ASSESSMENT OF HEAD INJURY

HISTORY

- Take a thorough handover from pre-hospital provider considering Mechanism, Injury, Signs and Treatment provided
- Enquire as to the presence of any intoxicating substances which may impact on examination findings
- **High risk features** on history include:
  - Dangerous mechanism (*Pedestrian struck, Ejection, Fall ≥ 3m*)
  - Post injury seizure
  - Significant retrograde amnesia
  - ≥ 2 episodes of vomiting
  - Witnessed LOC > 5 min
  - Abnormal drowsiness

EXAMINATION

Examination in the head injured patient should be tailored to identify:

**Evidence of neurological injury**
- GCS < 13
- Focal neurological deficit, posturing
- Signs of raised ICP
  - pupillary defect
  - Cushing’s response
  - papilloedema (not always present acutely)
  - tense fontanelle

**Evidence of bony injury**
- Palpable step/ depressed #
- Haemotympanum
- Otorrhoea, Rhinorrhoea
- Battle’s sign, raccoon eyes

**Any associated injuries which can lead to secondary insults**
- Hypotension
- Hypoxia
- Coagulopathy

INVESTIGATION

**Bedside**
- ensure a **BSL** is taken early to exclude hypoglycaemia

**Laboratory**
- **blood gas** sampling is important in severe head injury to optimise pO₂ and pCO₂
- coagulation profile, FBC, ELFT, lipase, BHCG, GPH are all indicated in severe injury to identify and limit associated injuries
**Imaging**

**CT imaging**

Non-contrast CT head is the imaging modality of choice in the investigation of head injury.

*Strong predictors for abnormal CT imaging:*

- Seizure
- Focal neurology
- Signs BOS #
- Anticoagulants/Bleeding diathesis

Clinical decision rules can be used to guide CT imaging in head injuries – particularly minor head injuries. They were derived with the intention to allow more selective ordering of CT scans – with resulting cost and radiation limiting benefits.

Care needs to be taken in the application of decision rules however. They are not a substitute for clinical judgment.

**Adult population**

In adult patients the Canadian CT Head Rule (CCHR) and the New Orleans Criteria (NOC) are examples of clinical decision rules for CT imaging in minor head injury\(^1\). A prospective cohort study validating these two rules found them both to be 100% sensitive for detecting injuries requiring neurosurgical intervention, but the CCHR was more specific and resulted in lower CT rates compared to the NOC.

NEXUS II Investigators (from UCLA) also developed a decision rule using recursive partitioning on 13,728 patients presenting to hospital with a blunt head injury\(^2\). 6.7% had a significant intracranial injury. They developed the BEAN BASH mnemonic to guide CT head imaging. It had a 98.3% sensitivity at identifying clinically significant head injuries. Unlike the CCHR and the NOC this trial included paediatric patients.

### Canadian CT head Rule

<table>
<thead>
<tr>
<th>CT recommended if GCS 13 – 15 and 1 of following :</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk for Neurosurgical Intervention</strong></td>
</tr>
<tr>
<td>GCS &lt; 15 2 hours after injury</td>
</tr>
<tr>
<td>Suspected open/depressed skull #</td>
</tr>
<tr>
<td>Signs of BOS #</td>
</tr>
<tr>
<td>≥ 2 episodes of vomiting</td>
</tr>
<tr>
<td>≥ 65 years old</td>
</tr>
<tr>
<td><strong>Medium Risk for Brain Injury Detection by CT</strong></td>
</tr>
<tr>
<td>Retrograde amnesia ≥ 30 minutes</td>
</tr>
<tr>
<td>Dangerous mechanism:</td>
</tr>
<tr>
<td><em>Pedestrian struck</em></td>
</tr>
<tr>
<td><em>Ejection from vehicle</em></td>
</tr>
<tr>
<td><em>Fall ≥ 3m or 5 stairs</em></td>
</tr>
</tbody>
</table>

Exclusion criteria : GCS < 13, <16yo, warfarin therapy or bleeding diathesis
### New Orleans Criteria

CT required if GCS 15 and 1 of the following:

- Headache
- Vomiting
- 60 yo
- Drug and alcohol intoxication
- Persistent anterograde amnesia
- Visible trauma above the clavicles
- Seizure

### NEXUS II

CT recommended if **BEAN BASH**

- Behaviour abnormal
- Emesis intractible
- Age > 65yo
- Neurological deficit
- Bleeding disorder
- Altered mental status
- Skull fracture
- Haematoma scalp

### Paediatric population

There are several clinical decision rules available to guide imaging for paediatric patients with isolated suspected minor head injury, designed to reduce the radiation exposure to paediatric patients and cost associated with un-necessary scans while minimising missed injury. They have no role to play in the multi-injured patients.

The CHALICE (Children’s Head Injury Algorithm for the prediction of Important Clinical Events) Rule\(^3\) was developed in the UK to be applied specifically to the paediatric population. It was derived from 22772 children presenting with any head injury over a 2 ½ year period. In this group the rule had a sensitivity of 98% for the prediction of clinically significant head injury – and if applied would have led to a CT scanning rate of 14% (3210) of children presenting with any head injury. Of the population studied 1.2% (281) had an abnormal CT scan, of which half (137) required neurosurgical intervention.
### CHALICE rule

A CT scan is required if any of the following criteria are present:

#### HISTORY
- Witnessed LOC > 5 min
- History of amnesia > 5 min
- Abnormal drowsiness
- ≥ 3 vomits post injury
- Suspicion of NAI
- Seizure after head injury in a patient with no history of epilepsy

#### EXAMINATION
- GCS < 14, or GCS <15 if under 1 yo
- Suspicion of penetrating/depressed skull injury or tense fontanelle
- Signs of BOS
- Focal neurology
- Presence of a bruise, swelling or laceration > 5cm if under 1 yo

#### MECHANISM
- High speed MVA (pedestrian, cyclist or occupant)
- Fall > 3m
- High-speed head injury from a projectile

A validation study based at the RCH in Melbourne retrospectively applied the CHALICE rule to 1091 children presenting with any head injury. They found implementing the CHALICE rule would double the number of CT scans in this population compared to a decision to scan made on clinical judgement. This has significant implications in paediatrics from a radiation and cost perspective as well as the risks associated with requiring sedation to facilitate scan. Of the patients that did meet the CHALICE criteria and were not scanned (that is the decision not to scan was made on the grounds of clinical judgment) 1.6% had an abnormal CT scan subsequently, none of which required neurosurgical intervention.

PECARN (Pediatric Emergency Care Applied Research Network) CT Head Algorithm for Children < 2 (A) and > 2 years old (B)

The PECARN algorithm was derived and validated across 25 emergency departments in North America enrolling 43 904 patients under 18 years of age, of which 10 718 were younger than 2 years of age. Clinically important traumatic brain injury was defined as death from traumatic brain injury, injury requiring neurosurgical intervention, intubation for > 24 hours due to TBI, hospital admission for more than 2 nights in association with TBI on CT. TBI in 376 children (0.9%) and 60 (0.1%) required neurosurgical intervention. In the < 2 y age group, the rule had a negative predictive value of 100% and a 100% sensitivity for clinically significant TBI. In the > 2 y age group the negative predictive value was 99.95% and sensitivity of 96.8% (did not miss injury requiring neurosurgical intervention).
The above algorithm if applied would have led to a reduction of CT scans by 25% in children < 2 y and 20% for children > 2 y.

**Other**

- Cranial ultrasound can be employed in the infant with open fontanelles for the detection of intracranial collections. The sensitivity is less than with CT imaging, but serves as a cheap, safe and easily reproducible imaging option where available.
- Skull Xray has a limited role in the assessment of head injury.

**References**


**Appendix 1**

<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Adult</strong></td>
<td><strong>Score</strong></td>
<td><strong>Paediatric</strong></td>
</tr>
<tr>
<td><strong>Eye Opening</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spontaneous</td>
<td>4</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>To Speech</td>
<td>3</td>
<td>To Speech</td>
</tr>
<tr>
<td>To pain</td>
<td>2</td>
<td>To Pain</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>None</td>
</tr>
<tr>
<td><strong>Verbal Response</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientated</td>
<td>5</td>
<td>Coos, babbles (age appropriate)</td>
</tr>
<tr>
<td>Confused</td>
<td>4</td>
<td>Irritable, cries</td>
</tr>
<tr>
<td>Inappropriate</td>
<td>3</td>
<td>Cries to pain</td>
</tr>
<tr>
<td>Incomprehensible</td>
<td>2</td>
<td>Moans to pain</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>None</td>
</tr>
<tr>
<td><strong>Motor Response</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obeyes</td>
<td>6</td>
<td>Spontaneous movement</td>
</tr>
<tr>
<td>Localises</td>
<td>5</td>
<td>Withdraws to touch</td>
</tr>
<tr>
<td>Withdraws</td>
<td>4</td>
<td>Withdraws to pain</td>
</tr>
<tr>
<td>Decorticate posturing</td>
<td>3</td>
<td>Decorticate posturing</td>
</tr>
<tr>
<td>Decerebrate posturing</td>
<td>2</td>
<td>Decerebrate posturing</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>None</td>
</tr>
</tbody>
</table>