UAMS MEDICAL CENTER
TRAUMA and CRITICAL CARE SERVICES MANUAL

SUBJECT: Management of Traumatic Brain Injury

SUPERSEDES: 12/15/17 **PAGE:** 1 of 5

RECOMMENDATION(S): Kyle Kalkwarf, MD **APPROVAL: 12/15/2017**

CONCURRENCE(S): Dr. J.D. Day/Trauma Faculty
Last Revised: 05/17/19 **EFFECTIVE: 12/15/2017**

Purpose: To provide recommendations for the treatment and management of patients with severe traumatic brain injury.

Definitions:
Severe TBI - Glasgow Coma Scale (GCS) of 3 to 8 without systemic sedation and after resuscitation, with positive brain imaging.

Principles of Care:
- Elevate HOB ≥30 degrees (unless contraindicated by spine or pelvic fractures)
    - if elevating the HOB is contraindicated, place the patient in reverse Trendelenburg)
    - If ICP being monitored, patients needing operative interventions should undergo a "lay flat" trial to ensure ICP stays within parameters before being cleared for the OR
- 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)
- Repeat head CT evaluation will occur 4 hours after the initial abnormal head CT
- Ensure adequate pain control.
- Propofol should be the first choice for sedation in the acute phase, unless the patient is hypotensive.
    - Other sedatives may be used as second line agents as dictated by hemodynamics.
- Avoid hypothermia and hyperthermia.
    - Consider cooling measures (e.g. acetaminophen, cooling blanket) for temp >100°F.
- Maintain the patient in a euvolemic state
- Maintain serum sodium 145-165
- There are no indications for systemic steroids in the treatment of severe TBI
- If patient requiring intensive management of ICP:
    - Obtain q6 BMP and serum osmolality; consider adding ABG, CBC, and/or ROTEM if clinically indicated
    - Place a central venous catheter for hemodynamic monitoring and medication administration
    - Place an arterial line for blood pressure measurement and frequent labs
    - If GCS ≤ 8T, consider 24 hour cEEG or MRI if radiographic imaging findings do not explain the clinical condition 72 hours after admission
    - Refer to Goals of Care for parameter targets

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. ICP monitor will not routinely be placed before CT imaging has been obtained.

- Indications for ICP monitoring:
  - GCS 3-8[i] & CT findings consistent with intracranial hemorrhage or indicative of elevated ICP[ii]

    or
  - 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 a contraindication exists).*

Goals of Care:

	ICP	<22 mmHg[iii]
	CPP	>60 mmHg[iv,v]
	Seizure prophylaxis	7 days duration of anti-epileptic[vi] (Keppra 1g q12h)
	Head of bed	>30 degrees
CV	SBP	≥100 for 50-69y/o, ≥110 for 15-49 or ≥70y/o
	CVP	>5 mmHg
Pulm	SpO2	>92%[ix]
	PaO2	> 60 mmHg
	PaCO2	35-42 mmHg[vii]
Coag	CT	IN = 122-208 / EX = 43-82
	A10	40-60
	Alpha	63-83
	CFT	34-159
	ML	< 3%
	Hgb	≥7 g/dL
	DVT prophylaxis	TED/SCDs; LMWH 24 hours after stable CT Head; LMWH 48 hours after craniotomy; heparin q8 hr if Cr Cl <30

Endo	Glucose	80-150 mg/dL
	Serum Osmolality	<340
Renal	Serum Na	145-165
	Nutrition	Early enteral feeding; initiated by 24 hours and to goal by at least day 5)[viii]
GI	Stress ulcer prophylaxis	Famotidine

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For Sustained (>15 minutes) ICP Elevations ≥ 22 mmHg.

- Always consider an expanding mass lesion with ICP elevations refractory to therapy and obtain a CT head.
- **First Tier Therapies**:
  - Ensure head of bed > 30 degrees
  - Maintain normothermia (36.5-38.0 C/97.7-100.4 F, cooling blankets)
  - 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 290-340).
    - Hold hypertonic saline (HTS) if serum Na >165 and/or serum osmolality >340
    - Hypertonic saline:
      - ❖ Maintenance fluid: 3% NaCl as a continuous infusion at a rate of 30 ml/hr
      - ❖ Bolus therapy: 500cc of 3% NaCl infused over 20 minutes up to q4h prn (OR)
      - ❖ Bolus therapy: 60cc 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.[iii]
      - ❖ Do not give without approval by the attending
      - ❖ Hold mannitol if serum osmolality is >340
      - ❖ Avoid in patients with known kidney dysfunction
      - ❖ May cause or worsen hypotension.
- **Second Tier Therapies (notify NSGY team)**:
  - Paralysis: rocuronium 50 mg IV x once (or vecuronium 10 mg IV) and evaluate for response. If paralysis improves ICP, start continuous drip with Train of 4 monitoring, continue for 24hrs of controlled ICP prior to wean
  - Hypothermia; goal 34-35°C
- **Third Tier Therapies (notify NSGY team):**
  - Craniectomy, in consultation with Neurosurgery.
  - Temporary hyperventilation (60 minutes) to PaCO2 30-35 mmHg
  - Barbiturate coma with continuous EEG monitoring.[iii]

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

1) Ensure euvolemia:
    - Urine output ≥ 0.5ml/kg/hour
    - CVP > 5mmHg
    - IVC collapse with inspiration <50%
    - Pulse Pressure/Stroke Volume Variation <12%
    - Consider placing a pulmonary artery catheter if volume status is unclear utilizing arterial line and CVC
2) Ensure ICP <22 mmHg
    - Consider CSF drainage via EVD
    - Consider HTS if ICP>22 and CPP<60 (or on pressors)
    - Consider mannitol if ICP>22 and CPP>60
3) Begin pressors if euvolemia and CPP remains <60:
    - Norepinephrine gtt
        - consider phenylephrine gtt if 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 > 22 mmHg for ≥15 min despite initial intervention):

1) ABC's: Verify patent airway, oxygenation, and ventilation
2) Re-dose osmotic agent (if appropriate),
3) Call Neurosurgery and SICU attending immediately
4) Obtain EMERGENT CT Head

Removal of Intracranial Monitors → All intracranial monitors will stay in place for a minimum of 72 hours

- If persistently elevated ICP, the monitor will stay in place for further treatment guidance
- If the patients neurologic exam has improved and the monitor has served its purpose, the monitor will be removed after Attending ICU and Attending Neurosurgeon discussion

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