**Paediatric Trauma Guidelines**

**Management of Severe Traumatic Brain Injury** *(GCS 8 or less)*

### Neuroprotective measures

- Avoid hypoxia
- Avoid hypotension
- Sedate and paralyse
- 30° head up tilt
- Head midline
- Normothermia
- Normoglycaemia
- Keep Na > 135 mmol/L
- Phenytoin 20 mg/kg

### Signs of critically raised ICP

- Unequal or unreacting pupils
- Bradycardia / hypotension

### Management of critically raised ICP

- Sedate and paralyse
- Ensure collar not too tight
- Hyperventilate to PaCO$_2$ of 4.0 – 4.5 kPa
- Hyperosmolar therapy:
  - 3% Saline 3 ml/kg
  - 20% Mannitol 1.25 – 2.5 ml/kg (0.25 – 0.5 g/kg)

### Systolic blood pressure targets (age specific)

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Target Systolic Pressure</th>
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</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>&gt; 80 mmHg</td>
</tr>
<tr>
<td>1-5 years</td>
<td>&gt; 90 mmHg</td>
</tr>
<tr>
<td>5-14 years</td>
<td>&gt; 100 mmHg</td>
</tr>
<tr>
<td>&gt; 14 years</td>
<td>&gt; 110 mmHg</td>
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</tbody>
</table>

### Airway

- Intubate and ventilate with cervical spine control

### Breathing

- Avoid desaturation
- Aim for PaO$_2$ > 13 kPa
- Aim for PaCO$_2$ 4.5-5.5 kPa

### Circulation

- Avoid hypotension
- Do not delay for arterial or central access
- Consider blood after 20 ml/kg fluid

### Disability

- Check pupils every 15 mins
- CT head and C-spine < 30 mins
- Institute neuro-protection

### Urgent referral to RSCH Neurosurgery Team

**Ext 62032**

### Management of severe traumatic brain injury

1. Refer to Southampton General Hospital Paediatric Neurosurgery Team via Southampton Oxford Retrieval Team (SORT)
2. RSCH Neurosurgery team to decide re: urgent surgery or blue light transfer to definitive Neurosurgical Centre.
3. They will liaise with relevant Neurosurgical Team pre- or post-operatively.
4. Contact Consultant Paediatric Anaesthetist, Paediatric ODP and CED Consultant via switchboard to attend and co-ordinate transfer*

### Contact telephone numbers

<table>
<thead>
<tr>
<th>Service</th>
<th>Telephone Number</th>
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<tbody>
<tr>
<td>RSCH Neurosurgery</td>
<td>02032994207</td>
</tr>
<tr>
<td>KCH Neurosurgery</td>
<td>02380777222</td>
</tr>
<tr>
<td>SGH Neurosurgery</td>
<td>02071885000</td>
</tr>
<tr>
<td>STRS</td>
<td>02380775502</td>
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</table>

*Contact STRS or SORT if having any difficulties contacting Neurosurgery at definitive centre*

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Severe traumatic brain injury

Background

Severe traumatic brain injury is classified as a GCS of 8 or less. This GCS is post-resuscitation, and must not be post-ictal. Most common cause is pedestrian vs car RTC followed by falls.

In infancy, non-accidental injuries remain an important cause. If senior clinician has concerns that injury may have been inflicted (you do not have to be certain) – discuss with social care / police as soon as possible, EVEN IF THE CHILD IS RETRIEVED.

The Named / Designated Doctor should be informed for all suspected non-accidental head injuries, whether admitted to RACH or retrieved. See ‘Suspected abusive head trauma’ guideline.

Management aims to prevent secondary damage from:

- Hypoxia
- Hypotension
- Raised intracranial pressure (ICP).

Priorities

1.) Stabilise airway, breathing and circulation before attending to other injuries
2.) Facilitate rapid, safe CT head and C-spine to enable identification of time critical injury.
3.) If a time critical injury is identified, follow the current guideline for “head injuries with CT scan changes and other neurosurgical emergencies”.
4.) If emergency surgery is not performed at BSUH, the transfer team should depart within 60 minutes of the CT scan.

Management

On arrival to the ED, assess and deal with airway, breathing, circulation and disability as per APLS guidelines.

Airway (c-spine) and breathing

- protect C-spine if mechanism of injury suggests the possibility of cervical spine injury.
  
  Start with manual in-line stabilisation. If not possible, use head block and strapping.
Paediatric Trauma Guidelines

- Get patient off spinal board ASAP. Nurse flat with spine in alignment. Log-roll to move patient.
- If spontaneously breathing administer high flow oxygen
- Intubate and ventilate if:
  - Severe respiratory distress or haemodynamic instability
  - Depressed conscious state (GCS < 9) or agitation
- Measure oxygen saturations, respiratory rate, and blood gas
- Perform CXR

Circulation

- Assess and monitor heart rate, blood pressure and capillary return
- Insert large bore intravenous cannula (ideally x 2). If unable, gain I.O access.
- Take trauma panel bloods
- If circulation is inadequate give fluid bolus(es)
  - 10 ml/kg crystalloid in first instance then warmed blood in 10 ml/kg aliquots. Assess response after each aliquot
  - Activate the massive haemorrhage protocol if 40 ml/kg has not stabilised the child

Disability

- Assess and monitor GCS and blood sugar
- Perform regular (15 minutely) pupil checks
- Check core temperature
- Analgesia

When intubated, insert nasogastric or orogastric tube (beware facial fractures). Place a urinary catheter to measure UOP and avoidance of bladder distension.

Once patient is resuscitated, urgent CT imaging of the head and spine is the next priority (ideally within 30 minutes of arrival).

- The patient must be transferred to CT by an appropriately trained Anaesthetist with full monitoring. At least: ECG, pulse oximetry, non-invasive blood pressure, end-tidal carbon dioxide monitoring.

If CT imaging identifies a time critical lesion requiring urgent neurosurgical intervention, the patient will need rapid management by an appropriately trained Neurosurgical team.
Paediatric Trauma Guidelines

The first port of call for discussion of a seriously head injured child is the Neurosurgical team at the Royal Sussex Country Hospital (RSCH).

The patient should be discussed directly with the Registrar on call on extension 62032, or if they are unavailable, the on-call Consultant via the BSUH switchboard (ext. 198).

As soon as possible after telephone contact has been made, in order to facilitate clear communication and record keeping, refer the patient online via www.referapatient.org.

If transfer to a definitive care centre is required, the child must be accompanied by an appropriately trained anaesthetist. Our current definitive care centres are Southampton General Hospital and Kings College Hospital. The RSCH Neurosurgery team will liaise with their counterparts at the definitive care centre once a decision has been made about where the child should go.

Neuroprotection measures

**Imperative to avoid hypoxia or hypotension**

1. **Airway and breathing**
   - Oxygen saturations > 98%
   - Ventilate to maintain ET CO₂ 4.5 – 5.0 kPa (correlate with venous / capillary / arterial blood gases)

2. **Circulation**
   - Cerebral perfusion pressure = MAP – ICP (ICP may be >20 mmHg)
   - Maintain systolic BP to targets for age:
     - < 1 year: >80 mmHg
     - 1-5 year: >90 mmHg
     - 5-14 year: >100 mmHg
     - >14 year: >110 mmHg
   - Treat hypotension aggressively with
     - Fluid boluses (10 ml/kg)
Paediatric Trauma Guidelines

- Blood products
- Inotropes: suggested agents would be dopamine if peripheral access only, or noradrenaline if central access gained.

Ensure active bleeding is managed prior to transfer – this may necessitate surgery at BSUH. Involve Paediatric Surgeons early.

3. CNS / disability

Maintain cervical spine immobilisation with blocks and tape.
Log roll should be used if turning patient for any reason.

Keep patient 30° head up (tilt bed)
Keep head in midline. Avoid neck lines and ETT ties.

Once intubated, patients MUST be adequately sedated and paralysed. Recommended drugs are morphine and midazolam with paralysis or propofol if BP allows. Avoid spikes in intracranial pressure during handling / suction with boluses of sedation.

Keep blood sugar > 3 mmol/L
Maintain normothermia (core temp 36 – 37°C)
Load with phenytoin (20 mg / kg over 20 minutes) if any seizures
Maintenance fluid 1-2 ml/kg – use 0.9% saline +/- 5% dextrose

Management of critically raised intracranial pressure

Bradycardia, hypertension, slowly reacting or fixed dilated pupil(s).

1. Ensure neuroprotective strategies are maintained.
2. Place patient on a manual bagging circuit and initiate manual hyperventilation to reduce ET CO₂ to 4 – 4.5 kPa.
3. Give a dose of either 3 ml/kg of 2.7% or 3% Saline or 1.25 ml/kg of 20% mannitol.
Making and using 3% sodium chloride (hypertonic saline)

Commercially available 2.7% sodium chloride
Hypertonic saline can be obtained in commercially pre-packaged containers. Use ‘ready-made’ hypertonic saline solutions if available in preference to mixing 3% sodium chloride to reduce risk of drug preparation errors.

Making 500ml of 3% sodium chloride
1) Obtain a 500ml bag of 0.9% sodium chloride.
2) Remove 36ml from the 500ml bag of 0.9% sodium chloride and discard the 36ml.
3) Add 36ml of 30% sodium chloride to the bag of saline.
4) This solution is now 3% sodium chloride.

Making 50ml of 3% sodium chloride
1) Draw up 5ml of 30% sodium chloride. Mix with 45ml of 5% dextrose.
2) This solution is now 3% sodium chloride.

Using 3% sodium chloride
1) Do not connect bags of 3% sodium chloride to the patient, to prevent accidental excess infusion.
2) Draw up each dose of 3% sodium chloride in a syringe and deliver the dose to the patient over 10 minutes.