

SOUTHAMPTON OXFORD
RETRIEVAL TEAM

**Guideline for
the initial management
of Severe Traumatic
Brain injury in children
(GCS 8 or less)**

Guideline for the initial management of severe traumatic brain injury in children (GCS 8 or less)

Introduction

Severe traumatic brain injury is classified as a Glasgow Coma Scale (GCS) of 8 or less. This GCS must be a post-resuscitation, and must not be post-ictal. Severe traumatic brain injury (TBI) is the leading cause of death in children in the UK, accounting for 15% of deaths in 1-15 year olds and 25% of deaths in 5-15 year olds. The most common cause is pedestrian versus car road traffic accidents followed by falls. In infancy, non-accidental injuries remain an important cause.

The aims of management are to prevent secondary damage/injury by the prevention of hypoxia, hypotension, and raised intracranial pressure (ICP). If CT imaging identifies a time critical lesion (eg extradural haematoma with mass effect) requiring urgent neurosurgical intervention then the patient requires rapid transfer by the local team to the paediatric neurosurgical centre.

Priorities:

- **Stabilize Airway, Breathing and Circulation before attending to other injuries.**
- **Facilitate rapid, safe CT head and cervical spine to enable identification of time critical brain injury.**
- **If a time critical neurosurgical injury is identified the local team should transfer the patient to the nearest neurosurgical centre (Southampton or Oxford). The team should depart within 60 minutes of the end of the CT scan.**
- **Discuss the patient early with the regional paediatric transport co-ordination consultant on the SORT hotline 02380 775502.**

1. Airway

1. All children with a GCS of 8 or less must be intubated and ventilated.
2. Spinal immobilization before, during and after intubation is essential. Intubation of these patients therefore requires a minimum of 4 people to manage the process (in-line immobilisation, cricoid pressure, intubator, assistant).
3. Ketamine & suxamethonium or rocuronium – are the agents recommended for induction and muscle relaxation, unless contra-indicated.
4. Once intubated all patients must be adequately sedated with morphine & midazolam and muscle relaxation maintained (e.g. with rocuronium boluses).

2. Spinal Protection

1. All patients with severe traumatic brain injury should have their cervical spine immobilised either with a) manual in line stabilisation (MILS) or b) with hard collar, blocks and tape.
2. Cervical spine immobilisation should be achieved with manual in line stabilisation during intubation.
3. Log roll should be used if turning the patient for any reason to protect the cervical, thoracic and lumbar spine.
4. The duration that the patient is on a hard spinal board should be minimised; this is to avoid pressure sores. Spinal boards are a pre-hospital device used to assist extrication of patients from damaged vehicles. Patients should not be transferred between hospitals on spinal boards.
5. All patients should be transferred on a vacuum mattress if available.

3. Ventilation

1. All patients should be adequately sedated (morphine & midazolam) & muscle relaxed (e.g. rocuronium boluses) for transfer. Drug doses and ranges are provided in section 8.
2. All patients must have end-tidal carbon dioxide (CO₂) monitoring.
3. Patients should be ventilated to an end tidal carbon dioxide level that correlates to a blood carbon dioxide level (PaCO₂) of 4.5-5 kPa. Blood samples for blood gas analysis may be venous, capillary or arterial.
4. Provide oxygen to maintain saturations ≥98% or an arterial PaO₂ >13kPa.
5. Ventilate all patients with positive end expiratory pressure (PEEP) of at least 5 cmH₂O.

4. Circulation

1. Every patient should have a minimum of 2 large bore peripheral cannulae or intraosseous needles.
2. Blood should be taken for cross match, blood sugar, blood gas, urea and electrolytes, full blood count, coagulation.
2. Treat hypotension aggressively. Hypotension is the biggest cause of secondary ischaemic injury
3. Maintain **systolic** blood pressure above 95th centile for age, this is to ensure adequate cerebral perfusion pressure:

<1 year	>80mmHg
1-5 year	>90mmHg
5-14 year	>100mmHg
>14year	>110mmHg
4. **Do not delay CT or time critical transfer for insertion of central and arterial access.**

5. Consider resuscitation with blood products early in haemorrhagic shock (see massive haemorrhage guideline).
6. If cardiovascularly unstable despite fluid resuscitation, it is vital to reconsider sites of bleeding – these can be onto the floor (external haemorrhage), into the chest, into the abdomen, into the pelvis or into the femur. In infants with an open fontanelle, intracranial haemorrhage can be significant.
7. If there is ongoing bleeding, the patient should not be transferred until the bleeding has been controlled. This might necessitate the patient going to theatre in the local hospital. Discussion with the regional paediatric transport co-ordination consultant on 02380 775502 is advised.
8. Some cardiovascularly stable head injured children need additional vasoactive drug support to maintain their target blood pressures. If the patient only has peripheral access, then use dopamine to maintain their target systolic blood pressure. If the patient has central access, then use noradrenaline to maintain target systolic blood pressure. In patients with myocardial dysfunction, central dopamine should be used in addition to noradrenaline.
9. All patients must have a urinary catheter placed.
10. Ensure blood sugar is >3mmol/l

5. Imaging

1. CT head & cervical spine (or Trauma CT if indicated) within 30 minutes of presentation.
2. All patients must be transferred to CT by an appropriately trained intensivist/anaesthetist with appropriate monitoring. At least: ECG, pulse oximetry, non-invasive blood pressure, end tidal carbon dioxide monitoring.
3. CT must be reported immediately for life threatening features and by a consultant radiologist within one hour.
4. If a time critical neuro-surgical lesion is identified then the patient requires rapid transfer by the local team to Southampton. Discuss with the regional paediatric transport co-ordination consultant on 02380 775502.
5. The lack of a CT scanner is a neurosurgical emergency and should mandate immediate transfer by the referring hospital team. Discuss with the regional paediatric transport co-ordination consultant on 02380 775502.

6. Neuroprotection

1. Ensure blood sugar is >3mmol/l
2. Ensure the patient's head is in the mid-line position.
3. Ensure the bed is tilted to 30 degrees head up.
4. Ensure adequate analgesia and sedation (often require large amounts of morphine & midazolam). Muscle relaxation must be maintained during transport.

5. Maintain good oxygenation (saturations $\geq 98\%$ or arterial $\text{PaO}_2 > 13\text{kPa}$).
6. Maintain PaCO_2 at 4.5-5.0kPa (this can be measured on blood gases from venous, capillary or arterial sources).
7. Maintain blood pressure targets as above (section 4).
8. Maintain normothermia (core temperature 36 to 37 degrees Celsius).
9. Load with phenytoin (20mg/kg over 20 minutes).
10. Intravenous maintenance fluids should be given at 2/3 maintenance. If the patient weighs more than 10kg, use 0.9% saline as maintenance fluid. If the patient weighs less than 10kg, use 0.9% saline with 5% dextrose.
11. Keep serum sodium (Na) more than 135mmol/l. Boluses of 3ml/kg of 3% hypertonic saline are safe and effective.

7. Management of Raised Intracranial Pressure

This should be undertaken if the patient shows evidence of raised intracranial pressure - bradycardia, hypertension, slowly reacting or fixed dilated pupil(s). These procedures should not be performed for evidence of cerebral oedema on CT scan.

1. Ensure all neuro-protective steps are optimized (see section 6).
2. Place the patient on a manual bagging circuit and initiate manual hyperventilation. Reduce the end tidal carbon dioxide level to correlate with a PaCO_2 of 4 to 4.5kPa.
3. Give a dose of either 1.25ml/kg of 20% mannitol or 5ml/kg of 3% saline. These therapies act to reduce cerebral oedema.
4. Discuss with the regional paediatric transport co-ordination consultant on 02380 775502.