



BOTTOM LINE RECOMMENDATIONS:

Severe Head Trauma

HEAD TRAUMA is categorized as mild, moderate or severe. Head trauma is considered **SEVERE** when children present with a [Glasgow Coma Scale \(GCS\)](#) score of ≤ 8 . These children often have intracranial injury as seen by neuroimaging and all will have suffered traumatic brain injury (TBI), an alteration in brain function caused by external force. **TBI is a critical public health issue** with injury being the leading cause of death in children >1 year of age and TBI the most significant cause of death and disability in this group¹.

PEDIATRIC CONSIDERATIONS

- » Normal curiosity in young children and increased risk-taking behaviour amongst adolescents put children and youth at increased risk of injury. Smaller size and reduced awareness of environmental hazards can increase the likelihood and severity of injuries resulting as occupants in motor vehicle collisions or as pedestrians/cyclists.
- » Anatomically, children have larger head-to-body size ratios (higher incidence of head trauma), thinner cranial bones (increased likelihood of skull fractures) and unfused sutures (better tolerance of increased intracranial pressure).
- » Pediatric brains have increased water content and decreased myelination. **Children are therefore more susceptible to shear injuries such as diffuse axonal injury (DAI) and are at higher risk for cerebral swelling.**
- » Practitioners should be alert for abusive head trauma, particularly in infants and young children.

ASSESSMENT PRINCIPLES

- » Children with severe head trauma should be stabilized as per the principles of advanced trauma life support (ATLS) with special attention to the unique differences in childhood anatomy and physiology (see [TREKK multisystem trauma recommendations](#)). Appropriate cervical immobilization should occur. **Once the need for advanced trauma care is identified, early referral and organization of transport after stabilization is important for optimizing outcomes.**
- » When children present with significant head trauma, assume multisystem injury due to the mechanisms of injury with which children commonly present and their smaller size and unique anatomy. **It is critical to identify and treat shock; unrecognized hypotension significantly increases secondary brain injury.**
- » The modified [Glasgow Coma Scale for Infants and Children](#) should be used to assess and document neurological status in preverbal children. Alternatively the AVPU scale (Alert, Voice, Pain, Unresponsive) can be used; a child who is responsive only to pain or completely unresponsive can be assumed to have a GCS of ≤ 8 and will need to be managed accordingly.
- » Children with severe head trauma will need to have their airway managed prior to transport. **Hypoxia significantly increases secondary brain injury; children should be well-oxygenated pre and post intubation.**
- » Cerebral herniation is a **life-threatening emergency** recognized by symptoms such as:
 - » Progressive obtundation
 - » Unilateral pupillary dilatation
 - » Cushing's triad (hypertension, bradycardia, abnormal respirations)
- » Children requiring referral and transport to a pediatric trauma centre should **NOT** undergo CT imaging prior to transport unless the decision to do so is made with the Trauma Team Leader. CT imaging should **NOT** delay transport and additional scans may result in increased radiation to the patient.

TREATMENT

- » After severe head injury, the main goal of treatment is to **prevent secondary brain injury and minimize increased intracranial pressure.**
- » The foundation of treatment for TBI is excellent cardiopulmonary resuscitation. It is imperative that every effort is made to **avoid hypoxia and hypotension** with effective airway support and appropriate attention to shock. These two factors play the largest role in contributing to secondary brain injury.

Cerebral perfusion pressure (CPP) = Mean Arterial Pressure (MAP) - Intracranial Pressure (ICP)

- » Pain and sedation should be addressed to reduce intracranial hypertension; specific agent outcome data is not available. Choices include fentanyl [1-2 mcg/kg administered intravenously (IV)] and midazolam (0.1 mg/kg IV) if blood pressure allows.
- » Rapid sequence intubation (RSI) agents for pediatric head trauma include the following:
 - » **PRE-INDUCTION** – Atropine 0.02 mg/kg (min 0.1 mg, max 0.5 mg) if < 1 year of age. Have available for any age. **Note:** lidocaine 1.5 mg/kg or fentanyl 2-5 mcg/kg used 3-5 minutes prior to induction may be used but there is limited evidence supporting this practice and should not delay securing an airway.
 - » **INDUCTION** – Ketamine 2 mg/kg **or** etomidate 0.3 mg/kg **or** propofol 1–4 mg/kg.
 - » **PARALYTICS** – Rocuronium 1 mg/kg **or** succinylcholine 1-2 mg/kg.

MANAGEMENT OF CEREBRAL HERNIATION

- » This includes STAT (immediate) reduction of intracranial pressure:
 1. Hyperventilation to pupillary response (watch for constriction).
 2. Use of hypersomolar agents (**3% hypertonic saline 3ml/kg** and repeat as needed, and/or **mannitol 0.25-1 g/kg**). **Note:** hyperosmolar therapy is generally used only for patients showing signs of clinical herniation.
 3. Airway protection with RSI while cervical spine immobilization is maintained. Head of bed can be raised to 30 degrees (reverse Trendelenburg).
 4. Neurosurgical intervention for hematoma evacuation or decompressive craniectomy.
- » Aim for **euthermia and normocapnia (end tidal CO₂ 35-40)**. **Hyperventilation should be reserved for herniation.** Inadvertent hyperventilation with low or low-moderate paCO₂ contributes to cerebral ischemia and should be avoided.
- » Seizures should be controlled with benzodiazepines (ativan or midazolam 0.1 mg/kg IV) and consideration of phenytoin or fosphenytoin (10-20 mg/kg IV) for further prophylaxis.
- » Hemostatic resuscitation, including blood products and consideration of tranexamic acid (if less than 3 hours from injury), should be administered as needed if hemorrhage and ongoing shock.

The purpose of this document is to provide healthcare professionals with key facts and recommendations for the diagnosis and treatment of severe head trauma in children in the emergency department. This summary was produced by the severe head trauma content advisor for the TREKK Network, Dr. Suzanne Beno of the Hospital for Sick Children, and uses the best available knowledge at the time of publication. However, healthcare professionals should continue to use their own judgment and take into consideration context, resources and other relevant factors. The TREKK Network is not liable for any damages, claims, liabilities, costs or obligations arising from the use of this document including loss or damages arising from any claims made by a third party. The TREKK Network also assumes no responsibility or liability for changes made to this document without its consent.

This summary is based on:

- 1) Catherine A Farrell; Canadian Paediatric Society, Acute Care Committee. *Management of the paediatric patient with acute head trauma*. Paediatric Child Health 18 (5); 253-8 (2013).
- 2) Kochanek, PM et al. *Guidelines for the acute medical management of severe traumatic brain injury in infants, children and adolescents - 2nd edition*. Pediatric Critical Care Medicine, 13(1), (2012).
- 3) Zebrack, M, Dandoy, C, Hansen, K, Scaife, E, Mann, NC, Bratton, SL. *Early resuscitation of children with moderate-to-severe traumatic brain injury*. Pediatrics, July; 124 (1); 56-64 (2009).

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