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

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

<table>
<thead>
<tr>
<th>EYE OPENING</th>
<th>Peds GCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td>PEDS GCS</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>4 Spontaneous</td>
</tr>
<tr>
<td>To Verbal Stimuli</td>
<td>3 To speech</td>
</tr>
<tr>
<td>To pain</td>
<td>2 To pain</td>
</tr>
<tr>
<td>None</td>
<td>1 None</td>
</tr>
</tbody>
</table>

## GCS vs Peds GCS

<table>
<thead>
<tr>
<th>BEST VERBAL RESPONSE</th>
<th>PEDS GCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS</td>
<td></td>
</tr>
<tr>
<td>Oriented</td>
<td>1 Coos, babbles</td>
</tr>
<tr>
<td>Confused</td>
<td>2 Irritable, cries</td>
</tr>
<tr>
<td>Inappropriate words</td>
<td>3 Cries to pain</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td>4 Moans to pain</td>
</tr>
<tr>
<td>None</td>
<td>5 None</td>
</tr>
</tbody>
</table>

## GCS vs Peds GCS

<table>
<thead>
<tr>
<th>BEST MOTOR</th>
<th>Peds GCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GCS</strong></td>
<td><strong>PEDS GCS</strong></td>
</tr>
<tr>
<td>Follows commands</td>
<td>6 Normal spont. mvmt</td>
</tr>
<tr>
<td>Localizes pain</td>
<td>5 Withdraws to touch</td>
</tr>
<tr>
<td>Withdraws to pain</td>
<td>4 Withdraws to pain</td>
</tr>
<tr>
<td>Flexion to pain</td>
<td>3 Abnormal flexion</td>
</tr>
<tr>
<td>Extension to pain</td>
<td>2 Abnormal extension</td>
</tr>
<tr>
<td>None</td>
<td>1 None</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>HIGH RISK (need for neurological intervention)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) GCS &lt;15 at 2h after injury</td>
</tr>
<tr>
<td>2) Suspected open or depressed skull fracture</td>
</tr>
<tr>
<td>3) History of worsening headache</td>
</tr>
<tr>
<td>4) Irritability on examination</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MEDIUM RISK (brain injury on CT scan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Any sign of basal skull fracture</td>
</tr>
<tr>
<td>2) Large, boggy hematoma of scalp</td>
</tr>
<tr>
<td>3) Dangerous mechanism of injury (MVC, fall ≥3 ft or down 5 stairs, falling from a bicycle without a helmet)</td>
</tr>
</tbody>
</table>

- 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

PECARN rule in ≥ 2 yo

- GCS=14 or other signs of altered mental status†, or signs of basilar skull fracture:
  - Yes: CT recommended
    - 14.0% of population
    - 4.3% risk of ciTBI
  - No:
    - History of LOC, or history of vomiting, or severe mechanism of injury†, or severe headache:
      - Yes: Observation versus CT on the basis of other clinical factors including:
        - Physician experience
        - Multiple versus isolated§ findings
        - Worsening symptoms or signs after emergency department observation
        - Parental preference
      - 27.7% of population
      - 0.9% risk of ciTBI
      - No:
        - 58.3% of population
        - <0.05% risk of ciTBI
        - CT not recommended¶
PECARN rule in < 2 yo

**GCS = 14 or other signs of altered mental status†, or palpable skull fracture**
- Yes
  - 13.9% of population
  - 4.4% risk of ciTBI
- No
  - Occipital or parietal or temporal scalp haematoma, or history of LOC ≥5 s, or severe mechanism of injury‡, or not acting normally per parent
    - Yes
      - 32.6% of population
      - 0.9% risk of ciTBI
    - No
      - 53.5% of population
      - <0.02% risk of ciTBI
- CT recommended
- Observation versus CT on the basis of other clinical factors including:
  - Physician experience
  - Multiple versus isolated§ findings
  - Worsening symptoms or signs after emergency department observation
  - Age <3 months
  - Parental preference
- CT not recommended
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

Catherine A Farrell; Canadian Paediatric Society, Acute Care Committee
Paediatr Child Health 2013;18(5):253-8
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

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Paediatr Child Health 2013;18(5):253-8
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

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Paediatr Child Health 2013;18(5):253-8
Patient ≥2 years of age with history of acute impact to head

Take history
Perform physical and neurological exam
Determine Glasgow Coma Scale (GCS)

GCS = 14-15
YES
All of the following:
Patient asymptomatic
General exam normal
Neurological exam normal
Low-risk cause of trauma
GCS = 15
YES
Box 5
Determine if other medical or social indication for admission
YES
Consider discharge
Provide caregivers with written instructions
NO
Box 6
Admit for observation
Consider consult with Trauma/Neurosurgery

NO
Box 12
Admit to hospital
Contact Neurosurgery

NO
Go to Box 6

NO
Is CT scan positive?
YES
Box 12
Contact Neurosurgery
NO
Go to Box 6

NO
Observe in ED for 4 h to 6 h
Consider CT scan

NO (or not obtained)
Symptoms improved
Physician discretion
YES
Go to Box 5
NO
Go to Box 6
Consider CT scan

YES
Perform CT scan

YES
Any of the following:
Abnormal mental status
Abnormal neurological exam
Suspect skull fracture

NO
Any of the following:
History of loss of consciousness
Amnesia
Confusion
Lethargy or irritability
Repeated or persistent vomiting
Severe or persistent headache
Immediate post-traumatic seizure

NO
Go to Box 6
Consider CT scan

YES
Any of the following:
Patient asymptomatic
General exam normal
Low-risk cause of trauma
GCS = 15

NO
Exit algorithm