1. Purpose
This workplace instruction describes the processes for the management of severe traumatic brain injury.

2. Scope
This work instruction describes the processes for all staff in the Intensive Care Unit, Mackay Base Hospital to manage the care of patients with a severe brain injury.

3. Instruction for Management of Severe Traumatic Brain Injury

Definition
Severe traumatic brain injury can be an isolated event or occur in the context of a polytrauma patient. Severe brain injury is defined as a GCS<9 after non-surgical resuscitation, not attributable to any other cause.

Process
Maintenance of oxygenation, carbon dioxide levels and brain perfusion pressure, and early surgical intervention when needed are the cornerstones of brain injury management. Simple measures to reduce raised intracranial pressure are also required.

Airway
Indications for endotracheal intubation
1. GCS <9
2. Patients who cannot maintain adequate oxygenation and ventilation. (Aim for PaO$_2$ > 60mmHg, SpO$_2$ > 90%, PCO$_2$ 35 -35 mmHg)

Anticipate difficult airway
Seek senior assistance
Workplace Instruction: Management Of Severe Traumatic Brain Injury

Oxygenation
- Aim for PaO₂ > 60mmHg, SpO₂ > 90%, PCO₂ 35 – 45mmHg
- Apply continuous SaO2 monitoring with visual waveform
- Use 100% O2 during initial resuscitation phase

Blood Pressure
- Every patient needs invasive BP monitoring
- Goals: SBP > 90 mmHg always
- MAP > 80 and < 90 in absence of ICP monitor
- CPP 60 – 70 mmHg in presence of ICP monitor

Act immediately on systemic hypotension

In severe brain injury, cerebral perfusion pressure should be maintained as follows:

- CPP = MAP – ICP
- Assume ICP > 20 in severe injuries (GCS < 8)
- Maintain CPP as below

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Cerebral perfusion pressure (mmHg)</th>
<th>MAP required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonates</td>
<td>&gt;30</td>
<td>&gt;50</td>
</tr>
<tr>
<td>1-6 months</td>
<td>&gt;35</td>
<td>&gt;55</td>
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<tr>
<td>6-12 months</td>
<td>&gt;40</td>
<td>&gt;60</td>
</tr>
<tr>
<td>1-4 years</td>
<td>&gt;45</td>
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<tr>
<td>5-9 years</td>
<td>&gt;50</td>
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</tr>
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<td>10-15 years</td>
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<td>&gt;75</td>
</tr>
<tr>
<td>&gt;15 years</td>
<td>&gt;60</td>
<td>&gt;80</td>
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</table>

- In Paediatric patients (age < 16 years) seek urgent advice from a Paediatric Intensivist
- Maintain Hb of 80 – 100

Surgical Consultation
A senior staff member should discuss all patients with moderate or severe brain injuries with the duty neurosurgeon at Townsville Hospital as soon as possible. All brain imaging should be sent immediately to Townsville for review.
Minimise Intracerebral Pressure

- Adequate sedation and with/without paralysis
- Elevate head 30°
- Prevention of seizures
- Prevention of hypercapnoea
- Prevention of hyponatraemia
- Maintaining normothermia
- Maintaining euglycaemia
- Head in neutral position
- NO tight ties around neck (to secure ETT)
- Minimal PEEP

**AVOID MANNITOL**

These are further discussed below

**Sedation/Paralysis**

Propofol or midazolam with Morphine/Fentanyl.

Barbiturates not recommended in MBH due to limited resources.

**Elevate Head**

Elevation of the head to 30 degrees improves venous flow and reduces cerebral pressure. It also reduces risk of ventilator acquired pneumonia.

Spinal precautions must be observed and the whole bed tilted until the thoracolumbar spine has been cleared.

**Seizure Prophylaxis**

Phenytoin 15 - 20mg/kg to max 1.5g, diluted in 100 ml normal saline given over 1 hour IV followed by 300-400 mg/day for next 7 days. To abort seizures use IV Midazolam or Diazepam.

**PaCO2 Control**

- Maintain a PaCO2 of 35 – 40mmHg
- Monitor ABG’s hourly and adjust ventilator settings
- Hyperventilation (PaCO2 of 25mmHg or less) is **only** recommended as a temporizing measure for the reduction of elevated intracranial pressure (ICP) if signs of herniation are present (see below)

**Sodium Levels**

- Hyponatraemia should be prevented under all circumstances
- Aim to maintain serum Na 145 – 155 (Use 3% Saline at about 30 ml/h in adults)
- Check Na on ABG every 2 -4 hours
- The use of hypotonic fluids (eg 5% dextrose) are absolutely contraindicated
Workplace Instruction: Management Of Severe Traumatic Brain Injury

Maintaining Normothermia
- Maintain Normothermia (37 ± 0.5 °C)
- Treat fever aggressively
- Moderate hypothermia to treat refractory intracranial hypertension is under evaluation

Glucose Control
Goal: Serum glucose 7 – 10 mmols/L
Check every 2 hours

Steroids
Steroids are contraindicated.
Its use is associated with increased mortality and is contraindicated.

Cervical Spine Protection
Cervical spine precautions should be implemented in all comatose brain injured patients. If the patient is heavily sedated, remove the collar and apply sandbags and tape to maintain alignment. Reapply collar for transportation and for waking the patient up.

Infection Prophylaxis
No established role of prophylactic antibiotics unless undergoing surgery.

Deep Venous Thrombosis Prophylaxis
Graduated compression stockings or intermittent pneumatic compression stockings are recommended unless lower extremity injuries prevent their use. Use should be continued until patients are ambulatory.
Low molecular weight heparin or unfractionated heparin should not be used in the initial 24 hours, and only after this time after discussion with a neurosurgeon.

Stress Ulcer Prophylaxis
Brain injured patients are at high risk of stress-related gastric ulceration. H2-receptor antagonists or Proton pump inhibitors should be used prophylactically.

Nursing Strategies to Reduce ICP
- Position patient with head elevated 30° (unless contraindicated) maintaining head and neck alignment. Proper positioning promotes cerebral venous outflow, reducing ICP
- Avoid knee and hip flexion
- Ensure end of bed is not touching patient’s feet
- Ensure cervical collar and endotracheal tube ties not too tight especially behind the neck. Cervical collar can be replaced with sandbags and tape until patient is transferred.
- Ensure adequate sedation is administered
- Administer medications to prevent or treat seizures
Workplace Instruction: Management Of Severe Traumatic Brain Injury

- Suction as needed:
  - Pre-oxygenate patient with 100% oxygen for 1 minute prior to suctioning
  - Pass the catheter for no longer than 10 seconds
  - Use the fewest catheter passes necessary to clear the airway
  - Avoid unnecessary airway stimulation by securing the ETT and taking care to avoid the carina whilst suctioning
  - Minimise stimuli that could induce Valsalva response
  - Bolus sedation prior to nursing interventions (if BP allows) to prevent rises in blood pressure and ICP
  - Monitor blood glucose levels 2\textsuperscript{nd} hourly to ensure normal levels

Environment
- Group interventions to allow rest periods for the patient (“clustering care”)
- Avoid unnecessary procedures
- Screen visitors to allow rest periods for the patient
- Minimise noise and lighting
- Avoid stimulation and prioritise interventions if ICP is raised

Approach to the Coning Patient

Signs of Coning:

**CALL FOR HELP**

**Transtentorial herniation**
- Dilated ipsilateral pupil
- Decerebrate ipsilateral posturing
- Altered conscious state and falling Glasgow Coma Score

**Tonsillar herniation**
- Profound coma
- Fixed, midsize pupils
- Hypertension
- Bradycardia

**Immediate Steps**
- Defend blood pressure (MAP >90) and oxygenation (100%)
- Deeply sedate and paralyse patient
- Hyperventilate to PaCO2 <25
- Ensure no obstruction to venous drainage (tube ties, stiff collars etc)
- Administer hypertonic saline (5ml/kg 3% NaCl or 1ml/kg of 20%)
- Urgent surgical review – expedite craniotomy or burr holes if possible
- Thiopentone infusion
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- 5-10mg/kg load – beware systemic hypotension
- 1-3mg/kg/hr infusion
- Support CPP with fluids and inotropes
- Monitor burst suppression on EEG
- Seek further advice from Townsville Intensive Care and Neurosurgery specialists

4. Supporting Documents


'Adherence to guidelines for management of cerebral perfusion pressure and outcome in patients who have severe traumatic brain injury' 2015, Journal Of Critical Care, 1, p. 111, Academic OneFile, EBSCOhost, viewed 21 September 2015


5. Consultation

<table>
<thead>
<tr>
<th>Date</th>
<th>Key Stakeholder /s</th>
<th>Position</th>
<th>Status Tracking</th>
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<tr>
<td>June 2008</td>
<td>ICU Protocol Committee</td>
<td>All staff</td>
<td>Developed &amp; Approved</td>
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6. Work Instruction Revision and Approval History

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<tr>
<th>Date</th>
<th>Amendment</th>
<th>Authorised by</th>
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<tr>
<td>November 2011</td>
<td>Three year review references updated changes made to all pages of the document and best practice updated</td>
<td>Michael Rampton, Dr Nitin J Chavan and Critical Care Protocol Committee</td>
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| August 2015 | Review of content with more recent references and studies indicating no significant change to management noted | ICU protocol committee |

7. Audit Strategy

| Level of risk | Medium |
| Audit strategy | Prime for clinical incidents |
| Audit tool attached | No |
| Audit date | Continuous |
| Audit responsibility | All Clinical Staff |
| Key Elements / Indicators / Outcomes | Patients with severe traumatic brain injury will be cared for using best practice guidelines |