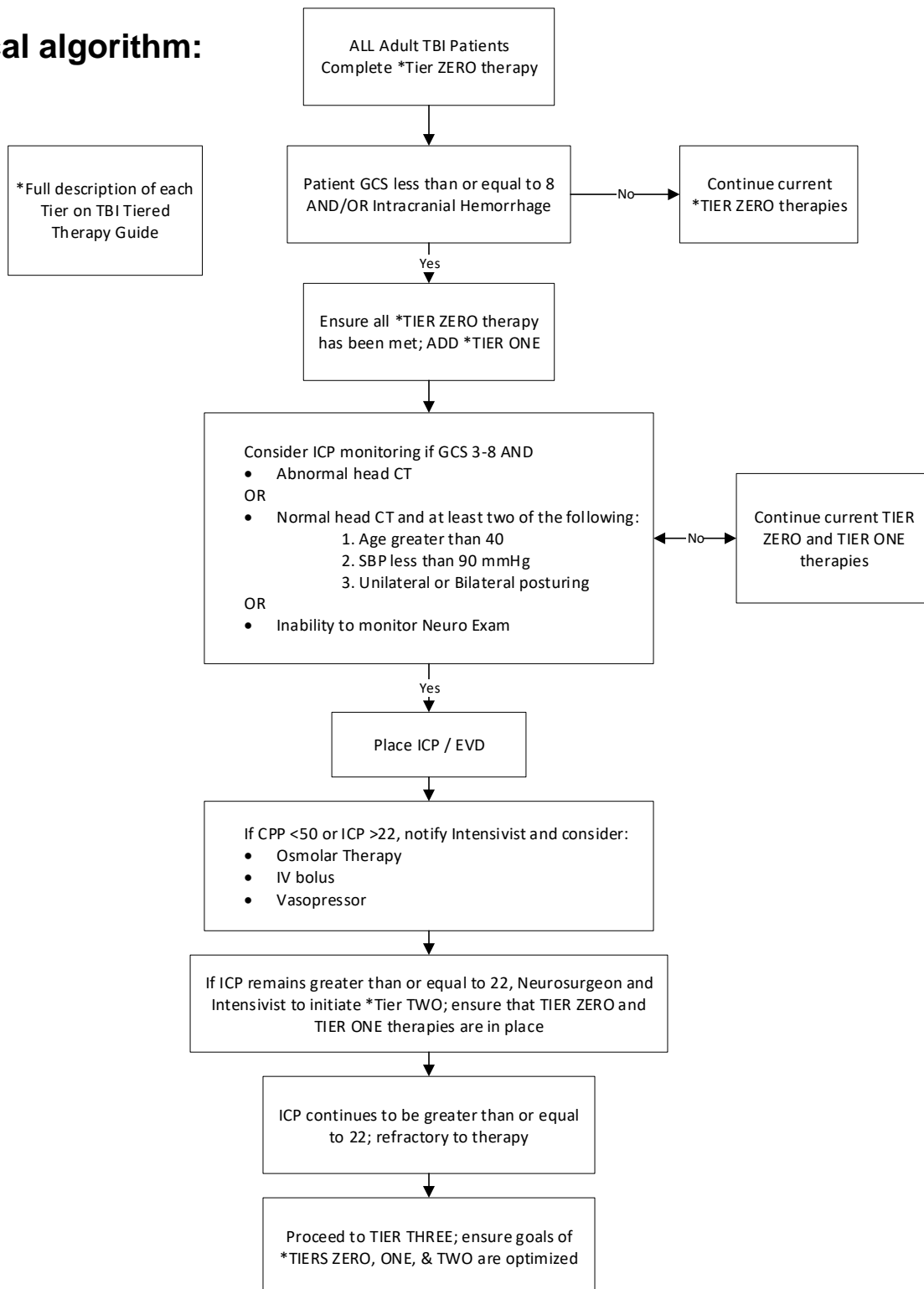


# Guideline: TRAUMATIC BRAIN INJURY, ADULT

Updated: March 3, 2022

## Clinical algorithm:



## **Clinical guideline summary**

**CLINICAL GUIDELINE NAME:** Traumatic Brain Injury, Adult, Guideline

**PATIENT POPULATION AND DIAGNOSIS:** Adult patients with Traumatic Brain Injury (TBI)

**APPLICABLE TO:** Butterworth (Level 1 Trauma Center)

**BRIEF DESCRIPTION:** The Adult TBI Algorithm and TBI Tiered Therapy Guide were developed through a collaboration of Trauma, Neurosurgery, Surgical Critical Care, Neuro Critical Care, and Neurology/ Neuroscience clinical experts from medical and nursing disciplines. Evidence-based guidelines for TBI management have been used to guide this work along with consensus from the experts when no published evidence is available.

**OVERSIGHT TEAM LEADER(S):** Dr. Gaby Iskander, Dr. Patricia Pentiak, Dr. Allister Chapman, Dr. Paul Mazaris

**OWNING EXPERT IMPROVEMENT TEAM (EIT):** TBI Workgroup

**MANAGING CLINICAL PRACTICE COUNCIL (CPC):** Acute Health

**CPC APPROVAL DATE:** June 28, 2022

**OTHER TEAM(S) IMPACTED:** SICU, Neurosurgery, Neuropsychology, Speech Language Pathology

**LAST REVISED:** March 3, 2022

**FOR MORE INFORMATION, CONTACT:** Dr. Patricia Pentiak

# Clinical pathways clinical approach

## TREATMENT AND MANAGEMENT:

### Definitions

**Glasgow Coma Scale (GCS):** practical method for assessing the full spectrum of disorders of consciousness, from very mild to severe. GCS rates a patient's performance in three domains of response; eye, verbal, and motor. Recommended to be reported in three separate components, e.g. E4V4M5, versus the sum score only, e.g. GCS 13. However, the sum score is more relevant for comparisons at the group level for the purpose of classification and prognosis.

**Traumatic Brain Injury (TBI):** A GCS score of greater than or equal to 13 correlates with mild TBI. A GCS score of 9 to 12 correlates with moderate TBI. A GCS of less than or equal to 8 correlates with severe TBI.

**Tiered Therapy:** Approach to caring for TBI patients of all levels. Some therapies are more appropriate for critical care level and others are appropriate for all patients with TBI. The clinical parameters described in the [TBI Tiered Therapy Guide](#) should be maintained as part of goal-directed TBI treatment.

Upon initial presentation of the patient the following table can be used as initial triage for patients with intracranial hemorrhage. Patients with less severe brain injury fall under the BIG 1 category. BIG 2 are intermediate and BIG 3 being the more severe. Use the following chart to help categorize patients for the need for admission, timing of repeat head CT if needed, and necessary consultant.

Variables	BIG 1	BIG 2	BIG 3
Loss of Consciousness (LOC)	Yes or No	Yes or No	Yes or No
Neurologic Examination/GCS	Normal	Normal	Abnormal
Intoxication	No	Yes or No	Yes or No
Anticoag/Antiplatelet therapy (including ASA) Other coagulopathy or INR >1.4	No	No	Yes
Skull Fracture	No	Non-displaced	Displaced
Subdural Hemorrhage (SDH)	≤4mm	5-7mm	≥8mm and/or midline shift
Epidural Hemorrhage (EDH)	No	No	Yes
Intraparenchymal Hemorrhage (IPH)	≤4mm and 1 location	5-7mm or 2 locations	≥8mm or multiple locations
Subarachnoid Hemorrhage (SAH)	Trace: small volume, single sulcus	Localized: >1 sulcus, single brain region	Scattered: >2 sulci, multiple brain regions
Intraventricular Hemorrhage (IVH)	No	No	Yes
Therapeutic Plan			
Hospitalization	Observation (6 hours)	Yes	Yes
Repeat Head CT	No (Repeat if condition changes)	No (Repeat if condition changes)	Yes
Neurosurgical Consultation	No	No	Yes
Neuropsych/Physiatry consult	Yes/No	Yes/Yes	Yes/Yes
Follow up Recommendations	TBI clinic (Deshpande 221 MI)	Per Neuropsych/Physiatry**	Per Neuropsych/Physiatry

\*\*If evaluation cannot be performed prior to discharge, refer to TBI clinic

For all patients admitted to the surgical intensive care unit with a traumatic brain injury, use the following TBI Tiered Therapy Guide below.

**TBI TIERED THERAPY GUIDE**

<b>Goals of TBI Tiered Therapy:</b>	<ul style="list-style-type: none"> <li>• Age 15-49 systolic blood pressure (SBP) greater than 110; Age 50-69 SBP greater than 100; Age over 70 SBP &gt; greater than 110.</li> <li>• Mean arterial pressure (MAP) goal greater than 60 mmHg for all ages</li> </ul>	<b>Intracranial pressure (ICP) less than 22 mmHg</b>	<b>Cerebral perfusion pressure (CPP) greater than 50 mmHg (CPP= MAP-ICP)</b>	<b>Serum glucose less than 150 mg/dL</b>
<b>SPO2 greater than 94 %</b>	<b>PaO2 80-120 mmHg</b>	<b>PaCO2 35-40 mmHg</b>	<b>Serum sodium greater than 135 mEq/L; Max of 160-if greater than call ICU attending</b>	<b>Temp 36-37° C</b>

**TIER ZERO- all TBI pts**

\*Initiate Admission to Critical Care Orderset AND Traumatic Brain Injury Orderset.

- Elevate HOB to 30 degrees but not greater than 45 degrees; reverse Trendelenburg if applicable
- Maintain SPO2 goal; use supplemental O2 as needed
- Maintain Serum Na+ goal; use isotonic IV fluids as ordered
- Head in neutral position; ensure c-collar not too tight and not obstructing venous return
- Complete hourly neuro checks as ordered
- Correct coagulopathy if indicated
- Maintain Normothermia; use Acetaminophen as ordered
- Ensure early nutritional support; obtain post pyloric enteral access to feed patient within 48 hours unless contraindicated (ex. ileus, obstruction, etc.).
- VTE prophylaxis within 24 hours of stable head CT per Neurosurgery
- Stress Ulcer prophylaxis as ordered
- Maintain skin breakdown prevention measures
- Neuropsych Consult
- If a Spinal Cord Injury is suspected or confirmed; initiate Spinal Cord Injury Order set.
- If patient is flat bedrest for spinal precautions notify neurosurgery to ensure there is no contraindication

## **TIER ONE- GCS $\leq$ 8**

Ensure ALL TIER ZERO criteria are met

- Protect airway- Intubate if indicated; per ICU Ventilation Order set
- Continuous EEG monitor; rule out non-convulsive status epilepticus
- Consider ICP monitoring
  - Initiate ICP management per policy and Neurosurgery orders
- Maintain Sodium goal between 135 and 145
- Consider Osmolar Therapy
  - 3% Sodium infusion per orders
  - Check serum electrolytes q 6hrs if therapy initiated
  - Check serum osmolality if mannitol therapy initiated
  - Notify physician if Na<sup>+</sup> fluctuates by greater than 3 mEq/L from previous measurement
- Insert Arterial line and Central Line for Central Venous Pressure (CVP) monitoring
- Maintain Euvolemia
- Maintain cerebral perfusion (CPP goal 50-70); if CPP less than 50 then notify Intensivist AND per TBI Order set:
  - If CVP less than 8 or SVV greater than 13 then Give Isotonic Saline bolus
  - If CVP greater than 8 or SVV less than 13 then begin Norepinephrine
- Optimize analgesia to control pain per ICU Sedation Order set
- Provide judicious sedation to control agitation per ICU Sedation Order set
- Evaluate seizure activity; provide seizure prophylaxis for 7 days unless history of seizure activity, then continue seizure prophylaxis per Neurosurgery
- Consider Braces, Splints, and/or Orthotics per TBI Order set
- Sedation; maintain RASS goal -1 to 1 per orders
- Maintain Normothermia, if temp greater than 38 notify attending service
  - Give ordered Acetaminophen; PRN or Scheduled
  - Ensure ambient room temp adequate
  - Blanketrol as ordered
  - Consider intravascular cooling device as needed

## **TIER TWO- ICP $>$ 22**

Ensure ALL TIER ZERO and TIER ONE criteria are met.

Determine cause of elevated ICP:

- Check ABG; ensure PaO<sub>2</sub> & PaCO<sub>2</sub> goals are still met
- Continue to maintain adequate analgesia and sedation
- Consider EVD placement for drainage per Neurosurgery
- Consider repeat head CT; rule out space occupying lesion or worsening hydrocephalus.
- Stop any source of stimulation
- Administer phenylephrine 25-200mcg/minute when CPP is less than 50 for more than 15 minutes with adequate fluid resuscitation and despite Norepinephrine.

Level A:

- ICP greater than 22 mm Hg for more than 2 minutes without external stimulation; if patient has an EVD, keep EVD open at 15 mm Hg above the foramen of Monroe to allow drainage of CSF per provider order.
  - If drainage of more than 15 ml of CSF within 1 hour; notify Neurosurgery for further instructions.
- Hyperosmolar therapy as ordered; 23% Sodium chloride bolus 125 mEq. Current evidence suggests 23% may lower ICP for a longer period of time than mannitol.
  - If sodium is greater than 155 then hold hyperosmolar therapy and notify attending.
- If more than two episodes of ICP greater than 22 over a 24 hour period initiate 3% Sodium chloride infusion at 50ml/ hour to raise sodium to 145-150.

#### Level B:

- ICP greater than 22 mm Hg for more than 10 minutes without external stimulation; initiate 3% Sodium Chloride infusion as ordered 50 ml/hour unless contraindicated.
  - Raise sodium goal to 150-155 with serum sodium level every 6 hours.

#### Level C:

- If refractory ICP despite Level A and B therapies notify Neurosurgery.
- Add mannitol bolus and neuromuscular blockade. (Add link to NMB policy)
  - Mannitol bolus of 0.5-1 gram per kilogram
    - Can be used concurrently with 23% bolus if needed
    - Administer bolus of Neuromuscular blockade therapy
  - Then, if requiring continuous infusion of Neuromuscular blockade therapy, use Nimbex as ordered.

### **TIER THREE- ICP still > 22**

Ensure ALL TIER ZERO, TIER ONE, and TIER TWO criteria are met.

If ICP remains refractory to current therapy:

- If ICP remains greater than 25 mm Hg for more than 15 minutes; notify Neurosurgery about failed therapy.
  - Consider surgical decompression per Neurosurgery in salvageable patients.
  - Consider mild and short term hyperventilation with temporary goal of PaCO<sub>2</sub> 30-34 mm Hg per Neurosurgery.
- For refractory ICP in non- surgical candidates, consider Barbiturate coma using Pentobarbital or Palliative care.

#### Desalation of Therapy

- Therapies should be removed in reverse order and according to potential complications and toxicity
- If ICP stabilized and less than 22 without external stimulation then, clamp EVD if patient has an EVD. Notify neurosurgery prior to doing this.
- If ICP remains stable while EVD clamped and hyperosmolar therapy discontinued for 24-48 hours, consider removal of ICP monitor per Neurosurgery.
  - Prior to removal; Collect CSF fluid for culture.

- If patient requires ongoing sedation for management of ventilator. Determination of ICP removal will be made by Neurosurgery.

### **Partial Brain tissue oxygenation (PbO<sub>2</sub>) Protocol**

Goal: maintain PbO<sub>2</sub> greater than 20mmHg

After placing the PbO<sub>2</sub> monitor a period of 2 hours is necessary prior to initiating any readings. Probe damage during insertion is a possibility. An FiO<sub>2</sub> challenge of 100% for 5 mins will be needed to ensure there is an appropriate increase in PbO<sub>2</sub>. If there is no increase in PbO<sub>2</sub> then the system may not be functioning adequately. Neurosurgery team should be contacted to trouble shoot.

Post op CT is necessary to ensure there is no large hemorrhage around the probe and that it is not in infarcted tissue.

If PbO<sub>2</sub> drops below 20: ensure ICP and CPP are within protocol parameters.

If ICP and CPP normalization does not improve PbO<sub>2</sub> then initiate 100% FiO<sub>2</sub> challenge for 5 mins then titrate FiO<sub>2</sub> down to maintain PbO<sub>2</sub> greater than 20.

Assess for ventilator associated drops in PaO<sub>2</sub> (mucous plug, pulmonary toilet, pulmonary pathology, may need to increase PEEP)

Assess and correct metabolic delivery (volume status, MAP) and demand (pain, fever, seizures, paralysis may be needed),

If these measure fail then consider transfusion to maintain PRBCs greater than 10mg/dl.

Consider augmenting CPP to 60-70.

Consider head CT/computer tomography angiography (CTA)/ transcranial doppler (TCD) to rule out stroke/vasospasm.

Consider decompressive craniectomy if PbO<sub>2</sub> remains below 20 for greater than 15 minutes despite maximal medical management for elevated ICP

### **Follow up for all Moderate and Severe TBI patients:**

All severe and moderate TBI patients should follow up in Dr. Patra, Dr. Mazaris or Leah Lyons, PA-C in the clinic at 6 months for outcome assessment including Glasgow outcome scale and JFK-CRS-R.

## References:

**ACS TQIP: Best Practices in the management of Traumatic Brain Injury-** This link has the presented best practice regarding care of the TBI patients based on the best available evidence or, if evidence is lacking, based upon the consensus opinion of the expert panel.

<https://www.facs.org/~media/files/quality%20programs/trauma/tqip/traumatic%20brain%20injury%20guidelines.ashx>

**Brain Trauma Foundation website**

<https://www.braintrauma.org/>