Head Injury

This article particularly refers to the National Institute for Health and Care Excellence (NICE) and Scottish Intercollegiate Guidelines Network (SIGN) clinical guidelines for head injury.\[1\] [2]

Head injury can arise from blunt or penetrating trauma and result in direct injury at the impact site. Indirect injury may also be caused by movement of the brain within the skull, leading to contusions on the opposite side of the head from the impact, or disruptive injuries to axons and blood vessels from shearing or rotational forces as the head is accelerated and decelerated after the impact.

Traumatic brain injury may be categorised as primary (damage occurring at the time of impact) or secondary (injury as a result of neurophysiological and anatomical changes minutes to days following primary insult - eg, from cerebral oedema, haematoma or increased intracranial pressure).

Epidemiology

- Hospital Episode Statistics data for the 2012-2013 annual dataset indicate that there were 171,600 admissions to hospitals in England with a primary diagnosis of head injury.\[3\]
- 70% are males.
- 33-50% are children under 15 years of age.\[2\]
- There is an increasing number of patients admitted with head injuries aged ≥75 years (approaching 40%).\[5\]
- Severe traumatic brain injury defined as Glasgow Coma Score (GCS) <9, has a bimodal presentation - 15-25 years and 65-75 years. This occurs in 11,000 people per year and has a mortality rate reaching 50%.\[4\]

Aetiology

- Falls (22-43%) and assaults (30-50%) are the most common cause of a minor head injury, followed by road traffic accidents (25%). Road traffic accidents account for a far greater proportion of moderate-to-severe head injuries.\[5\]
- Alcohol may be involved in up to 65% of adult head injuries.

Assessment

Head injury patients should be taken directly to a centre which can provide resuscitation and management of head injuries and trauma leading to multiple injuries.\[2\]

Management should begin immediately with resuscitation, as outlined by the appropriate guidelines - eg, Adult Trauma Life Support guidelines. Following this:

In patients with normal or near-normal GCS and who are alert
- Haemodynamic status - pulse rate, blood pressure, fluid status.
- Neurological assessment - full history and examination, make notes of pupil size and reaction to light.
- Look for other possible injuries and any other relevant examination.

In patients with reduced GCS
- Resuscitate but make a quick assessment of GCS and pupils. The priority is to get the patient to hospital and CT scanned within the first hour after injury.\[1\][2]
Prehospital management

Resuscitation

- Basic and Advanced Trauma Life Support, and Basic and Advanced Paediatric Life Support as necessary. In severe traumatic brain injury the time from injury to definitive neurosurgical care plays a crucial role, best outcomes being in those who achieve this within four hours. Other factors pertinent to all cases and especially to severe traumatic brain injury:
  - Airway - endotracheal intubation should only be performed by those experienced and with concomitant anaesthesia (risk of increasing intracranial pressure). Insertion of laryngeal mask airways is easy and provides a good seal around the oropharynx.
  - Breathing - oxygen should be provided with an aim to beginning ventilation as soon as possible. End tidal CO$_2$ monitoring is advisable, as hyperventilation is associated with poorer outcomes, probably relating to cerebral vasoconstriction.
  - Circulation - the systolic blood pressure should be maintained >90 mm Hg ensuring an adequate cerebral perfusion pressure - eg, boluses of 0.9% normal saline

Full cervical spine immobilisation

- Attempted (unless other factors prevent this) if:
  - GCS is <15 at any time since the injury.
  - There is neck pain or tenderness.
  - There is focal neurological deficit.
  - There is paraesthesia in the extremities.
  - Any other clinical suspicion of cervical spine injury exists.

- An alerting call to the destination A&E department should be made for all patients with a GCS <15.

Indications for referral to hospital A&E department

History of head injury

- A high-energy head injury - eg, diving accident, high-speed motor vehicle collision.
- GCS <15 at any time since injury.
- Any loss of consciousness as a result of the injury.
- Any focal neurological deficit since the injury.
- Amnesia for events before or after the injury.
- Persistent headache since the injury.
- Any vomiting episodes since the injury (clinical judgement should be used in those aged ≤12 years).
- Any seizure since the injury.
- Irritability or altered behaviour, particularly in infants and young children.
- Any suspicion of a skull fracture or penetrating head injury since the injury (eg, clear fluid from the ears or nose, black eye with no associated damage around the eyes, bleeding from one or both ears, new deafness in one or both ears, bruising behind one or both ears).
- Visible trauma to the head not covered above but still of concern to the professional.

Past history

- Age ≥65 years.
- Any previous cranial neurosurgical interventions.
- History of bleeding or clotting disorder.
- Current anticoagulant therapy such as warfarin or newer oral anticoagulants.

Other concerns

- Suspicion of non-accidental injury.
- Current drug or alcohol intoxication.
- Adverse social factors (eg, no one able to supervise the injured person at home).
- Continuing concern by the professional about the diagnosis.
- Continuing concern by the injured person or their carer about the diagnosis.
Admission

The following patients meet the criteria for admission to hospital following a head injury:[2]

Adult

- New, clinically significant abnormalities on imaging.
- Not returned to GCS equal to 15 after imaging, regardless of the imaging results.
- When a patient fulfils the criteria for CT scanning but this cannot be done.
- Continuing worrying signs (eg, persistent vomiting, severe headaches).
- Other sources of concern - eg, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, CSF leak).

Children

- History of loss of consciousness.
- Neurological abnormality, persisting headache or vomiting.
- Clinical or radiological evidence of skull fracture or penetrating injury.
- Difficulty in making a full assessment.
- Suspicion of non-accidental injury.
- Other significant medical problems.
- Not accompanied by a responsible adult or social circumstances considered unsatisfactory.

Patients not requiring admission

All patients and their carers should be given clear advice, both in verbal and written form. This should include information on:[2] [6]

- Details of the injury - including the nature and severity.
- Warning signs that warrant further immediate medical assessment:
  - Increasing drowsiness.
  - Worsening headache.
  - Confusion or strange behaviour.
  - Two or more bouts of vomiting.
  - Focal neurological problem - eg, limb weakness.
  - Dizziness, loss of balance, or convulsions.
  - Any visual problems such as bluring of vision, or double vision.
  - Blood, or clear fluid, leaking from the nose or ear.
  - Unusual breathing patterns.

- That a responsible adult will stay with the patient until the first 24 hours following the injury.
- How long recovery is likely to take and what this will involve - including when they can go back to work and undertake everyday activities (eg, school and sports).
- Potential complications.
- Whom to contact if further help is needed.
- Available support organisations.

Investigations

- The current primary investigation of choice for the detection of acute clinically important brain injuries is CT imaging of the head. See separate article CT Head Scanning Indications.
## CT Scan in Head Injuries

<table>
<thead>
<tr>
<th>Selection of adults for CT scan</th>
<th>Selection of children (under 16 years) for CT scan</th>
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<tbody>
<tr>
<td>CT scan of the brain within one hour (with a written radiology report within one hour of the scan being undertaken):</td>
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<tr>
<td>- Glasgow Coma Scale (GCS) &lt;13 when first assessed or GCS &lt;15 two hours after injury</td>
<td>- Clinical suspicion of non-accidental injury</td>
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<tr>
<td>- Suspected open or depressed skull fracture</td>
<td>- Post-traumatic seizure (no past medical history of epilepsy)</td>
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<tr>
<td>- Signs of base of skull fracture*</td>
<td>- GCS &lt;14 on initial assessment or, if &lt;1 year, GCS &lt;15</td>
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<td>- Post-traumatic seizure</td>
<td>- GCS &lt;15 two hours after injury</td>
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<tr>
<td>- Focal neurological deficit</td>
<td>- Suspected open or depressed skull fracture or tense fontanelle</td>
</tr>
<tr>
<td>- &gt;1 episode of vomiting</td>
<td>- Signs of base of skull fracture*</td>
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All patients with a coagulopathy or on oral anticoagulants should have a CT brain scan within eight hours of the injury, provided there are no other identified risk factors, as listed above. Again, a written radiology report should be available within one hour of the scan being undertaken.

If none of the above are present then CT brain scan within one hour if more than one of the following are present (with a written radiology report within one hour of the scan being undertaken):

- Witnessed loss of consciousness >5 minutes
- Amnesia (antegrade or retrograde) >5 minutes
- Abnormal drowsiness
- ≥3 Discrete episodes of vomiting
- Dangerous mechanism of injury (high-speed RTA, fall from >3 m, high-speed projectile)

If only one of the aforementioned risk factors is present then observe for a minimum of four hours - CT scan of the brain within one hour if any of the following occur (with a written radiology report within one hour of the scan being undertaken):

- GCS <15
- Further vomiting
- Abnormal drowsiness

*Signs of basal skull fracture: haemotympanum, 'panda' eyes (bruising around the eyes), CSF leakage (ears or nose) or Battle's sign (bruising which sometimes occurs behind the ear in cases of basal skull fracture).

- Guidelines on the indications for CT scans following a head injury have also been developed in Canada, New Orleans and the USA. [7][8][9]
- Patients who present several hours following the head injury should be reviewed by senior clinicians before deciding on CT scanning.
- MRI: for safety, logistic and resource reasons, MRI scanning is not currently indicated as the primary investigation.
- Skull X-rays have largely been superseded by CT scanning. See separate article Plain Skull X-ray.

## Investigations for the cervical spine

Always consider the possibility of cervical spine injury in cases of head injury. [2]
CT of the cervical spine should be undertaken within one hour if there is a head injury and any one of the following:

- GCS is <13.
- The patient is intubated.
- Plain X rays are abnormal or technically inadequate.
- A definitive diagnosis is needed - eg, before surgery.
- The patient is alert and stable and there is a clinical suspicion of cervical injury with any one of the following:
  - Age 65 years or older.
  - Dangerous mechanism of injury - eg, a fall of height >1 m, a fall down five stairs, axial load to head.
  - Focal neurological deficit.
  - Paraesthesia in the upper or lower limbs.
- Other areas are also to be scanned - eg, multi-region trauma.

For assessment see separate article Whiplash and Cervical Spine Injury.

**Indications for neurosurgical opinion**

- New, surgically significant abnormalities on imaging.
- Persisting coma (GCS ≤8) after initial resuscitation.
- Unexplained confusion which persists for more than four hours.
- Deterioration in GCS score after admission (greater attention should be paid to motor response deterioration).
- Progressive focal neurological signs.
- A seizure without full recovery.
- Depressed skull fracture.
- Definite or suspected penetrating injury.
- ACSF leak.

**Management**

The following statements relate to the routine management of patients following a head injury. See separate article Rising Intracranial Pressure.

- Early nutritional support may be associated with a trend towards better outcomes in terms of survival and disability.\[10\]
- There is no reduction in mortality with methylprednisolone in the two weeks after head injury.\[11\][\[12\] One large study showed an increase in mortality with steroids suggesting that steroids should no longer be used routinely in people with traumatic head injury.\[13\]
- There is no consistent evidence that hypothermia is beneficial in the treatment of head injury.\[14\][\[15\][\[16\]
- High-dose mannitol is beneficial in the pre-operative management of patients with acute intracranial haematomas. There are insufficient data on the effectiveness of pre-hospital administration of mannitol for acute traumatic brain injury.\[17\]
- Prophylactic anti-epileptics are effective in reducing early seizures, but there is no evidence that treatment with prophylactic anti-epileptics reduces the occurrence of late seizures.\[18\]

**Complications**

- Amnesia: common, and may be retrograde and/or antegrade.
- Raised intracranial pressure, cerebral oedema.
- Cerebral herniation.
- CSF leak (test fluid for glucose or drop on filter paper to see double halo):
  - From the ear - possible fracture of petrous temporal bone, may involve VII/VIIIth nerves, leak closes spontaneously, lower risk of meningitis.
  - From the nose - possible fracture of cribriform plate, may originate from ear, anosmia, leak may require surgery, don't blow nose or insert nasogastric tube.
Meningitis: following skull fracture, may occur weeks to years later. The role of prophylactic antibiotics for CSF leak are controversial.

Intracranial haemorrhage:
- **Extradural**: not common. Classically, the middle meningeal artery is torn under a temporal bone fracture and follows an injury-lucid interval coma pattern. However, many are non-classical. 80% progress to uncal herniation. Immediate evacuation of the haematoma is required.
- **Subdural**: caused by sudden acceleration-deceleration of brain parenchyma with tearing of the bridging veins. Common in severe traumatic brain injury, atrophic brains (the elderly, alcoholics) and children aged <2. May be acute (<24 hours), subacute (1-14 days) or chronic (>2 weeks). There may be few signs with chronic subduras. High morbidity and mortality if acute. Surgery is usually required.
- **Subarachnoid**: the most common haemorrhage in moderate-to-severe injury. May present with meningeal signs and has a significant mortality. Nimodipine shows a beneficial effect in brain injury patients with subarachnoid haemorrhage, but the increase in adverse reactions indicates that the drug is harmful for some patients.[19]
- **Intracerebral**: cerebral contusions are common and often associated with a subarachnoid haemorrhage. Intracerebral haemorrhage can occur days after significant blunt trauma, often at the site of resolving contusions (especially in patients with a coagulopathy). CT scans in the immediate post-injury phase may be normal.

Extracranial haemorrhage: scalp lacerations, nasal injuries and injuries to the face and neck can lead to significant blood loss.

Skull fractures: up to 50% will not have significant loss of consciousness or any neurological findings. Prophylactic antibiotics are controversial.

Diffuse axonal injury: shearing/rotational forces disrupt axonal fibres in the white matter and brainstem. Common in motor vehicle accidents and 'shaken baby syndrome'. Injury occurs immediately and is essentially irreversible. There is a rapid increase in intracranial pressure and patients are often unresponsive. CT scan may be normal. Treatment is limited to minimising secondary damage.

Penetrating injuries - eg, **gunshot wounds**. There is a high incidence of infection and mortality.

Seizures: more common following penetrating injury. Can lead to secondary brain injury.

Concussion: symptoms of amnesia and confusion. Duration of amnesia is predictive of injury severity. Other symptoms include dizziness, headaches, poor concentration, nausea, and vomiting. Resolution is often rapid, but symptoms may persist as a post-concussive syndrome for weeks, months or occasionally years.

Late complications of head injury include chronic daily headache, post-traumatic stress disorder, vertigo and cognitive impairment.[20]

Prognosis

- Head injury is the leading cause of death in people aged 1-40 years.[2]
- Death rates are estimated at 0.2% of all patients who attend A&E.[2]
- The annual incidence of disability in adults with head injuries admitted to hospital is 100-150 per 100,000 population.
- Survival with moderate or severe disability has been reported as common after mild (GCS 13-15) head injury (47% of patients) and is similar to that after moderate (45%) or severe injury (48%).[21] Moderate head injury was defined as GCS score of 9-12 and severe as GCS ≤ 8. These figures are higher than previous data and excluded patients under the age of 14 years, where mild head injuries without sequelae are very common. Yet a follow-up study 12-14 years after the initial head injury reported a similarly high recurrence of disability (51%).[22]

Prevention

- Preventative measures include safer roads, barriers to prevent falls, and gun control legislation.
- In addition, bicycle and motorcycle helmets, seatbelts, airbags, and soft surfaces on playgrounds are effective.[23]
- 25-30% of head injuries in infants are the result of an abuse - healthcare professionals need to be trained in safeguarding and to raise concerns without delay.[2]
Further reading & references

- Brain injury rehabilitation in adults; Scottish Intercollegiate Guidelines Network - SIGN (Mar 2013)
- Head injury; NICE Quality Standards (October 2014)

1. Early Management of Patients with a Head Injury; Scottish Intercollegiate Guidelines Network - SIGN (Mar 2009)
2. Head injury; Triage, assessment, investigation and early management of head injury in children, young people and adults; NICE Clinical guideline (Jan 2014)
3. Hospital Episode Statistics, Admitted Patient Care, England, 2012-2013; Health and Social Care Information Centre
6. Head Injury Instructions; Patient
9. Head injury: Triage, assessment, investigation and early management of head injury in children, young people and adults; NICE Clinical guideline (Jan 2014)
12. Head Injury Instructions; Patient
15. Head injury: Triage, assessment, investigation and early management of head injury in children, young people and adults; NICE Clinical guideline (Jan 2014)
18. Head Injury Instructions; Patient
22. Head Injury Instructions; Patient

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