Acute head injury: initial resuscitation and transfer

David Kirby
David K Menon

Initial resuscitation

In the UK, about 11% of all patients in Emergency Departments have sustained a head injury, ranging from trivial to fatal. About 1% of these patients will be referred to a specialist neurosurgical centre. The Glasgow Coma Scale (GCS) (Figure 1) is the best method of assessing patients clinically. This allows the severity of head injury to be classified as mild (GCS 14–15), moderate (GCS 9–13), or severe (GCS 8 or less). Initial assessment and resuscitation of all trauma patients should follow the ATLS guidelines. Thus, the identification and treatment of compromised airway, inadequate ventilation or circulatory insufficiency take precedence over detailed assessment of the neurological state.

Airway management: the priority is to secure, maintain and protect a clear airway. This is achieved by a stepwise progression of intervention, coupled with the provision of supplemental oxygen. Secretions and foreign bodies should be removed by suction. It is also important to immobilize the cervical spine using a rigid neck collar, sandbags and tape. The two sandbags are placed one on each side of the head, with two pieces of tape, one across the forehead and one across the chin, to secure the head and the sandbags to the trolley. The risk of associated cervical spine injury in an unconscious patient following trauma is 5–10%. A normal lateral radiograph does not exclude the possibility of important cord injury. Therefore cord injury should be assumed to be present until it can be confidently excluded.

Tracheal intubation is indicated in certain circumstances (Figure 2). The anaesthetic drugs (induction agents and neuromuscular blockers) used for intubation are an individual decision. Even in neurologically obtunded patients, intravenous anaesthetic agents must be used before intubation to attenuate the associated rise in intracranial pressure. Manual immobilization is the preferred technique to control the cervical spine during intubation. Leaving the rigid collar in place, limits mouth opening and makes tracheal

David Kirby *is Clinical Fellow in Neurocritical Care and Specialist Registrar in Emergency Medicine at Addenbrooke's NHS Foundation Trust, Cambridge.*

David K Menon *is Professor of Anaesthesia at the University of Cambridge and Consultant in the Neurosciences Critical Care Unit at Addenbrooke's Hospital, Cambridge. He trained at the Jawaharlal Institute, India, Leeds General Infirmary, the Royal Free Hospital, and Addenbrooke's Hospital. His research interests include mechanisms of secondary neuronal injury, metabolic imaging of acute brain injury and imaging anaesthetic action in the brain.*

Glasgow Coma Scale (GCS)

Eye opening response	
Spontaneously	4
To speech	3
To pain	2
None	1
Best motor response	
Obeys commands	6
Localization to painful stimuli	5
Normal flexion to painful stimuli	4
Spastic flexion to painful stimuli	3
Extension to painful stimuli	2
None	1
Best verbal response	
Oriented	5
Confused	4
Inappropriate words	3
Incomprehensible sounds	2
None	1
Normal adult total score	**15**

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Indications for intubation and ventilation after head injury

Immediately

- Coma (not obeying, not speaking, not eye opening; GCS < 8)
- Loss of protective laryngeal reflexes
- Ventilatory insufficiency (as judged by blood gases):
  - hypoxaemia (PaO_2 < 11 kPa on oxygen)
  - hypercarbia ($PaCO_2$ > 6 kPa)
- Spontaneous hyperventilation causing $PaCO_2$ < 3.5 kPa
- Respiratory arrhythmia

Before the start of transfer to the neurosurgical unit

- Deteriorating consciousness (GCS has decreased by 2 points or more since admission to A&E, not caused by drugs) even if not in coma
- Bilaterally fractured mandible
- Copious bleeding into mouth (e.g. from skull base fracture)
- Seizures

An intubated patient must also be ventilated: aim for PaO_2 > 11 kPa, $PaCO_2$ 4.5–5.0 kPa

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intubation more difficult. Suxamethonium has a rapid onset of action, which outweighs any theoretical risk that it might cause a rise in intracranial pressure (ICP). Judicious use of opioids (fentanyl, alfentanil) may benefit the intubated and ventilated patient, though large doses can reduce mean arterial pressure (MAP) and reflex rises in ICP, even in the ventilated patient. The tracheal tube should be taped to the face only and not tied round the neck because this can compress venous return from the head. However, it may be essential to tie tracheal tubes to ensure a secure airway if there are major facial injuries. An orogastric tube should be passed under direct vision, to decompress the stomach; the nasal route is best avoided until basal skull fracture has been excluded.

Clearing the cervical spine: the key is maintaining a high index of suspicion. Features that suggest cord injury in an unconscious patient include flaccid areflexia, diaphragmatic breathing, hypotension and bradycardia, loss of sensation or pain below a certain dermatome, loss of reflexes below an identified level, and priapism. Purists claim that the cervical spine can be fully cleared only in a conscious, non-intoxicated patient with normal neurological examination, normal plain radiographs and with no painful distracting injury. This is impossible in a patient with head injuries and a reduced conscious level. In such patients, the use of plain radiographs and CT is acceptable (see *Anaesthesia and Intensive Care Medicine* **6:6**). There is increased interest in using MRI to exclude ligamentous injury, because CT reveals only bony anatomy.

Breathing: after intubation, a mechanical ventilator should be used and its settings and configuration guided clinically and by blood gas analysis. It is preferable to place an indwelling arterial line for the initial blood gas sampling. Pulse oximetry provides no information about ventilation and carbon dioxide tension, but is a useful guide to oxygenation. Excessive hyperventilation depresses the myocardium and produces cerebral oedema, and should be avoided. Aim for a $PaCO_2$ of 4.5–5.0 kPa. End-tidal carbon dioxide monitoring can complement arterial blood gas measurement to ensure that this target is maintained.

Circulation: Figure 3 shows the circulatory management of the patient with head injuries. Hypotension is a late sign of hypovolaemic shock, especially in children and fit young adults. Clinical guides to early shock are pulse rate, pulse pressure, capillary refill and respiratory rate. An isolated head injury is almost never a cause of shock, especially in adults, so look for other causes. The ultimate outcome of the brain is best achieved by maintaining the cerebral perfusion pressure (CPP) above 60 mm Hg (CPP = MAP – ICP). Although not measured at this stage, it is best to assume that ICP is greater than 20–30 mm Hg, especially if suggested on CT (tight brain) and thus target MAP should be above 90 mm Hg. Excessive hypertension (MAP > 120 mm Hg) may increase the risk of cerebral oedema.

Resuscitation is achieved initially with the placement of two large-bore, peripheral, intravenous cannulae and the rapid infusion of a normotonic solution such as 0.9% saline or Hartmann's solution (not dextrose because it reduces plasma sodium and exacerbates cerebral oedema, and causes hyperglycaemia which is associated with a worse neurological outcome). Under-infusion is more common than over-infusion. The loss of more than 15% of the circulating volume must be corrected by blood transfusion. Control of haemorrhage is also important and should be concurrent. Delay in recognizing thoraco-abdominal and pelvic sources of bleeding is common and is associated with a poor outcome. Patients who are in shock despite adequate fluid resuscitation must not be transported for CT or to the neurosurgical unit until the hypovolaemia has been corrected and bleeding controlled, in theatre if necessary. Remember C comes before D.