020). During this reconstructive surgery, the cranial space that encloses the brain is repaired by inserting plastic and metal plates. If the person's own skull bone was preserved with minimal damage, this can also be reinserted (Johns Hopkins Medicine, 2022b; Princeton Neurological Surgery, 2022). Cranioplasties decrease the likelihood of brain damage and protects patients from seizures as it reestablishes the body's natural protection of the brain.

Current Rehabilitative Treatments

After the immediate effects of a TBI have been addressed, the focus shifts to rehabilitation and recovery. The rehabilitation process after a TBI is a crucial part of the recovery journey and involves various therapies, medications, proper nutrition, rest, a gradual return to activities, and follow-up care. A multidisciplinary approach is taken to address physical, cognitive, and emotional functioning, with the aim of helping the patient regain independence, improve their quality of life, and reach their full potential. The purpose of rehabilitation after TBI is to provide the patient with the support and resources necessary to overcome the challenges posed by their injury and achieve the best possible outcomes.

Depending on the impacts of the injury, rehabilitation therapies may help patients with mild, moderate, and severe TBI regain functions and skills. The cognitive, emotional, and physical deficits one experiences can vary, but patients generally require a comprehensive team of specialists, including physical therapists, occupational therapists, speech therapists, and neuropsychologists, who work together to address the unique challenges faced by each individual patient (*What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020). Additionally, therapy can be necessary for only a short period of time after the injury, occasionally, or continuously throughout a patient's life.

TBI patients often suffer from physical dysfunctions, including weakness, disrupted coordination and balance, and challenges performing daily tasks (*Physical Effects of Brain Injury*, 2012; Substance Abuse and Mental Health Services Administration, 2021). Improving these and other physical abilities typically involves a combination of physical and occupational therapy. Physical therapy helps patients rebuild strength, balance, coordination, and mobility. In some cases, TBI patients may also benefit from the use of assistive devices, such as braces or crutches. Meanwhile, occupational therapy addresses motor and planning skills involved in activities of daily living and self-care (Cleveland Clinic, 2021; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020).

Furthermore, TBI patients commonly experience cognitive impairments such as compromised communication abilities, memory loss, difficulty with attention and concentration, and impaired executive function skills such as planning, problem-solving and decision-making (Arciniegas et al., 2002; Neumann & Lequerica, 2020; Rabinowitz & Levin, 2014). To overcome these hindrances, patients may undergo cognitive rehabilitation and speech therapy. Cognitive rehabilitation therapy utilizes specific exercises and activities aimed at regaining cognitive abilities, such as memory, attention, and planning skills (Barman et al., 2016). Speech therapy, on the other hand, addresses language, communication, and speech impairments (Cleveland Clinic, 2021; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020).

Lastly, TBI patients may experience emotional and behavioral changes such as anxiety, depression, irritability, aggression, and decreased motivation (Schwarzbold et al., 2008; *TBI 101*, 2017; Zwilling et al., 2022). To address these emotional challenges, TBI patients may benefit from therapies such as cognitive-behavioral therapy, supportive therapy, and psychotherapy. Cognitive-behavioral therapy aims to replace negative patterns of behavior with positive ones, and supportive therapy provides emotional support and guidance to help patients cope with the challenges of TBI. Psychotherapy involves working with a mental health professional to explore an individual's thoughts, behaviors, and feelings (Ashman et al., 2014; Benedictus et al., 2010; "Cognitive Behavioral Therapy after Traumatic Brain Injury," 2021; *Traumatic Brain Injury Counseling*, 2023). Collectively, these therapies aim to help the patient understand and manage their emotions and behaviors, improve their interpersonal relationships, and enhance their quality of life (Ashman et al., 2014; Benedictus et al., 2010; Bray, 2022; Cleveland Clinic, 2021).

Medication can also play a role in addressing various cognitive, emotional, and physical symptoms related to TBI. Anxiety medications are often prescribed to ease feelings of nervousness, while antidepressants help to alleviate depression and mood changes. To improve alertness and attention, stimulants may be prescribed, and muscle relaxants are used for symptoms of muscle cramping caused by injury to motor neurons. Pain management is also a consideration, and pain relievers are used to alleviate discomfort (Davis, 2021; *Medications*, 2023; *What Are the Treatments for Traumatic Brain Injury (TBI)?*, 2020).

Aside from the therapeutic and medicinal treatments a physician may prescribe, healthy behaviors are also an important component of post TBI clinical care guidelines. A balanced and nutritious diet enables the body to heal and repair damaged tissues while also maintaining the patient's overall health (Erdman et al., 2011). The body also requires a proper amount of rest with the exact amount dependent on the severity of injury. For severe head injuries, extended periods of rest are necessary for proper recovery, and a premature return to activities can have detrimental effects on a patient's recovery. However, it is important to avoid excessive rest for milder head injuries, as this may make it more challenging for the patient to resume their normal activities, such as school, socializing, and hobbies (CDC Injury Center, 2019; National Institute of Neurological Disorders and Stroke, 2023). Making a gradual and careful return to typical activities, as determined by the patient's physician, is crucial in the rehabilitation process.

Finally, follow-up care allows physicians to monitor the patient's progress, assess any lingering symptoms or complications, and adjust their treatment plan as necessary. It also provides an opportunity for the patient to receive support and guidance as they continue to recover and adapt to life after their injury. In addition, follow-up care helps to identify and address any setbacks or new symptoms that may arise and ensures that the patient receives the necessary treatment in a timely manner. Attending regular follow-up appointments helps to ensure the patient is on track for a successful recovery and promotes long-term outcomes (*Follow-Up Care*, 2023; Seabury et al., 2018; Wade et al., 1998).

Following acute treatment, TBI rehabilitation and recovery requires a comprehensive approach to address physical, cognitive, and emotional functioning. Through various avenues of support, TBI patients can work to overcome the challenges posed by their injury and achieve the best possible outcomes.

Chapter III: Barriers to Treatment Access for Victims of Abuse in Foster Care

Even with the development of innovative medical treatments and therapies for TBI, their efficacy is limited if patients are unable to access them due to various personal and environmental barriers. This section explores the various circumstances that can prevent foster youth from accessing medical care following abuse-related head injuries, and provides insights into the challenges faced by this vulnerable population. While some abuse-related TBI victims may be able to access certain components of standard medical care, others may be denied a diagnosis, acute treatment, and proper recovery altogether. By identifying and understanding the challenges faced in this community, comprehensive approaches can be developed to improve the outcomes for foster youth who have experienced TBI.

Psychological and Environmental Barriers

As established in the prior sections, proper care for TBI entails prompt medical evaluation and treatment, ample rest and nourishment at home, and possibly rehabilitative therapies and medications for the best possible outcome. In the immediate aftermath of an abuse-related head injury, the injured child, perpetrator, other adults in the home environment, and other children may have various reasons to be reluctant to seek help. Moreover, in the weeks following the injury, the child's symptoms, the child's own reticence, or the reluctance of other members of the home may deny the child subsequent support. Additionally, environmental barriers may prevent the child from accessing medical and therapeutic services when needed. Achieving clarity about the extent and nature of these barriers will help to reduce the number of children who cannot receive the necessary acute, follow-up, and ongoing care after an abuse-related head injury.

Summary of Personal and Environmental Barriers to TBI Care

	Acute Care	Follow-Up Care	Ongoing Care
Child Abuse Victim	- Fear - Guilt - Ignorance - Distrust - Denial - No autonomy - Normalization	- Distress - Pain - No motivation - No support - Negative coping mechanisms	- Fear - Guilt - Ignorance - Distrust - Distress - Shame
Perpetrator Note- Barriers to providing follow-up care and ongoing care only apply when the perpetrator is a foster caregiver	- Fear - Neglect - Guilt - Denial	- Fear - Neglect - Guilt - Distress - Scheduling challenges	- Fear - Neglect - Denial - Distress - Scheduling challenges - Stigma - Personal TBI history
Unoffending Foster Caregiver	- Fear - Neglect - Denial - Loyalty	- Fear - Neglect - Distress - Guilt - Scheduling challenges	- Fear - Neglect - Denial - Distress - Scheduling challenges - Stigma - Personal TBI history
Child Witnesses or Confidants	- Fear - Shame - Ignorance - Distrust - Loyalty - Trauma		- Fear - Shame - Ignorance - Distrust - Guilt - Distress - Sworn secrecy
Environmental Factors	- Low resources - Finances - Ignorance - Language barriers	- Low resources - Finances - Ignorance - Language barriers - Lack of executive skills - Distant facilities	- Low resources - Finances - Ignorance - Language barriers - Lack of executive skills - Distant facilities

Table 3: Summary of Personal and Environmental Barriers to TBI Care for Victims of Child Abuse in the Foster Care System

Beginning with the hours immediately after an injury, there are various psychological factors to consider. From the injured child's perspective, fear can be a substantial reason to not seek help, particularly if the perpetrator of the abuse is someone they know or trust. On the one hand, the perpetrator may intimidate or threaten the child into staying quiet. On the other hand, the child may have an emotional connection to the perpetrator and not want them to get into trouble. This can be true both in cases where the perpetrator is the foster caregiver and when the perpetrator is an adult outside of the home. Additionally, the child may fear being taken away from their foster family if they report the abuse (Huziej, 2021; O'Grady & Matthews-Creech, 2016). Generally, when the law imposes unwanted repercussions to disclosures, disclosures decline. In the case of abuse, children may have difficulty trusting that the system wants to protect them and may be reluctant to disclose the abuse because they do not want or do not understand the potential repercussions.

The child may also experience profound shock as a result of the abuse, inducing a state of emotional numbness, dissociation, confusion, and exhaustion (Center for Substance Abuse Treatment (US), 2014). Extensive research on the impacts of physical harm on memory suggests that the overwhelming nature of abusive experiences can disrupt memory consolidation and retrieval processes, contributing to the child's inability or reluctance to acknowledge and disclose the abuse (Children's Bureau, 2023; H. Hart & Rubia, 2012; McCrory et al., 2011). Furthermore, the child may feel ashamed or guilty about the abuse, and even believe that the abuse is their fault. Lastly, the child may not be capable of understanding the severity of their injuries or the importance of seeking medical care (Hillstrom, 2022; Huziej, 2021; O'Grady & Matthews-Creech, 2016). These reasons can all contribute to the child's hesitation or lack of awareness when it comes to seeking help.

An important note is that children typically lack the autonomy to seek medical care independently and instead rely on adults to do so on their behalf. Even when the child would seek medical care on their own, the child may fear that if they tell someone, nothing will happen to the perpetrator, and the abuse will only get worse. The child may also distrust non-offending adults including other caregivers at home, their teachers, their coaches, their neighbors, and any other adults in their life so they may conceal their injuries (American Academy of Pediatrics, 2022; Crosson-Tower, 2003). Finally, due to the normalization of injuries and violence in the foster care system, the child may have become accustomed to these adverse events, and believe that seeking medical help is unnecessary (Cusimano, Lamont, et al., 2021).

For obvious reasons, it is difficult to obtain information from perpetrators about their motives following an injury to a child, so there is little empirical evidence available in this area. However, we can reason about several psychological barriers that can prevent the child from being treated. As the scope of this thesis focuses on child abuse, this section assumes that the perpetrator is an adult and excludes cases where a TBI is inflicted by another child. A major motivator can be a perpetrator's guilt and shame for their actions which can prevent them from taking the child to a medical professional themselves, or asking someone else to do so. They may also fear that the healthcare professionals will report the abuse and they will face legal consequences for their actions. Additionally, the perpetrator may be in denial about the severity of the child's injuries and may believe that the child does not need any treatment. It is also entirely possible that the perpetrator may lack concern for the child's well-being, and thus not care if the child receives treatment.

Empirical evidence on the thought processes of non-offending foster caregivers and other adults who know of the injury is scarce as well, but it can be reasoned why they may also resist taking the child to get care. They may fear the perpetrator of the abuse, and anticipate retaliation toward themself, the already injured child, or others in the home. Alternatively, the adult may feel a sense of loyalty to and/or dependence on the perpetrator, particularly if they are a family member, close friend, or significant other. Similarly to the perpetrator, the adult may be in denial about the severity of the child's injuries, or they may deny that any abuse happened at all. They may also fear that if the abuse is discovered they could be found complicit and suffer legal consequences. Unfortunately, they could also disregard the child's well-being.

While other children in the home may witness or find out about the abuse-related head injury, they may avoid seeking immediate medical help for several reasons. The child may be afraid of retaliation from the foster caregivers if they report the incident, especially if one of them is the perpetrator. Additionally, witnessing the abuse may cause shock and trauma, making the child resistant to seeking help or speaking up about what they saw. Confusion may also play a role, as the child may not know how to interpret the events or how to seek help. And, the child may feel loyalty to the perpetrator. Shame and embarrassment about what they saw can also make the child hesitant to talk about it with others. Lastly, the child may not trust adults or authority figures, which can make them hesitant to speak up about what they witnessed (Pappas, 2011; *"Why Didn't You Say Anything?*, n.d.).

In addition to these psychological barriers, there are various environmental barriers that can contribute to delays in seeking medical care. Limited healthcare resources, such as a shortage of healthcare providers or long waiting times, can make it difficult to get timely appointments or treatment. Additionally, if the child or their caregivers do not have insurance or adequate financial resources, they may struggle to afford the necessary medical care. Lack of knowledge about how to seek medical care or where to go for help can also be a significant barrier, particularly in communities with limited access to information. Finally, language barriers can complicate matters, as it may be challenging to communicate effectively with healthcare providers, especially with the added burden of explaining the cause of the injury (Garney et al., 2021; Holm, n.d.; Neighmond, 2015; Theimer et al., 2020).

In the weeks to months following a TBI, as the brain begins to heal, follow-up treatment, various therapies, medications, rest, and a gradual return to activities may be necessary components for TBI recovery. A child's follow-up care adherence is largely dependent on the child's foster caregivers and their home environment, but can also be inhibited by the TBI-related symptoms. Physically, the child may experience pain, discomfort, and headaches, especially if they were unable to receive treatment, making it challenging to rest and eat properly (Hillstrom, 2022). Emotionally, distress and anxiety may cause nightmares and other sleep disturbances, making it difficult to relax and get proper rest.

Additionally, the child may lack motivation to return to regular activities due to the physical and emotional challenges of recovery. This can further complicate recovery because if the child rests for too long, they may have difficulty reengaging cognitive skills such as memory or attention (Cleveland Clinic, 2021). A lack of support from caregivers or peers may also make it difficult for the child to get enough rest and stay motivated during the recovery process. This, too, is problematic because returning to activities too soon can make symptoms worse (Cleveland Clinic, 2021).

Finally, negative coping mechanisms can develop in response to the stress, trauma, and uncertainty that often accompany TBI. For example, substance use and avoidance are two common negative coping mechanisms that can interfere with a child's ability to engage in follow-up care adherence (Cusimano et al., 2020; Krpan et al., 2011; Mayo Clinic, 2021a). A child who turns to substance use to cope with the emotional pain of a TBI may be less likely to follow medical advice or engage in rehabilitation therapies. Similarly, a child who avoids medical appointments or treatment sessions may be less likely to make progress in their recovery or experience improved outcomes (Spaw et al., 2018). These negative coping mechanisms can further complicate an already challenging situation and may require targeted interventions to address.

For the same reasons as with acute care, there is little direct evidence about foster caregivers' barriers to prioritizing follow-up care. Due to the nature of follow-up care, foster caregivers are largely responsible for establishing an environment that adheres to proper guidelines. We can reasonably surmise that feelings of guilt, shame, or remorse may have worsened since the injury occurred and could impact a foster caregiver's ability to provide care for the child. Fear of re-injuring the child or causing further harm could also lead to overprotection and reluctance to allow the child to engage in normal activities. A foster caregiver may also experience psychological distress related to the child's injury, and/or have other health issues which could impact their ability to provide appropriate care and support during the recovery process. Additionally, they may fail to attend follow-up appointments due to their feelings of guilt, their fear of facing legal consequences for the abuse, or because they find themselves too busy. As stated before, the caregiver may also simply lack concern for the child's well-being and deny them the ability to rest and recover.

If rehabilitative therapy and/or other longer-term medical attention is deemed necessary, the foster caregivers are largely responsible for ensuring children have access and adhere to such care, as it can be even more challenging than in the case of acute care for the child to secure it independently. For the injured child, previously described factors including fear, distress, shame, guilt, lack of trust, and lack of knowledge can keep them from seeking help from the foster caregivers or other adults (Hillstrom, 2022; Huziej, 2021; O'Grady & Matthews-Creech, 2016). Other children who witnessed the injury or were confidants may also hesitate for these reasons, or may be asked not to say anything by the injured child.

Meanwhile, foster caregivers may refrain from pursuing these resources due to feelings of guilt and denial as explained above, as well as the persistent fear of being reported to authorities for the abuse. Coordinating rehabilitative therapy appointments and other ongoing medical treatment can also be challenging due to scheduling conflicts with the caregiver's own schedule, and difficulties coordinating with multiple healthcare providers. The child's school schedule can also complicate follow-up care adherence as missing school to attend appointments can be detrimental to the child's education. Additionally, foster caregivers may be hesitant to schedule appointments or retrieve prescriptions due to stigmas which make them feel ashamed or embarrassed for needing such services (Subramaniyan et al., 2017).

Another component that can interfere with follow-up care adherence is if the caregiver who is primarily responsible for arranging the child's care has also suffered from a TBI. There is evidence that many perpetrators of abuse were previously victims of abuse (Caykoylu et al., 2011; Teicher, 2000). Additionally, while empirical evidence is limited, it is logical to assume that some perpetrators who are violent with a foster youth can also be violent with a foster caregiver. A foster caregiver who suffers from a TBI may experience cognitive and physical limitations, such as memory deficits, impaired decision-making abilities, fatigue, and chronic pain, which can impact their ability to coordinate recurring appointments and medication management for the foster child. Additionally, caring for a child following a TBI can be an extremely emotional ordeal and the caregiver may experience a level of distress which can make it difficult to coordinate and adhere to follow-up care appointments and treatment plans (Whiffin et al., 2021). Alternatively, as previously mentioned, some caregivers may lack concern for their child's well-being and therefore be less likely to seek out appropriate care.

Environmental barriers may also prevent a child from receiving proper rest at home, gradually returning to activities, and seeking therapy services or medication following an abuse-related head injury. For the reasons already described, financial restraints, limited healthcare resources, and language barriers could all impact a foster caregiver's ability to provide adequate care for the child. Furthermore, financial restraints may contribute to the previously described appointment scheduling complications if the foster caregivers and/or the injured child need to work. Foster caregivers may also lack the knowledge or resources to properly understand and adhere to the concordantly high demands of some follow-up care regimens which may include multiple therapies on top of medication management. Additionally, some children may live in rural areas and the lack of specialized medical facilities and health professionals could be a significant obstacle in ensuring the child receives the necessary care. (Garney et al., 2021; Holm, n.d.; Subramaniyan et al., 2017; Theimer et al., 2020). These environmental barriers can significantly interfere with the coordination of follow-up care and prevent an optimal recovery.

Consequences of Untreated or Inadequately Treated Traumatic Brain Injuries

Barriers to proper TBI treatment and rehabilitation can have severe consequences, as brain injuries can inhibit multiple pathophysiological mechanisms and lead to prolonged physical and cognitive deficits. Inadequate care or a lack of treatment can exacerbate these effects, resulting in even more pronounced and long-lasting negative outcomes (Bramlett & Dietrich, 2015). This is because when the neurological damage sustained during a TBI is not treated properly, or proper recovery does not follow treatment, secondary injuries continue to worsen and can cause various symptoms such as headaches, dizziness, nausea, and fatigue. Prolonged, these symptoms can negatively impact a child's ability to engage in daily activities (Park et al., 2008). Additionally, structural injuries can disrupt the growth and function of the brain, and a child can experience a multitude of cognitive, physical, and emotional impairments, depending on which part of the brain becomes compromised (Bennett et al., 2016).

Brain damage in the frontal lobe, which is roughly at the front of the head, would impact a child's ability to control their emotions, impulses, and behavior or alter their judgment and critical thinking processes. Additionally, deficits in this area of the brain may cause difficulty in bodily movement or the ability to speak (*Functions of the Brain*, 2022). The temporal lobes, one on the left and right side of the head, maintain memory, organization, and auditory capabilities. Cell and tissue damage in this area may lead to trouble with communication or memory (*Functions of the Brain*, 2022). The parietal lobe, the lobe at the top of the head, largely controls touch, spatial perception, and identification of sizes, shapes, and colors. Children with impairments in their parietal lobes may have difficulties with their five primary senses (*Functions of the Brain*, 2022). The occipital lobe, which is at the back of the head, is responsible for vision and damage in this area may lead to vision and visual perception deficits (*Functions of the Brain*, 2022).

The cerebellum sits just under the occipital lobe at the back of the head and coordinates voluntary muscle movements, posture, and balance. Compromised cells and tissues in the cerebellum may affect any of these functions temporarily or permanently (*Functions of the Brain*, 2022). Lastly, the brainstem, which serves as a means of communication between the brain and the spinal cord, maintains many involuntary bodily functions such as breathing, heart rate, and digestion. Damage to the brain stem can be life-threatening, and will likely induce long-term problems with movement, sensation, and speech if survived (*Brain Anatomy and How the Brain Works*, 2021).

If a child experiences any physical or cognitive dysfunctions as outlined above and they are unable to receive the necessary therapies and support, they may be unable to recover the skills they need to manage their injury (Fong, 2023). For example, they may not receive physical therapy to help regain their strength, or speech therapy to help improve their communication skills, which could impact their ability to participate in physical activities and socialize respectively (Hegde, 2014; Lendraitienė et al., 2016). If losing these skills prevents the child from achieving developmental milestones such as walking and talking, the child may experience delays in development (Stiles et al., 2005). Moreover, children who do not receive proper treatment for their TBI often develop secondary conditions, such as depression, anxiety, and aggression, or intellectual impairments including problems with memory and attention (T. Hart & Cicerone, 2017; Li & Liu, 2013). These conditions can further impair their quality of life and worsen their overall development. Finally, children who do not receive proper treatment for TBI may be at an increased risk for developing long-term health problems including seizures, sleep disorders, and neurodegenerative diseases (Bramlett & Dietrich, 2015).

After 24 hours pass without treatment for a TBI, the individual enters what is called the subacute phase for up to three weeks post-injury. After three weeks without treatment, the individual enters the chronic phase. In general, the effectiveness of the acute care procedures and conventional rehabilitative treatments for TBI established in Chapter II diminishes as time passes. This is because the brain goes through a natural healing process in the weeks and months following the injury, and after a certain point, the healing process becomes more limited (Dang et al., 2017). Given the barriers that foster youth face in accessing medical care, it must be acknowledged that child abuse victims in the foster care system may be prevented from obtaining a diagnosis, receiving treatment, and/or properly recovering during the acute phase of their injuries. Thus, subacute and chronic TBI treatments must be established and made available to victims of abuse-related head injuries.

Chapter IV: Potential Methods for Trauma Informed Diagnosis and Treatment

Traditional methods of treatment for TBI, which depend on immediacy and proper recovery time, can be difficult to achieve for victims of abuse in the foster care system who may not have had access to appropriate medical care at the time of their injury. Therefore, emerging methods of identifying and treating subacute and chronic TBI offers the possibility of improved outcomes and a brighter quality of life for survivors of abuse-related head injuries. This section explores some of the new and emerging methods for identifying and treating TBI which could be beneficial to survivors of abuse in the foster care system, and emphasizes that increasing access to these treatments is essential to improving the long-term outcomes for these vulnerable individuals. As these treatments become more reliable and mainstream, it is important that they become visible to current and former foster youth, and affordable via multiple avenues.

Identifying Untreated Traumatic Brain Injuries

In order to discuss potential protocols for identifying TBI in the foster care system, it is important to note the current procedures followed in the United States. In 2008, the Fostering Connections to Success and Increasing Adoptions Act amended the Social Security Act (SSA), specifically 42 U.S.C. § 622(15), to require all states to collaborate with the state agency, pediatricians, other experts in health care, and experts in and recipients of child welfare services to ensure a coordinated strategy for identifying and responding to the health care needs of foster youth. This act specifically requires that states establish a schedule for initial and follow-up health screenings, a plan to monitor and treat health care needs that are identified, and procedures to ensure that foster youth are not inappropriately diagnosed (*42 U.S. Code § 622 - State Plans for Child Welfare Services*, 2023). Additionally, states must provide individuals who are aging out of foster care with options for health insurance, information about a health care power of attorney, and documents to establish a health care proxy (*42 U.S. Code § 622 - State Plans for Child Welfare Services*, 2023). States must adhere to the federal requirements of the SSA or they risk losing funding due to the spending clause. However, the wording of the SSA allows each state to develop their own specific guidelines and protocols based on their interpretation of the law and the needs of their population.

To better understand how each state interprets the requirements of the SSA, the Center for Health Care Strategies conducted a survey asking each state about their requirements for initial health screenings and further assessments. A health screening involves asking questions to determine an individual's current health condition and identify any unmet and pre-existing conditions. If any issues become apparent, an assessment will follow to define the nature of the problem, determine a diagnosis, and develop treatment recommendations. To provide a complete clinical picture, this may include multiple tests, clinical interviews, observations, clinical record reviews, and collateral information (American Psychological Association, 2014). Data were collected from 47 states— Hawaii, Mississippi, and Montana did not respond— and the District of Columbia.

With the exception of Nevada, all responding states and the District of Columbia require an initial screening of a child's physical, behavioral, and/or oral health shortly after placement in foster care (Allen, 2010). However, only 65 percent of the respondents require screenings in all three domains. This can limit the information gathered about a child's health and leave some health conditions undetected. Additionally, while the majority of states require that initial screenings take place within 60 days of placement, state-mandated timeframes are inconsistent and fail to reflect nationally recognized guidelines (Allen, 2010). Without timely initial assessments, efforts to address health care needs may be delayed or inadequate which can potentially worsen long-term health outcomes.

In response to a positive screen, all states expect in-depth assessments to be conducted. However, only 35 percent of the responding states explicitly require them for each of the three domains (Allen, 2010). The purpose of a screening is simply to indicate whether there is a need for further diagnosis or treatment. Assessments provide further examinations that can establish the extent to which treatment and follow-up care are required. This lack of emphasis on assessments calls to question whether the federal requirement for initial and follow-up screenings is truly being fulfilled. Furthermore, the overall findings of this study demonstrate significant opportunities for improvement in nation-wide health screening and assessment requirements.

In addition to implementing a screening protocol, the SSA mandates that states determine how they will ensure the continuity of treatment and other health care services for foster youth, including coverage for these services. For children currently in the foster care system, medicaid is the primary source of health care coverage. Most foster youth under the age of 19 are eligible for Medicaid either by qualifying for Title IV-E assistance or based on income as they are considered independent (Children's Bureau, 2022). Additionally, some foster youth may qualify for Medicaid based on diagnosed congenital or acquired disabilities and receive additional benefits through this pathway (Medicaid and CHIP Payment and Access Commission, 2015). Foster youth continue to receive Medicaid while they are in foster care, and may maintain eligibility or be provided coverage from an equivalent program if they are adopted but continue to need medical, mental health, or rehabilitative care (Children's Bureau, 2022).

Health care coverage for former foster youth was introduced in 1999, when 30 states opted in to the Chafee Act extending Medicare eligibility for foster youth aging out of the system until they were 20, 21, or 22 years old as determined by state law (Bullinger & Meinhofer, 2021). In 2014, the ACA expanded upon the Chafee Act and established Medicaid eligibility for the "former foster care" group which enables young adults who have aged out of foster care to receive Medicaid until the age of 26. In 2018, the Substance Use-Disorder Prevention that Promotes Opioid Recovery and Treatment for Patients and Communities Act amended the ACA to ensure that young adults who were previously in foster care would still be eligible for Medicare if they moved to a different state (Children's Bureau, 2022). Between the ages of 26 and 64, an adult previously in foster care may only qualify for Medicaid by disability or if their household income is no more than 133 percent of the federal poverty level (Children's Bureau, 2022; Medicaid and CHIP Payment and Access Commission, 2013, p. 3). During this time, subsidized programs or other health insurance plans can be viable options for health care coverage.

The final relevant component of the SSA requires states to ensure that foster youth are not inappropriately diagnosed. When an abuse-related TBI victim receives a health screening and subsequent assessment, these procedures reveal all health symptoms and conditions, including those related to TBI. Unfortunately, many symptoms for other physical and behavioral health concerns, such as emotional trauma can overlap with the symptoms of TBI. Consequently, it can be difficult to distinguish whether current symptoms were pre-existing, exacerbated by the injury, or a result of trauma related to being placed in foster care (Washington State Department of Children, Youth, and Families, 2019). To date, no state has established a clear protocol to prevent the misdiagnosis of TBI. Due to the significant association between TBI-related symptoms and psychological distress or mood disorders, untreated TBI is often mistakenly identified as a psychiatric disorder and the individual incorrectly referred to a psychiatrist for treatment (Deurr, 2021; Fann et al., 2009; T. Hart & Cicerone, 2017; Robert, 2020).

To improve nation-wide protocols for identifying untreated TBI in current and former foster youth, the federal requirements mandated by the SSA need to be more specific. The Washington State Department of Children, Youth, and Families (DCYF) has proposed two potential strategies to more reliably identify a history or presence of TBI in current foster youth. The first strategy would incorporate specific TBI-related questions in initial physical health screening questionnaires. Answers to these questions will allow medical professionals to actively assess for a history of TBI and more easily differentiate between TBI symptoms and other physical or behavioral health concerns. Moreover, TBI-related questions in the initial health screening will establish a baseline against which all future health screenings can be compared. This will allow medical professionals to easily flag differences in future screenings that may indicate effects of a TBI. Redefining physical health screenings to include specific TBI-related questions will increase and standardize the detection of TBIs in foster youth and contribute to more timely interventions and enhanced overall outcomes (Washington State Department of Children, Youth, and Families, 2019).

In accordance with the DCYF's first proposal, the inconsistencies in state screening protocols recorded by the Center for Health Care Strategies must be addressed. While states may ultimately define their requirements, the SSA mandates that they collaborate with medical experts and child welfare experts to determine the best strategies (*42 U.S. Code § 622 - State Plans for Child Welfare Services*, 2023). The American Academy of Pediatrics and the Council on Accreditation have both established specific recommendations for the screening and assessment of children in foster care. The American Academy of Pediatrics recommends that upon entry into foster care, a health screening should occur within 72 hours of placement. Further, a detailed, comprehensive evaluation of the child's mental health, developmental health if they are under 6 years old, educational needs if they are over 5 years old, and dental health must be available within 30 days. Lastly, a follow-up health visit should occur within 60-90 days after placement (Allen, 2010). Similarly, the Council on Accreditation recommends that an initial physical, behavioral, and dental health screening occurs within 72 hours of placement and follow-up assessments take place within 30 days (Allen, 2010). Based on the consensus of these and other national organizations, I suggest that federal laws be amended to require states to conduct physical, behavioral, and dental health screenings within 72 hours of a child's placement, complete further assessments no more than 30 days later, and begin any necessary treatment within 60 days in order to appropriately identify and address TBIs (Allen, 2010).

The second strategy proposed by the DCYF would include a recommendation to perform TBI screening in the Medicaid Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) Program Billing Guide (Washington State Department of Children, Youth, and Families, 2019). This guide provides medical professionals with instructions on billing appropriately for services provided under the EPSDT program, which is a benefit for all Medicaid-covered children. Including TBI screening as part of the EPSDT, would create a focus on brain injuries in a well-established medical exam and provide a public health approach to the issue (Washington State Department of Children, Youth, and Families, 2019). Establishing routine TBI screenings ensures comprehensive and widespread assessment, leading to early detection and intervention for improved outcomes.

By decreasing the number of untreated TBI cases, the two proposals of the DCYF would address the SSA requirement of state procedures that prevent foster youth from being inappropriately diagnosed (*42 U.S. Code § 622 - State Plans for Child Welfare Services*, 2023). It is especially important to avoid misdiagnosing or failing to identify TBI in foster youth because earlier treatment and rehabilitation has been found to achieve better treatment outcomes (Dang et al., 2017). Moreover, misdiagnosis of TBI as a psychiatric disorder can lead to an individual receiving the wrong treatment and, although conventional therapies and medications can improve psychological symptoms, they will not address the underlying brain damage from the TBI (Bramlett & Dietrich, 2015; Dang et al., 2017; National Academies of Sciences et al., 2022). Thus, specifying the law to require all states to adopt Washington's proposals would help ensure that TBI cases are promptly and properly diagnosed as they are expected to be under the SSA.

When a foster youth ages out of the system, the SSA no longer requires states to meet their health care needs, but it does dictate that the individual be provided with options for health insurance, information about a health care power of attorney, and documents to establish a health care proxy (*42 U.S. Code § 622 - State Plans for Child Welfare Services*, 2023). However, as foster youth age out of the system, they may unknowingly suffer from unresolved health conditions due to the complex nature of the foster care system. Without proper understanding and awareness of these conditions, they may not recognize the need to seek assistance or support for their conditions. In order to identify untreated TBI in foster youth who have aged out of the system, states should be required to educate these individuals on their health insurance status, how to seek medical care, and health conditions that are commonly affiliated with the foster care system, including TBI.

I suggest that the SSA be amended in two ways to increase the self-identification of untreated TBI in all foster youth. First, all foster youth, not just those who are aging out, should be taught the details of their insurance coverage, how to establish a power of attorney and health care proxy, and how to seek medical care should they need to. Information should be tailored to be applicable and comprehensible for different age groups, but every child in foster care should understand their right to proper health care. A special emphasis should be placed on the disability pathway of Medicaid as individuals who qualify may be able to access additional benefits. The purpose of this is to promote an awareness of health from the moment an individual is placed in foster care. Research shows that not knowing how to access treatment increases the likelihood that an individual will avoid or delay seeking treatment (Coombs et al., 2021; Radez et al., 2021). By clearly teaching foster youth how they can afford and access medical care, states can empower foster youth to value their health and seek timely treatment whenever they are injured.

Second, all foster youth should be educated on the symptoms of highly prevalent health conditions in the foster care system, including TBI. There is an abundance of research on the high prevalence of undiagnosed or under-treated medical problems among foster youth and the barriers that medical professionals face in identifying these issues (American Academy of Pediatrics, 2021). Although not applicable to all health conditions, states can educate foster youth on many common issues such as TBI, fractures, infections, asthma, visual or hearing loss, anxiety, and depression which have distinct warning signs that foster youth can learn to report. Understanding how a TBI can occur, what its symptoms look like, and why it can be dangerous could help young adults recognize when they need to seek treatment (National Academies of Sciences et al., 2022). Additionally, this increased self-awareness and knowledge may help an individual realize the importance of getting care immediately and alleviate any reticence.

One drawback to increasing the frequency of TBI screening is that the process may uncover incidents of abuse that children are not emotionally ready to disclose. Speaking out about abuse can be incredibly difficult for a child for all of the reasons explained in Chapter III. Moreover, if an abuse-related TBI is revealed for the first time by a TBI screening rather than the child disclosing it themself, the child may be more reluctant to speak up or completely deny that the abuse ever took place (Rush et al., 2014). This barrier is difficult to address, especially with children, but my hope is that if foster youth could be made more aware of the consequences of TBI and their options for getting care, they may be more motivated to seek treatment. With this amendment, my goal is to better equip current and former foster youth with the knowledge and resources to identify and address any TBIs they may have experienced while in care.

Altogether, improving the identification of untreated TBI in the foster care system will require federal laws that explicitly dictate time frames for TBI screenings, and laws that require states to educate foster youth on their right to health care and how to self-identify common health conditions. While the SSC currently provides a framework for health screenings and assessments, there are inconsistencies among the interpretation of the law by states. With these proposed revisions, federal law would hold states to a higher standard and health care professionals may be able to identify untreated cases of TBI earlier and more frequently.

Emerging Treatment Methods

Victims of abuse-related head injuries face many barriers in accessing care such that by the time they are able to get treatment, a significant amount of time may have passed since the initial injury. At this point, the effectiveness of the acute care procedures and conventional rehabilitative treatments mentioned in Chapter II may diminish. However, over time, certain barriers that can impede a foster youth from reporting an abuse-related TBI may diminish or disappear. The cessation of abuse and removal of the perpetrator from their life can alleviate fear and enable the child to feel more comfortable speaking out about their experiences. Additionally, transitions such as moving to a new foster placement or leaving the foster care system altogether may provide opportunities for the child to disclose the abuse they have endured. As a result, as circumstances change, abuse victims may become more inclined to seek and accept the necessary treatment and support they require for their recovery. Thus, methods of treatment that would be efficacious weeks, months, and even years after the injury is sustained may improve the recovery outcomes for those who suffer from an abuse-related TBI in the foster care system.

To reiterate a previous point, there are many symptoms of TBI that can be misdiagnosed as its own disorder and treated as such (Deurr, 2021; Pozzato et al., 2020; Substance Abuse and Mental Health Services Administration, 2021). However, to fully address traumatic brain injury, it is necessary to not only treat the symptoms but also target the underlying physical brain damage (Bramlett & Dietrich, 2015; Dang et al., 2017; National Academies of Sciences et al., 2022). Emerging treatment methods offer hope for victims of abuse-related TBI who may have limited access to conventional care due to the barriers present in the foster care system. These methods take into account the unique needs and circumstances of each patient, and aim to address the physical brain damage as well as the associated symptoms.

Stem Cell Therapy. Recent studies have proposed the use of stem cells for treating TBI due to the cells' unique ability to migrate to injured brain tissue, and take on specific functions and characteristics in order to replace the damaged cells. Some stem cells also play a role in reducing inflammation and promoting growth, leading to a significant improvement in brain function. A recent publication reviewed several types of stem cells and their effects and limitations in treating TBI (Y. Zhou et al., 2019).

Mesenchymal stem cells (MSCs) are found in many different tissues throughout the body, including bone marrow, fat, and umbilical cord tissue. MSCs can potentially help in the repair of damaged brain tissue by migrating to the site of injury, releasing anti-inflammatory and growth factors, and differentiating into new cells. A study in 2021 produced favorable safety and efficacy outcomes for the treatment of chronic motor deficits with MSCs after TBI (Kawabori et al., 2021). However, the ability of MSCs to fully replace damaged brain cells is limited and still being studied.

Multipotent adult progenitor cells (MAPCs) are derived from bone marrow and may improve spatial learning, information retention, memory retrieval, and dyskinesia after TBI, and maintain the integrity of the blood brain barrier. MAPCs can differentiate into a wider range of cell types than MSCs, however, the mechanisms of action are not fully understood and they may be limited in what kind of cells they can become and their role in the immune system.

Induced pluripotent stem cells (iPSCs) are generated in a lab by reprogramming adult cells to behave like embryonic stem cells. iPSCs can differentiate into more cell types than MAPCs, but their potential for treating TBI is limited as they may cause tumors and not much is known about the genetic and epigenetic characteristics of the reprogrammed cells.

Endothelial progenitor cells (EPCs) are stem cells that can replace damaged blood vessel cells after injury. They can also improve white matter integrity and reduce capillary damage. Treating brain damage with EPs has shown promising results in improving neurological function after TBI, but more research is needed to ensure their effectiveness and safety.

Neural stem cells (NSCs) demonstrate the greatest potential for TBI treatment as they can differentiate into neurons, glial cells, and oligodendrocytes, and may be an effective, long-term treatment for neurological recovery. In a study using adult rats, researchers found that NSCs can enter a damaged brain, survive, migrate, and promote functional recovery (Jeong et al., 2003).

However, research is still ongoing as to the effectiveness of NSC therapy in the subacute and chronic phases of TBI (Schepici et al., 2020; Y. Zhou et al., 2019).

Stem cell therapy shows promise as a treatment for subacute and chronic TBIs, and could directly benefit those who were unable to receive care following the initial injury. By promoting tissue regeneration and neurological repair, stem cell therapy holds promise for restoring damaged brain tissue and improving overall recovery outcomes. While there are still limitations to the large-scale application, safety, and efficacy of stem cell therapy, recent studies have shown promising results in animal models and early-stage clinical trials.

Transcranial Magnetic Stimulation (TMS). Non-invasive brain stimulation techniques could potentially treat subacute and chronic TBI by stimulating specific areas of the brain to improve cognitive function, reduce depression, and enhance plastic changes to facilitate learning and recovery of function (Barman et al., 2016; Demirtas-Tatlidede et al., 2012). TMS is a painless procedure in which a magnetic coil is placed on the scalp to deliver magnetic pulses to targeted regions of the brain.

Current literature supports that during the subacute stage, TMS may help to improve damaged circuits in the brain that can still be salvaged by keeping the individual alert and avoiding the activation of other competing circuits (Demirtas-Tatlidede et al., 2012). Another study on pediatric rats with TBI demonstrated that TMS successfully improved long-term function of brain cells and restored neuronal functions to levels seen in healthy rats of the same age (Lu et al., 2015). These results suggest that TMS can guide neurorehabilitation after pediatric TBI. A later study investigated the effects of TMS in adult rats alongside stimulation of the brain by their physical and social surroundings and found that the combined therapy enhanced cortical excitability and led to significant functional improvement (Shin et al., 2018).

While the evidence for the effectiveness of TMS in treating subacute and chronic TBI is still mainly theoretical, there is potential for this technique to further improve cognitive skills and functional abilities. However, further research is needed to fully understand the potential benefits and limitations of TMS in the treatment of TBI.

Transcranial Direct Current Stimulation (tDCS). tDCS is another non-invasive brain stimulation technique that has shown promise as a potential treatment for both subacute and chronic TBI. The technique involves applying a low electrical current to the scalp in order to modulate neuronal activity in the brain. The current is delivered through electrodes placed on the scalp, and it is thought to modify the excitability of neurons in the targeted brain region. The effects of tDCS are believed to result from changes in the resting membrane potential of neurons, which can lead to alterations in synaptic plasticity and functional connectivity (Demirtas-Tatlidede et al., 2012).

Research has found that tDCS may counter chemical secondary injuries in the subacute stage by preventing excitotoxicity, whereas during the chronic stage, tDCS can promote the learning of new skills and cortical plasticity to enhance behavioral recovery (Demirtas-Tatlidede et al., 2012). A systematic review of 14 studies identified positive outcomes for responsiveness, cognition, and motor functions, however, there were some conflicting results and more research is needed to confirm that tDCS improves TBI recovery (Zaninotto et al., 2019). Nonetheless, overall results were encouraging and further studies, especially involving markers to track therapeutic progress, could help better identify the best application for tDCS.

Hyperbaric Oxygen Therapy (HBOT). HBOT is a treatment that involves breathing pure oxygen in a pressurized chamber, typically at a pressure higher than sea level atmospheric pressure. It is thought to be a potential treatment for sub-acute and chronic TBI because it can increase the amount of oxygen available for damaged brain tissue, promoting healing and reducing inflammation (Wei et al., 2014). HBOT has been used for a long time with TBI patients, however, there have been many conflicting studies on its effectiveness, and more research is needed to both establish the treatment's reliability and understand its mechanisms (Q. Hu et al., 2016).

In some cases, HBOT has been shown to have positive effects on cerebral blood flow, brain metabolism, and neuroplasticity in animal and human studies of subacute and chronic TBI (Ahmadi & Khalatbary, 2021; Dang et al., 2017; Wei et al., 2014). Literature has also supported that HBOT can increase the pressure gradient for delivering oxygen to brain tissue and help in wound healing by providing oxygen to areas where red blood cells cannot reach (B. Zhou et al., 2016). Still, other studies have found that HBOT provides no benefits during TBI recovery, and that mechanisms of its impact remain unestablished (Crawford et al., 2017; B. Zhou et al., 2016). The conflicting and inconclusive literature on the effectiveness of HBOT for TBI highlights the urgent need for further research, but the promising results observed in some studies suggest that HBOT holds significant potential as a viable treatment option for TBI.

Victims of abuse-related TBIs often face significant barriers to accessing timely care, resulting in delays in treatment. However, as these barriers can diminish over time, individuals may be more inclined to seek support. Emerging treatment methods, such as stem cell therapy, brain stimulation, and hyperbaric oxygen therapy, could potentially allow physicians to treat the underlying physical brain damage of TBIs, even if years have passed since the initial injury.

Additional Rehabilitative Therapies

In order to optimize the outcomes of TBI treatments, it is important to incorporate rehabilitative therapies as needed. Conventional therapies, including physical, occupational, cognitive, and emotional therapies, can significantly aid in the recovery of individuals with TBI by promoting functional improvement, enhancing independence, and improving overall quality of life. However, the effectiveness of these therapies can decrease as more time passes since the initial injury, and additional therapies may be necessary to further maximize recovery potential (Dang et al., 2017). In conjunction with the aforementioned therapies, these complementary therapies can further improve cognitive skills and functional abilities.

Virtual Reality Therapy. Virtual reality therapy is a rehabilitation technique that uses computer-generated simulations to create an interactive 3D environment for TBI patients to practice daily living tasks and improve their cognitive function, balance, and motor skills. The therapy combines computer-aided training with audio and visual stimulations to engage different components of impairment, such as memory, attention, and visual perception, in order to create a personalized experience for patients. This type of therapy is particularly effective in promoting patient interest and enthusiasm in participation. The advanced computer-aided training system fabricates a unique opportunity for integrating computer technology and cognitive science. This integration has incomparable advantages for the assessment and training of cognitive impairment compared with traditional cognitive training by rehabilitation therapists (Dang et al., 2017).

Current literature supports that computer-aided strategies can improve postural stability and mobility in patients with chronic TBI (Chanpimol et al., 2017; Tefertiller et al., 2022; Ustinova et al., 2014). Other studies have found that virtual reality training significantly improves attention, memory, and execution capabilities as well as mood and attitude in subacute and chronic TBI patients (De Luca et al., 2023; Zanier et al., 2018). Virtual reality training also provides aural and visual feedback that allows TBI patients to experience emotional success while reducing anxiety during treatment. Furthermore, this type of training promotes persistence in patients, as they are motivated to practice until they succeed (Dang et al., 2017).

Virtual reality therapy enhances cognitive rehabilitation by providing an effective and personalized approach to subacute and chronic TBI recovery. Due to the computer program's ability to focus on specific impairments, this can be an ideal treatment option for individuals seeking recovery outside of the acute phase.

Neurofeedback Therapy. Neurofeedback therapy uses brain activity feedback to teach patients how to self-regulate and improve their brain function. The process involves placing electrodes on the patient's scalp to measure brain activity, which is then displayed on a computer screen in real-time. The patient then performs specific tasks or exercises designed to stimulate the targeted brain regions or networks. As the patient's brain activity changes in response to the task, the computer provides feedback in the form of visual or auditory cues. In the context of TBI rehabilitation, neurofeedback therapy is used to target specific brain regions or networks that have been affected by the injury. By reviewing feedback on brain activity, patients can learn how to modify their brain waves in real-time, leading to improvements in cognitive function, emotional regulation, and behavior (Gray, 2017; May et al., 2013; Rostami et al., 2017).

Studies have shown that neurofeedback therapy can be effective for improving some cognitive functioning, reducing symptoms of depression and anxiety, and enhancing overall quality of life in patients with TBI (Gray, 2017; May et al., 2013). However, placebo-controlled studies are underrepresented and more research is needed to determine neurofeedback's true efficiency (Gray, 2017; May et al., 2013; Rostami et al., 2017). Some research has also found that neurofeedback therapy can lead to improvements in neuroplasticity, suggesting that it may have neuroprotective effects (Crupi et al., 2020). These findings indicate that neurofeedback therapy can protect brain cells and prevent further damage in the event of re-injury or disease, promoting recovery and minimizing long-term disability.

While more research is needed to determine the long-term efficacy and safety of neurofeedback therapy for TBI treatment, these initial findings are promising. Neurofeedback therapy is a non-invasive and personalized approach to TBI recovery that can be tailored to each patient's specific needs and goals, making it a potentially useful tool for improving outcomes in patients with TBI beyond the acute phase.

Neuropsychological Rehabilitation. Neuropsychological rehabilitation is a combination of therapeutic services which includes individual and group therapies, psychotherapy, psychoeducation, and family therapy. The holistic neuropsychological intervention stresses metacognitive and emotional regulation techniques for cognitive deficits and emotional difficulties (Wilson, 2008). TBI patients who undergo neuropsychological rehabilitation demonstrate greater improvements in community functioning compared to those who received conventional rehabilitation. This technique facilitates skill development, behavioral and affective regulation, and community integration (Barman et al., 2016).

Neuropsychological rehabilitation is an optimal choice for victims of abuse-related TBI in the foster care system because it aims to address the complex interplay between cognitive, emotional, and behavioral symptoms. The comprehensive nature of this approach means that patients can receive a range of services from one therapist or team of therapists, rather than having to balance multiple individual therapists. This can be more convenient and efficient as it reduces the need to travel to multiple appointments and coordinate between different providers. Ultimately, neuropsychological rehabilitation provides a holistic, patient-centered approach that can greatly improve outcomes and quality of life for those with chronic and subacute TBI.

Maintaining Affordability and Accessibility

As emerging procedures and therapies for subacute and chronic TBI become more established, victims of abuse-related head injuries in the foster care system must be kept informed of the available treatments and ways to obtain them. Health care professionals and advocates for foster youth can play a significant role in increasing awareness about TBI and improving treatment affordability in order to alleviate these barriers.

There are several ways health care professionals and foster youth advocates can increase awareness about TBI among current and former foster youth. Health care professionals can educate and provide resources to both foster youth and their caregivers about the nature and impacts of TBI. This can involve providing informational materials, such as brochures or pamphlets, as well as educating caregivers on how to identify and respond to potential signs and symptoms. Health care professionals can also work with foster youth advocates and collaborate with the foster care system to provide workshops, seminars, and informational materials on TBI prevention, symptoms, and treatment options. Additionally, social media platforms can be used to disseminate information and raise awareness among the foster youth themselves. Lastly, health care professionals and foster youth advocates can lobby for policy changes that prioritize the provision of accessible TBI treatments and resources for this vulnerable population.

As for ensuring that emerging TBI treatments remain affordable, both health care professionals and advocates for foster youth can fight for policies that promote access to affordable health care, such as comprehensive insurance coverage by Medicaid and other providers for TBI treatments. They can also work with lawmakers to increase funding for TBI research and treatment programs, and support initiatives that provide financial assistance for TBI treatments not currently covered by Medicaid. Additionally, advocates can educate the public and raise awareness about the importance of affordable TBI treatments for foster youth and work to reduce any stigma and discrimination associated with TBI.

Health care professionals, specifically, can use their platforms to advocate for treatment affordability under multiple insurance providers. They can also ensure their patients understand which financial assistance programs or resources can help them cover the costs of treatment, especially after patients have aged out of the foster care system. Furthermore, health care professionals can work with their patients to develop treatment plans that are affordable and take into consideration the patient's financial situation. By taking on an intentional role in improving treatment affordability, health care professionals can help ensure that their patients receive the care they need without facing financial hardship.

Increasing the awareness and affordability of emerging treatments for subacute and chronic TBI is an essential component of addressing the abuse-related head injury epidemic in the foster care system. Even as potential treatment options become established, foster youth who have been living with a TBI may not understand their injuries or be aware that they can seek treatment. As such, an active effort from healthcare professionals and foster youth advocates will help to ensure that every victim of an abuse-related TBI in the foster care system has the opportunity to be treated for their injuries and guided through rehabilitation for optimal patient outcomes.

Conclusion

Physical abuse and TBI are common in the foster care system, but many foster youth are denied treatment and proper recovery due to psychological barriers and circumstantial factors. Without appropriate medical care, TBI can have significant consequences on a child's physical, cognitive, emotional, and social development, but methods of treatment outside of the optimal acute time frame are not fully established. This thesis explored the treatment gap for subacute and chronic TBI originating from child abuse in the foster care system, and identified emerging screening processes, procedures, and rehabilitative therapies that may someday bridge this gap.

Part III of this thesis detailed numerous psychological barriers and circumstantial factors that can hinder a foster youth's ability to receive proper treatment, follow-up care, and/or recovery following an abuse-related TBI. Emotional barriers including fear, guilt, denial, distress, and loyalty can cause a reluctance by the child abuse victim, the perpetrator, unoffending caregivers, and child witnesses or confidants to seek medical attention. Barriers such as ignorance and neglect can also prevent post-injury care. Other interfering factors such as limited resources, financial constraints, language barriers, and lack of knowledge and awareness can further complicate recovery efforts. All of these factors create significant challenges for foster youth in accessing appropriate care and achieving full recovery from TBI.

Part IV identified a few methods for recognizing and treating TBI in the subacute and chronic phases that could mitigate long-term consequences among abuse-related TBI victims. Federal provisions establishing TBI-specific screening protocols as a component of regular medical exams could help to ensure a reliable identification of TBI among foster youth, and diminish the amount of untreated injuries. Furthermore, procedures involving stem cells, brain stimulation, and oxygen therapy could address the root of TBI by repairing or replacing damaged brain tissue regardless of how much time has passed since the initial injury. Finally, additional therapies using virtual reality, neurofeedback, or a holistic neuropsychological approach could promote better recovery of functional and cognitive abilities.

While this thesis explored the impact of abuse-related head trauma in the foster care system and potential ways to alleviate this epidemic, there are several limitations that should be acknowledged. First, the scope of this study was limited to physical trauma and did not include other forms of brain damage such as emotional trauma. The complex interplay between physical and emotional trauma, especially among foster youth, may impact the effectiveness of subacute and chronic TBI treatments. Second, more research will be required to study the trends of decreased disclosure when the law imposes repercussions. The treatment and identification protocols proposed in Chapter IV are tailored to individuals who at some point after sustaining a TBI will want to seek help. However, future proposals should continue to find ways to outweigh an individual's opposition to repercussions via cost-benefit analysis. Third, this thesis focused only on the United States foster care and healthcare systems. This may limit the generalizability of the findings to foster care populations in other countries. Finally, this thesis was restricted to open-access literature and findings may not have been as comprehensive as possible.

Future research might address these limitations by conducting a more thorough analysis of the relationship between physical and emotional trauma, examining the laws that tend to decrease disclosure of abuse, and expanding beyond the United States to other orphaned populations worldwide. To overcome resource constrictions, future studies should incorporate a broader range of literature, including non-open access sources, to ensure that findings are comprehensive and up-to-date.

Going forward, bridging the treatment gap for subacute and chronic TBI has the potential to reduce the number of current and former foster youth suffering from long-lasting consequences of an inadequately treated abuse-related TBI. Future research in this area should focus on further developing the diagnosis and treatment methods mentioned in this thesis as well as other effective treatment methods that can meet the unique needs of foster youth with TBI. Additionally, research should explore ways to improve access to care and support for this vulnerable population, including better coordination between healthcare providers, foster care agencies, and other support services.

Appendix

Response Type	Ages 5-21 Response	Ages 0-5 Response	Score
Eye Response	No response	No response	1
	Eyes open to pain	Eyes open to pain	2
	Eyes open to sound	Eyes open to sound	3
	Eyes open spontaneously	Eyes open spontaneously	4
Verbal Response	No response	No response	1
	Incomprehensible sounds	Moans in response to pain	2
	Inappropriate words	Cries in response to pain	3
	Confusion	Cries in irritation	4
	Oriented response	Coos and babbles	5
Motor Response	No response	No response	1
	Abnormal extension to pain	Abnormal extension to pain	2
	Abnormal flexion to pain	Abnormal flexion to pain	3
	Withdrawal from pain	Withdrawal from pain	4
	Purposeful movement to painful stimulus	Withdrawal from touch	5
	Obeys commands	Moves purposefully	6

Table 1: The Glasgow Coma Scale (Jain & Iverson, 2022)

Criteria	Mild TBI	Moderate TBI	Severe TBI
Neuroimaging	Normal	Normal or Abnormal	Normal or Abnormal
Loss of Consciousness	0 - 30 Minutes	30 Minutes - 24 Hours	> 24 Hours

Alteration of Mental State	1 Minute - 24 Hours	> 24 Hours	> 24 Hours
Memory Loss	0 - 1 Day	1 - 7 Days	> 7 Days
GCS Score	13-15	9-12	3-8

Table 2: Criteria Used to Classify TBI Severity (Brasure et al., 2012)

	Acute Care	**Follow-Up Care**	**Ongoing Care**
Child Abuse Victim	- Fear - Guilt - Ignorance - Distrust - Denial - No autonomy - Normalization	- Distress - Pain - No motivation - No support - Negative coping mechanisms	- Fear - Guilt - Ignorance - Distrust - Distress - Shame
Perpetrator Note- Barriers to providing follow-up care and ongoing care only apply when the perpetrator is a foster caregiver	- Fear - Neglect - Guilt - Denial	- Fear - Neglect - Guilt - Distress - Too busy	- Fear - Neglect - Denial - Distress - Scheduling challenges - Stigma - Personal TBI history
Unoffending Foster Caregiver	- Fear - Neglect - Denial - Loyalty	- Fear - Neglect - Distress - Guilt - Too busy	- Fear - Neglect - Denial - Distress - Scheduling challenges - Stigma - Personal TBI history
Child Witnesses or Confidants	- Fear - Shame - Ignorance - Distrust - Loyalty - Trauma		- Fear - Shame - Ignorance - Distrust - Guilt - Distress - Sworn secrecy

Environmental Factors	- Low resources - Finances - Ignorance - Language barriers	- Low resources - Finances - Ignorance - Language barriers - Lack of executive skills - Distant facilities	- Low resources - Finances - Ignorance - Language barriers - Lack of executive skills - Distant facilities

Table 3: Summary of Personal and Environmental Barriers to TBI Care for Victims of Child Abuse in the Foster Care System

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