

UAMS MEDICAL CENTER
ACS SERVICES MANUAL

SUBJECT: Management of Moderate & Severe TBI

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UPDATED: 05/2019; 05/2022, 10/2022

EFFECTIVE: 5/11/2023

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PURPOSE:

To provide recommendations for treating and managing patients with severe traumatic brain injury.

DEFINITIONS:

- **CPP:** Cerebral perfusion pressure (CPP = MAP-ICP (mm Hg)) is the net pressure gradient that drives oxygen delivery to cerebral tissue.
- **EVD:** external ventricular drain which rests in the ventricle and allows measuring of ICP and drainage of CSF
- **ICP: intracranial pressure**
- **ICP monitor (bolt):** a microsensor placed on the surface of the brain to measure the ICP
- Intracranial hypertension.
- **MAP:** mean arterial pressure. ≥ 65 mmHg is typically defined as adequate in ICP patients
- **SBP:** target systolic blood pressure should be maintained according to patient's age:
 - 110 mmHg for the young (15-49 years of age)
 - 100 mmHg for 50-69 years of age
 - 110 mmHg for elderly (≥ 70)
- **Moderate TBI:** Glasgow Coma Scale (GCS) of 9 to 12 without systemic sedation and after resuscitation, with positive brain imaging
- **Severe TBI:** Glasgow Coma Scale (GCS) of 3 to 8 without systemic sedation and after resuscitation, with positive brain imaging

Moderate TBI (GCS 9-12)

- Correct ROTEM (including hyperfibrinolysis)
- Order Keppra: 1g q12 hours for 7 days
- Monitor in the ICU with q1 hr neuro checks
- If abrupt mental status worsening, consider intubation, rescan head, and notify NSGY
- Repeat head CT scan 4-6 hours after the initial abnormal head CT and then repeat until stable
- Place NGT or feeding tube and start multimodal pain therapy and tube feeds
- Hold VTE prophylaxis until 24 hours after stable head CT scan.

Severe TBI (GCS 3-8)

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 is 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)

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- Repeat head CT evaluation will occur within 6 hours after the initial abnormal head CT; repeat until stable.
- Order Keppra: 1g q12 hours for 7 days
- Correct ROTEM (including hyperfibrinolysis)
- 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, NSAIDs, cooling blanket) for temp >36°C.
- Maintain the patient in a euvolemic state
- Maintain serum sodium 145-165
- Place NGT or dohoff and start multimodal pain therapy and tube feeds
- There are no indications for systemic steroids in the treatment of severe TBI
- Hold VTE prophylaxis:
 - 24 hours after stable head CT
 - 48 hours after craniectomy/craniotomy or EVD/ICP monitor

Intracranial Pressure Monitoring:

- ICP monitoring is performed based upon admission GCS and initial CT head. Admission GCS is determined post-resuscitation and after paralytics and sedation wear off. CT head on admission is reviewed for hematomas, contusions, swelling, herniation, or compressed basal cisterns.
- 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.
- If a patient requires intensive management of ICP:
 - Obtain q6 BMP and serum osmolality; consider adding ABG, CBC, and 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
- Indications for ICP monitoring:
 - GCS 3-8 & CT findings consistent with intracranial hemorrhage or indicative of elevated ICP
or
 - an abnormal CT Head in whom a neurologic exam will be unable to be obtained for an extended period (e.g., prolonged general anesthesia or neuromuscular blockade)
or
 - Two 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, contact the Neurosurgery service to inquire why and document that one was not placed.*

For Sustained (>15 minutes) ICP \geq 22 mmHg.

- Consider an expanding mass lesion with ICP elevations refractory to therapy and obtain a CT head.

First Tier Therapies:

- Ensure the head of the bed is > 30 degrees
- Maintain normothermia (36.5-38.0° C/97.7-100.4° F)
 - First line: acetaminophen or NSAIDs
 - Second line: cooling blankets (may need chemical paralysis if shivering)
- Ensure no external compression of the neck from a cervical collar and that the neck is in a midline, neutral position

Second Tier Therapies:

- Ensure adequate sedation and analgesia
 - Propofol is the preferred sedative (it can cause hypotension and no analgesia)
 - Multimodal is the preferred analgesia
 - Initial escalation should be fentanyl drip which can provide analgesia & sedation (at high levels)
- Initiate CSF drainage via ventriculostomy; if ventriculostomy is present, ensure that it is patent and functioning (level and frequency to be determined by neurosurgery)

Third Tier Therapies:

- Initiate hyperosmolar therapy
 - First line: 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
 - Bolus therapy: 60cc of 23.4% NaCl infused over 30 minutes up to q4h prn
 - goal serum Na 145-165 (hold HTS if Na > 165)
 - goal serum osmolality 290-340 (hold HTS if serum osm >340)
 - Second line: Mannitol (requires attending approval)
 - Bolus: 0.25-1 g/kg over 20 minutes
 - followed by infusion: 0.25 g/kg q6 hours.
 - Do not give without approval from the attending
 - Hold mannitol if serum osmolality is >340
 - Avoid in patients with known kidney dysfunction
 - May cause or worsen hypotension.

Forth Tier Therapies (notify NSGY team):

- Neuromuscular blockage:
 - rocuronium 50 mg IV x once (or vecuronium 10 mg IV)

- evaluate for a response.
- if NMB improves the ICP, start continuous infusion with Train of 4 monitoring
- continue for 24hrs of controlled ICP before wean
- Craniectomy by Neurosurgery.
 - may consider temporary hyperventilation < 60 min on the way to the OR PaCO₂ 30-35 mmHg
- Barbiturate coma with continuous EEG monitoring.

For sustained (> 15 min) CPP <60 mmHg

- 1) Ensure euvolemia:
 - Urine output > 0.5ml/kg/hour
 - Ultrasound IVC collapse with inspiration <50%
 - Pulse Pressure/Stroke Volume Variation <12%
 - Straight leg raise
- 2) Ensure ICP <22 mmHg
 - Consider CSF drainage via EVD
 - Consider HTS if ICP>22 and CPP<60 (or on pressors)
- 3) Begin pressors if euvolemic, and the CPP remains <60:
 - Norepinephrine gtt
 - Add vasopressin with escalating doses of pressors (max dose: 0.04 U/min)

Removal of Intracranial Monitors

All intracranial monitors will stay in place for a minimum of 72 hours

- If persistently elevated ICP, the monitor will remain in place for further treatment guidance
- If the patient's neurologic exam has improved and the monitor has served its purpose, the monitor will be removed after Attending ICU and Neurosurgeon discussion
- If new data regarding neurological prognosis (ie EEG, MRI, SPECT) and/or goals of care discussion determine that no further aggressive management of ICP continue, then the monitor can be removed after Attending ICU and Neurosurgeon discussion.

For Acute Clinical Deterioration

- Acute mental status change
- Evidence of cerebral herniation
- New focal neurologic symptoms
- Progressive (2 boluses of hyperosmolar therapy in 24 hours)
- Refractory ICP elevation (ICP > 22 mmHg for ≥15 min despite initial intervention):

Treatment

- 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

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Goals of Care

Neuro	ICP	<22 mmHg
	CPP	60-70 mmHg
	Seizure prophylaxis	7 days duration of anti-epileptic
	Head of bed	>30 degrees
CV	MAP	≥65 mmHg
	SBP	110 SBP (age 18-49 or ≥=70); 100 SBP (age 50-69)
Pulm	SpO2	92-97%
	PaO2	> 60 mmHg
	PaCO2	35-42 mmHg
Coag/Heme	CT	INTEM = 122-208 / EXTEM = 43-82
	A10	FIBTEM > 10 / EXTEM > 40
	Alpha	63-83
	CFT	34-159
	ML	< 15%
	Hgb	≥ 7 g/dL
	VTE prophylaxis	Immediately: SCDs See VTE prophylaxis Guideline for details on initiating in TBI patients
Endo	Glucose	80-150 mg/dL
	Serum Osmolality	<340
Renal	Serum Na	145-165
GI	Nutrition	Initiate enteral feeding by 12 hours Goal TF by at least hospital day 4

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These guidelines were prepared by the UAMS ACS Division. They are intended to serve only as a guideline based on current review of the medical literature and practice. They are neither policies nor protocols. Their use is at the discretion of the managing physician.

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