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Traumatic brain injury (TBI) is a major cause of death in all age groups in the United States, contributing to over 30% of all trauma-related deaths. TBI has been classified into mild (Glasgow Coma Scale, or GCS, 13-15), moderate (GCS 9-12), and severe (post-resuscitation GCS ≤ 8). Protocolized management of severe TBI improves patient outcomes. Primary endpoints in the management of severe TBI include minimizing cerebral edema and intracranial pressure (ICP) while simultaneously optimizing cerebral perfusion pressure (CPP) and tissue oxygenation to reduce secondary ischemic injury. Management of severe TBI patients using guideline-based recommendations is recommended to decrease mortality.

RECOMMENDATIONS

SIBICC guidelines for TBI treatment now allow jumping between tiers to achieve patient treatment goals

All Patients with Traumatic Brain Injury (TBI) – Mild Moderate, or Severe

- Perform Head CT to define extent of TBI
- Reverse anticoagulation (see recommendations below)
- Elevate head of bed 30-45 degrees at all times
- Protect the patient's airway and intubate if GCS ≤ 8
- Maintain systolic blood pressure > 100 mmHg and SpO₂ $> 94\%$
- Avoid core body temperature above 38°C; consider early antipyretics and cooling blankets for temperatures above 38°C
- Provide judicious sedation/analgesia to control pain and agitation
- Perform serial evaluations of neurological status in a neuromonitoring capable unit
- Obtain a repeat Head CT six hours after initial imaging and repeat as appropriate until stable

Management of Severe TBI (GCS ≤ 8) and Intracranial Hypertension

- **TIER ZERO (considered to be basic ICU interventions)**
 - Admission to the ICU for neurological monitoring
 - Serial neurological exams to include pupillary reactivity
 - Elevate the head of the bed 30-45°
 - Ensure good venous return from the head by keeping the head midline and confirming the cervical collar (if present) is not too tight
 - Protect the patient's airway with intubation and mechanical ventilation
 - Provide adequate sedation/analgesia for signs of pain, agitation, and ventilator asynchrony
 - Insert an intracranial pressure (ICP) monitoring device in salvageable patients within 24 hours of resuscitation with initial goals of ICP < 22 mmHg and CPP 60-70 mmHg
 - Maintain SpO₂ $\geq 94\%$
 - Target core temperature of 36.0-37.9°C; treat temperatures above 38°C with antipyretics and cooling blankets
 - Maintain hemoglobin > 7 g/dL
 - Insert an arterial line for continuous blood pressure monitoring with goal systolic blood pressure (SBP) of 100-160 mmHg
 - Avoid hyponatremia (serum Na goal 135-145 mEq/L)
 - Initiate seizure prophylaxis for first seven days post-injury with levetiracetam 1000 mg BID (see text for exemptions)

RECOMMENDATIONS (continued)

- **TIER ONE**
 - Maintain CPP 60-70 mmHg
 - Utilize sedation and analgesia to lower and achieve ICP goals
 - Maintain PaCO₂ 35-38 mmHg
 - Administer hypertonic saline by intermittent bolus (see protocol recommendations)
 - Administer mannitol by intermittent bolus (0.25-1.0 g/kg) (see protocol recommendations)
 - Consider placement of extraventricular drain (EVD) to allow drainage of CSF
 - Obtain electroencephalography (EEG) monitoring (spot vs. continuous)
- **TIER TWO**
 - Maintain PaCO₂ 32-35 mmHg (mild hypocapnia) if ICP goals unmet
 - Consider neuromuscular paralysis to lower ICP (see protocol recommendations)
 - Perform mean arterial pressure (MAP) challenge (see protocol recommendations) to evaluate autoregulation; adjust MAP according to protocol outcome/recommendations
- **TIER THREE**
 - Administer phenobarbital or sodium thiopentone; titrate to ICP if found to be effective in lowering ICP (see protocol below)
 - Consider secondary craniotomy
 - Maintain mild hypothermia (35-36°C) using active cooling measures
- **Inter-Tier Recommendations**
 - Repeat and review imaging, physiological parameters, and physical examinations
 - Re-evaluate the patient for other potential sources of ICP elevation (i.e. intra-abdominal hypertension or elevated intrathoracic pressure)
 - Consider surgical options including repeat surgical therapy
 - Consider transfer to a tertiary referral center

Surgical Management of TBI

- **Evacuating epidural hematoma (EDH) and subdural hematoma (SDH)**
 - Perform urgent evacuation of large hematomas (>25 mL) for comatose patients with a meaningful chance of recovery
 - Evacuate large traumatic hematomas before neurological deterioration (even in patients with a high GCS)
 - Maintain a low threshold for surgery in patients with posterior fossa lesions
 - Promptly evacuate delayed or enlarging bleeds found on repeat imaging
- **Decompressive Craniectomy**
 - Initial/Primary - after mass lesion (i.e. acute SDH) evacuated and swelling ensues
 - Secondary - recommended for persistently raised ICPs refractory to other interventions