GUIDELINE

Title:	Care of the Patient with Traumatic Brain Injury		
Department/Service Line:	Trauma Center		
Approver(s):	Trauma Medical Director Director, Surgical Trauma ICU Nursing Director, Trauma Services		
Location/Region/Division:	Scott & White Medical Center – Temple		
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SCOPE

This document applies to Scott & White Medical Center - Temple.

DEFINITIONS

When used in this document with initial capital letter(s), the following word(s)/phrase(s) have the meaning(s) set forth below unless a different meaning is required by context. Additional defined terms may be found in the BSWH P&P Definitions document.

None.

GUIDELINE

To establish the procedures for the care of a patient with traumatic brain injury.

PROCEDURE

Patients with severe TBI (Glasgow Coma Scale (GCS) of ≤ 8) will be cooperatively managed by the Emergency Trauma, Neurosurgical and Surgical Intensive Care services with the assistance of other surgical subspecialties as indicated. All patients with severe TBI will have a timely Neurosurgical consultation.

Intracranial Pressure Monitoring

- Intracranial pressure monitoring (ICP) will be employed in patients with an admission GCS ≤ 8 and an abnormal brain CT.
- ICP monitoring should be considered in patients with a GCS >8 who have structural brain damage with risk for progression (large/multiple contusions, coagulopathy).
- ICP monitoring should be considered in patients who require urgent surgery for extracranial injuries, who need mechanical ventilation because of extracranial injuries, or who evidence progression of pathology on CT imaging or clinical deterioration.
- An external ventricular drain (EVD) will be employed as the ICP monitor when technically possible.

Hemodynamic Monitoring

- Hypotension will be prevented and aggressively treated. The patient should have a normal blood pressure or be moderately hypertensive while perfusion is rapidly restored.
    1. An arterial line will be placed in all patients with severe TBI. The blood pressure measured by a properly functioning arterial line will be used to guide therapy. The arterial line will be zeroed at the level of the external auditory meatus.

2. A mean arterial pressure of 90 will be the initial minimum goal of blood pressure management. The goal is that the patient will be euvolemic or slightly hypervolemic.

3. Once ICP monitoring is initiated, the blood pressure goal will be to maintain a cerebral perfusion pressure (CPP) ≥ 60 torr at all times. CPP is the difference between the mean arterial pressure and intracranial pressure.

- Maintenance of CPP will be achieved with the infusion of dextrose-free isotonic crystalloid infusions (initially Normal Saline (NS)) and blood products as necessary.
    1. The Hgb will be maintained at >7 gm/dl, platelets ≥ 80,000 and any coagulopathy will be corrected.

- Vasoactive agents will be utilized as a temporizing measure to maintain CPP.
    1. Aggressive volume resuscitation will be continued to allow discontinuation of vasopressor therapy as soon as possible.

- Invasive hemodynamic monitoring will be considered in any patient requiring continued vasoactive medications, or who has hypoxemic respiratory failure, deteriorating renal function, worsening metabolic acidosis, or other evidence of inadequate perfusion.

Respiratory Management

- All patients with severe TBI will require endotracheal intubation and mechanical ventilatory assistance.
    1. The ventilator settings should provide full or nearly full ventilatory support.
    2. Patients will not be routinely hyperventilated to maintain oxygen saturation of 100% and the initial target $PaCO_2$ will be 32-36 torr.

ICP Management

- <u>The goal will be to maintain an ICP < 25 with a CPP > 60 during all phases of patient care. The alert threshold is an ICP of 20 mm Hg. An ICP of >25 mm Hg will serve as a trigger for treatment of intracranial hypertension.</u>

- <u>General considerations</u>
    1. The arterial line will be leveled to the external auditory meatus
    2. Head midline to prevent compression of jugular veins
    3. Appropriately sized cervical collar to prevent jugular vein compression
    4. Achieve euvolemia or mild hypervolemia
    5. Maintain patients temperature 35 – 37^0 C
    6. Corticosteroids will not be given to patients with Traumatic Brain Injury.
    7. Nutrition should begin early, as soon as the patient is hemodynamically stable, and ideally within 24-48 hours of injury.
    8. Goal for serum sodium should be high normal (140-145 mm Hg) for all patients with TBI.
    9. The decision to employ prophylactic anticonvulsants will be made on a case by case basis. Patients who do receive prophylactic anticonvulsants will usually be treated for 7 days after injury.
        a. Serum levels will be monitored if the patient receives phenytoin
        b. If there is no clinical evidence of seizure activity, the anticonvulsant should be discontinued on day 8.

- <u>Specific therapies for ICP >25:</u>

<u>Tier 1</u>

1. Head of bed elevated at 30 degrees (reverse Trendelenburg) to improve cerebral venous outflow.
2. Sedation and analgesia using recommended short-acting agents (for example, Propofol, Fentanyl, Midazolam) in intubated patients.
3. Consider ventricular drainage performed intermittently. <u>Continuous drainage is not recommended</u> unless an additional ICP monitor is placed, as when the drain is open, it does not accurately reflect the true ICP.
4. Repeal CT imaging and neurological examination should be considered to rule out the development of a surgical mass lesion and guide treatment.

If ICP remains >25 mmHG proceed to Tier 2.

Tier 2

- In patients with a parenchymal ICP monitor an EVD should be considered to allow for intermittent CSF drainage.
- Hyperosmolar therapy should be given intermittently as needed for ICP elevation and not on a routine schedule.
    1. Hypertonic saline may be administered in intermittent boluses of 3% sodium chloride solution (250ml over ½ hour) or other concentrations (e.g. 30 ml of 23.4%). Serum sodium and osmolality must be assessed frequently (every 6 hours) and additional doses should be held if serum sodium exceeds 160 mEq/L. Hypertonic saline may also be administered as a continuous infusion to achieve and maintain the serum sodium in the desired target range (usually 155-160 mEq/L)

    2. Mannitol should be administered in intermittent boluses (usually 0.5 gm/kg body weight) for acute threatening intra-cranial hypertension. Urine output should usually be replaced with isotonic crystalloid. Hypovolemia must always be avoided. Mannitol can be repeated every 3-6 hours. The serum sodium and osmolality must be assessed frequently (every 6-12 hours) and additional doses should be held if serum osmolality exceeds 320 mOsm/L.

- Pa CO2 goal of 32-36 mmHg should be maintained, as long as brain hypoxia is not encountered. Additional neuromonitoring (e.g. Pbt02, Sjv02, CBF) may help determine optimal PaCO2.
- Establish ventriculostomy if not already in place.
- Repeat CT imaging and neurological examination should be considered to rule out development of a surgical mass lesion and guide treatment.
- Neuromuscular paralysis achieved with a bolus “test dose” of a neuromuscular blocking agent should be considered if the above measures fail to adequately lower ICP and restore CPP. If there is a positive response, continuous infusion of a neuromuscular blocking agent should be employed (Tier 3). An objective measure of brain function (Sedline, BIS other) should be used as an adjunct to subjective sedation assessments in patients who are receiving neuromuscular blocking agents.

If ICP remains > 25 mmHg proceed to Tier 3

Tier 3

- Decompressive hemi-craniectomy or bilateral craniectomy should only be performed if treatments in Tiers 1 and 2 are not sufficient or are limited by development of side effects of medical treatment.
- Neuromuscular paralysis via continuous infusion of a neuromuscular blocking agent can be employed if there is a positive response to a bolus dose. The infusion should be titrated to maintain at least two twitches (out of a train of four) using a peripheral nerve stimulator. Adequate sedation must be utilized. An objective measure of brain function (Sedline, BIS other) should be used as an adjunct to subjective sedation assessments in patients who are receiving neuromuscular blocking agents.
- Barbiturate coma may be induced for those patients who have failed to respond to aggressive measures to control malignant intracranial hypertension; however it should only be instituted if a test dose of barbiturate results in a decrease in ICP, thereby identifying the patient as a “responder”. Hypotension is a frequent side effect of high dose therapy with barbiturates. Meticulous volume resuscitation should be ensured and infusion of vasopressor/inotropes may be required. Continuous EEG may be used to ensure targeting of the infusion to burst suppression. Each case needs to be individually assessed by STICU senior staff. Usual loading dose is pentobarbital 10mg/kg IVPB over 1 hour followed by up to 3 additional doses of 5mg/kg IVPB each over 30 minutes if the ICP is >25. The usual rate of the continuous pentobarbital infusion is 1-2 mg/kg/hour.
- Hypothermia (<36 °C) is not currently recommended as an initial TBI treatment. Hypothermia should be reserved for “rescue” or salvage therapy after reasonable attempts at ICP control via the previous Tier 3 treatments have failed.

Surgical Intervention

- Early referral for neurosurgical evaluation/consideration of craniectomy:
    1. Midline shift >5mm or compression of basal cisterns associated with traumatic mass lesion.

2. Mass effect from epidural hematoma, subdural hematoma or intra-cerebral hematomas.
3. Depressed skull fractures greater than the depth of the inner table.

DVT Prophylaxis

- UF heparin or LMWH for DVT prophylaxis may be considered once a follow-up CT scan has not shown progression of hemorrhage or contusions. This decision will be made on a case by case basis.

ATTACHMENTS

None.

RELATED DOCUMENTS

None.

REFERENCES

None.

Attachment Name:	Management of TBI		
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