

Children and Infants - Acute Management of Head Injury

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Summary Basic Clinical Practice Guidelines for the acute treatment of infants and children with head injury.

On 8/7/2011 the Clinical Practice Guideline attachment was updated to amend the address and contact details for the Better Health Centre (inside front cover). The policy content has not changed.

Replaces Doc. No. Children and Infants with Head Injury - Acute Management [PD2005_391]

Author Branch Statewide and Rural Health Services and Capital Planning

Branch contact Trish Boss 9424 5706

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This Policy Directive may be varied, withdrawn or replaced at any time. Compliance with this directive is **mandatory** for NSW Health and is a condition of subsidy for public health organisations.

INFANTS AND CHILDREN: ACUTE MANAGEMENT OF HEAD INJURY

PURPOSE

The *infants and children: acute management of head injury* clinical practice guideline (attached) has been developed to provide direction to clinicians and is aimed at achieving the best possible paediatric care in all parts of the state.

The clinical practice guideline was prepared for the NSW Department of Health by an expert clinical reference group under the auspice of the state wide Paediatric Clinical Practice Guideline Steering Group.

MANDATORY REQUIREMENTS

This policy applies to all facilities where paediatric patients are managed. It requires all health services to have local guidelines/protocols based on the attached clinical practice guideline in place in all hospitals and facilities likely to be required to assess or manage children with head injury.

The clinical practice guideline reflects what is currently regarded as a safe and appropriate approach to the acute management of head injury in infants and children. However, as in any clinical situation there may be factors which cannot be covered by a single set of guidelines. This document should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. **It does not replace the need for the application of clinical judgement to each individual presentation.**

IMPLEMENTATION

Chief Executives must ensure:

- Local protocols are developed based on the *infants and children: acute management of head injury* clinical practice guideline.
- Local protocols are in place in all hospitals and facilities likely to be required to assess or manage paediatric patients with head injury.
- Ensure that all staff treating paediatric patients are educated in the use of the locally developed paediatric protocols.

Directors of Clinical Governance are required to inform relevant clinical staff treating paediatric patients of the revised protocols.

REVISION HISTORY

| Version | Approved by | Amendment notes |
|-------------------------------|--|-----------------|
| May 2011 (PD2011_024) | Deputy Director-General Strategic Development | Second edition |
| December 2004 (PD2005_391) | Director-General | New policy |

ATTACHMENT

1. Infants and Children: Acute Management of Head Injury – Clinical Practice Guideline.

Infants and children:
Acute management of Head Injury
second edition

CLINICAL PRACTICE GUIDELINES



NSW HEALTH

NSW DEPARTMENT OF HEALTH

73 Miller Street

North Sydney NSW 2060

Tel. (02) 9391 9000

Fax. (02) 9391 9101

www.health.nsw.gov.au

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This Clinical Practice Guideline booklet is extracted from the PD2011_024 and as a result, this booklet may be varied, withdrawn or replaced at any time. Compliance with the information in this booklet is mandatory for NSW Health.

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For further copies of this document please contact:

The Better Health Centre

PO Box 672

NORTH RYDE 2113

Tel. (02) 9887 5450

Fax. (02) 9887 5452

Information Production and Distribution

Tel. 02) 9391 9186

Fax. (02) 9391 9580

Further copies of this document can be downloaded
from the NSW Health website: www.health.nsw.gov.au

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Introduction

These Guidelines are aimed at achieving the best possible paediatric care in all parts of the State. The document should not be seen as a stringent set of rules to be applied without the clinical input and discretion of the managing professionals. Each patient should be individually evaluated and a decision made as to appropriate management in order to achieve the best clinical outcome.

The formal definition of clinical practice guidelines comes from the National Health and Medical Research Council:

‘systematically developed statements to **assist** practitioner and patient decisions about appropriate health care for specific clinical circumstances.’ (National Health and Medical Research Council “*A Guide to the Development, implementation and evaluation of Clinical Practice Guidelines*”, Endorsed 16 November 1998, available from www.nhmrc.gov.au/publications/synopses/cp30syn.htm)

It should be noted that this document reflects what is currently regarded as a safe and appropriate approach to care. However, as in any clinical situation there may be factors which cannot be covered by a single set of guidelines, this document should be used as a guide,

rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. It does not replace the need for the application of clinical judgment to each individual presentation.

This document represents basic clinical practice guidelines for the acute management of acute head injury in children and infants.

Each Area Health Service is responsible for ensuring that local protocols based on these guidelines are developed. Area Health Services are also responsible for ensuring that all staff treating paediatric patients is educated in the use of the locally developed paediatric guidelines and protocols.

In the interests of patient care it is critical that contemporaneous, accurate and complete documentation is maintained during the course of patient management from arrival to discharge.

Parental anxiety should not be discounted: it is often of significance even if the child does not appear especially unwell.

Summary

Head injuries are a common reason for a visit to the Emergency Department. In 2008-2009 head injury presentations (based on International Classification of Diseases) constituted 7.1 % of all paediatric presentations (<16years) to NSW Emergency Departments ⁽¹⁾. The majority are minor head injuries, of which a small but significant proportion actually have an intracranial injury ⁽²⁾. The evaluation and management of injured children may be influenced by local practice settings, the availability of technology and/or appropriately trained staff ⁽³⁾.

However, it is critical to adopt a consistent approach to the management of such children. These guidelines apply to children and adolescents under 16 years, neonates excluded. It is recognised that the borderline between childhood and adulthood is not distinct and in some instances the guidelines need to be interpreted with caution particularly if there is co-existent longstanding disability.

Guidelines for the initial management of closed head injury in adults can be found at http://www.health.nsw.gov.au/policies/pd/2008/pdf/PD2008_008.pdf ⁽⁹⁾.

The initial management plan for children is based on Early Management of Severe Trauma (EMST) principles but it is in the apparently minor head injury that considerable judgement is required. Delay in diagnosis and intervention is a major factor influencing the decision to adopt a clinical strategy of urgent CT scan as opposed to patient observation. Given that many injuries in NSW occur some distance from a CT scanner, practitioners should be familiar with the different patterns of injury in children versus adults. This knowledge, aided by case discussion with experienced practitioners in the children's hospitals and retrieval services, will ensure the appropriate management of all children with head injuries and the identification of those most at risk.

Significant changes from 2004 CPG Version

The most notable change in the management of paediatric head injury is widespread adoption of the CHALICE criteria as indicators for head CT (Children's Head Injury Algorithm for the prediction of Important Clinical Events) ⁽⁷⁾. These criteria have been used in this document to define three risk groups for serious intracranial injury; high risk that require urgent head CT and consultation, intermediate risk that may need a period of observation and low risk that may discharge immediately (see Table 3). Where clear evidence has not been established, the working group has provided a consensus opinion on some aspects of head injury management.

This guideline also includes a new reference entitled Management of Suspected Inflicted Head Injury in Infancy in a Tertiary Centre and is included as Appendix 4.

Patterns of head injury in children

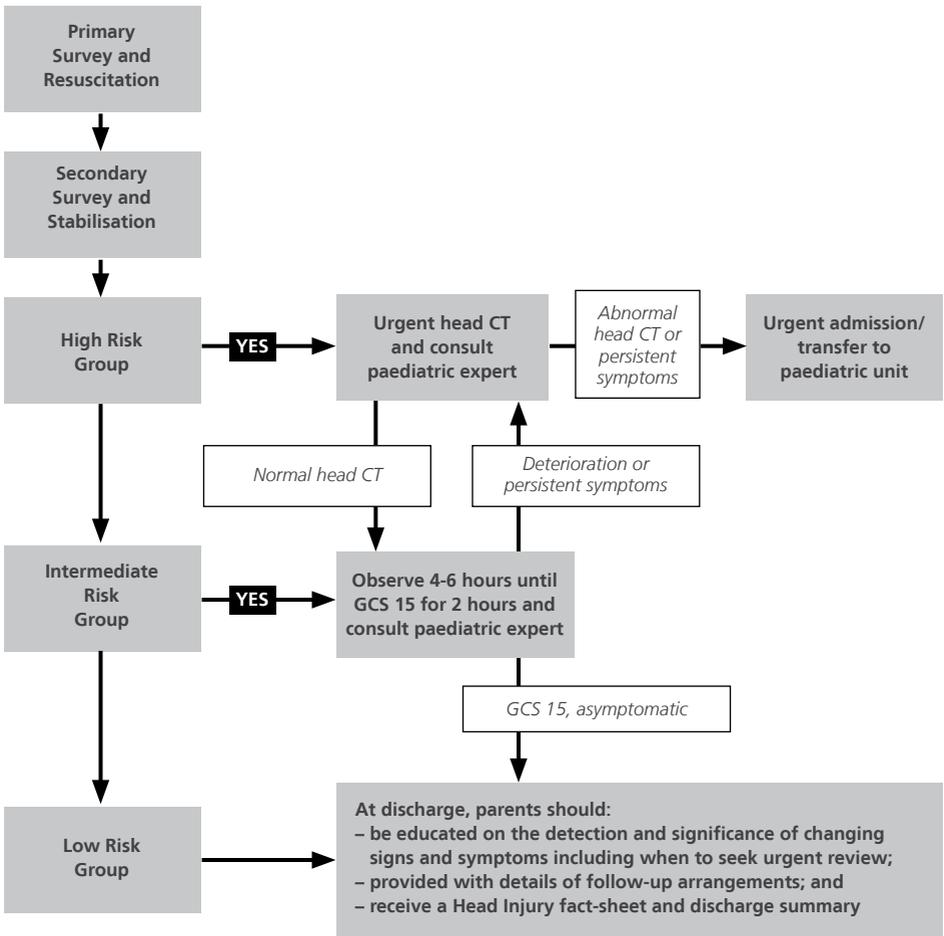
The patterns of head injury and the principles of management in children have some important differences from adults. These relate to the developmental level of the child, anatomic variations particularly of the head, the frequency of inflicted head injury in the young child and finally the response of the child's brain to trauma ⁽⁴⁾. In particular these include:

- A history of loss of consciousness may be unobtainable or unwitnessed. Children, particularly those aged less than two years ⁽⁵⁾, with no history of loss of consciousness can still have a significant risk of intracranial injury ⁽⁶⁾.
- The Glasgow Coma Scale (GCS) may be unreliable in young children with limited verbal skills and a modified scale should be adopted for infants and small children (see Appendix 2).
- Parents generally provide the most reliable and trustworthy information, however, if the history is inconsistent and / or does not match the physical findings then an investigation into the possibility of inflicted head injury must be carried out. Children with inflicted head injury (child abuse) present to Emergency Departments. Much of this may go unrecognised unless a high index of suspicion is maintained.

The current NSW guidelines stipulate that recognition of inflicted head injury is a duty of care for all practitioners and that notification is mandatory in all suspected cases (see Appendix 3).

- Blunt trauma to a child's head may be followed within a short time by acute brain swelling. This can occur despite the absence of a significant history or any visible physical abnormality in the head region. Fluid balance is critical because of the propensity to cerebral oedema ⁽⁴⁾.
- The physical characteristics of a child's skull alter the likelihood of certain injuries. Depressed skull fractures are more common after a direct blow, eg golf club injury. In contrast, the pliability of the skull means local injury to the brain, with or without bleeding, can occur in the absence of a fracture ⁽⁴⁾.
- Blood loss into an intracranial haematoma or a scalp haematoma can be considerable and is likely to be underestimated given the compensatory mechanisms present. The head represents 18 per cent of the body surface area in infants, versus nine per cent in adults, and as a consequence scalp lacerations can result in life-threatening haemorrhage.

Overview: Management of head injury in children



For definitions of High / Intermediate / Low risk groups see following table.

Table 1: Risk groups in head injury

| | LOW RISK (All features) | INTERMEDIATE RISK (Any feature / not low or high risk) | HIGH RISK (CHALICE Criteria) (Any feature) |
|---|-------------------------------------|--|---|
| HISTORY | | | |
| Witnessed loss of consciousness | nil | <5 minutes | >5 minutes |
| Anterograde or retrograde amnesia | nil | possible | >5 minutes |
| Behaviour | normal | mild agitation or altered behaviour | abnormal drowsiness |
| Episodes of vomiting without other cause | nil or 1 | 2 or persistent nausea | 3 or more |
| Seizure in non-epileptic patient | nil | impact only | yes |
| Non accidental injury (NAI) suspected | no | no | yes |
| Headache | nil | persistent | persistent |
| Co-morbidities | nil | present | present |
| Age | >1yr | <1yr | Any |
| MECHANISM | | | |
| Motor Vehicle Accident (MVA) (pedestrian, cyclist or occupant) | low speed | <60kmph | >60kmph |
| Fall | <1m | 1-3m | >3m |
| Force | low impact | moderate impact or unclear mechanism | high speed projectile or object |
| EXAMINATION | | | |
| Glasgow Coma Scale (GCS) | 15 | fluctuating 14 - 15 | <14 or <15 if under 1 yr old |
| Focal neurological abnormality | nil | nil | present |
| Injury | | | *high risk features eg scalp haematoma in <1yr of age (see below) |
| * 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 | | | |
| PLACEMENT | | | |
| Observation Area | Anywhere in ED | Acute area in ED | Acute or resuscitation bay |
| OBSERVATIONS | | | |
| <ul style="list-style-type: none"> Respiratory rate, oxygen saturations Pulse, blood pressure Temperature GCS, pupillary response & size, limb strength Pain assessment Sedation score as necessary | Hourly observations until discharge | Half-hourly observations for 4 to 6 hours until GCS 15 sustained for 2 hours, then hourly observations until discharge. Revert to half hourly observations/ continuous monitoring if signs of deterioration occur. | <ul style="list-style-type: none"> Continuous cardio-respiratory and oxygen saturation monitoring BP and GCS every 15 to 30 minutes |

Initial management

The aim of initial evaluation and management is rapid assessment of the severity of injury and initiation of appropriate treatment for a child with a head injury, with or without other injuries.

All children with head injury should be **triaged** according to the Australasian Triage Scale and placed in an appropriate area for assessment and resuscitation. Further guidance regarding triage can be found in Appendix 1.

Observations – range for age values

Observations that are considered to be normal for heart rate, blood pressure, and respiratory rate varies widely with a child's age and weight. Heart rate and respiratory rate typically decline with age, while systolic BP increases. This guideline should be read in conjunction with the Standard Paediatric Observation Chart (SPOC) which provides details regarding the range of vital signs for children. The observation charts show "normal" values in white; with blue, yellow and red zones representing increasingly abnormal ranges and the need for escalation of care.

For additional information on the Between the Flags project:

<http://www.health.nsw.gov.au/initiatives/btf/index.asp>

Primary survey

- Airway with cervical spine immobilisation
- Breathing pattern and adequacy
- Circulation and haemorrhage control
- Disability: rapid neurological examination
- Exposure: complete examination with protection against hypothermia
- Blood Glucose.

Airway and breathing

Oxygenation should be optimised to prevent the development of secondary brain injury.

- Oxygen saturations should be checked and maintained at $\geq 95\%$ at all times.
- Non-intubated children with signs of shock should receive 10 litres of oxygen via a non-rebreather mask regardless of oxygen saturation readings.

Indications for considering intubation⁽⁷⁾:

1. GCS less than or equal to 8.
2. Loss of protective laryngeal reflexes.
3. Abnormal breathing pattern or hypoventilation (see Table 1 for normal ranges).
4. Inability to obtain saturations $\geq 95\%$ or a PaO₂ > 80mmHg in maximal facial oxygen.
5. Inability to obtain a PaCO₂ between 30-44mmHg.

Naso-tracheal intubation and naso-gastric tube insertion should not be performed in children with head injuries because of the risk of intracranial penetration through a base of skull fracture.

Ongoing neuromuscular blockade after initial intubation may mask signs of deterioration such as fitting and should be used judiciously.

End tidal CO₂ should be monitored in all intubated patients with head injury. If possible the PaO₂ should be > 80mmHg (SaO₂ > 95%) and PaCO₂ kept in the range 35-40mmHg. Routine hyperventilation to a PaCO₂ below these values is not indicated.

Cervical spine immobilisation

Cervical spine (c-spine) immobilisation is indicated in head injury⁽⁷⁾⁽¹¹⁾ when there exists:

- GCS less than 15
- Neck pain or tenderness
- Focal neurological deficit at any time since injury
- Paraesthesia in the extremities
- Distracting injury
- Intoxication
- Any other clinical suspicion of cervical spine injury.

Spinal precautions can be challenging to apply to uncooperative children. The neck and body should be manually immobilised during assessment and consideration given to the child's requirements for reassurance, analgesia or sedation and intubation.

The c-spine must remain immobilised during procedures such as intubation and for all patient transfers. The process

of 'clearing' a c-spine requires clinical and radiological evaluation⁽¹¹⁾ Clinicians who are uncertain about this process should seek early consultation with paediatric experts.

Circulation

Adequate systemic blood pressure is required to maintain perfusion of the brain and avoid secondary brain injury.

Early signs of shock may be subtle, and include tachycardia, reduced (thready) pulse volume and increased central capillary refill time. Blood pressure may be normal. Hypotension occurs late and is often a sudden sign of cardiovascular decompensation.

The treatment of shock is the administration of 20mL/kg normal saline given IV or IO

Isolated traumatic brain injury rarely leads to severe hypotension; presence of shock signifies the likelihood of a concomitant injury. Fluid resuscitation with normal saline should continue until normal perfusion and cardiovascular parameters are achieved.

Maintenance fluids

Following resuscitation, usual maintenance fluids should be administered. Children with head injuries are susceptible to cerebral oedema. In the severely head injured child who is well perfused consider fluid restriction to two-thirds maintenance volume.

Disability

- A rapid neurological assessment can be performed using AVPU to assess responsiveness:
- **A**lert
- Responds to **V**oice
- Responds to **P**ain only
- **U**nresponsive.
- Further assessment includes pupils (size and reaction to light) and posture (normal, decerebrate or decorticate)
- The Glasgow Coma Scale (GCS) is the best quantitative measure of a patient's conscious state. A modified GCS (with amendments to the assessment of the verbal response) is useful in young children (Appendix 2)
- A sedation score⁽¹³⁾ should be recorded where opiates have been given (see Table 2).

Temperature

Children are susceptible to hypothermia because of large surface area to body mass ratio. Temperature must be monitored and normothermia maintained. Hypothermic management of severe head injury may be considered with neurosurgical consultation.

Glucose

Blood glucose should be checked on arrival for all children with an altered level of consciousness and monitored at least 4th hourly in infants who are nil by mouth. Blood sugar levels below

3.0mmol/L may require a 2 - 5mL/kg 10% dextrose IV bolus and the addition of extra dextrose to maintenance fluids⁽¹²⁾.

Analgesia and sedation

These medications may be useful in maintaining the airway, during procedures and in the reduction of pain and stress which are associated with increases in cerebral metabolic rate⁽³⁰⁾. Many head injured patients will have concomitant injuries, and effective analgesia is essential. Paracetamol may be used as a simple analgesic. Narcotics are not contraindicated in head injury and should be carefully titrated to pain score using a validated pain assessment tool. More severe pain from other injuries may require a bolus of IV morphine (50-100microgram/kg) and may be followed by a morphine infusion (20-40microgram/kg/hr) once adequate analgesia is achieved⁽¹²⁾. Sedation may be considered as an adjunct for the treatment of painful and noxious stimuli and elevated ICP in the management of significant head injury⁽³⁰⁾.

With the introduction of sedation or an opioid analgesic care must be taken to differentiate between signs of sedation versus altered level of consciousness related to deterioration in condition. A sedation score (Table 3) should be recorded along with regular observations for all children who have received sedative or opiate medication⁽⁹⁾.

Table 3: University of Michigan Sedation Scale (UMSS)⁽¹³⁾

| |
|--|
| <ol style="list-style-type: none">0. Awake and alert.1. Minimally sedated: tired / sleepy, appropriate response to verbal conversation and / or sound.2. Moderately sedated: somnolent / sleeping, easily aroused with light tactile stimulation or a simple verbal command.3. Deeply sedated: deep sleep, arouses only with significant physical stimulation.4. Unrousable. |
|--|

Anti-emetics

Vomiting increases intra-cranial pressure and places children in cervical spine protection at risk of aspiration.

Ondansetron 0.15mg/kg may be given IV or orally to children who are nauseous, vomiting or immobilised (12). It should be noted that episodes of vomiting separated by periods of recovery are more concerning than where emesis occurs shortly after injury⁽⁷⁾.

Other adjuncts

- Oro-gastric tubes and urinary catheters are unpleasant and stressful in the conscious child. They should be inserted in patients who are intubated or considered in the presence of other usual clinical indicators.
- Intravenous cannulation, blood investigations and a trauma series of x-rays including chest, pelvis and

lateral cervical spine x-ray should be considered for all significant trauma cases.

Ongoing management

The objective of ongoing management is to limit the likelihood of secondary brain injury, diagnose acute deterioration and facilitate appropriate investigation of head injury.

Secondary survey

- Perform a systematic examination of each region of the body from head to toe including formal neurological examination with GCS if not previously recorded.
 - palpate for boggy or swelling of the scalp
 - look for signs of base of skull fracture such as Battle’s sign (bruising over the mastoid) or ‘raccoon’ eyes
 - examine for haemo-tympanum or signs of CSF leak from ears or nose.
- Examine specifically for signs of inflicted head injury:
 - look for bruises, contusions, abrasions or lacerations of the scalp, face, lips, inside of mouth, ears, neck, chest, abdomen and limbs (and photograph these, if possible)
 - check the eyes for sub-conjunctival and retinal haemorrhages
 - measure the head circumference

- check for “grip marks” on the limbs or chest.

See Appendix 3 for comprehensive information regarding diagnosis and notification of inflicted head injury in children.

Further history

- A careful history including the time and mechanism of injury, recall of events, loss of consciousness, seizures, behaviour and activity since time of injury. Impact seizures occur immediately at the time of injury and are not predictive of clinically significant intracranial injury.
- Identify co-morbidities that predispose to intracranial injury eg intra-cerebral shunt, AV malformation or bleeding disorders including vitamin K deficiency.
- Become suspicious of inflicted head injury when:
 - a) inadequate history is provided for a serious head injury
 - b) there is a serious head injury after a reportedly minor fall
 - c) there is a significant change in the history over time
 - d) another child is being blamed for the findings
 - e) there seems to have been an unreasonable delay in presentation.

Ongoing observation

Head injuries are traditionally classified by *severity* into mild, moderate and severe,

based on the level of consciousness. Children with **mild** head injury have a GCS of 14 or 15, **moderate** head injuries have a GCS between 9 and 13 and **severe** head injuries have a GCS of 8 and below ⁽¹⁴⁾.

This document uses a more comprehensive classification based on risk of serious intracranial injury as defined in the CHALICE head injury algorithm for the prediction of important clinical events rule. A number of risk factors, including level of consciousness, are used to guide key management decisions: the inclusion of such risk factors improves accuracy in detecting intracranial injury. The presence of any high risk feature places the patient in the high risk group⁽⁷⁾ (see Table 1).

Each group has different requirements for observation and supportive care, as shown in Table 1. Observations must be taken to assess response to resuscitation or to monitor progress during the observation period. All drugs and fluids administered must be recorded.

Children aged less than 1 year

Special care must be taken with infants under 1 year of age who require greater vigilance due to difficulty in clinical assessment and a greater risk of inflicted head injury. A high index of suspicion for intracranial injury must exist for these patients. If all risk factors *except age* are in the low risk category the child may be managed in the low risk group after consultation with paediatric experts.

Table 4: Observation of head injured children

| | LOW RISK | INTERMEDIATE RISK | HIGH RISK |
|---|---|--|---|
| PLACEMENT | | | |
| Observation Area | Anywhere in ED | Acute area in ED | Acute or resuscitation bay |
| OBSERVATIONS | | | |
| <ul style="list-style-type: none"> Respiratory rate, oxygen saturations Pulse, blood pressure Temperature GCS, pupillary response & size, limb strength Pain assessment Sedation score as necessary | Hourly observations until discharge | Half-hourly observations for 4 to 6 hours until GCS 15 sustained for 2 hours, then hourly observations until discharge. Revert to half hourly observations/ continuous monitoring if signs of deterioration occur. | <ul style="list-style-type: none"> Continuous cardio-respiratory and oxygen saturation monitoring BP and GCS every 15 to 30 minutes |
| SUPPORTIVE CARE | | | |
| Patient Position | Intubated patients should be supine with bed flat. All others may be nursed in position of comfort. | | |
| Oxygen | Maintain oxygen saturations $\geq 95\%$. Children in shock require 10 litres via a non rebreather mask regardless of oxygen saturation readings. | | |
| Temperature | Aim for normothermia. Consider hypothermic management of severe head injury in consultation with neurosurgical unit. Avoid hyperthermia at all times. | | |
| Oral intake | Nil By Mouth (NBM) until clinical review. A fluid balance chart should be kept for all children with intermediate or high risk head injuries. | | |
| Glucose | Monitor BSL in infants at least 4th hourly if NBM or on IV fluids. | | |
| Pain management | Consider the need for oral, intranasal, IV or IO analgesia. | | |

Investigation and disposition

The management of children with head injury can generally be approached according to the risk category into which they fall. This is summarised in Table 1.

HIGH RISK – urgent imaging and neurosurgical advice

Inclusion in the high risk group is related to indicators for urgent head CT. These indicators are based on the CHALICE study (2006) and are consistent with subsequent studies⁽¹⁵⁾ including the CATCH Study (2006)⁽¹⁶⁾. The presence of any of the high risk criteria in Table 1

suggests the need for urgent imaging. Consultation with a paediatric expert (eg paediatric neurosurgeon, emergency physician or intensive care specialist) must occur regarding children at high risk of intracranial injury. Decisions around patient transfer, CT or observation in hospital require consultation ⁽⁸⁾.

Abnormalities detected on CT should be managed according to neurosurgical advice. Children from the high risk group with normal head CT should continue to be observed closely for up to six hours, as outlined for the intermediate group, because of the risk of cerebral oedema or delayed bleeding. Admission may be required where symptoms persist beyond six hours and these cases should also be discussed with a paediatric expert ⁽⁸⁾.

INTERMEDIATE RISK – close observation

If a child has any features of the intermediate risk group, a period of prolonged observation is required ⁽⁸⁾. These children should be observed closely for 4 to 6 hours post injury until GCS is sustained at 15 for 2 hours. A head CT is indicated in this group if there is an acute deterioration or persistent symptoms (vomiting, headache, irritability, abnormal behaviour or unsteady gait) at six hours post injury. Children may be discharged at the conclusion of this time period if they have a GCS of 15, are asymptomatic, have responsible carers and a normal head CT if performed. Any child who is not asymptomatic and neurologically normal

at six hours should be discussed with a paediatric expert or neurosurgical unit.

LOW RISK – consider immediate discharge

Children frequently fall over and sustain minor head injuries; many do not require prolonged observation ⁽⁸⁾. The criteria for inclusion in the low risk group are based on the PECARN Study (2009) ⁽¹⁷⁾. Children with no loss of consciousness, a non-severe injury mechanism, normal behaviour or mental state and no high risk features on examination are at very low risk of clinically important brain injury after head trauma. Those who are in the low risk group and have responsible carers may be safely discharged after medical review. These patients must be readily able to return to the Emergency Department in case of deterioration.

Identification of acute deterioration

The following clinical signs indicate acute deterioration and are an indication for urgent consultation / intervention ⁽⁸⁾:

- a drop of one point in GCS for at least 30 minutes (greater weight should be given to a drop in the motor score of the GCS) ⁽¹⁸⁾
- a drop of greater than two points point in GCS regardless of duration or GCS sub-scale
- development of severe or increasing headache or persistent vomiting
- development of agitation or abnormal behaviour

- clinical signs suggestive of seizure activity
- clinical signs consistent with coning or uncal herniation:
 - Cushing’s reflex: hypertension, bradycardia and irregular respirations
 - extensor posturing or hemiparesis
 - pupillary signs: sluggish reaction or unilateral/bilateral pupillary dilation.

In general, the younger the child, the more non-specific the clinical signs of elevated intracranial pressure may be (due to CNS immaturity and greater reflex activity).

Adjunctive therapy

Management of acute deterioration

- Secure the airway and reassess ABC. If necessary commence bag valve mask ventilation. Hyperventilation may provide an effective short term measure to reduce intracranial pressure.
- If seizing, administer midazolam (0.15mg/kg bolus) or diazepam (0.25mg/kg bolus) and consider loading with phenytoin 20mg/kg in normal saline over 30 minutes. If vascular access is not available consider diazepam 0.5mg/kg PR, or midazolam 0.15mg/kg IM, or midazolam 0.3mg/kg Buccal ⁽¹⁹⁾.
- Administration of hyperosmolar therapy may be considered only

after discussion with **paediatric referral centre**. Options include mannitol 0.5g/kg IV (2.5mls/kg of 20% mannitol) over 20 minutes ⁽¹²⁾ or hypertonic saline 3%, 3mL/kg over 30 to 60 minutes or as directed by the referral centre ⁽²⁹⁾. If hyperosmolar therapy is commenced an IDC must be inserted to accurately monitor urine output ⁽³⁰⁾.

- Urgent discussion with retrieval team or neurosurgeon regarding performing / repeating the CT scan and other potential interventions such as emergency craniotomy / burr holes.

Diagnostic tests

CT scans in children

The most accurate and rapid means of detecting intracranial injury is with a CT scan. A CT scan is relatively safe, although some children (particularly between six months and four years of age) will require sedation or general anaesthesia for the procedure. Access to monitoring and resuscitation is essential during transfer and scanning. CT involves a larger dose of radiation than conventional x-ray ⁽²⁰⁾ therefore exposure should be minimised by utilising this imaging modality only when clinically indicated ⁽²¹⁾ (Table 1). A CT scan is used to identify intra-cerebral bleeding, cerebral oedema or diffuse brain injury but may be normal if performed early. Subdural haematoma classically manifests clinically some time after the initial injury, often with subtle signs or

symptoms: a repeat CT scan should be considered for persistent symptoms or evolving signs. Young children are particularly difficult to evaluate. Where there are ongoing clinical concerns, a repeat CT scan or consultation with a paediatric expert is essential.

Given the issue of distance and dislocation for families if the child requires transfer to a larger centre, the benefits of a scan have to be weighed against the risks of delay in diagnosis resulting from an “observation-only” policy. All high risk patients who are unable have immediate CT scanning should be discussed with an expert regarding indication for transfer or observation in hospital for at least 24 hours⁽⁹⁾.

Cervical spine CT scans

Cervical spine injuries are less common in children than adults⁽¹¹⁾ but consideration should be given to imaging the c-spine at the same time as head CT in the following circumstances⁽⁷⁾:

- Midline cervical spine tenderness
- Focal neurological signs or symptoms
- GCS less than or equal to 8
- Abnormal or suspicious plain films
- Strong suspicion of injury despite normal or inadequate plain films.

Role of skull X-ray

Skull X-rays have no role in the identification of intracranial injury⁽²²⁾ as intracranial contents are not seen on

plain films. Although the radiological presence of a skull fracture significantly increases the risk of intracranial injury⁽²³⁾ paediatric skull X-rays are difficult to interpret. Skull X-rays may be interpreted as abnormal in children who do not have intracranial injury (eg due to suture lines) or may be normal where intracranial injury is present⁽²⁴⁾.

When there is no local CT scanning facility available, there may be a limited role for skull X-ray to complement clinical assessment and observation in deciding which children with intermediate risk head injury should be transferred for CT⁽²⁵⁾. If used, findings should be interpreted with caution and considered in conjunction with clinical observation. All abnormal skull X-rays should be discussed with a paediatric expert.

Transfer of the child with a severe head injury to a children’s hospital

***NETS hotline telephone number is
1300 36 2500***

NETS (Newborn & paediatric Emergency Transport Service) is the statewide retrieval service for infants and children in NSW. Calls to NETS usually lead to simultaneous conferencing of a number of specialists (eg NETS consultant, paediatric emergency physicians, intensivists, neurosurgeons, paediatric surgeons) in order to provide clinical consultation and management advice.

Early referral to NETS (or a local retrieval service) is encouraged for clinical support or advice or to activate a medical retrieval. Any change in the condition of a patient should result in further consultation with the retrieval service, even after retrieval has been arranged, to discuss modification in management strategy if required.

Psychosocial needs of the family

Childhood injury can be devastating. Most head injuries are mild and have a good prognosis, but moderate to severe head injuries are associated with poorer outcomes. Parents should be provided with timely information on their child's condition and be involved in the decision-making process. Health professionals should make arrangements for the parent to be with the child at all times with the exception of urgent interventions. The child, especially if conscious, will be more co-operative and interpretation of clinical symptoms and signs will be more reliable in the presence of a parent.

Consideration may be given to offering families access to social work or pastoral care support, particularly in case of severe injury (consistent with local policies and resources).

Discharge information and follow up

All parents of head injured children should be given verbal information and written head injury advice on discharge. The role of the local medical practitioner will be essential during the child's recovery period. All patients who have undergone

head CT should be reviewed by their general practitioner within a week. Most post-concussive symptoms and cognitive deficits resolve within three months but persistent problems should be referred to a specialist in brain injury eg rehabilitation medicine specialist. Contact details for NSW paediatric brain injury rehabilitation units are included below. Information should be provided at the time of discharge to general practitioners and on some occasions to the child's school if there is a possibility of ongoing problems.

**Sydney Children's Hospital
Randwick**
02 9382 1590

**The Children's Hospital
Westmead**
02 9845 2132

**John Hunter Children's Hospital
Newcastle**
02 4921 3932

or go to the following website
www.health.nsw.gov.au/birp/

Appendix One – Triage of children with head injuries

A consistent approach to the principles of triage should be applied (Australasian Triage Scale, www.acem.org.au and the Emergency Triage Education Kit, Australian Department of Health and Ageing, 2007)

The following serves as a triage guide to a range of factors related to paediatric head injury presentations. It does not replace the need for clinical judgement in individual circumstances and settings.

Triage 1

- Unconscious / responds only to pain
- Significantly agitated / combative / confused
- Fitting
- Signs of cardiovascular compromise

Triage 2

- Responds to voice / abnormal drowsiness
- Decreased activity, hypotonic, poor eye contact
- Loss of consciousness of more than 5 minutes
- Focal signs or history of seizure
- Vomiting 3 or more times
- Severe pain or headache
- High risk mechanism

Triage 3

- Alert but altered behaviour
- Loss of consciousness less than 5 minutes
- Vomit once or twice
- Moderate pain or headache
- Moderate risk mechanism
- Significant co-morbidities or less than one year of age
- Possible inflicted head injury, otherwise well

Triage 4 or 5

- No neurological signs or symptoms
- Low impact mechanism
- No co-morbidities or concerns regarding inflicted head injury
- More than one year of age
- Not a recent problem

NB: Substance use may impede triage assessment and require allocation of a higher triage score

Appendix Two – Glasgow Coma Scale and Children’s Coma Scale

Glasgow Coma Scale (4-15 years)

| Eye opening response | |
|----------------------|---|
| Spontaneously | 4 |
| To verbal stimuli | 3 |
| To pain | 2 |
| No response to pain | 1 |

| Best motor response | |
|--|---|
| Obeys verbal command | 6 |
| Localises to pain | 5 |
| Withdraws from pain | 4 |
| Abnormal flexion to pain (decorticate) | 3 |
| Abnormal extension to pain (decerebrate) | 2 |
| No response to pain | 1 |

| Best verbal response | |
|---------------------------|---|
| Oriented and converses | 5 |
| Disoriented and converses | 4 |
| Inappropriate words | 3 |
| Incomprehensible sounds | 2 |
| No response to pain | 1 |
| No response to pain | 1 |

Child’s Coma Scale (<4 Years)

| Eye opening response | |
|----------------------|---|
| Spontaneously | 4 |
| To verbal stimuli | 3 |
| To pain | 2 |
| No response to pain | 1 |

| Best motor response | |
|---|---|
| Obeys verbal command or performs normal spontaneous movements | 6 |
| Localises to pain or withdraws to touch | 5 |
| Withdraws from pain | 4 |
| Abnormal flexion to pain (decorticate) | 3 |
| Abnormal extension to pain (decerebrate) | 2 |
| No response to pain | 1 |

| Best verbal response | |
|---|---|
| Alert, babbles, coos, words or sentences to usual ability | 5 |
| Less than usual ability and/or spontaneous irritable cry | 4 |
| Cries inappropriately | 3 |
| Occasionally whimpers and/or moans | 2 |
| No response to pain | 1 |
| No response to pain | 1 |

Ref: APLS 4th Edition 2005 ⁽¹⁰⁾

Appendix Three – Recognition of inflicted head injury

Epidemiology

The leading causes of head injury in children aged 5 years or less in the USA are:

- falls (50.6 per 100,000 children),
- motor vehicle accidents (25.9 per 100,000 children)
- suspected inflicted head injury (12.8 per 100,000 children)⁽²⁶⁾

There are no comparable data from Australia.

The most common cause of serious head injury in infants < 1 year is physical assault by a carer. Severe accidental head injuries are rare, with one study finding that 95% of serious intracranial injuries and 64% of all head injuries (excluding uncomplicated skull fractures) are due to abuse⁽²⁷⁾.

Presentation of inflicted head injury

One of the most common presentations of inflicted head injury is that of an infant < 1 year old who presents to the Emergency Department with a history of sudden unconsciousness, apnoea and / or seizures⁽²⁸⁾. A CT scan may show a recent subdural haemorrhage and / or cerebral oedema.

Become suspicious of inflicted head injury in situations where infants have:

1. Symptoms and signs of head injury (a) vomiting, (b) decreased level of consciousness, (c) irritability, (d) lethargy, (e) apnoea, (f) seizures, (g) hypothermia, (h) bradycardia and, (i) a bulging fontanelle. Symptoms which may suggest that a child has had a previous brain injury are (a) irritability and vomiting, (b) feeding difficulties, (c) lethargy and drowsiness, (d) a rising head circumference.
2. Concerning features on history and examination (a) the history does not fit the findings (see below), (b) the history changes significantly, (c) the injury is blamed on another child (d) there seems to have been an unreasonable delay in presentation (e) there is unexplained facial, head, or other bruising, or evidence of old injury.
3. When there is an obvious serious head injury with: (a) no explanation, (b) other minor trauma to the head, or, (c) a history of a short fall, usually less than 1.2 metres.

Specific situations

1. Falls

- Short falls usually result in focal injuries from blunt trauma such as soft tissue injury, skull fracture or deformations, extradural haemorrhage, localised subdural haemorrhage (under the fracture), or cortical contusions.
- Falls down stairs, particularly in walkers, or in the arms of a caretaker, or falls from bunk beds, can result in more extensive skull fractures, more serious intracranial bleeding and, sometimes, intraparenchymal injury.
- Diffuse brain injury is very unusual after short falls.
- Short falls do not result in extensive retinal haemorrhages.

2. Other explanations

- It would be very rare, but not impossible, for another child to cause severe head injury; this history would need an expert review.

History

Where the possibility of inflicted head injury is raised, the following details must be obtained:

- detailed history of all events from the time the child was last well. This should be done by asking open-ended questions. Specific points can be clarified.
- exact events prior to, during, and after the injury and who was with the child.

- specifically ask if there was any trauma to the head or elsewhere and, if there was a fall, get details of distance and impacting surface.
- full medical history from pregnancy through to the present, including any neonatal problems and any neurological complaints.
- history of vitamin K administration and any bleeding tendency in the infant.
- detailed past medical / family history can be elicited later.

Examination

Perform a thorough physical examination looking for:

- bruises, contusions, abrasions or lacerations of the scalp, face, lips, inside of mouth, ears, neck, chest, abdomen and limbs (and photograph these, if possible).
- haemo-tympanum or CSF leak.
- boggy swelling of the scalp.
- "grip marks" on the limbs or chest.
- have an ophthalmologist check for retinal haemorrhages (if possible).
- measure the head circumference.

Specifically check the ears for petechiae within the curls of the pinna and for haematomas on the edge of, or behind, the pinna. Look for subconjunctival haemorrhage or facial petechiae. Look for dried blood in the mouth and nose. Check the oral surfaces of the lips for contusions and the frenula (labial and lingual) for tears. Look for external injury to the neck

particularly bruising, abrasion, induration or local redness over the carotid arteries. Examine the whole body for bruises, contusions, abrasions, lacerations and burns. Record any abnormal findings and photograph, if possible. Note any shapes or patterns.

Investigations

Blood should be collected for full blood count, electrolytes, basic clotting studies, liver enzymes and amylase. A head CT as indicated according to this Head Injury Guideline. Further investigations should be guided by usual clinical indicators.

Refer

Any infant or young child with a suspicious head injury may have been physically assaulted and therefore should be referred immediately to a tertiary centre. Consultation with a tertiary centre is advisable in all cases where there is the slightest suspicion that an infant has been abused.

Report to Community Services child protection helpline

Practitioners are advised to use the NSW Mandatory Reporter Guide in all cases where there is a reasonable suspicion of inflicted head injury. The guide is available at: www.sdm.community.nsw.gov.au/mrg

The Mandatory Reporter Guide is a structured decision making tool that supports professional judgment and facilitates consistent decision making.

It takes mandatory reporters through a series of questions to assist practitioners to assess whether or not a case involves suspected risk of significant harm and if it does, a report must be made to the Child Protection Helpline. In all other cases of suspected inflicted head injury, the Mandatory Reporter Guide will help inform the practitioner's next steps, which might include making a report to a NSW Health Child Wellbeing Unit on 1300 480 420.

In all suspected cases, if there are young siblings in the house they will need to be examined.

Further information about reporting can be found in the NSW Health Information Bulletin:

IB 2010_005 Keep Them Safe – Making a Child Protection Report, available at:

<http://www.health.nsw.gov.au/initiatives/kts/index.asp>

Child Protection Helpline:
133 627

Health Child Wellbeing Unit:
1300 480 420

NSW Health Keep Them Safe website:
<http://www.health.nsw.gov.au/initiatives/kts/index.asp>

DPC Keep them Safe website:
http://www.keepthemsafe.nsw.gov.au/reporting_children_at_risk

Mandatory Report Guide:
www.sdm.community.nsw.gov.au/mrg

Appendix Four – Management of suspected inflicted head injury in children in a tertiary centre

This Guideline applies ONLY to tertiary paediatric referral centres in NSW (Sydney Children’s Hospitals Network (Randwick & Westmead) and John Hunter Children’s Hospital Newcastle). It is included as an appendix to the 2010 Head Injury Clinical Practice Guidelines for completeness and SHOULD NOT be used by non-tertiary hospitals).

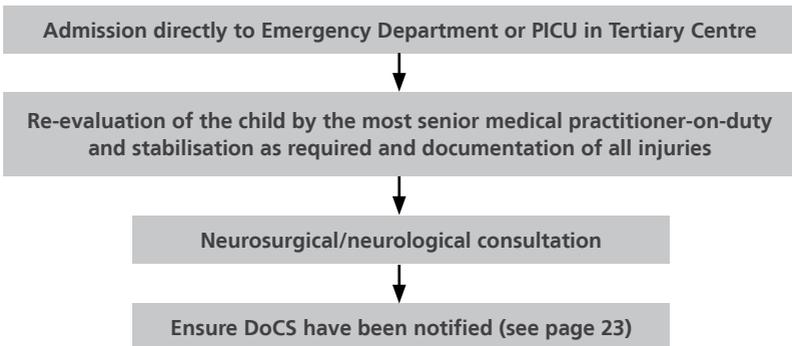
NSW guidelines stipulate that the recognition of inflicted head injury is a **duty of care** for all practitioners.

In suspected inflicted head injury, in the non-tertiary setting, there should be communication with the paediatric

referral centre to discuss the clinical features of the case. If it is agreed that a child represents a case of suspected inflicted head injury then transfer to a paediatric referral centre should occur. The Department of Community Services (DoCS) must be notified of the suspicion and the transfer (see page 23).

If the child is suspected of having suffered inflicted head injury, initial management should follow the NSW Health Clinical Practice Guidelines for the Management of Infants and Children with Acute Head Injury. Investigation of inflicted head injury begins **after** resuscitation and stabilisation are complete.

Investigation and management of suspected inflicted head injury
Initial flowchart for a tertiary centre



Tertiary hospital investigation by child protection consultant

| | |
|--|---|
| <p>Review relevant prior medical history</p> | <p>Complications in pregnancy including drug and alcohol history Complications in delivery and neonatal period Follow-up with obstetric records including any imaging available Prior neurological problems Developmental history Consanguinity and family history of OI Unexplained MR or foetal loss Vitamin K administration Vaccination status Previous trauma, DV or substance abuse Resuscitation performed prior to admission and/or transfer A full bleeding history of the child from birth to include bleeding from umbilicus, nose, mouth, teeth, after surgery, following immunisation and any unusual bruising, family bruising / bleeding history. A recent drug history, particularly ingestion of NSAIDs</p> |
| <p>Complete physical examination</p> | <p>External injuries - including scalp swelling or bruising, black eyes, ear / facial bruising or abrasions, burns, intra-oral injury, grip marks or any other injuries or marks on any part of the body. Facial petechiae and subconjunctival haemorrhages. Blood in mouth or nose. Tears of labial or lingual frenum and contusions inside lips Funduscopy and head circumference Examine abdomen / anus and genitals Diagrammatic documentation and forensic photography with measurements</p> |
| <p>Investigations</p> | <p>CSF – xanthochromia indicates prior CNS trauma Urinalysis FBC including platelets, urea, creatinine, electrolytes, coagulation screen (see below) Liver enzymes, lipase and amylase Toxicology Metabolic screen including organic acids* (see below)</p> |
| <p>Photographic documentation</p> | <p>Should be carried out by Medical Illustration as soon as practicable</p> |
| <p>Ophthalmological examination by paediatric ophthalmologist, as early as possible (This is required even if retinal exam carried out in non-tertiary hospital)</p> | <p>Ophthalmologist to be asked to describe haemorrhages in detail: Number Layer Location / extent, defined anatomically Document presence of retinoschisis / perimacular folds, papilloedema Documentation by retcam photograph and /or diagram</p> |

| | |
|---|---|
| <p>Imaging</p> <p>All imaging to be reviewed by a Paediatric radiologist</p> | <p>CT head</p> <p>3D CT useful for fracture v. developmental variants</p> <p>MRI on Day 3 – 5</p> <p>MRI always necessary (should include cervical region using STIR) including T1, T2, GRE T2, FLAIR and diffusion weighted imaging (DWI/ADC). Consider whether MRA necessary. .</p> <p>Consider repeat MRI to monitor ischaemic / haemorrhagic process as well as contusions and tears in 3 to 6 months. .</p> <p>Skeletal survey and bone scan (see below)</p> |
| <p>Coagulation Profile</p> | <p>Full coagulation screen including:</p> <p>Full Blood Count and film</p> <p>PT</p> <p>APTT</p> <p>INR</p> <p>TT</p> <p>Fibrinogen</p> <p>FDP or D-Dimers, if DIC is suspected</p> <p>PFA 100</p> <p>Von Willebrand antigen,</p> <p>Ristocetin co-factor activity</p> <p>Collagen binding assay</p> <p>Platelet Aggregation Studies, after consultation with haematologist and PFA abnormal</p> <p>Factor Assays: Factors V11, V111, 1X, X1, X111 for everyone</p> <p>Others after discussion with haematology if there is an abnormality.</p> <p>Check normal values with haematology as age-based physiological differences exist.</p> |
| <p>Abdominal injury / thoracic injury - bruising, distension, guarding. Blood in urine. Elevated liver enzymes, elevated amylase/ lipase</p> | <p>Contrast enhanced CT of abdomen</p> <p>If head CT being performed at the same time, perform prior to contrast administration</p> |

Forensic investigations to detect occult trauma

| | |
|---|---|
| Skeletal survey ¹ (under 2 years). Older children on a case-by-case basis. | To be reviewed by a Paediatric radiologist. Best for skull # and metaphyseal #. Specific coned views may be necessary depending on bone scan results. |
| Bone scan ² | Best for ribs, pelvic, foot and long bone shaft # All injury seen on bone scan to be followed up by x-ray of appropriate part |
| Metabolic screen ³ | See below. Not to detect trauma, but keep in mind |

¹ Skeletal survey

A skeletal survey is a very useful tool for detection of occult fractures in children in whom abuse is suspected, particularly in children < 24 months. A new suspicious fracture or intracranial injury significantly increases the likelihood of finding an occult fracture (Belfer et al. Use of the skeletal survey in the evaluation of child maltreatment. Am J Emerg Med. 19: 122-124)

² Complementary use of skeletal survey and bone scan in detection of bony injuries in suspected child abuse

20% of children in this series had abnormalities on bone scan which were not seen on skeletal survey.
10% of children had abnormalities on skeletal survey which were not seen on bone scan.
These modalities are complementary.
(Mandelstam et al. Arch Dis Child 2003; 88: 387-390)

³ Metabolic Screen

Metabolic disease is more likely if there is a history of: previous neurological problems or signs of previous neurological abnormality, fronto-temporal atrophy and no other signs of abuse, such as fractures.

Consultation to include

- Child Protection Specialist
- Child Protection Social Worker
- Paediatric Neurosurgeon+/- Paediatric Neurologist / Paediatric Brain Rehabilitation Specialist
- Paediatric Radiologist
- Paediatric Nuclear Medicine Specialist
- Paediatric Ophthalmologist
- Paediatric General / Orthopaedic Surgeon (as determined by injuries)
- Paediatric Haematologist (if any abnormalities on haematology profile).

Scene examination

Usually the Police will examine the scene. If explanation has been offered by caretaker, Police should do video re-enactment. Measurements of distances fallen and other relevant recordings should be made. Note the composition of reported impact surfaces. Blood should be looked for at site if blood seen on child. Child Protection Specialist should assess objects and scenario presented in history to determine whether alternative explanations (to inflicted injury) are more likely. Correlate with clinical information and the literature.

Coming to a decision about inflicted injury

It is essential that Child Protection Specialist has extensive consultation with colleagues in the specialties outlined above, before arriving at a diagnosis. All medical conditions which could possibly be confused with the diagnosis of inflicted head injury must be ruled out.

However, opinions about the force, mechanism and timing of injury are the province of the Child Protection Specialist and should not be expressed as a consensus opinion. The injuries should be classified into focal, diffuse, primary and secondary and a biomechanical analysis attempted. The mechanism of injury should be stated to be consistent with impact, rotational (inertial) injury, rotational + impact deceleration injury, whiplash, compression, penetration, suffocation / asphyxia, or multiple mechanisms.

Long term follow-up and monitoring

Assessment of neuro-developmental status (including vision and hearing) prior to discharge and on subsequent follow-up is necessary. The long term sequelae of brain injury (physical, cognitive, behavioural and social impairments) can be significant and emerge after a number of years. Long term follow-up in a Brain Injury Rehabilitation Clinic recommended at least until school entry.

Siblings in Inflicted Head Injury

Infant siblings should be reviewed by a paediatric specialist with child abuse expertise.

Placement of child

An Interagency case conference should take place to determine placement of the child.

High-risk abused children and occult inflicted head injury

- If a child < 2 years presents with a history of possible inflicted head injury (eg, being shaken or thrown by a carer) and, after consultation with the person who reported the event, there are reasonable grounds to believe this has happened, then screening, by MRI preferably, or CT scan, for occult head injury should be done, even if there are no neurological signs (Rubin et al. Ped. 2003. Vol.111; 6: 1382 – 6.).
- Any child < 2 years, with evidence of possible inflicted injury, eg unexplained facial injury, suspicious fracture, or multiple fractures, should also have screening (MRI or CT) for occult head injury. The younger the child the more pressing the need for imaging. Remember that the absence of findings on imaging should not deter clinicians from making a diagnosis of abuse, if appropriate.

Patterns of presentation of inflicted head injury

There are several patterns of presentation of Inflicted Head Injury related to the intensity and type of injury suffered. There are many mechanisms of injury and the term **Shaken Baby Syndrome** should be avoided.

Four types of inflicted brain injury predominate.

The following patterns were documented by Minns et al. BMJ Vol 328 27 March 2004 766-767

| Type | % | Pathology | Presentation |
|---|-----|--|--|
| Hyperacute encephalopathy | 6% | Cervico-medullary syndrome. Post-mortem may reveal localised axonal damage at the craniocervical junction, corticospinal tracts, and cervical cord roots, consistent with hyperflexion and hyperextension of the neck and angular acceleration/ deceleration, with or without impact. May have only thin sub-dural hematoma (SDH) | 2-3 months old of age Acute respiratory failure (direct medullary trauma) cerebral oedema (reversal sign on imaging) Rapid death |
| Acute encephalopathy | 53% | Bilateral SDH over convexity or interhemispheric and widespread haemorrhagic retinopathy. May have co-existent rib fractures, metaphyseal fractures, or other inflicted injuries. May have signs of impact, such as focal SDH, subgaleal haemorrhage, scalp injury or skull fracture MRI shows convexity SDHs enlarging over the first week (as well as interhemispheric, subtemporal, suboccipital, and posterior fossa subdural haemorrhages), torn bridging veins, cerebral oedema, haemorrhagic contusions and lacerations, and, rarely, white matter shearing, with tears and petechial haemorrhages at the grey/white matter junction and in the corpus callosum. | Depressed conscious state, raised ICP, fits, apnoea, hypotonia or decerebration, anaemia, shock Long term morbidity in 60% |
| Subacute non-encephalopathic presentation | 19% | Brain injury is less intense, without swelling, no diffuse cerebral hypo densities various combinations of subdural and retinal haemorrhages, rib fractures and other fractures, bruising etc | No clinical encephalopathic features Better outcome |
| Chronic extracerebral presentation | 22% | Isolated subdural haemorrhage, which is often chronic (> 3 weeks) Retinal haemorrhage (RH) may have disappeared | Child commonly a few months old present with increasing head circumference and signs of raised intracranial pressure- irritability, failure to thrive, vomiting, hypotonia, seizures No evidence of encephalopathy. Usually difficult to determine the causative mechanism and its timing if investigation reveals no other features of abuse and there are no obvious risk factors found after psychosocial assessment. |

Written by Dr Kieran Moran, FRACP, Sydney Children's Hospital and Dr Anne Piper, FRACP, South Western Sydney Area Health Service

Consultation with Dr Terry Donald, FRACP, Women's and Children's Hospital Adelaide, Dr Otilie Tork, FRACP, Children's Hospital Westmead, Dr Dimitra Tzioumi, FRACP, Sydney Children's Hospital, Dr Paul Tait, FRACP, Children's Hospital Westmead, and Prof Graham Vimpani FRACP, John Hunter Children's Hospital

Last updated October 2010

Appendix Five – References

1. NSW Health: Demand, Performance and Evaluation Branch (per John Agland, Manager, Reporting). NSW Department of Health Emergency Department Data Collection.– June 2010
2. Haydel MJ, Preston CA, Mills TJ, Luber S, Blaudeau E and DeBlieux PM. Indications for Computed tomography in patients with minor head injury. *N Engl J Med* 2000 Jul 13; 343(2):100-5.
3. NSW Dept. of Health. Clinical Services Planning Unit. Guidelines for the hospitalisation of children. NSW Health Dept, North Sydney 1998.
4. The Neurosurgical Society of Australasia. The management of acute neurotrauma in rural and remote locations. The Royal Australasian College of Surgeons, 2000 (second edition).
5. Greenes DS, Schutzman SA. Clinical indicators of intracranial injury in head-injured infants. *Pediatrics* 1999; 104:861–7.
6. Simon B, Letourneau P, Vitorino E, McCall J. Pediatric minor head trauma: indications for computed tomographic scanning revisited. *J Trauma* 2001; 51:231–7; discussion 237–8.
7. J Dunning, J Patrick Daly, J-P Lomas, F Lecky, J Batchelor, K Mackway-Jones et al. Derivation of the children’s head injury algorithm for the prediction of important clinical events (CHALICE) decision rule for head injury in children. *Archives of Disease in Childhood* 2006;91:885-89.
8. NICE Guideline. Head Injury: triage, assessment, investigation and early management of head injury in infants, children and adults. The National Collaborating Centre for Acute Care, September 2007 <http://www.nice.org.uk/guidance/CG56>
9. Reed, D. Adult Trauma Clinical Practice Guidelines, Initial Management of Closed Head Injury in Adults. NSW Institute of Trauma and Injury Management, 2007 http://www.health.nsw.gov.au/policies/pdf/2008/pdf/PD2008_008.pdf
10. Advanced Paediatric Life Support. The Practical Approach. 4th Edition 2005, 5 2009. BMJ Books

11. Viccellio P, Simon H et al. National Emergency X-Radiography Utilization Study Group (NEXUS). A Prospective Multicentre Study of Cervical Spine Injury in Children. *Paediatrics* August 2001;108:e20
12. Royal Children's Hospital, Melbourne. *Paediatric Pharmacopeia*, 13th edition online, 2007.
13. Malviya S, Voepel-Lewis T, Tait AR, Merkel S et al. Depth of sedation in children undergoing computed tomography validity and reliability of the University of Michigan Sedation Scale (UMSS). *Br J Anaesth* 2002; 88; 241-5.
14. Advanced Trauma Life Support. 7th Edition. American College of Surgeons, Chicago 2004.
15. Mehta S. Neuroimaging for paediatric minor closed head injuries. *Paediatric Child Health*. 2007 July; 12(6):482-484.
16. Osmond MH, Klassen MD et al. Paediatric Emergency Research Canada (PERC) Head Injury Study Group. CATCH: a clinical decision rule for the use of computed tomography in children with minor head injury. *Acad Emerg Med*.2006;13:S11 and Canadian Medical Association Journal, Feb 2010
17. Kupperman N, Holmes J et al. Paediatric Emergency Care Applied Research Network (PECARN). Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet* 2009; 374:1160-70
18. Fortune PM and Shann F. The motor response to stimulation predicts outcome as well as the full Glasgow Coma Scale in children with severe head injury. *Paediatric Critical Care Medicine*: May 2010 – Vol 11, issue 3, pp339-342
19. NSW Health. *Acute Management of Seizures, Clinical Practice Guidelines*, second edition. 2009
20. Brenner D, Hall E. Computed Tomography – An increasing source of radiation exposure. *New England Journal of Medicine* 2007; 357: 2277-84
21. Jimenez RR. Radiographic Evaluation of the Paediatric Trauma Patient and Ionizing Radiation Exposure. 2010: Vol 11, No 1
22. Reed M, Browning JG, Wilkinson AG and Beattie T. Can we abolish skull x rays for head injury? *Arch Dis Child* 2005;90:859-864
23. Teasdale GM, Murray G, Anderson E, et al. Risks of acute traumatic intracranial haematoma in children and adults: implications for managing head injuries. *BMJ* 1990; 300: 363-67

24. Lloyd DA. Carty H. Patterson M. Butcher CK. Roe D. Predictive value of skull radiography for intracranial injury in children with blunt head injury. *Lancet*. 1997; 349(9055):821-4
25. Andronikou S, Kilborn T, Patel M, Fieggen AG. Skull fractures as a herald of intracranial abnormality in children with mild head injury: Is there a role for skull radiographs? *Australasian Radiology*. 2003; 47:381-5
26. CDC&P. Traumatic Brain Injury – Colorado, Missouri, Oklahoma and Utah. 1990 –1993. *MMWR Morb Mortal Wkly Rep*. 1997; 46: 8 –11
27. Billmire ME and Myers PA. Serious head injury in infants: accident or abuse? *Pediatrics*. 1985; 75: 340–342
28. Jenny C. Inflicted Childhood Neurotrauma. *AAP*; 2003:49-64
29. Sydney Children’s Hospital Intensive Care Handbook, 2009 and Children’s Hospital Westmead Intensive Care Protocol for administration of osmotic agents.
30. GE Roosevelt and NA Paradis: Cerebral Resuscitation. In JM Baren (ed), *Pediatric Emergency Medicine*. Philadelphia, Saunders Elsevier, 2008, pp98

Appendix Six – Resources

More detailed information on the management of paediatric head trauma may be necessary in practice. Possible sources include:

NSW Health Department CIAP web site, Managing young children and infants with head injury in Hospitals at: www.ciap.health.nsw.gov.au

Paediatrics Manual : The Children’s Hospital at Westmead Handbooksecond edition, 2009. Available as a book from the Children’s Hospital at Westmead or through CIAP at <http://www.ciap.health.nsw.gov.au/home.html> then access through “online books”.

Appendix Seven – Parent information

Parents and carers should be provided with verbal and written head injury advice on discharge.

Fact sheets has been developed jointly by the three NSW Children’s Hospitals to assist parents. Access to the fact sheets can be found on each of the Children’s Hospital websites:

John Hunter Children’s Hospital –
www.kaleidoscope.org.au

Sydney Children’s Hospital –
www.sch.edu.au

Children’s hospital at Westmead –
www.chw.edu.au

Appendix Eight – Working party members

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|--------------------------------|--|
| Dr Sarah Dalton (Chair) | Paediatric Emergency Physician Sydney Children’s Hospital & NETS |
| Ms Glenda Mullen (Co chair) | Nurse Practitioner Paediatrics – Emergency Sydney Children’s Hospital |
| Dr Patrick Ho | General Paediatrician Sydney West Area Health Service |
| Dr Paul Bloomfield | General Paediatrician Orange |
| Dr Matthew O’Meara | Emergency Department Paediatrician Sydney Children’s Hospital |
| Dr Nick Ryan | Emergency Department Physician Tamworth |
| Ms Alisha Baker | Emergency Department Nurse and Paediatric Clinical Nurse Consultant Sydney South West Area Health Service |
| Prof Trish Davidson | Paediatric Surgeon |
| Dr David Schell | Paediatric Intensive Care Physician Children’s Hospital Westmead |
| Dr John Christie | Neurosurgeon John Hunter Hospital |
| Dr Kathryn Edward | Trauma Fellow & Rehabilitation Sydney Children’s Hospital |
| Ms Debbie Andrews | Transitional Paediatric Nurse Practitioner Sydney West Area Health Service |
| Dr Kieran Moran | Forensic Physician / Child Protection Sydney Children’s Hospital |
| Ms Mary Crum | Senior Analyst, Clinical Policy Branch NSW Health |
| Ms Judith Lissing | GESCHN Coordinator Sydney Children’s Hospital |
| Mr Richard Thode | GESCHN Project Officer Sydney Children’s Hospital |

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