



# Algorithm: Imaging & Observation Decision-Making for Children with Head Injuries

Further details and footnotes are important to interpretation of the algorithm. Please see page 2.


**Clinician assessment of child presenting within 72 hours of head injury<sup>1,2</sup>**

**Does the child have these special conditions?**  
Possible abusive head trauma  
Drug or alcohol intoxicated  
< 6 months old  
Please see page 2  
Neurodevelopmental disorders  
Ventricular shunt  
Bleeding disorders

**GCS ≤ 13<sup>3</sup>**

**GCS 14-15<sup>3</sup>**

**Assess for risk factors for intracranial injury<sup>4</sup> & initial observation**

<b>All children:</b> GCS 14 or other signs of altered mental status <sup>5</sup> Abnormal neurological examination Severe mechanism of injury <sup>6</sup> Post-traumatic seizure(s)	<b>Age &lt; 2yrs:</b> Palpable skull fracture <sup>7</sup> Non-frontal scalp haematoma <sup>8</sup> History of LOC <sup>9</sup> ≥ 5 seconds Acting abnormally per parent	<b>Age ≥ 2yrs:</b> Signs of base of skull fracture <sup>10</sup> History of LOC <sup>9</sup> History of vomiting <sup>11</sup> Severe headache	 <b>If signs or symptoms deteriorate during observation stop and request senior clinician review.</b>
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**Any risk factors:** Recommended observation period is up to 4 hours post injury including 1 hour return to normal.<sup>12,13</sup>  
Clinician reassessment with deterioration, return to normal, or at 4 hours.

**No risk factors:**  
No need for observation.

**Alert senior clinician**  
Very close observation required

**High risk = imaging**  
Palpable skull fracture<sup>7</sup> OR  
Signs of base of skull fracture<sup>10</sup> OR  
Worsening signs and symptoms OR  
Persistent GCS 14 OR  
Persistent signs of altered mental status.<sup>5</sup>

**Intermediate risk = consider imaging**  
≥ 2 Risk factors OR  
Post-traumatic seizure(s) OR  
Persistent severe headache or persistent vomiting > 4 hours post injury.

**Low risk**  
Not intermediate or high risk AND  
Improving signs and symptoms:  
GCS 15, acting normally, no current signs of altered mental status, vomiting has stopped, severe headache resolved.

**Very low risk**  
No risk factors

**Head CT<sup>14</sup>**  
Is the CT normal OR  
Showing an isolated non-displaced skull fracture AND  
GCS 15?

**Senior clinician review to consider need for observation vs head CT vs discharge.**

**Senior clinician concerns?**

**Further observation with serial reassessment<sup>12</sup>**  
Is there neurological deterioration OR  
Patient has GCS 14 after 6 hours total observation?

**Senior clinician review**  
If signs or symptoms stable:  
consider (re)imaging or admission.  
If signs or symptoms worsening:  
(re)image and consult neurosurgery.

**Consult neurosurgery and admit**

**Discharge with advice if no other factors requiring admission<sup>13,15</sup>**

YES

NO

NO

YES

NO

YES



## Further details to aid algorithm interpretation

- <sup>1</sup> Always consider possible cervical spine injuries and abusive head trauma in children presenting with head injuries.
- <sup>2</sup> Children with delayed initial presentation (24-72 hrs post head injury) and GCS 15 should be risk stratified the same way as children presenting within 24 hours. They do not need to be assessed with a further 4 hrs of observation.
- <sup>3</sup> Remember to use an age-appropriate Glasgow Coma Scale (GCS).
- <sup>4</sup> Risk factors adapted from Kuppermann N et al. *Lancet* 2009;374(9696):1160-70.
- <sup>5</sup> Other signs of altered mental status: agitation, drowsiness, repetitive questioning, slow response to verbal communication.
- <sup>6</sup> Severe mechanism of injury: motor vehicle accident with patient ejection or rollover, death of another passenger, pedestrian or cyclist without helmet struck by motor vehicle, falls of  $\geq 1\text{m}$  ( $< 2$  yrs), fall  $> 1.5\text{m}$  ( $\geq 2$  yrs), head struck by high impact object.
- <sup>7</sup> Palpable skull fracture: on palpation or possible on the basis of swelling or distortion of the scalp.
- <sup>8</sup> Non-frontal scalp haematoma: occipital, parietal, or temporal.
- <sup>9</sup> Loss of consciousness.
- <sup>10</sup> Signs of base of skull fracture: haemotympanum, 'raccoon' eyes, cerebrospinal fluid (CSF) otorrhoea or CSF rhinorrhoea, Battle's signs.
- <sup>11</sup> Isolated vomiting, without any other risk factors, is an uncommon presentation of clinically important traumatic brain injury (ciTBI). Vomiting, regardless of the number or persistence of vomiting, in association with other risk factors, increases concern for ciTBI.
- <sup>12</sup> Observation to occur in an optimal environment based on local resources. Frequency of observation to be  $\frac{1}{2}$  hourly for the first 2 hours, then 1-hourly until 4 hours post injury. After 4 hours, continue 2-hourly as long as the patient is in hospital. Observation duration may be modified based on patient and family variables. These include time elapsed since injury/symptoms and ability of child/parent to follow advice on when to return to hospital.
- <sup>13</sup> Shared decision-making between families and clinicians should be considered.
- <sup>14</sup> Do not use plain X-rays, or ultrasound of the skull, prior to or in lieu of CT scan, to diagnose or risk stratify a head injury for possible intracranial injuries.
- <sup>15</sup> Other factors warranting hospital admission may include other injuries or clinician concerns e.g. persistent vomiting, drug or alcohol intoxication, social factors, underlying medical conditions, possible abusive head trauma.



## Special Conditions

### Possible abusive head trauma



Follow local screening tools for abusive head trauma (AHT). CT should be used as initial diagnostic tool to evaluate possible intracranial injury and other injuries relevant for the evaluation of AHT e.g. skull fractures. The extent of the assessment of a child with possible AHT should be co-ordinated with the involvement of an expert in the evaluation of non-accidental injury.

### Drug or alcohol intoxicated



Treat as if the neurological findings are due to the head injury. Decision to CT scan or observe should be informed by risk factors for intracranial injury rather than the child being intoxicated.

### < 6 months of age



Consider at higher risk of intracranial injury with a lower threshold for observation or imaging. Discuss with a senior clinician.

### Neurodevelopmental disorders



It is unclear whether these children have a different background risk for intracranial injury. As these children may be difficult to assess, consider structured observation or head CT scan and include the paediatric team that knows the child (parents, caregivers, and clinicians) in shared decision-making.

### Ventricular shunt (e.g. ventriculo-peritoneal shunt)



Consider structured observation over immediate CT scan if there are no risk factors of intracranial injury. If there are local signs of shunt disconnection/shunt fracture (such as palpable disruption or swelling) or signs of shunt malfunction, consider obtaining a shunt series based on consultation with a neurosurgical service.

### Bleeding disorders or anti-coagulant or anti-platelet therapy



Urgently seek advice from the treating haematology team around risk of bleeding and management of coagulopathy. Consider structured observation over immediate CT scan if there are no risk factors for intracranial injury. If there is a risk factor for intracranial injury a head CT should be performed. If there is a deterioration in neurological status, perform urgent head CT scan.

#### Coagulation factor deficiency

CT scan or decision to observe must not delay the urgent administration of replacement factor.

#### Immune thrombocytopenias (ITP)

Check a platelet count in all patients and blood group in all symptomatic patients if not already available. For ITP with platelet counts  $< 20 \times 10^9/\text{L}$ , consider empirical treatment after discussion with the treating haematology team.

#### On warfarin therapy or other newer anticoagulants (e.g. direct oral-anticoagulant) or anti-platelet therapy

Consider CT regardless of the presence or absence of risk factors for intracranial injury. Seek senior clinician review to inform timing of the CT and discuss the patient with the team managing the anticoagulation regarding early consideration of reversal agents. For children on anticoagulation therapy, if available, check the appropriate anticoagulant measure (e.g. International normalised ratio).