Division of Acute Care Surgery Clinical Practice Policies, Guidelines, and Algorithms:
Management of Severe Traumatic Brain Injury
Clinical Practice Policy

Definitions:
Severe TBI - Glasgow Coma Scale (GCS) of 3 to 8 without systemic sedation and after resuscitation
Moderate TBI – GCS of 9 to 12 without systemic sedation and after resuscitation

Intracranial Pressure Monitoring:
- ICP monitoring is performed based upon admission GCS. Admission GCS is determined post-resuscitation and after paralytics and sedation wear off.
- Admission GCS and ICP monitor placement should occur within 6 hours of arrival to the ED.
- Indications for ICP monitoring:
  - GCS 3-8,
  - Any patient with CT findings consistent with intracranial hemorrhage or indicative of elevated ICP,
  - Any patient with an abnormal CT Head in whom a neurologic exam will be unable to be obtained for any extended period (e.g. prolonged general anesthesia or neuromuscular blockade), or
  - 2 or more of the following features in a patient with GCS 3-8 and a normal CT head:
    - Age > 40 years
    - Unilateral or bilateral motor posturing
    - SBP < 90 mmHg

*If a patient has an above listed indication for ICP monitoring but does not receive an ICP monitor, please contact the Neurosurgery service. Know if an appropriate contraindication exists.*

Principles of Care:
- Elevate HOB ≥30 degrees, unless contraindicated by spine fractures
- Ensure adequate pain control with intermittent or continuous infusion of morphine or fentanyl.
- Propofol should be the first choice for sedation in the acute phase (0-48 hours). Transition to midazolam or other sedative after 48-72 hours as tolerated.
- Maintain the patient in a euvolemic state.
- Maintain serum sodium > 140.
- Aggressively avoid hypothermia and hyperthermia. Consider cooling measures (acetaminophen, cooling blanket) for temperatures >100°F.
- Avoid tight cervical collars and endotracheal tube ties. Maintain the head and neck in a neutral position (remove collar when possible according to established C-spine guidelines)
• If patient requiring intensive management of ICP:
  o Obtain q6 BMP and serum osmolality; consider adding ABG, CBC, and/or TEG if clinically indicated
  o Place a subclavian or jugular CVC to monitor CVP
  o Place an arterial line for blood pressure measurement and frequent labs
  o Refers to Goals of Care for parameter targets.

Goals of Care:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP</td>
<td>&lt;20 mmHg</td>
</tr>
<tr>
<td>CPP</td>
<td>&gt;60 mmHg</td>
</tr>
<tr>
<td>Head of bed</td>
<td>&gt;30 degrees</td>
</tr>
<tr>
<td>SBP</td>
<td>&gt;90 mmHg</td>
</tr>
<tr>
<td>CVP</td>
<td>&gt;5 mmHg</td>
</tr>
<tr>
<td>SpO2</td>
<td>&gt;93%9</td>
</tr>
<tr>
<td>PaO2</td>
<td>&gt; 60 mmHg</td>
</tr>
<tr>
<td>PaCO2</td>
<td>35-42 mmHg10</td>
</tr>
<tr>
<td>TEG r-value</td>
<td>&lt;8 min</td>
</tr>
<tr>
<td>rapidTEG ACT</td>
<td>&lt;128 sec</td>
</tr>
<tr>
<td>TEG/rapidTEG k-time</td>
<td>&lt;2.5 min</td>
</tr>
<tr>
<td>TEG/rapidTEG alpha angle</td>
<td>&gt;60 degrees</td>
</tr>
<tr>
<td>TEG/rapidTEG mA</td>
<td>&gt;55 mm</td>
</tr>
<tr>
<td>TEG/rapidTEG lysis</td>
<td>&lt;3 %</td>
</tr>
<tr>
<td>Hgb</td>
<td>≥7 g/dL</td>
</tr>
<tr>
<td>DVT prophylaxis</td>
<td>TED/SCDs; LMWH 24 hours after stable CT Head</td>
</tr>
<tr>
<td>Glucose</td>
<td>80-150 mg/dL</td>
</tr>
<tr>
<td>Serum Osmolality</td>
<td>280-320</td>
</tr>
<tr>
<td>Serum Na</td>
<td>145-165</td>
</tr>
<tr>
<td>Nutrition</td>
<td>Early enteral feeding; full support by 7 days11</td>
</tr>
<tr>
<td>Stress ulcer prophylaxis</td>
<td>Famotidine</td>
</tr>
</tbody>
</table>

For Sustained (>10 minutes) ICP Elevations > 20 mmHg.
• Always consider an expanding mass lesion with ICP elevations refractory to therapy and obtain a CT Head.
• First Tier Therapies:
  o Ensure head of bed > 30 degrees
  o Maintain normothermia (36.5-38.0 C/97.7-100.4 F, cooling blankets
  o Ensure no external compression of neck from cervical collar and that the neck is in a midline, neutral position
- Initiate CSF drainage via ventriculostomy; if ventriculostomy is present, ensure that it is patent and functioning (level and frequency to be determined by neurosurgery)
- Ensure adequate sedation and analgesia
- Initiate hyperosmolar therapy: goal serum Na 145-165, goal serum osmolality 280-320).
  - Hold hypertonic saline if serum Na >165 and/or serum osmolality >320
  - Hypertonic saline:
    - Maintenance fluid: 3% NaCl as a continuous infusion at a rate of 30 ml/hr
    - Bolus therapy: 250cc of 3% NaCl infused over 20 minutes up to q4h prn (OR)
    - Bolus therapy: 30cc of 23.4% NaCl infused over 30 minutes up to q4h prn
  - Mannitol 0.25-1 g/kg over 20 minutes followed by 0.25 g/kg q6 hours.
- Second Tier Therapies:
  - Paralysis: rocuronium 50 mg IV x once (or vecuronium 10 mg IV) and evaluate for response. If paralysis improves ICP, start continuous drip.
  - Hypothermia; goal 34-35°C
  - Craniectomy, in consultation with Neurosurgery.
  - Temporary hyperventilation (-60 minutes) to PaCO2 30-35 mmHg preparing for aggressive change in OR transport for craniectomy/craniotomy
  - Barbiturate coma with continuous EEG monitoring.
    - Load: 10-mg/kg pentobarbital IV over 30 minutes, then 5-mg/kg q1h x 3 doses
    - Maintenance: 1 mg/kg/hr

For sustained (> 10 min) Cerebral Perfusion Pressure <60 mmHg

1) Ensure euvoolemia:
   - Urine output > 0.5cc/kg/hour
   - CVP > 5mmHg
   - SVV < 15
   - Place pulmonary artery catheter if volume status is unclear utilizing arterial line and CVC
2) Ensure ICP <20 mmHg
   - Consider CSF drainage via EVD
   - Consider HTS if ICP>20 and CPP<60
   - Consider mannitol if ICP>20 and CPP>60
3) Begin pressors with euvoolemia and CPP remains <60:
   - Norepinephrine gtt with HR<100
   - Phenylephrine gtt with HR>100
   - Add vasopressin with escalating doses of pressors (0.04 U/min, do not titrate)

For Acute Clinical Deterioration – acute mental status change, evidence of cerebral herniation, new focal neurologic symptoms, progressive (2 bolus of hyperosmolar therapy in 24 hours) and refractory ICP elevation (ICP > 20 mmHg despite initial intervention):

1) ABC’s: Verify patent airway, oxygenation, and ventilation.
2) Re-dose osmotic agent
3) Call Neurosurgery immediately and
4) Obtain EMERGENT CT Head
References:


