

Acute Management of Traumatic Brain Injury

Updated: 8-1-2024

Purpose:

Provide a framework to the delivery of care to the brain-injured patient. This includes the treatment options for managing traumatic brain injuries in order to avoid secondary brain injury.

Objectives:

- Establish monitoring parameters for treatment
- Control increased intracranial pressure (ICP)
- Optimize cerebral perfusion pressure (CPP) to the brain
- Enhance cerebral oxygen delivery to the brain
- Guidelines for decompression

Definitions:

- Severe head injury includes: Post resuscitation GCS of 3-8 with or without an abnormality noted on a head CT scan.
- Moderate head injury includes: Post resuscitation GCS of 9-13

Indications for Neurosurgery Consultation:

1. Intracranial hemorrhage meeting Brain Injury Guideline 3 criteria
2. GCS 3-8 with traumatic mechanism regardless of Head CT findings, after initial resuscitation

I. Assessment:

Clinical Assessment includes:

- Glasgow Coma Scale (Table 1)
- Pupillary responsiveness
- Cranial Nerve Exam
- Motor Strength/Tone
- Sensory Assessment

Table 1: Glasgow Coma Score

	1	2	3	4	5	6
Eye Opening	None	To Pressure	To Sound	Spontaneous		
Verbal Response	None	Sounds	Words	Confused	Oriented	
Motor Response	None	Extension (Decerebrate)	Abnormal Flexion (Decorticate)	Normal flexion (Withdraws)	Localizing	Obeys Commands

Diagnostic assessment of brain injury may include:

- Brain imaging: CT*, MRI
- Cerebral Vascular imaging: CTA, MRA, MRV, angiography

CTA head should be obtained for all penetrating gunshot wounds to the head

- Cerebral perfusion imaging
- Intracranial pressure (ICP) monitor
- Cerebral brain tissue oxygen monitor (PbtO2)
- EEG monitoring

*All trauma patients undergo initial non-contrasted CT head and CTA neck (unless contrast contra-indicated) during initial trauma evaluation.

II. Initial Trauma Bay Management:

Table 2: Goals of Treatment for Traumatic Brain Injury (Prevention of secondary insult)

Pulmonary	Pulse Ox \geq 94%	PaO2 \geq 100	PaCO2 35-40 mm HG	
CV	SBP \geq 100 mm HG			
Neuro	ICP $<$ 22 mm HG	CPP \geq 60		
Metabolic	pH 7.35-7.45	Temp 36-38°C	Glucose 80-180	
Labs	INR $<$ 1.4	Plts \geq 100,000	Serum Na $>$ 138 & $<$ 160	Hgb \geq 7

1. Airway Management

- a. Supplemental O2 to maintain SaO2 \geq 94%
- b. Intubate for GCS 3-8 or inability to protect airway. Rapid sequence intubation is recommended.
- c. Titrate ventilator settings to maintain PaO2 \geq 100 mm HG and PaCO2 35-40 mm HG
 - i. Note: May hyperventilate to PaCO2 of 30-35 mm HG for brief time (up to 30 minutes) if concerns for active herniation. Otherwise prophylactic hyperventilation is not indicated and can cause rebound intracranial hypertension.

2. Circulation

- a. Establish minimum of 2 large bore IV's
- b. Place arterial line at earliest opportunity in Severe TBI patients without delaying diagnostic imaging (non-contrasted Head CT)
- c. Fluid resuscitation with Normal Saline (NS) or Lactated Ringers (LR)
- d. Avoid hypotension (goal SBP $>$ 100mm Hg, Goal MAP \geq 70 mm Hg)

3. Disability

- a. Determine patient's GCS and assess pupils
- b. Assess motor strength/tone
- c. Perform sensory assessment
- d. Assess for seizure activity

4. Diagnosis

- a. Rapidly progress through primary and secondary survey and obtain non-contrasted Head CT in patients stable for movement to CT

- b. Senior Resident or Attending should accompany patient to CT whenever possible and review CT imaging in real-time with **rapid consultation to Neurosurgery** based on CT findings.

5. Sedation and Analgesia

- a. Sedation: propofol gtt preferred
- b. Analgesia: fentanyl PRN preferred for initial resuscitation
 - i. Consider need for neuro examination and/or brain death testing prior to starting fentanyl gtt
- c. Avoid paralytics until after initial assessment. If paralytics necessary for patient safety use short acting agents and document time given
- d. Ketamine is no longer contraindicated in TBI patients and may be a useful agent in the hypotensive patient

6. Labs

- a. **All patients with an intracranial hemorrhage should have platelet mapping ordered in addition to basic coagulation studies, TEG and Anti-Xa testing.**
- b. See reversal protocol for details on how to interpret platelet mapping and treatment

7. TXA

- a. To be administered within 3 hours of injury
- b. Pt's with clinical signs of **moderate** or **severe** TBI should receive a **2gm bolus of TXA** delivered over 20 minutes.
- c. Pt's with mild TBI may benefit from this same TXA dosing and may be given at the discretion of the trauma attending

8. Medical Management

- a. **Step 1-Should be done in all patients with TBI**
 - i. Maintain neck in midline position and ensure cervical collar is not too tight
 - ii. Elevate the head of the bed to 30 degrees or place in reverse Trendelenberg if maintaining spine precautions
 - iii. Verify oxygenation and ventilation
 - iv. Ensure adequate sedation and analgesia in intubated patients
- b. **Rescue therapy: ONLY for signs of intracranial hypertension or herniation** (i.e. unequal/non-reactive pupils, Cushing's physiology, compressed/absent basal cisterns on CT, pending craniotomy/craniectomy)
- c. Administer hyperosmolar therapy - **Must have Attending approval**
 - i. First line: 3% saline 250 ml bolus
 - 1. Optional: Continue 3% at 50cc/hr pending finalizing hyperosmolar plan with NSGY team
 - ii. Second line: Mannitol 1 gram/kg bolus over 15 minutes
 - 1. Used as last line measure in trauma bay for actively herniating patients only. Avoid mannitol in hypovolemic patients.

- d. Hyperventilate to PaCO₂ goal of 30-35 mm Hg for clinical evidence of active herniation (short term, otherwise normocapnia)

9. Indications for ICP Monitoring:

- a. GCS \leq 8, with an abnormal admission head CT
- b. GCS \leq 8 with normal head CT if \geq 2 complicating factors:
 - i. Age $>$ 40
 - ii. Unilateral or bilateral posturing
 - iii. Systolic BP $<$ 90
- c. Monitor should be considered for:
 - i. GCS $>$ 8 with lesions at high risk for progression
 - ii. GCS $<$ 8 without other possible pathology (pharmacologic)
 - iii. Pt's with brain injury that require urgent operative intervention of other life threatening injuries (i.e. unable to perform serial neuro exams)

10. Seizure Prophylaxis:

- a. Patients with significant intracranial pathology should receive a one time 500mg dose of levetiracetam (Keppra)
 - i. loading dose of 20 mg/kg IV if evidence of seizure

11. Sugammadex Use

- a. Sugammadex is used in the reversal of NON-DEPOLARIZING neuromuscular blocking drugs to facilitate urgent neurologic assessment
- b. Sugammadex use in order to facilitate neurologic exam post-CT
 - i. **Requires trauma attending approval** and should only be used if the immediate neuro exam will determine if operative decompression is needed
 - 1. Otherwise, the post-CT neuro exam can be conducted once the paralytic dosing has worn off
 - 2. Assess twitches prior to administration, indicated for 0-2 twitches
 - ii. Requires pharmacy consultation to determine dosing

12. Anticoagulation Reversal in TBI

- a. Correction of coagulopathy is a cornerstone of intracranial hemorrhage management aimed at reducing the risk of expansion of the hemorrhage
- b. A detailed medication history, review of patients platelet count, INR, anti-Xa level, TEG, and platelet mapping should be performed on all patients with ICH.
- c. The decision to reverse a patient's therapeutic anticoagulation and which agent is needed to reverse therapeutic anticoagulation **requires trauma attending approval**
- d. See Anticoagulation Reversal Protocol for a discussion on anticoagulation medications and recommended reversal agents.