

## Predictors in Outcomes of Head Trauma in Pediatric Age Group: A Brief Review

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### Abstract

Head trauma is the leading cause of fatality around the world, and if survived can be a major cause of mental disability. It is therefore essential to look at the predictors, which can affect the outcome, management, and prognosis of head injury in pediatric age group. Some of the predictors discussed in this article include age, gender, extent of brain injury, type of trauma, types of sports, non-accidental injuries (e.g. child abuse resulting in shaken baby syndrome), preinjury behaviors, Glasgow coma scale (GCS), hypotension, previous injury, site of initial care, coagulopathies, polytrauma, pneumothorax, hospital stay less than seven days in a child < 18 years, and post-traumatic seizures. In addition, various protective predictors of head trauma, such as wearing a helmet and seat belt are also important predictors in deciding the outcomes.

**Keywords:** Neurotrauma; Neurology; Head Injury; Trauma; Pediatrics; Emergency Medicine

### Introduction

Trauma has been one of the leading cause of morbidity and mortality among all age groups. According to the world health organization (WHO), pediatric population is more prone to traumatic injuries, accounting for about 1 million deaths annually worldwide [1]. The percentage of deaths secondary to trauma is around 45% in children aged 1 - 14 year [2]. Each year an overwhelmingly large number of children with head injuries are admitted to the emergency department due to head trauma. It also tops the morbidity and mortality graphs in the pediatric population. Trauma is classified as accidental and non-accidental on basis of the mechanism of injury, falls are reported to be the most common cause of head traumas, followed by motor vehicle-related accidents. Child abuse is another important cause of trauma in kids less than 2 years of age [3]. Two types of brain injuries can occur following head trauma i.e. Primary and Secondary. Primary brain injury results from a direct mechanical damage at the time of injury, whereas secondary injury is caused by cellular damage that develops hours or days post-injury. Structural and physiological factors are found to be the cause of different outcomes in children when compared to adults e.g. thinner and more pliable cranial bones that make the brain more susceptible to the damage, large head to torso ratio and the development of air sinuses makes kids more prone to falls [4], also there are multiple physiological and adaptable changes that a child must counter during head trauma [5]. Several factors predict the outcomes of these traumatic injuries and a careful assessment of these factors can thus cause a significant decrease in disability amongst these patients. These factors include the age and gender of patient, type and extent of the injury. Overall, an early management can help decrease the mortality rate by 30% [6].

### Review

Head trauma is one of the most complicated cases reporting to an Emergency room (ER). It is associated with a high probability of fatality and if survived can lead to the development of multiple mental and neurological disabilities thus worsening the overall quality of

life [1,7]. Evidence suggests that there are multiple central nervous system problems that can arise after head trauma and it is advisable that a prompt treatment plan should be devised. The long-term outcomes and future of the brain pathology are still challenging for most clinicians [6,8] and there is no hard rule to predict the morbidity that comes with a head trauma among the children.

It is emphasized by Sharples, *et al.* that an adequate treatment plan if devised can reduce the sequelae of events that may occur after head trauma. The process should be identified by the clinicians with an accurate assessment of the injury and an effective critical care plan should be implemented [6]. This is only possible if the trauma team, pediatric attending and the critical care physicians all work together. In some cases, a neurosurgeon or an interventionist is required to quickly respond to a brain lesion. Also, a radiologist or an imaging technician should be part of the team to identify any injured tissue. In short, the outcomes of the head trauma are strongly depended upon the care that is received by the child after the event.

According to a meta-analysis study, if we consider the outcomes of the head trauma in children, it is often emphasized that the rates of surviving an injury are comparatively higher in children when compared to adults [9]. However, a minor head injury is still concerning in children due to the disabling outcomes in this age group caused by the intracranial injuries [9]. Many studies have been conducted to determine the factors that predict the outcomes following childhood head trauma. Some of these factors include the following; age, gender, extent of brain injury, type of trauma, types of sports, non-accidental injuries (e.g. child abuse resulting in shaken baby syndrome), pre-injury behaviors, Glasgow coma scale (GCS), hypotension, previous injury, site of initial care, coagulopathies, polytrauma, pneumothorax, hospital stay less than seven days in a child < 18 years, and post-traumatic seizures.

First, age at injury is the most significant factor which predicts the pattern of brain damage after head injury. Studies have shown that a child over 1-year of age will have a large subdural hematoma after injury; while children between age 2 - 3 months will have a different pattern of brain injury [10]. It is still considered that children less than 5 years of age have a poor prognosis [11,12], this, however, is still debatable as conflicting outcomes are found in one survey [5]. Gender can also be a predictive factor in childhood head trauma. Male children are reported to suffer head trauma more than their female counterparts but not much discussion is found about gender distribution, however, multiple assumptions of lifestyle and activities can be made. This distribution is only for the epidemiological purposes and does not affect the neurological outcomes in a child [13,14]. Also, a child's demeanor is an important variable, since pre-injury behavior predicts outcomes after traumatic brain injury. Increase in aggression is observed in an already aggressive child after head trauma. In addition, parenting styles can affect the outcomes post-injury and it is found that permissive or authoritarian styles can control the child for a short time but on long-term results in worse behavioral outcomes [15]. According to one study delinquent youth is at increased risk for traumatic brain injury and related functional impairments [16]. Mechanism of impact is another important factor, as it can determine the extent of brain tissue injury, for example, falling from a height and high-velocity trauma is associated with worse outcomes [17]. Likewise, sports orientation such as skiing and skateboarding is associated with an increased risk of head injuries. It is therefore recommended that training is provided to children who participate in these sports to prevent further injury [18]. In contrast to the above, taking protective measures such as helmets and seat belts have been found to positively predict the outcome of head trauma [19,20].

Other important aspects to consider are the non-accidental injuries like contusions and shaken baby syndrome (child abuse). These are more concerning as they can easily go undiagnosed and the outcomes can range from behavioral problems, profound mental retardation, spastic quadriplegia, severe motor function impairment to fatality. Severe shaking head injuries require an impact since shaking a normal baby doesn't result in head injuries as seen in shaken baby syndrome. The clue of child abuse is that the caretaker will not provide a history of the injury, the victim is preverbal, multiple hospital admissions or office visits in the past, children with suspicious demeanor, injuries like multiple bruises on different sites, rib fractures, patches of bald areas on scalp, bad dental carries, neglected wound care, severe diaper dermatitis and presenting with non-specific symptoms like vomiting, fever, or irritability. Also, the presence of risk factors like maternal smoking, two or more siblings, low infant birth weight, an unmarried mother and disabled child can be considered [21-25]. Furthermore, few children with recurrent mild traumatic brain injury (mostly accidental) experience worse mental health outcomes because of post-concussive syndrome, in which the patient complains of a headache, dizziness, depressed or anxious mood, fatigue, sleep disturbance, light sensitivity, forgetfulness, and concentration difficulties. The risk factors of post-concussive syndrome are injuries with LOC, initial disorientation, a longer period of persistent post-traumatic amnesia, traumatic brain injury-related abnormalities in neuroimaging, motor-vehicle-related trauma, hospitalization, younger age at injury, limited social support or family stressors, lower IQ, pre-injury behavior or learning problems, and involvement in litigation and the presence of these factors indicates close monitoring [9].

Moreover, the baseline status of the child after injury can also predict the outcomes. Glasgow coma scale (GCS) stays an excellent predictor, although it is controversial that GCS at the time of admission or the numbers at 6h after admission is more reliable in relating the outcomes. Overall, the initial GCS on basis of three degrees can help in deciding the prognosis and chances of mortality [26,27]. Low blood pressure can be an important factor also, even if its associated with blood loss or not. Pigula, *et al.* emphasized that pre-hospital blood pressures can decide the mortality in the head injured population [28]. However, it is also stated that low blood pressure or low oxygen saturation can combine to increase the mortality to many folds. The rates of mortality are reduced in patients who report as normotensive and normoxic levels. It is also considered that if the brain had a previous injury, the outcomes will be worsened. Low blood pressure is just not an important pathophysiological correlate to the head trauma but the concept of disruption in autoregulation with hypoperfusion and ischemia, all aggravate the process [29]. The site of initial care is also essential in determining the outcome of childhood head trauma. If a patient is managed at a hospital with well-trained physicians, they will show better results [30]. In addition, the presence of bleeding disorders, poly-trauma (pneumothorax), children less than 18 years of age, duration of hospital stay less than seven days and seizures are all poor predictors of childhood head trauma [14,31]. Finally, studies have shown that loss of consciousness, headache and vomiting have no effect on the prediction of outcome in childhood head trauma [32-34].

## Conclusion

In this review article we have discussed some of the predictors that can affect the outcome of the trauma in pediatric population. These predictors include age, gender, extent of brain injury, type of trauma, types of sports, non-accidental injuries preinjury behaviors, Glasgow coma scale (GCS), hypotension, previous injury, site of initial care, coagulopathies, poly trauma, pneumothorax, hospital stay less than seven days in a child <18 years, and post-traumatic seizures. We have also highlighted the importance of utilizing some safety equipment's that can lead to positive outcomes in case of neurotrauma.

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