



Pediatric Head Injury - When and when not to CT

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Disclosure

- I hereby disclose that I have no conflict of interest

Objectives

- Highlight some challenges clinicians face when assessing and imaging children with acute head trauma.
- Review key studies addressing imaging decision-making in pediatric acute head trauma
- Summarize an approach to CT scan decision-making as published in the latest position statement of the Canadian Pediatric Society



Background

- Head Trauma is one of the most common reasons for Emergency Department (ED) consultation
- Roughly 20,000 ED visits/yr in Canadian Pediatric Hospitals
- >470,000 ED visits/yr and 35,000 admissions in the U.S.



Background

- Only a small portion of patients will have a traumatic brain injury (TBI)
 - TBI defined as the symptoms resulting from trauma to the brain itself with or without CT head findings
 - One Italian study showed that the risk of fatal and non-fatal TBI was 0.5 and 5.2 per 1000 children respectively



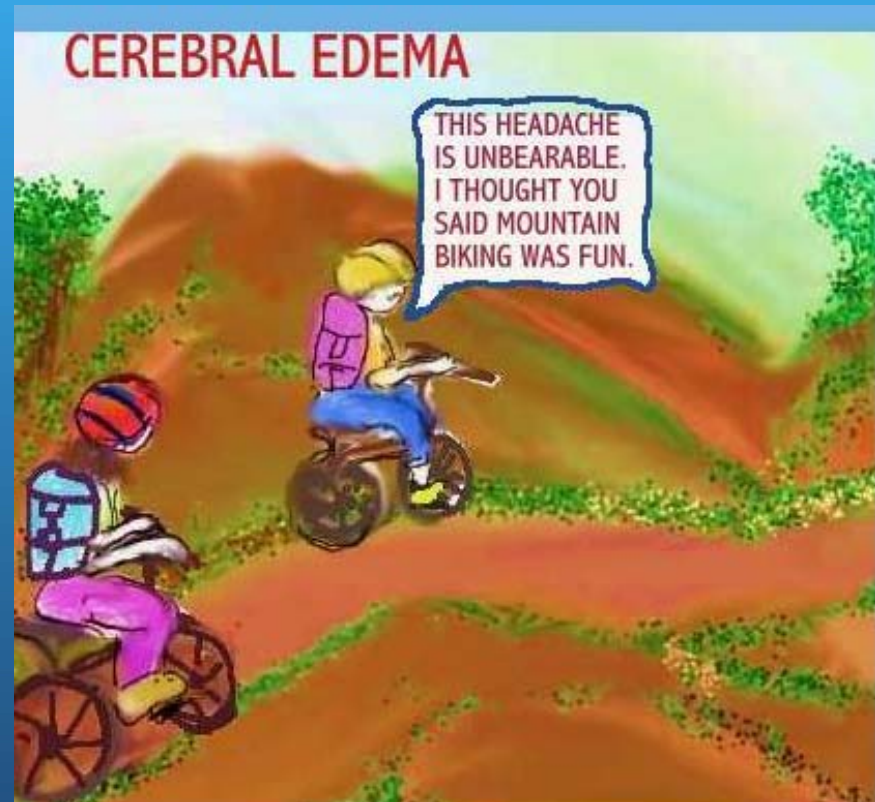
Da Dalt L, Marchi AG, Laudizi L, et al. Predictors of intracranial injuries in children after blunt head trauma. Eur J Pediatr 2006;165(3):142-8.

Pediatric Particularities

- Unique anatomy of children is such that they are more likely to develop an intracranial lesion
 - Larger head-to-body-size ratio
 - Thinner cranial bone
 - Less myelinated tissue

Pediatric Particularities

- More commonly: Pattern of diffuse axonal injury and secondary cerebral edema
- More rarely: Lesions requiring neurosurgical intervention (evacuating a hematoma)



Pediatric Assessment

- May have similar Sx as adults (h/a, amnesia, LOC, vomiting, seizures)
- Younger children: lethargy or irritability
- Signs particularly associated with intracranial injury:
 - Prolonged loss of consciousness
 - Impaired level of consciousness
 - Disorientation confusion or amnesia
 - Worsening headache
 - Repeated or persistent vomiting

Classification of Pediatric Head Trauma

- According to GCS - a validated tool
- Pediatric GCS for pre-verbal children
- GCS 14-15 = Minor - the majority of presentations
- GCS 9-13 = Moderate
- GCS ≤ 8 = Severe

GCS vs Peds GCS

| EYE OPENING | | |
|-------------------|---|-------------|
| GCS | | PEDS GCS |
| Spontaneous | 4 | Spontaneous |
| To Verbal Stimuli | 3 | To speech |
| To pain | 2 | To pain |
| None | 1 | None |

1. Holmes JF, Palchak MJ, MacFarlane T, Kuppermann N. Performance of the Pediatric Glasgow Coma Scale in children with blunt head trauma. Acad Emerg Med 2005;12(9):814-9.

GCS vs Peds GCS

| BEST VERBAL RESPONSE | | |
|-------------------------|---|------------------|
| GCS | | PEDS GCS |
| Oriented | 1 | Coos, babbles |
| Confused | 2 | Irritable, cries |
| Inappropriate words | 3 | Cries to pain |
| Incomprehensible sounds | 4 | Moans to pain |
| None | 5 | None |

1. Holmes JF, Palchak MJ, MacFarlane T, Kuppermann N. Performance of the Pediatric Glasgow Coma Scale in children with blunt head trauma. Acad Emerg Med 2005;12(9):814-9.

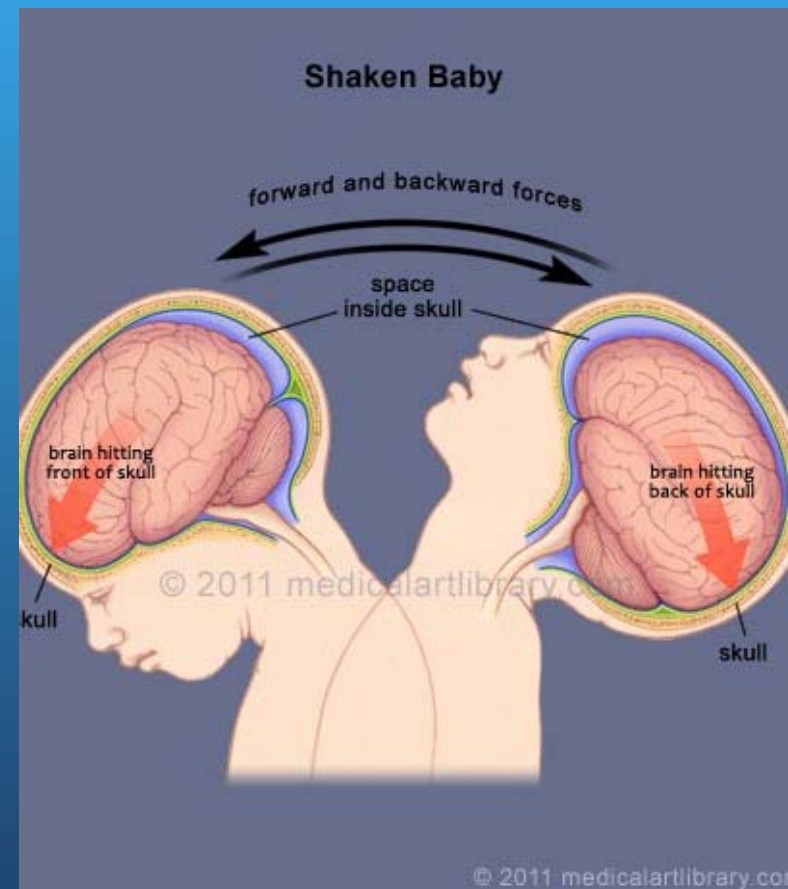
GCS vs Peds GCS

| BEST MOTOR | | |
|-------------------|---|--------------------|
| GCS | | PEDS GCS |
| Follows commands | 6 | Normal spont. mvmt |
| Localizes pain | 5 | Withdraws to touch |
| Withdraws to pain | 4 | Withdraws to pain |
| Flexion to pain | 3 | Abnormal flexion |
| Extension to pain | 2 | Abnormal extension |
| None | 1 | None |

1. Holmes JF, Palchak MJ, MacFarlane T, Kuppermann N. Performance of the Pediatric Glasgow Coma Scale in children with blunt head trauma. Acad Emerg Med 2005;12(9):814-9.

Nonaccidental trauma

- Suspect if:
 - Altered level of consciousness without obvious cause
 - Clinical findings not compatible with history
- May not be recognized initially:
 - Variable modes of presentation
 - Young age of victims
- Delay in recognition may lead to poor outcomes



To scan or not to scan?

- ALL patients with moderate or severe head trauma should undergo CT scan

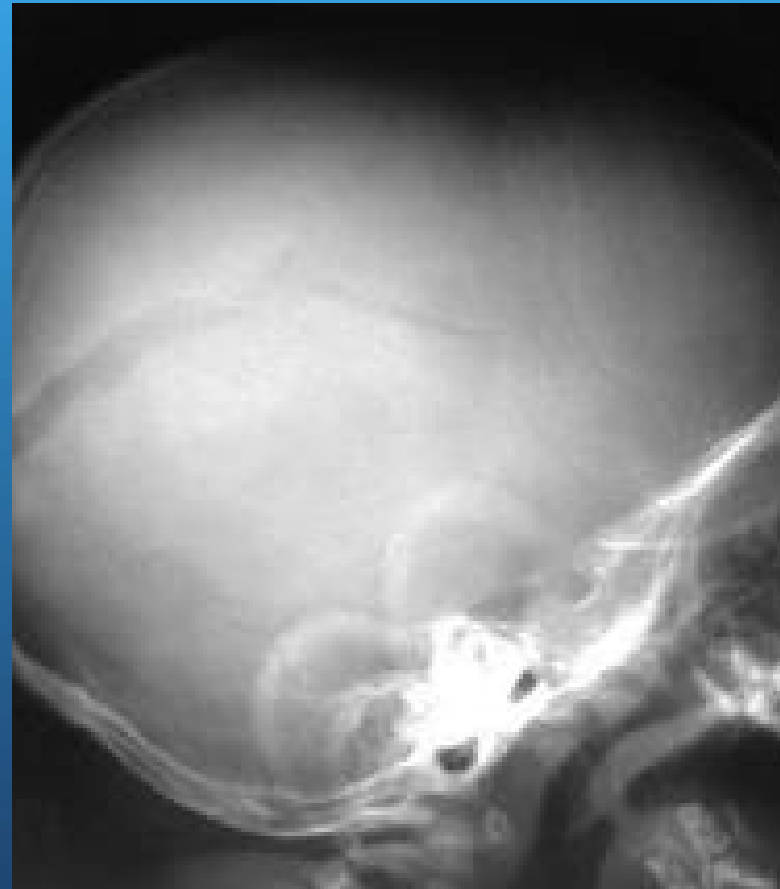


To scan or not to scan?

- Debate as to which patients with minor head trauma require CT
 - Potential for late deterioration due to delayed dx
 - Relative unreliability of clinical signs in predicting intracranial injury
 - Low rate of positive CT findings
 - Need for sedation in younger patients
 - Concern regarding radiation exposure

Absolute indications for CT

- Focal neurologic findings on exam
- Suspected open or depressed skull fracture
- Widened (diastatic) skull fracture on x-ray



Relative Indications for CT

- GCS <14 at any point; or GCS <15 at 2h post injury
- Deterioration over 4-6h of observation in a symptomatic patient (e.g., worsening headache, repeated vomiting)
- Large boggy scalp hematoma
- Signs of basal skull fracture
- Significant mechanism of injury (high velocity MVC)
- Persistent irritability in <2yo



Thiessen ML, Woolridge DP. Pediatric minor closed head injury. *Pediatr Clin North Am* 2006;53(1):1-26.

Development of clinical decision rules for CT scanning

- Due to considerable debate about which minor head injury patients require a CT scan.
- Advantage:
 - Help guide clinicians in deciding whether a scan should be performed
 - Avoid unnecessary imaging while not missing positive cases
- Problem:
 - Criticism over heterogeneity
 - Lack of prospective validation in multicentre cohorts

CATCH study



- Canadian Assessment of Tomography for Childhood Head Injury (CATCH) rule
- PERC Prospective Cohort Study
 - Involved 10 Canadian Pediatric ED's
 - 3886 children with symptomatic minor head trauma
- Meant to assist with CT decision making

CATCH definition of Minor Head Injury



- Injury within the past 24h in a patient with GCS 13-15, associated with:
 - Witnessed loss of consciousness
 - Definite amnesia
 - Witnessed disorientation
 - Persistent vomiting (>1 episode)
 - Persistent irritability in a child <2yo



Osmond MH, Klassen TP, Wells GA, et al; for the Pediatric 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. CMAJ 2010;182(4):341-8.

CT HEAD is required for children with a minor head injury PLUS ANY ONE of the following:

HIGH RISK (need for neurological intervention)

- 1) GCS <15 at 2h after injury
- 2) Suspected open or depressed skull fracture
- 3) History of worsening headache
- 4) Irritability on examination

MEDIUM RISK (brain injury on CT scan)

- 1) Any sign of basal skull fracture
- 2) Large, boggy hematoma of scalp
- 3) Dangerous mechanism of injury (MVC, fall ≥ 3 ft or down 5 stairs, falling from a bicycle without a helmet)

- 98% sensitivity for predicting acute brain injury (95% CI 95%-99%)
- Would require that 38% of patients undergo CT

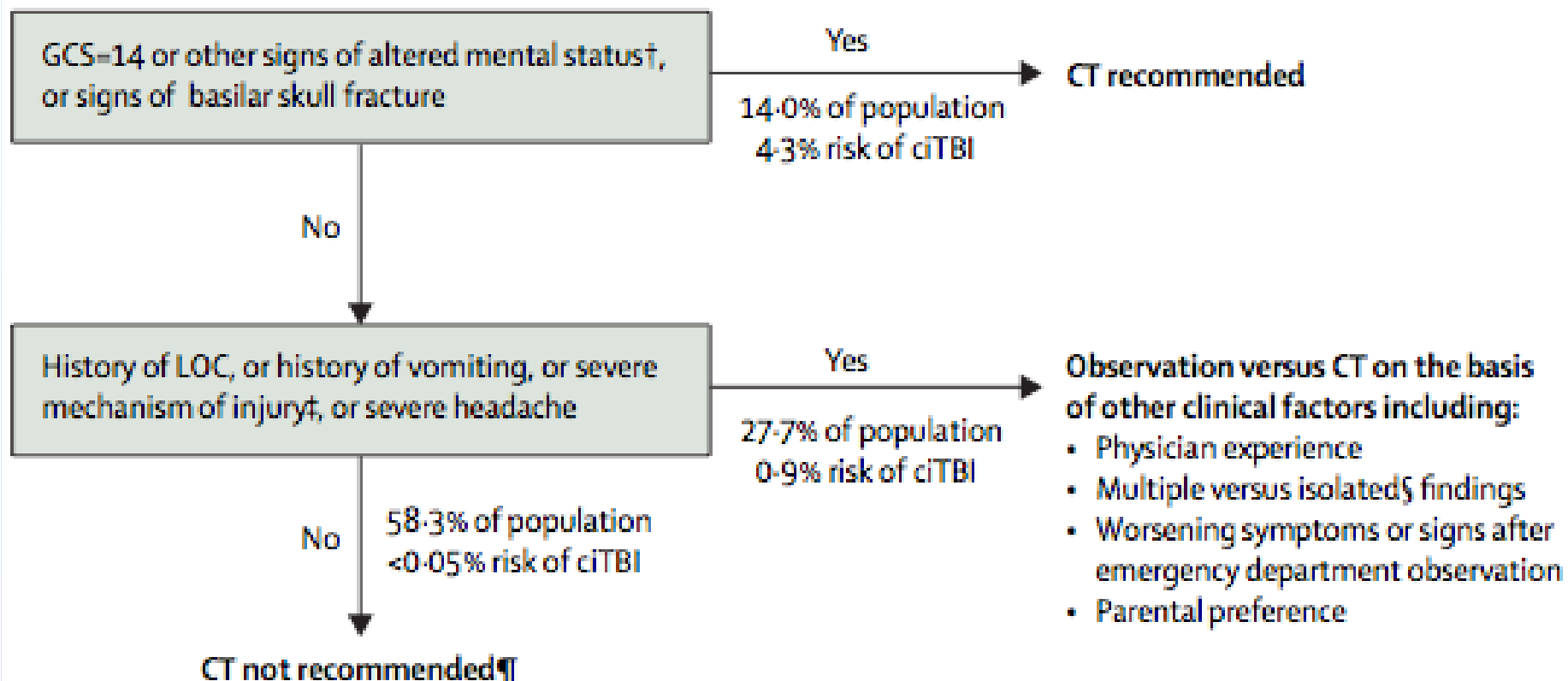
PECARN rule

- Prospective cohort study of 42,412 patients from 25 sites
- Derived and validated prediction rules for children at very low risk for traumatic brain injuries, for whom CT scans should be avoided.
- Meant to assist physicians in decision making
- Application of the rules could limit CT use

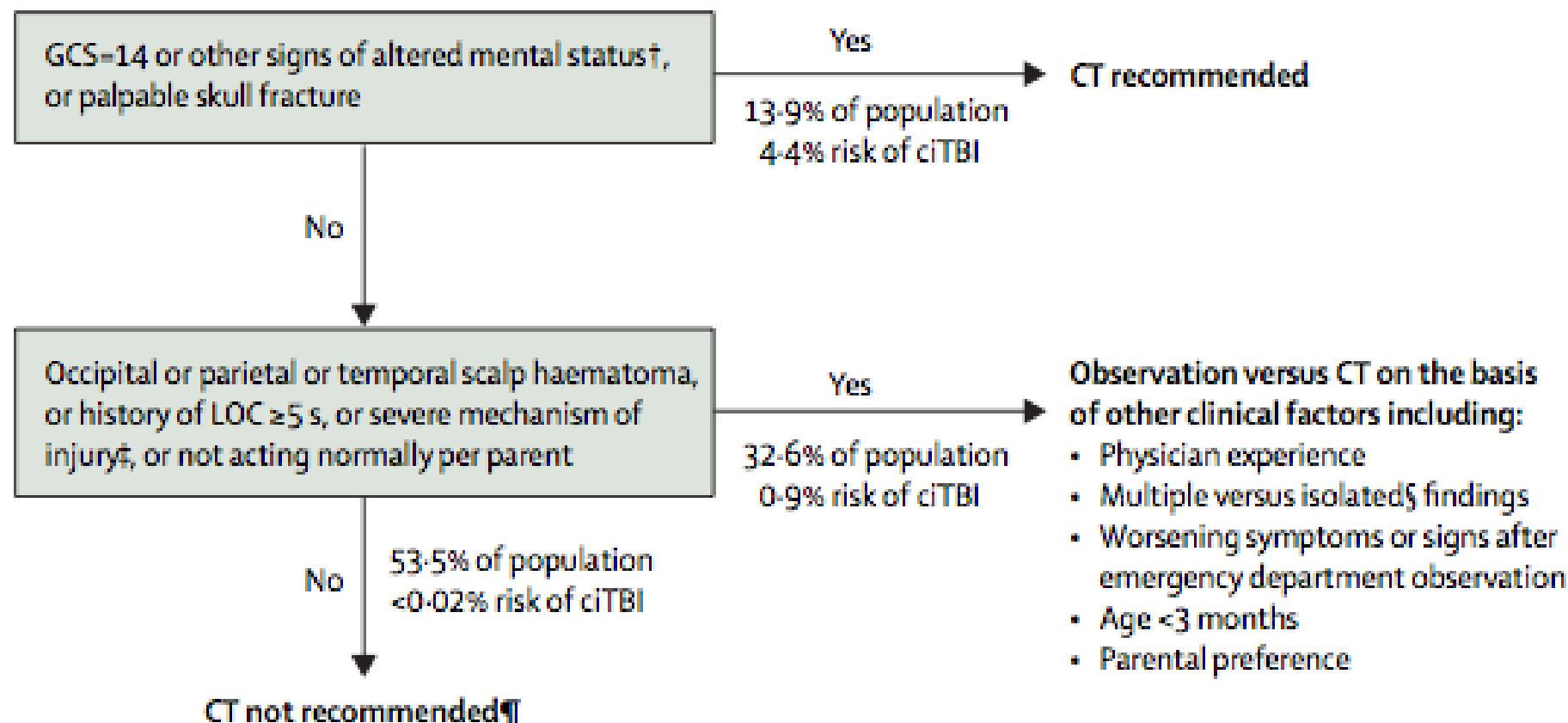


Kuppermann N, Holmes JF, Dayan PS et al; for the Pediatric Emergency Care Applied Research Network (PECARN). Identification of children at very low risk of clinically important brain injuries after head trauma: A prospective cohort study. Lancet 2009;37

PECARN rule in ≥ 2 yo



PECARN rule in < 2 yo



CPS guideline for management after initial assessment of minor head trauma



- Asymptomatic patients may be discharged home with parents
 - Provide written instructions:
 - Indications to return (worsening h/a, persistent vomiting)
 - Who to contact
 - When to f/u



CPS guideline for management after initial assessment of minor head trauma



- Symptomatic patients must be observed for a period, with reassessment.
- If improvement and GCS=15 → D/C home
- If no improvement:
 - ADMIT, neurovitals q2-4h
 - CT head if persistent symptoms after 18-24h of hospitalization, if not already performed



CPS guideline for management after initial assessment of minor head trauma



- Greater caution advised in children <2yo, particularly those <12 months old:
 - Challenging clinical assessment
 - Potential for Trauma X
- Observe for a longer period, frequent reassessments



