

**BC Children's Hospital
Division of Pediatric Emergency Medicine
Clinical Practice Guidelines**

**MINOR HEAD INJURY
in the Emergency Department**

AUTHOR:

Lisa Dyke, MD, FRCP (C)

Division of Emergency Medicine
B.C. Children's Hospital
4480 Oak Street
Vancouver, BC V6H 3V4
ldyke@cw.bc.ca

DIVISION OF PEDIATRIC EMERGENCY MEDICINE:

Ran D. Goldman, MD

Division Head and Medical Director
Division of Pediatric Emergency Medicine
BC Children's Hospital
rgoldman@cw.bc.ca

CLINICAL PRACTICE GUIDELINE TASK FORCE:

CHAIRMAN:

Paul Korn, MD FRCP(C)

Clinical Associate Professor
Head, Division, General Pediatrics
Department of Pediatrics, UBC
pkorn@cw.bc.ca

MEMBERS:

TBD

CREATED:

September, 2007

LAST UPDATED:

September 28, 2007

FIGURES:

1

NOTES:

At BC Children's Hospital this guideline has been reviewed by pediatric radiology, pediatric neurosurgery, and the pediatric emergency medicine specialists.

Michael Sergant, MD

Radiology
BC Children's Hospital
msergant@cw.bc.ca

Ash Singhal, MD

Neurosurgery
BC Children's Hospital
asinghal@cw.bc.ca

PURPOSE & SCOPE

This clinical practice guideline standardizes the management of Minor Head Injury in the pediatric population and provides a framework for clinical decision-making.

There are 2 guidelines, the first focusing on children less than 2 years of age, and the second on those 2 years of age and older, based on differences in the neurological evaluation of pre-verbal & verbal children. Furthermore, unique considerations related to development necessitate a lower threshold of diagnostic evaluation and treatment for children less than 2 years of age (1).

DEFINITIONS

Minor head injury is defined as a history or physical signs of blunt trauma to the scalp, skull or brain in an infant or child who is alert or awakens to voice or light touch.

Inclusion Criteria

- history of acute impact to the head
- GCS 14-15
- No focal neurologic deficits

Exclusion Criteria

- Multiple trauma
- Penetrating injury
- Known or suspected cervical spine injury
- Pre-existing neurological disorder
- Intracranial shunt
- Bleeding diatheses
- Suspected inflicted head trauma (NAI)
 - Vague or no history of trauma but with signs and symptoms of traumatic brain injury
- Intoxication (presence of drugs or alcohol)

High Risk Group (< 2 years of age)

- Signs of depressed or basal skull fracture
- Seizure
- Irritability or Lethargy
- Bulging fontanel
- Significant or prolonged vomiting (≥ 5 times or lasting longer than 6 h)
- Loss of consciousness ≥ 1 minute

Intermediate Risk Group (< 2 years of age)

- > 2 episodes of vomiting
- Loss of consciousness less than 1 min
- Higher force mechanism (e.g. fall ≥ 3 feet)
- Caretaker concern about patient's behavior
- Mechanism of a fall onto a hard surface
- Unwitnessed trauma with possible significant mechanism

- Younger than 12 months of age (especially < 3-6 months)

Low Risk Group (< 2 years of age)

- Low-energy mechanism
- No signs or symptoms at least 2 hours after injury
- ≥ 12 months of age

High Risk Group (2-16 years of age)

- Abnormal mental status on presentation
- Abnormal neurologic exam
- Physical signs of skull fracture

Intermediate Risk Group (2-16 years of age)

- Loss of consciousness
- Amnesia
- > 2 episodes of vomiting
- Severe or persistent headache
- Impact seizure
- Boggy scalp hematoma
- Confusion
- Lethargy or irritability

Signs of a skull fracture

- Palpable depression
- Hemotympanum
- Battle signs
- Raccoon eyes (periorbital ecchymosis)
- CSF drainage from nose or ear

Significant scalp hematoma

- < 1 year of age: any scalp hematoma
- ≥ 1 year of age: boggy hematoma

Criteria for Discharge

- No significant extracranial injury or other indication for admission
- Easily alerts and has a normal neurological exam
- No suspicion of abuse or neglect
- Lives in close proximity to health care
- Reliable caretakers who are able to return if necessary

CT: Computed tomography

MRI: Magnetic resonance imaging

GCS: Glasgow Coma Scale

Eye Opening	
Spontaneous	4
To speech	3
To pain	2
Nil	1
Verbal Response (modifications for small children below)	
Oriented Appropriate words or social smile, fixes, follows	5
Confused Cries but consolable	4
Inappropriate words Persistently irritable	3
Incomprehensible words Restless & agitated	2
Nil	1
Motor Response (modifications for small children below)	
Obeys commands Moves spontaneously or purposefully	6
Localizes to stimuli Withdraws from touch	5
Withdraws to stimuli Withdraws from pain	4
Abnormal flexion to pain (Decorticate posturing)	3
Extensor responses to pain (Decerebrate posturing)	2
Nil	1

RECOMMENDATIONS

Evaluation

All children presenting to the emergency department with a potential head injury should have a thorough history and a complete physical examination, with emphasis on the neurologic system. Note should be made of the patient's age, past medical history, medications, allergies, and immunizations, along with a detailed account of how the injury occurred. Any symptoms that develop after the injury should also be noted, including loss of consciousness, vomiting, amnesia, headache, seizures, drowsiness, visual problems, irritability, or neck pain.

Coexisting injuries should be looked for. The head should be examined for the presence of scalp hematoma, contusions, abrasions, and lacerations. The presence of a palpable skull depression and signs of a basal skull fracture such as raccoon eyes, Battle sign, cerebrospinal fluid drainage from the nose or ear, or hemotympanum, should also be noted.

Documenting a child's level of consciousness is the most important initial neurologic assessment. For this the GCS is used, and has been adapted to adjust for preverbal children. The neurologic examination should also include the assessment of cranial nerve function, motor and sensory examination, deep tendon reflexes, and gait (7).

This clinical guideline can then be applied for all children who fit the definition of a minor head injury: a history of acute impact to the head, presenting with a GCS of 14 or 15, and no focal neurologic deficit noted on physical examination. This guideline uses a GCS of 14 as the cut off for minor head injury based on studies which show that 33.8% of patients with a GCS of 13 had an intracranial lesion and 10.8% required emergency surgery (1, 14).

If any of the following are present, the patient is excluded and should exit the guideline: multiple trauma, penetrating injury, known or suspected cervical spine injury, pre-existing neurologic disorder, intracranial shunt, bleeding diathesis, suspected non-accidental injury, or intoxication.

(A) CHILDREN < 2 YEARS OF AGE

Children less than 2 years of age are classified based on High, Intermediate and Low risk groups.

Patients are felt to be in the **High Risk** group if there are signs of depressed or basal skull fracture, history of seizure, irritability or lethargy, bulging fontanel, history of loss of consciousness of 1 minute or greater, or vomiting 5 or more times or for longer than 6 hours post injury. A Head CT is recommended for these patients to identify any intracranial injury.

Patients are classified to be at **Intermediate Risk** if they have vomited more than twice, have a history of brief loss of consciousness (less than 1 minute), higher force mechanism such as fall from height greater than 3 feet, if the caretaker is concerned that the patients behavior is atypical, if there was a fall on to a hard surface, or if the trauma was unwitnessed with a possibility of a significant mechanism. Patients less than 1 year of age are also classified as Intermediate risk, especially those less than 6 months, given the higher likelihood of injury in this age group. For patients in this intermediate risk group, a head CT should be considered although not necessarily indicated unless the child develops further symptoms during a 6 hour

period of observation. If there is no deterioration in this observation period, the patient may be safely discharged as long as the appropriate discharge criteria are met (see below).

These patients in the intermediate risk group are further classified based on whether or not a significant scalp hematoma is present. If any scalp hematoma is present in a child less than 1 year of age, or if a boggy hematoma is present in a child older than 1, the recommendation is to obtain a skull radiograph, unless a head CT is already being done. If the skull radiograph shows a skull fracture, a Head CT should be strongly considered, as there is an increased likelihood of intracranial injury (3).

Patients who have a low energy mechanism, who are 12 months of age and older, and who have displayed no signs or symptoms at least 2 hours following the injury, are considered to be **Low Risk**. Children in this low risk group are highly unlikely to have intracranial pathology and qualify for either observation in the emergency department or by a reliable adult at home, provided the appropriate discharge criteria are met. If a patient in this low risk group has a boggy scalp hematoma, the recommendation is that these patients have a skull radiograph. If the skull radiograph shows a skull fracture, a Head CT can be considered, however if the patient is in the low risk group and stable, there is the option of admission for a longer period of observation, and the Head CT avoided.

(B) CHILDREN 2 – 16 YEARS OF AGE

As with the children less than 2 years of age, children aged 2-16 years are classified as either high or intermediate risk. A patient is considered to be in the **High Risk** group if there is an abnormality in the mental status on presentation, any abnormality on neurological exam, or physical signs of a skull fracture. A head CT is recommended for patients in this high risk group (1).

Patients who present with a history of loss of consciousness, amnesia, more than 2 episodes of vomiting, severe or persistent headache, history of seizure at impact, confusion, lethargy or boggy scalp hematoma are classified as **Intermediate Risk**. These children need close observation. A Head CT should be considered for these patients, and is at the discretion of the treating physician. If the CT is not done, these patients are to be observed for 6 hours for any signs of clinical deterioration. If the patient deteriorates or doesn't improve, a head CT should be done at that time.

If the child does not fall in to the high or intermediate risk groups, they are considered to be **Low Risk** and is eligible for discharge home for observation if they meet the discharge criteria.

Imaging

CT, MRI and Skull radiographs are the 3 imaging techniques used in the evaluation of patients with minor head injury.

The **Head CT** is the gold standard for evaluating the brain following trauma (1,13,7). The primary goal of the head CT is to identify intracranial abnormalities that need medical and/or surgical intervention early, so as to minimize secondary brain injury (1).

It was once felt that all head injured patients should have a CT head to rule out intracranial abnormalities, however it is now recommended only for those patients felt to be at higher risk for intracranial injury (7). One always has the option of admitting stable children for observation and then performing a CT head should there be any clinical deterioration, thus avoiding the risks of the CT scan itself.

Although **MRI** can sometimes detect subtle intracranial injuries that are not seen on CT scan (in patients with minor head injury), their limited availability in the acute care settings, as well as the length of time and frequent need for sedation prevents their routine use in these patients (7).

Skull radiographs are recommended as a screen for all asymptomatic infants younger than a year of age with any scalp hematoma, and asymptomatic infants who are older than one year of age if they have a boggy scalp hematoma. Skull radiographs are the initial study with follow-up CT head scans and/or admission for those patients who have a skull fracture identified (3). Skull radiographs further provide important documentation for children with suspected non accidental trauma (7). Children diagnosed with a diastatic linear skull fracture who are less than 3 years of age are at risk of developing a growing fracture, although this occurs very rarely. These patients should be seen in follow-up 2 to 3 months following the injury and be examined for cranial defects indicative of growing skull fractures (7).

Discharge

Patients may be discharged home for ongoing observation provided there is no significant extracranial injury, normal neurological examination, no suspicion of abuse or neglect, they live in close proximity to health care, there are reliable care takers. When discharged, there need to be clear discharge instructions indicating what the caregiver should expect and when to return for medical attention.

Home observation should not be considered for patients in whom the caretakers cannot be available to observe the patient, have a significant language barrier, are intoxicated, or are unable to access medical care quickly either because of lack of transportation or excessive distance to hospital (11).

Care givers should be told to seek medical attention if the following are present: a persistent or progressive headache, persistent vomiting 8 hours after injury, drowsiness, weakness or clumsiness, blurry vision, poor balance when walking, change in the appearance of the pupils, behavioral changes, seizures, and watery or bloody discharge from the nose or ears. Symptomatic children and those with isolated skull fractures who are discharged should return to their physician for follow-up within 24 hours (7).

Children with normal head CT findings and a normal neurologic examination have a negligible risk for subsequent neurologic deterioration and in most cases can be safely discharged (1). At the same time, it should be explained to the family of a child with mild head injury that a negative CT scan does not mean there was not a brain injury, and that some children can have sequelae of their injury for up to a year (following a minor head injury), including headaches, difficulty sleeping, difficulty concentrating, and behavior problems (11).

Patients should be admitted and neurosurgical consultation obtained if intracranial injuries are identified on the head CT scan or if there is a neurologic abnormality found on exam despite a normal head CT scan. Children with suspected non accidental trauma, children without reliable caretakers or access to an emergency medical system, and children with known skull fractures but without head CT scans should also be admitted for observation.

BACKGROUND

Head injury is the leading cause of death and disability in pediatric trauma victims. It accounts for 250,000 hospital admissions each year, whereas 5 million children present to hospital emergency departments seeking evaluation and care for head injuries (13).

Minor head injury in children is common and may leave children with long-term consequences if unrecognized. Currently there are variations in how minor head injury is diagnosed and managed, and this potentially places children at increased risk for delayed or undiagnosed learning and behavioral disabilities, as well as raising the danger and consequences of reinjury (1).

The cause of head injury in the pediatric population varies by age. In infants, falls are the most common cause of head trauma overall, whereas child abuse is the most common cause of severe head trauma. Falls or recreational activities account for most of the head trauma of all severities in older children, whereas motor-vehicle crashes and assault are the most commonly associated etiologies of severe head trauma in adolescents (11).

Identifying intracranial injury is important to minimize secondary brain injury, prevent complications, counsel parents, and document abuse (10). In the past the conservative approach to the diagnostic evaluation of head injury in infants had been recommended. This was due to the finding that infants are at increased risk of intracranial injury and that symptoms or signs of brain injury may be absent in patients with intracranial injury (3). A clear relationship between age and intracranial injury was found, with younger patients being more likely to have intracranial injury (3).

Skull radiographs and head CT readily identify fractures and intracranial injuries, respectively; however, their indiscriminate use wastes resources and raises costs (10). In actual fact, only approximately 18% of patients who present to the emergency department at BCCH with head injury undergo CT scanning of the head. This is because although it is accurate at making the diagnosis of intracranial injury, it must be used with discretion as it is not without risk. Young children often require sedation, which carries the risk of hypoxia, apnea, prolonged depressed level of consciousness, aspiration, and the need for intubation and mechanical ventilation (10,11).

The most important drawback to CT use is the radiation exposure associated with its use. The associated increase risk of cancer has resulted in the recommendation to limit radiation exposure as much as possible (11). The estimated lifetime cancer mortality risks attributable to radiation exposure from one CT scan of the head in a 1 year old child is 0.07%, a sharp increase over that of an adult (15).

In addition to the complications above, CT is not readily available in all facilities and requires skilled interpretation, especially in children (7), therefore having good guidelines for determining who needs imaging is very important.

There does not exist objective pediatric specific clinical criteria (e.g. loss of consciousness, amnesia, and vomiting) that accurately predict intracranial injury (1). There is consensus that head CT is recommended for children following head injury if an altered mental status or focal neurological deficits are present (7). In an effort to identify other factors that are associated with intracranial injury, a number of trials have been done or are ongoing, evaluating decision rules to be used in the evaluation of minor head injury.

The NEXUS II decision instrument, formulated from a prospective, multicenter study of all patients with blunt head trauma who underwent CT scanning in the United States, suggests that significant intracranial injury is extremely unlikely in any child who does not exhibit at least one of the following high-risk criteria: evidence of significant skull fracture (diastatic, depressed, open, or basilar), altered level of alertness, neurologic deficit, persistent vomiting, presence of scalp hematoma, abnormal behavior and coagulopathy (4).

As part of the Canadian Assessment of Tomography for Childhood Head Injury (CATCH) Study, a clinical decision rule for the use of head CT in children with minor head injury has been created and is in the process of being validated (12). This will form the basis of future guidelines in Canada, however in the meantime this guideline has been formulated using the current available evidence.

In patients with minor head injuries, the absence of loss of consciousness, drowsiness, amnesia, prolonged headache, clinical evidence of basal or non-frontal skull fracture identified 100% of children without intracranial lesions (2). Independent predictors of intracranial injury include altered mental status, focal neurologic deficit, signs of basal skull fracture, seizure and other skull fractures (3).

A significant scalp hematoma is the most sensitive predictor of intracranial injury. In one study, of 23 subjects with significant scalp hematoma and intracranial injury, 22 (96%) also had a skull fracture. Of the 75 subjects with significant scalp hematoma and skull fracture, 22 (29%) had intracranial injury. In contrast, of the 164 subjects with significant scalp hematoma and no skull fracture, only 1 (0.6%) had intracranial injury (3).

Skull fracture is a predictor of intracranial injury. In most studies of children with skull fractures, an associated intracranial injury was present in 15% to 30% (10). The relative risk for intracranial injury is increased almost four fold in the presence of a skull fracture, although the absence of a skull fracture does not rule out intracranial injury (13).

The usefulness of skull radiographs in the evaluation of head injury is controversial. In children over 2 years of age with minor head injury, skull radiographs have limited use and therefore are not recommended by the American Academy of Pediatrics. In this age group, skull fractures may be detected on skull radiographs in the absence of intracranial injury, and intracranial injury may be present when no skull fracture is detected on skull radiograph (1).

Children under 2 years of age are different. There is some value to skull radiographs in the presence of significant scalp hematoma for identifying a skull fracture. The skull radiographs are used as a screening tool. If a skull fracture is identified, these children should undergo head CT or be admitted for observation, depending on the clinical circumstances (7). If the plan is to obtain a head CT regardless of the skull radiograph results, skull films add little or nothing to the ultimate treatment plan and incur additional costs and radiation (1).

Children less than 2 years of age differ from older children and adults in several ways that make a low threshold for imaging necessary. Clinical assessment is more difficult, asymptomatic (or occult) intracranial injury occurs commonly, the risk for non accidental trauma is higher, the incidence of skull fractures from minor trauma is greater, and leptomenigeal cysts (growing fractures) may develop (10). Because of this, their age alone puts them in a moderate risk group for intracranial injury (3,10). Despite all this, universal imaging is not necessary and there is a role for good clinical guidelines. Admission for close observation for signs of clinical deterioration is a valuable option which can be used instead of or in conjunction with imaging.

References

1. Kamerling SN et al. Mild traumatic brain injury in children: practice guidelines for emergency department and hospitalized patients. *Ped Emerg Care* 2003; 19 (6) 431-440.
2. Da Dalt L et al. Predictors of intracranial injuries in children after blunt head trauma. *Eur J Pediatr* 2006; 165 (3): 142-148
3. Greenes DS, Schutzman SA. Clinical indicators of intracranial injury in head-injured infants. *Pediatrics* 1999; 104: 861-867.
4. Oman JA et al. Performance of a decision rule to predict need for computed tomography among children with blunt head trauma. *Pediatrics* 2006; 117 (2):238-246.
5. Dunning J et al. Derivation of the children's head injury algorithm for the prediction of important clinical events decision rule for head injury in children. *Arch Dis Child* 2006; 91: 885-891.
6. Dunning J et al. A meta-analysis of variables that predict significant intracranial injury in minor head trauma. *Arch Dis Child* 2004; 89:653-359.
7. Quayle K. Minor head injury in the pediatric patient. *Pediatric Clinics of North America* 1999; 46 (6): 1189-99
8. A synopsis of the AAP practice parameter on the management of minor closed head injury in children. *Pediatrics in Review* 2000; 21 (12): 413-415.
9. Management of minor closed head injury in children. *Pediatrics* 1999; 104 (6)
10. Schutzman S et al. Evaluation and management of children younger than two years old with apparently minor head trauma. *Pediatrics* 2001; 107 (5): 983-993.
11. Berger RP, Adelson PD. Evaluation and management of pediatric head trauma in the emergency department: current concepts and state-of-the-art research. *Clin Ped Emerg Med* 2005; 6: 8-15.
12. Osmond MH et al. A clinical decision rule for the use of head CT in children with minor head injury. *Acad Emerg Med* 2004; 11(5): 449-450
13. Quayle K. et al. Diagnostic Testing for Acute Head Injury in Children: When are Head CT and Skull Radiographs Indicated? *Pediatrics* 1997; 99: 11-18
14. Stein, SC. Minor head injury: 13 is an unlucky number. *J Trauma Inj Infect Crit Care*. 2001; 50: 759-760.
15. Brenner DJ. Estimated Risks of Radiation-Induced Fatal Cancer from Pediatric CT. *AJR* 2001; 176(2): 289-296.