Head Injury

Dr Sally McCarthy
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Emergency Care Institute NSW
Head injury in the emergency department

A common presentation

• 80% Mild Head Injury = GCS 14 – 15

• 10% Moderate Head Injury = GCS 9 – 13

• 10% Severe Head Injury GCS = 3 – 8
Aetiology

**Traumatic Injuries**
Major Causes of Traumatic Brain Injuries

- Falls: 28%
- Motor Vehicle Accident: 20%
- Struck by... (incl. Sports): 19%
- Assault: 11%
- Other: 21%
- Suicide: 1%

Source: National Center for Injury Prevention and Control, CDC
The following groups of patients are at particular risk:

- The elderly (risk of falls, cerebral atrophy)
- Infants (large head size, compressible skull, risk of non-accidental injury)
- Patients with a bleeding diathesis (e.g. on warfarin)
- Chronic alcoholics (at risk of falls and assaults, cerebral atrophy, coagulopathy due to chronic liver disease)
Some sobering facts

• Traumatic brain injury (TBI) is still the major cause of death under 45 years of age.

  Chirurg. 2009 Feb;80(2):153-64 [Diagnosis and treatment of traumatic brain injury.]

• Patients > or =65 years who survived mild TBI have decreased functional outcome at 6 months compared with younger patients


• Female sex (particularly those age > or =55 y) is associated independently with higher mortality in isolated severe TBI

Adult Trauma Clinical Practice Guidelines
Anatomy and Physiology

What are the unique features of brain anatomy and physiology, and how do they affect patterns of brain injury?
Anatomy and Physiology

Effects

- Rigid, non-expansile skull filled with brain, CSF, and blood
- Cerebral blood flow (CBF) usually autoregulated
- Autoregulatory compensation disrupted by brain injury
- Mass effect of intracranial haemorrhage
Pathophysiology

Head injury

- Primary brain injury
  - direct damage that occurs at time of injury
- Secondary brain injury
  - systemic
  - intracranial causes
Secondary brain injury

Head injury

- **Systemic causes**
  - Hypoxia
  - Hypo- or hypercarbia
  - Hypovolaemia
  - Hypo- or hypertension
  - Hypo- or hyperglycaemia

- These are all preventable causes
Secondary brain injury

Head injury

- Intracranial causes
  - Seizures
  - Cerebral oedema and raised intracranial pressure (ICP)
  - Intracranial haematomas

- These are all treatable causes
Secondary Brain Injury

Once the primary brain injury has been recognized, the main objective of the management of acute traumatic brain injury is the prevention of secondary brain injury.
Classification of head injuries

By mechanism of injury

• blunt and penetrating

• Blunt trauma can be of high or low velocity (e.g., motor vehicle crashes, falls, and blunt assault.)
Classification of head injuries

By morphology
Diffuse injuries
These range from simple concussion with an excellent prognosis to diffuse axonal injury with associated grim prognosis

Focal injuries
• Basal skull fractures have an associated risk of CSF leak.
• Clinical symptoms (eg, raccoon eyes, Battle’s sign, otorrhea, and rhinorrhea) should increase the index of suspicion in identifying basal skull fractures.
• Extradural
• Subdural
• Intracerebral
• Traumatic SAH

By clinical impact: GCS level
Extradural haemorrhage (aka epidural hemorrhage)

Uncommon.

— Lenticular shaped opacity on CT
— Most commonly (80%) due to tearing of middle meningeal artery due to a temporal fracture
— Classically (i.e. <50%) have lucid period after injury before subsequently deteriorating (“talk and die”).
Extradural Haematoma
Subdural haemorrhage

More common

— especially in the presence of cerebral atrophy (e.g. elderly and alcoholics)
— Concave shaped on CT
— Due to tearing of veins draining cerebral cortex.
— May present as acute or chronic
Subdural haematoma
Compression of the right lateral ventricle

Subdural haemorrhage
Intracerebral hemorrhage

— Ranging from contusions to haematoma.

— Can evolve over time.
Intracerebral Haematoma / Contusion

Large Frontal Contusion with Shift
Diffuse Brain Injury

Normal CT

Diffuse Injury
• John, tell everybody about the case!!!!!
GCS

GCS is used both for the initial assessment and classification of closed head injuries and for serial assessment of closed head injuries.

Initial GCS on admission to hospital is used to classify head injuries into the broad prognostic groups of mild (GCS 14-15), moderate (GCS 9-13) and severe (GCS 3-8).

There is good quality evidence to relate initial GCS score to outcome.
Head injury classification

- 80% Mild Head Injury = GCS 14 – 15
- 10% Moderate Head Injury = GCS 9 – 13
- 10% Severe Head Injury GCS = 3 – 8
Minor Head Injury - Assessment

• Do the ABCDE’s initially
• Initial period of clinical observation: at least 4 hours
• Assess for risk factors
• CT-scan if GCS <15 at 2 hrs. post injury or any other RF detected
• (Consider) Admission in present of any RF
• In case of doubt or deterioration consult neurosurgical service regarding further management and disposition
• D/C with head injury device at 4 hrs post injury if clinical improving with either normal CT-scan or no RF’s
Risk Factors

- Persistent GCS <15 at 2 hrs. post injury
- Prolonged loss of consciousness (>5 mins)
- Prolonged anterograde or retrograde amnesia (>30 mins)
- Post traumatic seizure
- Focal neurological deficit
- Clinical suspicion of skull Fx
- Repeated vomiting (>2 occasions)
- Persistent severe headache
- Age > 65 years
- Known coagulopathy
- Deterioration in GCS
- Multi system trauma
- Dangerous mechanism
- Intoxication
- Known neurological/neurosurgical impairment
- Delayed presentation
- Failure of clinical improvement
Minor Head Injury

GCS 14-15

High Risk
= any RF present

Low Risk
= no RF, normal CT-scan
Indications for CT-scan

• Mild head injury with at least 1 risk factor present

• Any moderate head injury (9-13)

• Any severe head injury (8 or less)
### CT scan?

These patients **should not routinely have CT scanning** if they have **all** of the following features:

On initial assessment:
- GCS 15 at two hours post injury
- No focal neurological deficit
- No clinical suspicion of skull fracture
- No vomiting
- No known coagulopathy or bleeding disorder
- Age <65 years
- No post traumatic seizure
- Nil or brief loss of consciousness (<5min)
- Nil or brief post traumatic amnesia (<30min)
- No severe headache
- No large scalp haematoma
- Isolated head injury
- No dangerous mechanism
- No known neurosurgery / neurological impairment
- No delayed presentation or representation.

**After a period of observation (until at least four hours post time of injury):**
- GCS 15/15
- No post traumatic amnesia (A-WPTAS 18/18)
- Normal mental status including alertness, behaviour and cognition.
- No clinical deterioration during observation.
- Clinically returning to normal

These patients **should have early CT scanning** if available, if they have **any** of the following features:

On initial assessment:
- GCS<15 at two hours post injury**
- Focal neurological deficit
- Clinical suspicion of skull fracture
- Vomiting
- Known coagulopathy or bleeding disorder
- Age >65
- Witnessed seizure
- Prolonged loss of consciousness (>5min)
- Prolonged post traumatic amnesia (>30min)

**On serial assessment:**
- Decrease in GCS
- Persistent GCS<15 at two hours post injury
- Persistent abnormal alertness/behaviour/cognition
- Persistent post traumatic amnesia (A-WPTAS<18/18)
- Persistent vomiting (≥2 occasions)
- Persistent severe headache
- Post traumatic seizure

**Clinical judgement required if:**
- Initial GCS 14 within two hours of injury**
- Large scalp haematoma or laceration
- Associated multi-system injuries
- Dangerous mechanism
- Known neurosurgery/neurological impairment
- Delayed presentation or representation

**NOTE:** Includes patients with abnormal GCS due to drug or alcohol ingestion.
What about Granny??

- CT to diagnose??
- CT to prognosticate??????

- Does it change our treatment

- Not surgical, admit neurology????
Minor Head Injury - Discharge

- **Clinical criteria**
  - Normal alertness/behaviour/cognition
  - Normal CT-scan or no indication for CT-scan
  - Clinical improving after observation

- **Social criteria**
  - Responsible person available to take home and observe
  - Patient able to return easily in case of deterioration
  - Discharge advice is understood

Written Discharge Advice
Standard management of head injuries

• Assess and stabilise ABCDEs
• Commence at least hourly clinical observations of vital signs, GCS, pupils, PTA and clinical symptoms.
• The initial assessment should be followed by a period clinical observation to detect risk factors for significant intracranial injury. The patient should be risk stratified into “low” or “high” risk groups based on the presence or absence of identified clinical risk factors.
• CT scan not routinely indicated unless one or more risk factors are present.
• Discharge for home observation with head injury advice sheet at 4 hours post injury if clinically improving with either no risk factors indicating need for CT scan or normal CT scan if performed.
• Consider hospital admission and consult regional neurosurgical service if abnormal CT scan.
• Consider hospital admission for observation if clinically not improving at 4 hours post injury irrespective of CT scan result.
• Consider hospital admission for observation if elderly, known coagulopathy or socially isolated.
• Advise patients to see their local doctor if they do not return to normal within 48 hours so they can be reassessed and monitored for post concussion symptoms.
Moderate/ Severe Head Injury Management

- Do the ABCDE’s
- Depends on assessment and varies depending on findings, however all require
  - Neurosurgical consultation
Standard care for severe HI

- Initial systematic assessment and resuscitation of ABCDEs.
- Early intubation.
- Supportive care of ABCDEs with appropriate attention to positioning (30° head up), basic nursing care and avoidance of hyperventilation.
- Prevention of secondary brain injury by avoiding hypoxaemia (O₂ saturation <90%) and hypotension (systolic BP<90).
- Early CT scan to identify acute neurosurgical lesions.
- Early neurosurgical consult
- Early retrieval consult if transfer required
- Consider use of anticonvulsants to prevent early post traumatic seizures
- Consider ICP monitoring to guide management of cerebral perfusion pressure.
- Low threshold to repeat CT scan if patient condition changes
- ICU admission
- Routine repeat CT scan at 24 hours
- Brain injury rehabilitation consult

**Minimum supportive care aims:**
\[ \text{PaO}_2 > 60, \text{SaO}_2 > 90, \text{PaCO}_2 35 – 40, \text{Systolic BP} > 90, \text{Head up 30°} \]
### The injured infant or child

#### Table 1: Risk groups in head injury

<table>
<thead>
<tr>
<th></th>
<th>LOW RISK (All features)</th>
<th>INTERMEDIATE RISK (Any feature / not low or high risk)</th>
<th>HIGH RISK (CHALICE Criteria) (Any feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HISTORY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Witnessed loss of consciousness</td>
<td>nil</td>
<td>&lt;5 minutes</td>
<td>&gt;5 minutes</td>
</tr>
<tr>
<td>Anterograde or retrograde amnesia</td>
<td>nil</td>
<td>possible</td>
<td>&gt;5 minutes</td>
</tr>
<tr>
<td>Behaviour</td>
<td>normal</td>
<td>mild agitation or altered behaviour</td>
<td>abnormal drowsiness</td>
</tr>
<tr>
<td>Episodes of vomiting without other cause</td>
<td>nil or 1</td>
<td>2 or persistent nausea</td>
<td>3 or more</td>
</tr>
<tr>
<td>Seizure in non-epileptic patient</td>
<td>nil</td>
<td>impact only</td>
<td>yes</td>
</tr>
<tr>
<td>Non accidental injury (NAI) suspected</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Headache</td>
<td>nil</td>
<td>persistent</td>
<td>persistent</td>
</tr>
<tr>
<td>Co-morbidities</td>
<td>nil</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Age</td>
<td>&gt;1yr</td>
<td>&lt;1yr</td>
<td>Any</td>
</tr>
</tbody>
</table>
Mechanism

The injured infant or child

<table>
<thead>
<tr>
<th>MECHANISM</th>
<th>low speed</th>
<th>&lt;60kmph</th>
<th>&gt;60kmph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicle Accident (MVA) (pedestrian, cyclist or occupant)</td>
<td>low</td>
<td>&lt;60kmph</td>
<td>&gt;60kmph</td>
</tr>
<tr>
<td>Fall</td>
<td>&lt;1m</td>
<td>1-3m</td>
<td>&gt;3m</td>
</tr>
<tr>
<td>Force</td>
<td>low impact</td>
<td>moderate impact or unclear mechanism</td>
<td>high speed projectile or object</td>
</tr>
</tbody>
</table>
### Examination

The injured infant or child

<table>
<thead>
<tr>
<th>EXAMINATION</th>
<th>15</th>
<th>fluctuating 14 - 15</th>
<th>&lt;14 or &lt;15 if under 1 yr old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glasgow Coma Scale (GCS)</td>
<td>15</td>
<td>fluctuating 14 - 15</td>
<td>&lt;14 or &lt;15 if under 1 yr old</td>
</tr>
<tr>
<td>Focal neurological abnormality</td>
<td>nil</td>
<td>nil</td>
<td>present</td>
</tr>
<tr>
<td>Injury</td>
<td>nil</td>
<td>nil</td>
<td><em>high risk features eg scalp haematoma in &lt;1yr of age (see below)</em></td>
</tr>
</tbody>
</table>

* High risk injury:  
  a) penetrating injury, or suspected depressed skull fracture or base of skull fracture  
  b) scalp bruise, swelling or laceration >5cm, or tense fontanelle in infants <1yr of age
## Disposition

The injured infant or child

<table>
<thead>
<tr>
<th>PLACEMENT</th>
<th>Anywhere in ED</th>
<th>Acute area in ED</th>
<th>Acute or resuscitation bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Respiratory rate, oxygen saturations</td>
<td>Hourly observations until discharge</td>
<td>Half-hourly observations for 4 to 6 hours until GCS 15 sustained for 2 hours, then hourly observations until discharge.</td>
<td>Continuous cardio-respiratory and oxygen saturation monitoring</td>
</tr>
<tr>
<td>Pulse, blood pressure</td>
<td></td>
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<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCS, pupillary response &amp; size, limb strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain assessment</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sedation score as necessary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When to transfer

Agitation
Drowsiness
Vomiting
Severe headache
Late signs of deterioration
  – Decrease in GCS by two or more points
  – Dilated pupil(s)
  – Focal neurological deficit
  – Seizure
  – Cushing’s response – bradycardia and hypertension
Discharge Criteria

Clinical criteria:
• GCS 15/15
• No persistent post traumatic amnesia (nb. A-WPTAS 18/18)
• Alertness / behaviour / cognition returning to normal
• Clinically improving after observation.
• Normal CT scan or no indication for CT scan.
• Clinical judgment required regarding discharge and follow up of elderly patients or patients with known coagulopathy or bleeding disorder due to increased risk of delayed subdural haematoma.
• Any patients who have minor CT abnormalities, who suffered significant clinical symptoms or who had prolonged post traumatic amnesia should be routinely referred to their GP for follow up of post concussion symptoms.
Summary

• Assess
  – Trauma approach
  – ? High or low risk: assess GCS and RF

• Manage
  – Avoid secondary brain injury

• High or low risk?

• Monitor, at least hourly obs

• Analgesia

• Seek assistance, early consultation, retrieval or transfer