

Head injury – Emergency Management in Children Children’s Health Queensland Hospital and Health Service

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Medical and Nursing staff working in
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Quality in Health Service Organisations
Standard 4: Medication Safety

1. Purpose

This procedure provides clinical practice guidelines to guide clinicians involved in the emergency management of children with a head injury.

2. Scope

This procedure relates to all staff involved in the care and management of children with a head injury.

3. Introduction

Head injuries in children are a common reason for presentation to an emergency service, accounting for 1 - 2% of all presentations to specialist children’s emergency services within Australia.¹ Although most are minor, head injuries remain a significant cause of morbidity and mortality.

Children sustaining head injuries at the more severe end of the head injury spectrum are usually readily identifiable and this should prompt immediate (and concurrent) intervention, investigation and referral for definitive management.

Children with clinical features of head injury at the “milder”, and by far more prevalent end of the spectrum, present far more frequently and provide their own challenges. Differentiating children with truly trivial and low risk head injuries from those at risk of a clinically significant injury such as an intracranial bleed or a depressed skull fracture can be problematic.

Although a CT (Computerised Tomography) scan remains the gold standard investigation to exclude clinically significant head injury in the acute setting, this investigation carries with it the incumbent risks of radiation exposure,^{2,3} and the potential need for sedation and/or transfer to a higher level children’s facility. With these risks noted, it is both impractical and inappropriate to perform a CT scan on every child presenting with a head injury to identify the relatively small number with a significant intracranial injury and the even smaller proportion requiring operative intervention.

Several Clinical Decision Rules (CDRs) have thus been derived to:

- Guide clinicians in risk stratifying children who present with an isolated head injury, and
- Guide clinical management



In particular, these rules help to identify which children may be safely discharged home without a CT scan and as such, form an integral part of the current approach to the assessment and management of a child or infant presenting with an isolated head injury to the emergency service.

This clinical procedure will examine application of these CDRs in the Queensland context, and more broadly, describe a clinical framework through which to both assess and manage the child or infant presenting with an isolated head injury of any severity.

4. Procedure - Assessment

Adequate assessment of risk in the child or infant presenting to the emergency service with an isolated head injury requires consideration of concerning features of the clinical history, examination and mechanism of injury. The optimal combination of clinical features to assist prediction of clinically important head injuries remains of some debate, with several recent CDRs for radiological imaging in head injury in children being proposed. The most recent of these are the CHALICE rule, derived from a multicentre study of 22,772 children in the UK,⁴ the larger US multicentre PECARN rule (33,785 children),⁵ and that proposed by the Canadian CATCH study (3866 children).⁶ Difficulties arise in comparing studies due to differences in inclusion criteria, assessment variables and definitions of injury and clinically significant outcomes. Figure 1 outlines CDRs during the assessment phase

Figure 1: Clinical decision rules for head injuries

The development of a clinical decision rule is a three (3) step process involving derivation, validation and impact analysis (assessing the impact of the rule on clinician behaviour).^{7,8} For isolated head trauma in children, several decision rules of varying methodological qualities, cohort size and rule performance have been proposed over the last decade,^{9,10} of which the three (3) mentioned in the guide are the most recent and the most robust.⁹ (See [Appendix 2: Clinical decision rules](#)). Of these, only the PECARN rule has been validated in a cohort independent of the original study cohort, although the validation cohort was still derived from the same centres and assessed by the same clinicians as the derivation group. No clinical decision rule for children's head injury has, as yet, been validated in an Australian context.

The three (3) decision rules are difficult to directly compare due to difference in inclusion criteria, definitions of significant head injury and sometimes subtle definitional difference in pertinent features of history, mechanism and examination. Strict application of any of the rules in our population (particularly the PECARN rule) though, is likely to result in a much higher rate of CT scan use than currently occurs,¹¹ a circumstance also noted in the original CHALICE cohort.^{4,12} The concept of a clinico-radiological rule has been included where, for some of the children stratified as at risk, CT or observation is provided as an option according to physician experience, the number of predictor variables, symptom progression, age and parent preference (See [Appendix 2: PECARN rule](#)). This concept also underlies the approach to the management of children's head injury provided in this guideline. Children are risk stratified with guidance from clinical decision rules, then a decision made to CT scan or observe according to other operant factors. (See flowchart [Appendix 1: Emergency management of children with a head injury](#))

All of these CDRs have a high sensitivity (close to 100%), although specificity varies widely. The negative predictive value of both the PECARN and CHALICE rules are 99.9% i.e. if the rule is negative (no features apply), the risk of a child having a significant intracranial injury is less than 0.1%. Methodologically, the PECARN rule appears to be the best validated rule currently available⁷ albeit validated by the same clinicians at the same catchment centres), however due to its low specificity, application in our population is likely to lead to an unacceptably high rate of CT scan use. As such, and as identified in a recent systematic review⁷ the CHALICE rule may provide the best appropriate alternative. Another option is to screen with both PECARN and CHALICE rules, requiring both to be negative. This approach though, may result in a significant increase in the number of children scanned, with only very small gains in the number of clinically significant injuries detected. [Appendix 2: Clinical Decision Rules](#) outlines the features of clinical assessment significantly associated with an increased risk of a clinically significant head injury in CHALICE, PECARN and CATCH rules respectively.



Clinical features

Level of consciousness

Level of consciousness (LOC) is generally the first discriminator applied to any child or infant presenting with a head injury. All CDRs (some through excluding such populations) consider that any child with a diminished or deteriorating Glasgow Coma Score (GCS) or diminishing alertness as measured by an alternative scale (e.g. AVPU — Alert, Verbal, Painful, Unresponsiveness neurological test) following a head injury, is at risk of significant intracranial injury and should receive immediate investigation. Careful initial and repeated clinical examination is required to identify signs of raised intracranial pressure (ICP) with immediate management and referral instituted.

Signs of **raised intracranial pressure** include:

- Deteriorating or diminished LOC
- Abnormal posture (decorticate or decerebrate)
- Abnormal pupillary responses, unilateral or bilateral dilatation
- Abnormal oculocephalic reflexes (doll's eye movement or dysconjugate upward gaze)
- Abnormal breathing patterns (hyperventilation, Cheyne-Stokes, apnoea)
- Cushing's triad (hypertension + bradycardia + breathing abnormalities) – a late sign of raised ICP

Other features of examination that have been shown to be significant predictors of intracranial injury (and should prompt CT scan) include:

- Suspicion of a depressed skull fracture (including boggy haematomas, palpable depressions)
- Suspicion of a penetrating injury
- Suspicion of a basal skull fracture (raccoon eyes, haemotympanum, battle's sign, csf leak via nose, ears)
- The presence of focal neurology
- Other features suggestive of more extensive injury (e.g. other signs of significant trauma or potential non-accidental injury)

Most CDRs identify these factors as definite indications for performing a CT scan. In infants and young children, the *size or location of a haematoma, swelling or laceration* (suspicious for skull fracture) or a *bulging fontanelle* may also warrant consideration of immediate CT scan. Examination should also always include a secondary survey for other potential injuries.

History and Mechanism

Abnormal behaviour such as agitation or drowsiness is generally identified as important, as is a history of loss of consciousness, although the duration considered to be significant varies. Vomiting is recognised as an important variable, but the number of vomits considered as significant varies. Other symptoms such as headache, amnesia and a history of post traumatic seizure (in a child with no history of epilepsy) are variably included in published decision rules. There are also well acknowledged difficulties in eliciting various symptoms at different ages for example, amnesia in the young child, and the issues with relying on retrospective estimates of time.

Mechanism of injury is also an important consideration. A significant mechanism may include:

- Fall from a significant height (e.g. Bunkbed, tree, play equipment, second-storey window)
- Involvement in a high speed motor vehicle
- Pedestrian versus vehicle accident
- Head trauma following impact by a high speed projectile object

Again, differences between rules exist between heights, speeds, objects and surfaces; and may in fact depend on other circumstances for example, age of child, the impact surface for height of a fall, method of restraint and damage to vehicle or other passengers for a motor vehicle accident.



Other important features of assessment include:

- Patient features — age, co-operation, deviation from normal behaviour
- Time of day
- Concurrent symptoms / suspicions of alternate diagnoses
- Socio-demographic variables—distance from hospital, access to support / transport / childcare etc
- Parental features — anxiety, health seeking behaviours, capacity to monitor at home
- Hospital / health care factors — access to definitive investigation / interventions if required, staff skill mix
- Awareness of special circumstances when assessing the child with a head injury (see **Figure 2**)

Figure 2: Special circumstances to consider

<i>Non-Accidental Injury (NAI)</i>	Suspicion or concerns of NAI necessitates mandatory discussion with hospital child protection advisors (CPAs), Child Protection Services and/or senior emergency clinicians and may require referral to other agencies for example, Child Safety Service Department of Communities and Police. These children often require more extensive investigation than would ordinarily be required in view of their clinical condition for example, MRI / Ophthalmic examinations.
<i>Multi-trauma patients</i>	Assessment, investigation and treatment should be considered in light of other clinical features and injury patterns.
<i>Cervical spine injury</i>	Consider the need for investigations / precautions if any concern exists. In-line immobilisation of the cervical spine should be maintained until a cervical spine injury has been excluded (either clinically or radiologically). Cervical spine imaging usually involves plain radiographs (Lateral, AP & Peg views). Cervical spine CT may be indicated in some circumstances (after discussion with a Radiologist)
<i>Alternative Diagnoses</i>	Alternative explanations for the presenting clinical picture (e.g. LOC, vomiting): Metabolic conditions, infectious diseases, poisoning, acute surgical conditions and non-convulsive status are among the conditions requiring immediate management that may mimic present with similar symptomatology i.e. the head injury may be a red herring.
<i>Other Factors</i>	Factors which may increase risk of significant injury independent of mechanism for example, coagulopathy, recent neurosurgery.

Investigations

CT Scan remains the gold standard investigation of intracranial injury in the acute setting. Associated risks include radiation exposure (exact exposure is dependent on the machine used and site specific protocols for use), and the possible need for sedation, particularly in the young or behaviourally difficult child. Transfer to a different facility may also be necessary. Very young infants may settle sufficiently with swaddling / wrapping after a feed if the clinical situation permits. Oral sucrose may facilitate comfort during the scan.

Pharmacological sedation,¹³ if required, should be performed by senior medical staff experienced with the agents used and airway management in children. Small doses of Midazolam (intravenous / nasal / buccal) or intravenous Ketamine are often used. Anaesthetic assistance may be required.

Plain skull x-rays are *not* routinely recommended for investigation of children with acute head trauma due to difficulties in non-specialist interpretation, and the poor correlation between skull fractures and intracranial injury. They may be used in some circumstances in consultation with a neurosurgeon and/or radiologist.

For safety, resource, and logistic reasons, *Magnetic Resonance Imaging (MRI)* is generally not indicated in the emergency situation, although it may be considered in some specific situations for example, a well child with suspected NAI.



5. Management

Management according to Risk Stratification

Low risk patients

Children may be considered at “low risk” if they have all of the following:

- History of head trauma with no concerning features on history, examination or mechanism of injury (i.e. No risk factors for intermediate or high risk head injury)
- Normal level of consciousness ([GCS 15](#)).

As per evidence available from published decision rules, these children are at *very low risk* of having a clinically significant head injury (<0.1%) and may be discharged home with head injury advice if other discharge criteria are met (see Disposition).

	<p>ALERT: Low risk / minor head injury is <i>not</i> no risk</p> <p>All carers of children discharged following a head injury, whether or not imaging has been performed, should receive verbal and written head injury advice.</p> <p>The impact of post-concussive symptoms and the potential for adverse neuropsychological sequelae with even relatively minor head injuries is increasingly being appreciated.^{14,15} Carers should be advised to seek medical attention if low grade or vague symptoms persist.</p>
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Intermediate risk patients

Intermediate risk patients include those with a [GCS 14 - 15](#) but concerning features on history, examination or mechanism of injury. Children who have any concerning features are at increased risk of a clinically significant head injury compared to those who do not, and further investigation or observation should be considered.

CT scan is the gold standard investigation to exclude clinically significant head injuries in the acute situation. However, scanning all children who have concerning features is likely to result in an unacceptably high rate of CT use in our population, and may necessitate transfer due to scan or sedation availability. As such, a period of observation may be an acceptable alternative in some situations. This decision should be made in consultation with senior medical staff, and can only occur where appropriate facilities and experienced staff are available to monitor the child during the period of observation with timely intervention / investigation if required.

Factors that may influence this decision include:

- Clinician experience
- Presence of multiple as opposed to isolated risk factors
- Presence of worsening or unresolved symptoms
- Age of the child
- Availability of resources at the local health care facility.

Examples of a situation where observation may be undertaken may include an otherwise well child subjected to a significant mechanism of injury; or a child presenting with a history of isolated infrequent vomiting who now appears completely well.

Observation

If the decision is made to observe a child following a head injury, this should only occur where appropriate facilities and experienced staff are available to monitor the child during the period of observation.

Children should generally be observed for at least six (6) hours after the initial injury as the likelihood of developing signs of a significant intracranial injury diminishes significantly after this time.¹⁶

Nursing observations should be performed at least half hourly for the first two (2) hours, hourly for the next four (4) and second-hourly thereafter unless deterioration occurs within the observed time. For those patients with a [GCS](#) of 14, half-hourly observation should occur until the patient achieves [GCS 15](#).¹⁷

If concerns persist after observation, or there is a clinical deterioration within the observation time, a CT should be performed. Discharge may occur after the observation period providing all discharge criteria are met (see [Disposition](#)).



High risk patients

Indications for immediate CT scan with high risk patients include children with the following:

- [GCS](#) <14
- Suspicion of a depressed, open or basal skull fracture
- Penetrating injury
- Suspicion of nai
- Presence of focal neurological deficit.

Concurrent investigation, management and referral may be required for the child or infant presenting with a high risk of a significant head injury. The urgency of neurosurgical consultation and ICU / retrieval consultation will depend on the severity of the clinical presentation and the availability of resources in the emergency service to which the child has presented.

Priorities include:

- Management of ABC and any suspicion of raised ICP
- Frequent clinical reassessment to examine for signs of deterioration
- Urgent CT scan (if available) OR transfer to a Level 6 facility for CT & further management
- Urgent neurosurgical consultation, with the need for retrieval being considered

Management of raised intracranial pressure (ICP)

Management of suspected raised ICP in children aims to prevent further rises in ICP and/or remove its cause (surgical evacuation of haematoma) whilst maintaining adequate cerebral perfusion. Both generalised cerebral oedema and focal haemorrhage / swelling may produce raised intracranial pressure in children.

Airway & Breathing

- Actively manage airway with oral endotracheal intubation and positive pressure ventilation. Nasal intubation is not recommended, particularly if base of skull fracture is suspected. Maintain cervical spine precautions
- Avoid hypercarbia and hypoxia. Current evidence supports low normocapnia (pCO₂ 35-40mmHg) except in the hyperacute situation of impending herniation where a short duration of hypocapnia may buy critical time or in situations of raised ICP that is refractory to other measures. Prolonged hypocapnia may increase secondary brain injury¹⁸⁻²⁰
- Rapid sequence induction (RSI) should be used for intubation. Hypoxia and hypotension should be avoided, and induction agents chosen with this in mind. In the past (on the basis of a small number of studies with few patients not undergoing emergency management of head injury), ketamine has been avoided due to concerns of increasing ICP. More recently, published reviews have found no evidence of significant rises in ICP in the head injured patient after ketamine use.²¹⁻²³ Indeed, the pharmacological properties of ketamine may indeed offer neuroprotective effects, avoiding haemodynamic instability and decreased cerebral perfusion. This may be particularly important in the hypotensive or multiple injured patient

Circulatory Support

- Maintain adequate blood pressure and avoid hypovolaemia, remembering that:
 - Cerebral perfusion pressure (CPP) = Mean arterial pressure (MAP) - Intracranial pressure (ICP).

Head tilt

- Raise head of bed 20 - 30 degrees¹⁸⁻²⁰



Hyperosmolar agents: mannitol and hypertonic saline

- Both pharmacological agents are used in the acute management of raised ICP (and impending herniation) in children
- A number of recent publications have examined the evidence behind the use of such of agents in children.²⁴⁻²⁷ While some reviews (based on a limited number of studies) have suggested that hypertonic saline may be more effective than mannitol in reducing ICP, other studies have found no significant difference. To date, no randomised control trials in children have been published for either agent or comparing agents²⁷ and studies on this topic, particularly in children are generally small, observational in nature and undertaken in highly varied clinical contexts. As such it is difficult to make a definite, or preferential, recommendation. Use of a particular agent in the emergency service may be determined by established local practice, specialist advice, familiarity with a particular agent and potential risks of use, ease of access, and co-morbidities of the patient
- Doses:
 - Mannitol: 0.5 - 1g/kg intravenously over 10 - 15 minutes
 - Risks of use include hypovolaemia & hypotension secondary to Mannitol's diuretic effects; potential for accumulation of Mannitol in injured areas of the brain with continuous infusions and thus worsening of oedema & ICP; renal failure at high serum osmolalities
 - Hypertonic Saline (3%): 1 - 5mls/kg intravenously over 10 - 15 minutes
 - Risks of use include rebound ICP rise following cessation of therapy, central pontine myelinosis with rapid sodium increase, subarachnoid haemorrhage with rapid brain shrinkage, and renal failure¹⁸

Other measures

- Adequate sedation and analgesia.
- Consider neuromuscular blockade — note that paralysis may mask seizure activity.
- Actively manage seizures and consider seizure prophylaxis (Phenytoin load 20mg/kg over 20-60 minutes) if there is a history of seizures.
- Avoid hyperthermia — if active cooling is commenced, shivering should be avoided with neuromuscular blockade administration.

Urgent neurosurgical consultation is required if raised ICP is suspected as emergency craniotomy may be required. Timely ICP monitoring may also be desirable.

Retrieval, if required, to a Level 6 facility also needs to be considered urgently in this situation.

Other considerations in Head Injury Management

Pain management: appropriate attention should be given to pain relief.

Anti-emetic therapy (Ondansetron): control of nausea and vomiting following a head injury through the use of anti-emetic therapy should only be considered when the decision to CT scan has already been made. Its use prior to this decision may interfere with the ability to apply CDRs where vomiting (or number of vomits) is used as a risk factor for significant intracranial injury. Usual dose: 0.15 - 0.2 mg/kg (maximum 8mg) IV or PO.

See flowchart [Appendix 1: Emergency Management of children with a head injury](#)



6. Disposition

A child may be safely discharged after a head injury if the following criteria are met:

- At least one (1) of the following conditions being met:
 - low risk or intermediate risk with unremarkable period of observation
 - negative CT Scan and no significant persistent symptoms / signs
 - well child with cranial injury deemed suitable for discharge following neurosurgical review e.g. some non-depressed linear skull fractures without intracranial injury.
- GCS remains at 15
- No concerns of non-accidental injury
- No concerns of serious alternate / concurrent diagnosis
- Parental / carer concerns adequately addressed
- Can be discharged into care of responsible adult who lives within a reasonable distance of the hospital and will be able to seek medical advice as appropriate. Time of day and other demands on a caregiver's time should also be considered.

Indications for specialist care include:

High dependency unit (HDU) or Intensive Care unit (ICU):

- Signs of raised ICP, deteriorating clinical condition, or significant intracranial injury
- Airway support, post-operative care or ICP monitoring required
- Closer neuro-observation required than available in ward situation.

Transfer to a Level 6 facility

- HDU / ICU level care / acute neurosurgical intervention required or deteriorating clinical condition
- Significant head injury diagnosed clinically or on imaging with risk of acute deterioration i.e. Requires monitoring with urgent intervention available if required
- Significant persistent symptoms despite negative neuroimaging
- CT scan required and unavailable at the current facility (due to reasons of scan availability or ability to safely sedate for scan)
- Insufficient / inappropriate staff / resources to appropriately monitor at current facility
- other specialised support required which is unavailable at the current facility

See flowchart [Appendix 3: Admission / discharge criteria for children with a head injury](#).

When a decision is made to transfer a child to a Level 6 facility, referral must be made through RSQ.²⁸

[Activation of the QLD emergency medical system coordination centre \(QCC\)](#)

Further information on the preparation of an infant prior to transport can be obtained through RSQ Clinical Guidelines paediatric section (page 31 - 35).²⁸

[Statewide RSQ Clinical Guidelines — Paediatrics](#)



7. Abbreviations

Term	Definition
ABC	Airway, breathing, circulation
AVPU	Alert, verbal, painful, unresponsiveness neurological test
Children	0-14 years of age
CHQ	Children's Health Queensland
CATCH	Canadian Assessment of Tomography for Childhood Head Injury
CDR	Clinical decision rules
CHALICE	Children's Head Injury Algorithm for the prediction of Important Clinical Events
CO2	Carbon dioxide
CPA	Child protection advisors
CPP	Cerebral perfusion pressure
CSF	Cerebrospinal fluid
CT	Computerised tomography
HDU	High dependency unit
ICP	Intra-cranial pressure
ICU	Intensive Care Unit
GCS	Glasgow Coma Score
LOC	Level of consciousness
MAP	Mean arterial pressure
MRI	Magnetic Resonance Imaging
NAI	Non accidental injury
PECARN	Paediatric Emergency Care Applied Research Network
RSQ	Retrieval Services Queensland
SCAN	Suspected Child Abuse and Neglect
SSU	Short stay unit

8. Supporting Documents

- [Emergency management of children with a head injury](#)
- [Clinical decision rules](#)
- [Admission / discharge criteria for children with a head injury](#)
- [Head injury in children fact sheet](#)



9. References and Suggested Reading

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10. Consultation

Key stakeholders (position and business area) who reviewed this version are:

- Director of Paediatric Emergency Medicine, Children's Health Queensland
- Clinicians (medical, nursing, allied health) working within Level 4, Level 5 and Level 6 Children's Health and Metro Children's Health Queensland in emergency, inpatient and ambulatory services
- Children's Health Services District clinical leaders — medical, nursing and allied health
- District Chief Executive Officers — Children's Health Queensland, Metro South, Metro North and West-Moreton Health Queensland Districts
- Queensland Ambulance Services — Manager Clinical Standards.

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- Dr Jason Acworth - Director of Paediatric Emergency Medicine, Children's Health Queensland
- Donna Franklin - Project Manager SEQ PP, Children's Health Queensland
- Dr John Gavranich - Director of Paediatrics, Ipswich Hospital
- Dr Robyn Brady - Staff Specialist, Emergency Services, Mater Children's Hospital
- Dr Natalie Phillips - Staff Specialist, Emergency Services, Royal Children's Hospital
- Shahn Horrocks - Nurse Practitioner, Emergency Services, Gold Coast and Logan Hospitals
- Tony Hsuig - Clinical Nurse Consultant, Emergency Services, Logan Hospital
- Andrea Hetherington - Clinical Nurse Consultant (Paediatrics) Emergency Services, Logan Hospital
- Elizabeth Ruddy - Clinical Nurse Consultant, Emergency Services, Mater Children's Hospital
- Rikke McTavish - Registered Nurse, Emergency Services, Royal Children's Hospital.

11. Procedure Revision and Approval History

Version No	Modified by	Amendments authorised by	Approved by
1.0	Director Paediatric Emergency Medicine – Children's Health Queensland	<ul style="list-style-type: none"> ■ Greater Brisbane metropolitan area clinical procedures working group ■ Chief Executive, CHQ 	Sue McKee



12. Audit / Evaluation Strategy

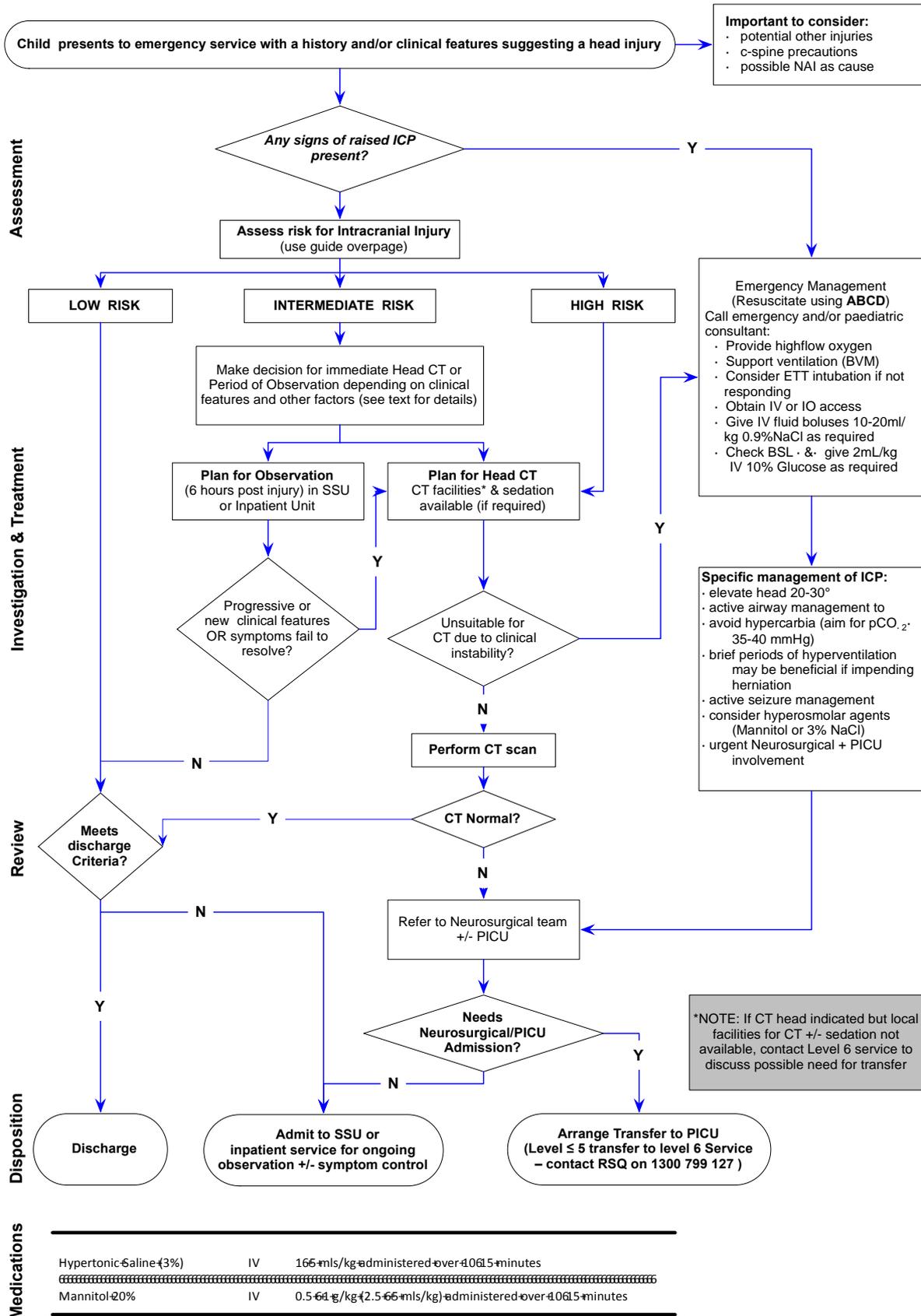
Level of risk	Medium
Audit strategy	<ol style="list-style-type: none"> 1. Staff survey to evaluate awareness of procedure and emergency management practices 2. Observe practice 3. Review documentation, i.e. chart audit, to evaluate compliance with procedure
Audit tool attached	NIL
Audit date	Annual snapshot review (August)
Audit responsibility	Individual Greater Brisbane Metropolitan hospitals, i.e. Ipswich, Logan, Redland, MCH, RCH, TPCH, Redcliffe, Caboolture
Key Elements / Indicators / Outcomes	<p>KPI 1 — greater than 80% staff awareness of procedure</p> <p>KPI 2 — greater than 80% compliance with procedure</p>

13. Appendices

- [Appendix 1: Emergency management of children with a head injury](#)
- [Appendix 2: Clinical Decision rules](#)
- [Appendix 3: Admission Discharge Criteria for children with a head injury](#)



14. Appendix 1: Emergency Management of children with a head injury

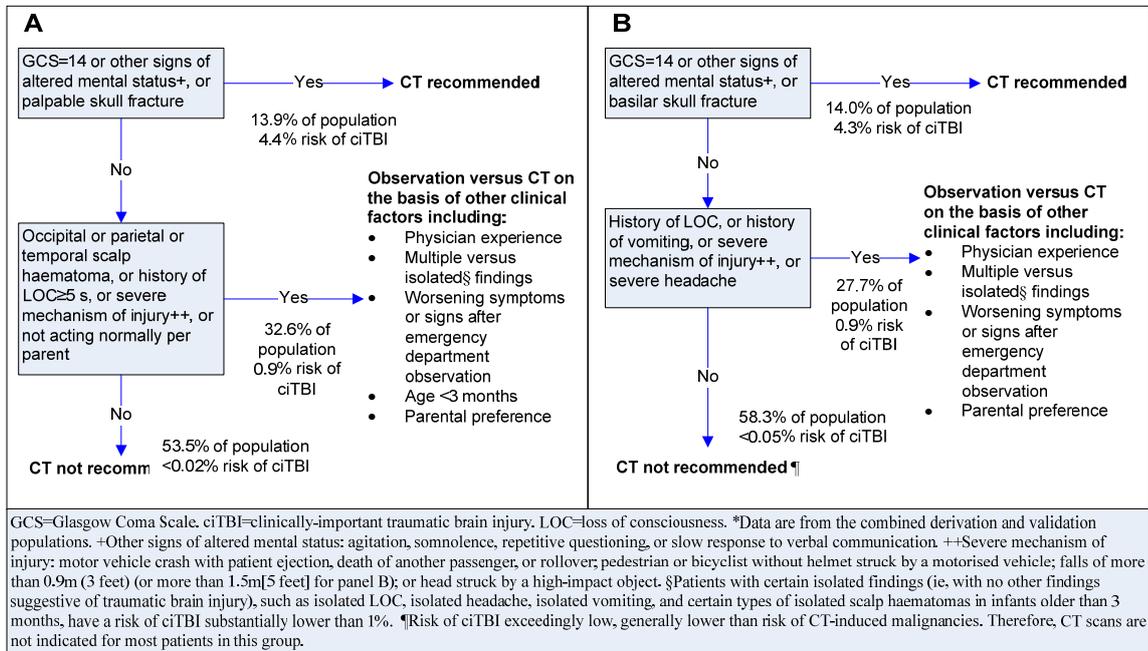


15. Appendix 2: Clinical decision rules

CHALICE

The children's head injury algorithm for the prediction of important clinical events rule		
A computed tomography scan is required if any of the following criteria are present:		
<ul style="list-style-type: none"> History <ul style="list-style-type: none"> - Witnessed loss of consciousness of >5 min duration - History of amnesia (either antegrade or retrograde) of >5 min duration - Abnormal drowsiness (defined as drowsiness in excess of that expected by the examining doctor) - ≥3 vomits after head injury (a vomit is defined as a single discrete episode of vomiting) - Suspicion of non-accidental injury (NAI, defined as any suspicion of NAI by the examining doctor) - Seizure after head injury in a patient who has no history of epilepsy 	<ul style="list-style-type: none"> Examination <ul style="list-style-type: none"> - Glasgow Coma Score (GCS)<14, or GCS<15 if <1 year old - Suspicion of penetrating or depressed skull injury or tense fontanelle - Signs of a basal skull fracture (defined as evidence of blood or cerebrospinal fluid from ear or nose, panda eyes, Battles sign, haemotympanum, facial crepitus or serious facial injury) - Positive focal neurology (defined as any focal neurology, including motor, sensory, coordination or reflex abnormality) - Presence of bruise, swelling or laceration >5 cm if <1 year old 	<ul style="list-style-type: none"> Mechanism <ul style="list-style-type: none"> - High-speed road traffic accident either as pedestrian, cyclist or occupant (defined as accident with speed >40 miles/h [>64km/h]) - Fall of >3 m in height - High-speed injury from a projectile or an object
If none of the above variables are present, the patient is at low risk of intracranial pathology.		

PECARN



CATCH

Box 1: Canadian Assessment of Tomography for Childhood Head injury: the CATCH rule

CT of the head is required only for children with minor head injury* and any one of the following findings:

High risk (need for neurologic intervention)

1. GCS < 15 at two hours after injury
2. Suspected open or depressed skull fracture
3. History of worsening headache
4. Irritability on examination

Medium risk (brain injury on CT scan)

5. Any sign of basal skull fracture (e.g., hemotympanum, "raccoon" eyes, otorrhea or rhinorrhea of the cerebrospinal fluid, Battle's sign)
6. Large, boggy haematoma of the scalp
7. Dangerous mechanism of injury (e.g. motor vehicle crash, fall from elevation ≥3 ft [≥91 cm] or 5 stairs, fall from bicycle with no helmet)

*Minor head injury is defined as injury within the past 24 hours associated with witnessed loss of consciousness, definite amnesia, witnessed disorientation, persistent vomiting (more than one episode) or persistent irritability (in a child under two years of age) in a patient with a GCS 13-15.

Source: Pickering A, Harnan S, Fitzgerald P, Pandor A. and Goodacre S. ⁹

16. Appendix 3: Admission / discharge criteria for children with a head injury

HIGH RISK for intracranial injury (≥ 1 of the following features):

- GCS < 14
- Focal neurological deficit
- Clinical suspicion of:
 - Basal skull fracture
 - Depressed skull fracture
 - Penetrating injury
 - Open skull fracture
 - Large haematoma or laceration in young child suspicious for underlying fracture
 - Non-accidental injury (NAI)

INTERMEDIATE RISK for intracranial injury (≥ 1 of the following features but no features of high risk):

- Severe headache
- Vomiting
- Amnesia
- Post-traumatic seizure
- Altered mental status (including drowsiness, agitation, repetitive questioning, slow verbal response)
- Significant mechanism of injury
 - MVA (high speed, ejection, others significantly injured, pedestrian vs car, cyclist vs car)
 - Impact from high speed projectile
 - Falls from a significant height

LOW RISK for intracranial injury (all of below):

- Well appearing child
- GCS 15
- No intermediate or high risk factors present

Criteria for discharge from emergency service

Criteria for discharging a child with a head injury from the emergency service includes a GCS 15 and at least one of the following conditions being met:

- low risk or intermediate risk with unremarkable period of observation
- negative CT Scan and no significant persistent symptoms/signs
- well child with cranial injury deemed suitable for discharge following neurosurgical review eg. Some non-depressed linear skull fractures without intracranial injury
- no concerns of non-accidental injury
- no concerns of serious alternate/concurrent diagnosis
- parental/carer concerns adequately addressed
- can be discharged into care of a responsible adult who lives within a reasonable distance of the hospital and will be able to seek medical advice as appropriate. Time of day and other demands on a caregiver's time should also be considered.

When discharging a child consider the following after the initial assessment and observation period:

- time of day;
- social circumstances;
- parents comprehension and compliance; and
- distance/access to rapid review of the child.

Criteria for admission to paediatric inpatient services

Criteria for admission to the paediatric inpatient service for a child with a head injury includes:

- need for ongoing observation or symptom control
- unplanned return within 24 hours of initial assessment
- social factors such as long distance to hospital, family not able to cope with symptom management
- Concerns regarding the parent/carers ability to observe for deterioration at home.

Criteria for admission to intensive care services

Consultation with the paediatric specialty team in the current facility and/or discussion with a Level 6 children's health service via Retrieval Services Queensland (RSQ) is required for children demonstrating criteria for admission to Intensive Care Services. These include:

- signs of raised ICP, deteriorating clinical condition, or significant intracranial injury
- airway support, post-operative care or ICP monitoring required
- closer neuro-observation required than available in ward situation
- significant head injury diagnosed clinically or on imaging with risk of acute deterioration ie. Requires monitoring with urgent intervention available if required.

