

Traumatic Brain Injury – Best Practice Guidelines

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|--------------------------------|---|
| Eye opening (E) | |
| None | 1 |
| To pressure | 2 |
| To sound | 3 |
| Spontaneous | 4 |
| Verbal response (V) | |
| None | 1 |
| Sounds | 2 |
| Words | 3 |
| Confused | 4 |
| Oriented | 5 |
| Motor response (M) | |
| None | 1 |
| Extension (decerebrate) | 2 |
| Abnormal flexion (decorticate) | 3 |
| Normal flexion (withdraws) | 4 |
| Localizing | 5 |
| Obey commands | 6 |

Glasgow Coma Scale

I. Triage & Transport

- a. GCS \leq 13 directly from the scene to highest available trauma facility.
- b. Transferring children with TBI to a pediatric trauma center reduces mortality and morbidity

II. Emergency Department Management

- a. Diagnosis and Imaging
 - i. Multi-detector computed tomographic (MDCT)
 1. Preferred non-contrast imaging of brain
 2. Indications
 - a. Adults
 - i. Altered/depressed mental status
 - ii. HX of loss of consciousness
 - iii. Significant post-traumatic amnesia
 - iv. (age > 65 years of age)
 - v. (anti-coagulants usage; includes novel oral anticoagulants)
 - b. Pediatrics {Pediatric Emergency Care Applied Research Network (PECARN)}
 - i. < 2 years of age
 1. GCS < 15
 2. Palpable skull fracture
 3. Altered mental status (AMS)

4. (Scalp hematoma – excluding frontal)
5. (LOC > 5 seconds)
6. (Not acting normally per parent)
7. (Severe MOI): Fall < 3 ft; MVA; Bike w/o helmet; Struck by high-impact object
- ii. > 2 years of age
 1. GCS < 15
 2. Signs of basilar skull fracture
 3. AMS
 4. (vomiting)
 5. (LOC)
 6. (Severe headache)
 7. (Severe MOI): fall > 5'; MVA; bike w/o helmet; High-impact strike
3. Repeat Imaging
 - a. Persistent AMS should repeat CT in 6 – 12 hours
 - b. Worsening neurologic exam – as soon as possible
 - c. Significant TBI should repeat exam to check progression: 6 – 12 hours
 - d. Patients with supra normal INR on arrival
 - e. Patients with thrombocytopenia
 - f. Patients on platelet inhibitors (e.g. ASA, clopidogrel): if initial exam was negative, then a repeat exam in 4 – 8 hours in ED prior to discharge.

b. Management

i. Goals of Treatment

1. Pulse Oximetry $\geq 95\%$
2. ABG: pH 7.35 – 7.45; PaO₂ ≥ 100 mmHg; PaCO₂ 35-45 mmHg
3. SBP ≥ 100 mmHg (ages 50 – 69) SBP ≥ 110 mmHg (ages 15-49; ≥ 70) – maintain euvolemia
4. Temperature: 36 - 38°C - normothermia
5. Electrolytes: Glucose 80 – 180 mg/dL; Sodium 135 – 145
6. INR ≤ 1.4 ; {consider TEG, ROTEM}
7. Hemoglobin ≥ 7 g/dL
8. Platelets $\geq 75 \times 10^3 / \text{mm}^3$
9. Seizure prophylaxis

ii. Management of Intracranial Hypertension

1. Primary Tier

- a. Elevate Head of Bed 30 - 45° if not contraindicated
- b. Keep neck straight; avoid jugular compression
- c. Airway Control – intubation, avoid hypertension
- d. Sedation/Analgesia (once airway established)
 - i. Benzodiazepines
 - ii. Opioids

- iii. Ketamine
- iv. Dexmedetomidine
- v. Propofol

2. Secondary Tier

- a. Hyperventilation: PaCO₂ 30 - 35 mmHg - temporary
- b. Hyperosmolar therapy (consider central line)

i. Mannitol

- 1. Intermittent boluses: 0.25 – 1 gm/kg – filter system
- 2. Hold for:
 - a. Na ≥ 155 mEq/L
 - b. Osmolality > 320 mOsm/L
 - c. Hypovolemia
 - d. Hypotension

ii. Hypertonic Saline (3%)

- 1. Intermittent boluses: 250 mLs over 30 minutes
- 2. Alternatively: 30 mLs of 23.4% Sodium Chloride
- 3. Hold for:
 - a. Na > 160 mEq/L
 - b. Osmolality > 320 mOsm/L

III. Intensive Care Unit (ICU)

a. Imaging – CT scan

- i. Persistent AMS should repeat CT in 6 – 12 hours
- ii. Worsening neurologic exam – as soon as possible
- iii. Significant TBI should repeat exam to check progression: 6 – 12 hours
- iv. Patients with supra normal INR on arrival
- v. Patients with thrombocytopenia
- vi. Patients on platelet inhibitors (e.g. ASA, clopidogrel)

b. Imaging – MRI

- i. May have role for DAI, CVA
- ii. May have role in pediatrics
 - 1. Consider child life specialist
 - 2. Consider anesthesia for airway and sedation

iii. Requires sedation

c. Monitoring

- i. Intracranial pressure (ICP) is indicated in comatose patients (GCS ≤ 8)
- ii. Evidence of structural brain damage, ventricle compression, or swelling on initial CT imaging
- iii. TBI with normal CT scan if 2 or more: age > 40; uni-bilateral motor posturing, SBP < 90 mmHg
- iv. External ventricular drain (EVD) is the preferred method for ICP monitoring
- v. Cerebral perfusion pressure (CPP) = mean arterial pressure (MAP) – ICP

- vi. Maintain ICP $\leq 20 - 25$ mmHg
- vii. Maintain CPP $\geq 60 - 70$ mmHg; aggressive treatment to maintain > 70 may increase ARDS
- viii. Maintain Brain Tissue O₂ Monitoring (PbrO₂) $\geq 20 - 25$ mmHg (if available)

d. Management of ICP

- i. EVD system zeroed at the midbrain with continuous drainage of CSF may be considered to lower ICP burden more effectively than intermittent use.
- ii. If Tier 1 and Tier 2 methods fail to reduce ICP and “test dose” of neuromuscular blocking agent (NMBA) should be considered.
- iii. Tier 3
 - 1. Continuous infusion of NMBA to maintain at least two twitches (train of four)
 - 2. Barbiturate or Propofol coma may be induced after a “test dose” to assure ICP reduction
 - 3. Decompressive hemi-craniectomy or bilateral craniectomy consideration if tier 1 or tier 2 treatments fail to reduce ICP or medical management has side effects.
- iv. Nutritional Support
 - 1. Nutrition should begin early, after hemodynamic stability, ideally within 24-48 hours of injury
 - 2. Feeding patients to attain basal caloric replacement at least by the fifth day and, at most, by the seventh day post-injury is recommended.
 - 3. Enteral nutrition is recommended over the use of parenteral nutrition
 - 4. Post-pyloric feeding is recommended to reduce the incidence of VAP.
 - 5. Maintain euglycemia
- v. Venous Thromboembolism (VTE) Prophylaxis
 - 1. VTE prophylaxis should be considered within the first 72 hours in most TBI patients
 - 2. IVC filter should be considered in those who cannot receive pharmacologic prophylaxis
 - 3. Consider sequential compression stockings (SCD) in TBI if low risk of increasing ICP
- vi. Seizure Prophylaxis
 - 1. Phenytoin is recommended to decrease the incidence of early post-traumatic seizures
 - 2. Levetiracetam (Keppra) has insufficient evidence to support routine use in early post-traumatic seizures when compared to phenytoin.

IV. Elderly TBI management considerations

- a. Neurologic evaluation of the elderly with a TBI can be complicated
- b. Anticoagulants and anti-platelet medications can exacerbate the sequelae of TBI
- c. Reversal of anticoagulants and anti-platelet agents to an INR should be considered early on
- d. Older age is associated with higher mortality and worse functional outcomes after TBI
- e. Severe TBI patients should receive full treatment for at least 72-hours post-injury, except those who are brain-dead or in whom advanced directives states against aggressive treatment.

V. References

- a. ACS TQIP Best Practices in the Management of TBI; ACS, January 2015
- b. ACS TQIP Best Practices Guidelines in Imaging; ACS, February 2019
- c. Brain Trauma Foundation, Guidelines for the Management of Severe TBI. 4th Edition. Sept 2016
- d. Appenteng R, Nelp T, Abdelgadir J, et al. A systematic review and quality analysis of pediatric traumatic brain injury clinical practice guidelines. PLoS ONE 13(8):e0201550.

GETAC Trauma Systems Committee - Pending Approval