NHS Children's Acute Transport Service

Clinical Guidelines

Traumatic Brain Injury

Document Control Information

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Document Version	Version 5	**Replaces Version**	Version 4
First Introduced	2002	**Review Schedule**	2 Yearly
Active Date	January 2016	**Next Review**	January 2022
CATS Document Number			
Applicable to	**All CATS employees**		

1. Assessment

Ask about:

- History
    - Time of injury
    - Mechanism of injury – pattern of injury and prognostic information
- Clinical
    - GCS (attention to trend of motor component - may be more sensitive)
    - Airway or need for intubation
    - Pupillary response
    - Signs of base of skull fracture
        - Haemotympanium, “panda” eyes, CSF otorrhoea, Battle’s sign
    - External signs of head injury including skull fractures, haemorrhage control
    - Post traumatic seizures (load with phenytoin)
    - Vomiting
    - Amnesia
    - Assessment of spinal cord function (movement of limbs, priapism, spinal shock)
- Other
    - SaO_2, Blood gases
    - Labs, including clotting
    - **Results of full secondary survey (needs senior orthopaedic surgeon/general surgeon to review) and presence of other injuries**
    - Trauma imaging (including abdominal assessment - FAST scan plus/or CT), particularly CT scans and cervical spine imaging

2. Initial management

- Stabilisation of airway and cervical spine, breathing and circulation (ABC) is the priority for all patients before attention to other injuries
    - ***Hypotension and hypoxaemia are strongly associated with poor outcome***
- Immobilise cervical spine if any suspicion of cervical spine injury, i.e. if:
    - GCS < 15 at any time
    - Neck pain/tenderness
    - Focal neurological deficit, paraesthesia
    - Distracting injury
    - Intoxication
    - Significant mechanism of injury
- If cardiovascularly unstable and requiring volume resuscitation, consider other sites of blood loss: chest, abdomen, pelvis and major limb fracture

- At least 2 good venous lines (use interosseous access if venous is difficult)
- Cross match blood and transfuse to Hb ≥ 10g/dL.
- Pass urinary catheter and orogastric tube
- Perform secondary survey
- Consider NAI, especially in children < 2 years of age

Indications for CT scanning

- GCS < 13 at any time since injury
- GCS equal to 13 to 14 at 2 hrs after the injury
- Suspected open or basal skull fracture
- Post traumatic seizure
- Focal neurological deficit
    - 1 episode vomiting
- Amnesia > 30 minutes of events before impact
- Dangerous mechanism of injury
- Coagulopathy

Cervical spine imaging

Increasing use of CT and MRI if suspected spinal cord injury without radiographic abnormality (SCIWORA). Seek expert advice from a Major Trauma Centre (MTC).

Make the appropriate referral.

- Criteria for referral to ICU/Neurosurgery include:
    - GCS ≤ 8 after initial resuscitation
    - Unexplained confusion > 4h
    - Deteriorating GCS
    - Progressive focal neurological signs
    - Seizure without full recovery
    - Suspected penetrating injury
    - CSF leak

- Great Ormond Street Hospital is the receiving centre for all head injury patients in North Thames, and Addenbrookes is the centre for the East of England. If the child is accepted by Great Ormond Street, the case must also be discussed with the neurosurgical registrar on call. In the event of any difficulty contacting the neurosurgical registrar, contact the neurosurgical consultant on call.

- If no bed is available at GOS, other centres are Kings College Hospital and St. Georges in South Thames.

3. Indications for intubation

- GCS of $\leq$ 8
- Loss of airway reflexes
- Ventilatory insufficiency (PaO_2 < 9 on air, < 13 in oxygen or $PaCO_2$ > 6)
- Spontaneous hyperventilation ($PaCO_2 \leq 3.5$)
- Respiratory arrhythmia
- Significant maxillofacial injury
- Bleeding with airway compromise potential
- Seizures

4. Management of intubation

- For intubation
- Ensure adequate circulating volume
- Continuous in-line immobilisation of cervical spine
- Rapid sequence induction (see CATS intubation guideline)
- Intubation must be with an oral tube.
- Secure well, preferably with Melbourne strapping (tight ties around neck may can raise ICP)

5 Management post intubation

- Maintain full in-line immobilisation and log rolling for transfer. Use other methods (sandbags, rolled towels, tapes) if it is not possible to adequately fit a C spine collar which may cause obstruction to cerebral venous return
- Sedate and paralyse adequately with fentanyl/remifentanil, midazolam and vecuronium infusions
- Use fentanyl (1-2 mcg/kg) +/or midazolam (0.1 mg/kg) boluses for procedures, e.g. suctioning, log rolling
- Ventilate to a normal $PaCO_2$ 4.0 – 5.0 kPa, mandatory $ETCO_2$ monitoring.
- Aim for saturations of ≥96% and PaO_2 of ≥13 kPa
- Haemodynamics: Avoid hypotension which is associated with poor outcome
- **Pre ICP bolt:** Initially target age appropriate systolic blood pressure ≥ 75th centile (not less than 90 mmHg)[1,2].
- **Post ICP bolt:** Target cerebral perfusion pressure[3] (CPP = mean arterial pressure MAP – intracranial pressure ICP in mmHg) of > 40 mmHg 0 to 5yrs and >50 mmHg 6 to 17 yrs to

maintain cerebral perfusion pressure (CPP), with noradrenaline as necessary. First choice for central venous line would be femoral placement

- Fluid restrict to 50% maintenance of isotonic solution, e.g. 0.9% NaCl
- Maintain blood glucose in normal range – add dextrose to 0.9% if
    - Blood glucose ≤ 4.4 mmol/l < 2years
    - Blood glucose ≤ 3.9 mmol/l ≥ 2years

- Load with phenytoin if any suggestion of seizure activity
- Consider mannitol (0.25 to 0.5 g/kg = 1.25 – 2.5 ml/kg of 20% solution) and/or 2.7% NaCl (3 ml/kg over 20 minutes, aim for serum Na 145) if lateralising pupillary signs (discuss with CATS consultant and neurosurgical SpR on call **prior** to administration)
- Monitor temperature: aim 36-37°C centrally. **Avoid hyperthermia**
- Antibiotic prophylaxis is recommended with:
    - Penetrating head injuries
    - Evidence of CSF leak
    - Use cefotaxime 50mg/kg + metronidazole 7.5mg/kg

5. Transport considerations

- If a child has an intracranial lesion requiring urgent neurosurgery (e.g. extradural haematoma), **the referring hospital should transport the child to the neurosurgical centre to avoid any delay**. See neurosurgical emergency guideline
- Resuscitation of the patient should be completed before transport
- A persistently hypotensive patient in the context of trauma may require damage limitation surgery prior to transport for definitive neurosurgery
- An appropriate vasoactive agent, e.g. noradrenaline, should be connected to a three way tap and ready to commence. These may be given via a peripheral line – discuss with CATS consultant
- Assume spinal injury: maintain in line immobilisation throughout
  Hard collars should not be applied if they are likely to obstruct venous return and therefore increase ICP (the risks of incomplete immobilisation should be balanced against the risks of raised ICP)**.** You should be able to pass a finger down a collar with ease if correctly applied
- Prepare sedation boluses: midazolam 0.1mg/kg boluses and/or fentanyl 1-2μg/kg iv if requires suction or responds to movement

1) Hardcastle N, *Paediatr Anaesth.* 2014 July;24(7):703-710. Doi:10.1111/pan.12415
2) Vavilala MS, *J Trauma*. 2003;55:1039-1044.[PubMed: 14676648]
3) Allen BB, *Pediatr Crit Care Med.* 2014 January;15(1):62-70. Doi10.1097/PCC.0b013e3182a556ea.