Cranium to Clavicle: Pediatric Head & Neck Trauma

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Cases

A 15-month-old presents with a forehead bruise after being hit in the head with a toy firetruck. He's vomited twice since. He looks GREAT.

An 18-month-old was properly restrained in a rollover MVC; one adult was taken immediately to the OR with life-threatening injuries. The only exam finding is a small bruise over the neck from the carseat strap.

A 7-year-old has R arm and leg weakness after falling from a second story window. GCS is 15 and the exam is otherwise normal.

Take-aways

Kids are not little adults.

PECARN is more than a tasty pie filling.

The future is now.

Goal

To streamline evaluation and management of children presenting to the ED with head and neck trauma, balancing detection of critical injuries with avoiding unnecessary testing.

Objectives

After attending this session, learners will be able to:

- Compare and contrast head and neck trauma in pediatric and adult patients.
- Apply evidence-based algorithms to risk stratify kids with head and neck trauma.
- Describe clinical criteria informing the decision for initial imaging.

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No commercial or financial interests to disclose.

What's so special about kids?

1. They're the best.
2. They're designed to bounce.
3. Less is more.
4. They can be squirrely!
5. They glow in the dark.

Radiation

- Risk **increases** with **decreasing** age
- Head CT:
  - Relative risk of developing brain cancer: **1.5**
  - **Lethal** malignancy: 1 in 1000 to 1 in 5000
- Neck:
  - Standard CT: **159.1** / 100,000 patients
  - Low dose CT: **86.2** / 100,000 patients
  - Plain radiograph: **11.0** / 100,000 patients

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Head Trauma

Head injury

- **Common**
- Highest morbidity & mortality
- Majority of kids undergoing imaging have no abnormalities

PECARN - head

- Published in 2009
- Algorithms for < 2 years and ≥ 2 years
- Derivation NPV and sensitivity:
  - < 2: 100% / 100%
  - ≥ 2: 99.95% / 96.8%
- Validation:
  - <2: 100% / 100%
  - ≥ 2: 98.8% / 100%
- **This works. Use it.**

younger than 2 years

AMS
or
GCS < 15
or
Palpable skull fx

CT Head Recommended

NONE

LOC > 5 sec
or
Non-frontal hematoma
or
Not acting normally
or
Severe mechanism*

Observation vs. CT Head

NONE

No CT Required!

Discharge

*SEVERE MECHANISMS

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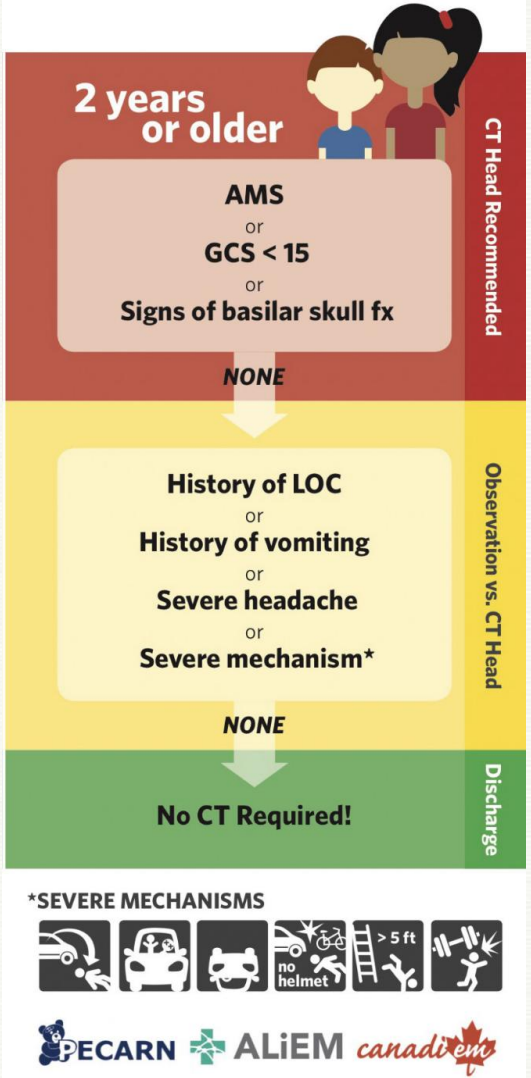
PECARN - head

- **How do we calculate an infant / toddler Glasgow Coma Score (GCS)?**
  - **Eyes**: Open spontaneously, to voice, to pain, closed
  - **Verbal:** Coos/babbles, irritable cry, cry to pain, moan to pain, silent
  - **Motor:** Moves spontaneously / purposefully, withdraws to touch, withdraws to pain, flexion, extension, still
  - **Don’t psych yourself out!**

PECARN - head

- **What does observation look like?**
  - As “normal” as possible– eat, drink, play, screen use, sleep
  - Involve caregiver
  - Be mindful of time of day



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Low-dose CT

- Significantly lowers organ-specific radiation dose
- Shorter time in scanner = less motion artifact
- No sacrifice in accuracy
- **Use low dose CT for kids.**

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Neck Trauma

Cervical spine

- Adults:
  - Prevalence: 3-4%, C6-C7 most common
  - Older adults: **5-10%!**
- Kids:
  - Rare! **<1% - 3%**
  - Higher injuries, especially in < 8 years
- Diagnosis can be challenging!
  - Exam difficulty *(not for us...)*
  - Skeletal development
  - **Radiation** ☢️

From source 7

Breaking news!

PECARN - C-spine

- **Risk factors for injury:**
  - GCS 3-8, Unresponsive on AVPU, abnormal ABCs, focal neuro deficit
  - Neck pain, AMS, substantial head injury, substantial torso injury, posterior midline neck tenderness to palpation
  - **NPV 99.9!**

PECARN prediction rule for cervical spine imaging of children presenting to the emergency department with blunt trauma: a multicentre prospective observational study

Julie C Leonard, Monica Harding, Lawrence J Cook, Jeffrey R Leonard, Kathleen M Adelgais, Fahd A Ahmad, Lorin R Browne, Rebecca K Burger, Pradip P Chaudhari, Daniel J Corwin, Nicolaus W Glomb, Lois K Lee, Sylvia Owusu-Ansah, Lauren C Riney, Alexander J Rogers, Daniel M Rubalcava, Robert E Sapien, Matthew A Szadkowski, Leah Tzimenatos, Caleb E Ward, Kenneth Yen, Nathan Kuppermann

Summary

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Background Cervical spine injuries in children are uncommon but potentially devastating; however, indiscriminate neck imaging after trauma unnecessarily exposes children to ionising radiation. The aim of this study was to derive and validate a paediatric clinical prediction rule that can be incorporated into an algorithm to guide radiographic screening for cervical spine injury among children in the emergency department.

Methods In this prospective observational cohort study, we screened children aged 0–17 years presenting with known or suspected blunt trauma at 18 specialised children's emergency departments in hospitals in the USA affiliated with the Pediatric Emergency Care Applied Research Network (PECARN). Injured children were eligible for enrolment into derivation or validation cohorts by fulfilling one of the following criteria: transported from the scene of injury to the emergency department by emergency medical services; evaluated by a trauma team; and undergone neck imaging for concern for cervical spine injury either at or before arriving at the PECARN-affiliated emergency department. Children presenting with solely penetrating trauma were excluded. Before viewing an enrolled child's neck imaging results, the attending emergency department clinician completed a clinical examination and prospectively documented cervical spine injury risk factors in an electronic questionnaire. Cervical spine injuries were determined by imaging reports and telephone follow-up with guardians within 21–28 days of the emergency room encounter, and cervical spine injury was confirmed by a paediatric neurosurgeon. Factors associated with a high risk of cervical spine injury (>10%) were identified by bivariable Poisson regression with robust error estimates, and factors associated with non-negligible risk were identified by classification and regression tree (CART) analysis. Variables were combined in the cervical spine injury prediction rule. The primary outcome of interest was cervical spine injury within 28 days of initial trauma warranting inpatient observation or surgical intervention. Rule performance measures were calculated for both derivation and validation cohorts. A clinical care algorithm for determining which risk factors warrant radiographic screening for cervical spine injury after blunt trauma was applied to the study population to estimate the potential effect on reducing CT and x-ray use in the paediatric emergency department. This study is registered with ClinicalTrials.gov, NCT05049330.

Findings Nine emergency departments participated in the derivation cohort, and nine participated in the validation cohort. In total, 22 430 children presenting with known or suspected blunt trauma were enrolled (11 857 children in the derivation cohort; 10 573 in the validation cohort). 433 (1·9%) of the total population had confirmed cervical spine injuries. The following factors were associated with a high risk of cervical spine injury: altered mental status (Glasgow Coma Scale [GCS] score of 3–8 or unresponsive on the Alert, Verbal, Pain, Unresponsive scale [AVPU] of consciousness); abnormal airway, breathing, or circulation findings; and focal neurological deficits including paresthesia, numbness, or weakness. Of 928 in the derivation cohort presenting with at least one of these risk factors, 118 (12·7%) had cervical spine injury (risk ratio 8·9 [95% CI 7·1–11·2]). The following factors were associated with non-negligible risk of cervical spine injury by CART analysis: neck pain; altered mental status (GCS score of 9–14; verbal or pain on the AVPU; or other signs of altered mental status); substantial head injury; substantial torso injury; and midline neck tenderness. The high-risk and CART-derived factors combined and applied to the validation cohort performed with 94·3% (95% CI 90·7–97·9) sensitivity, 60·4% (59·4–61·3) specificity, and 99·9% (99·8–100·0) negative predictive value. Had the algorithm been applied to all participants to guide the use of imaging, we estimated the number of children having CT might have decreased from 3856 (17·2%) to 1549 (6·9%) of 22 430 children without increasing the number of children getting plain x-rays.

Interpretation Incorporated into a clinical algorithm, the cervical spine injury prediction rule showed strong potential for aiding clinicians in determining which children arriving in the emergency department after blunt trauma should undergo radiographic neck imaging for potential cervical spine injury. Implementation of the clinical algorithm could decrease use of unnecessary radiographic testing in the emergency department and eliminate high-risk radiation exposure. Future work should validate the prediction rule and care algorithm in more general settings such as community emergency departments.

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One can clear a
child clinically.

Imaging kids

- **NO risk factors**: clinical clearance
- **High risk** factors:
  - GCS 3-8, Unresponsive on AVPU, abnormal ABCs, focal neuro deficit
  - **(Low dose) CT these kids.**
- If none, assess additional risk factors:
  - Neck pain, AMS, substantial head injury, substantial torso injury, posterior midline neck tenderness to palpation
  - **XR these kids.***

Imaging kids

- **High risk** PECARN:
  - Low dose CT
- **Intermediate risk** PECARN:
  - Plain films
    - Under 5: AP and lateral XRs
    - 5 and older: AP, lateral, and odontoid XRs
- Other screening:
  - Plain films

MRI

- **Consider MRI** in peds if:
  - Focal neurologic deficit
  - Suspicion for spinal cord or soft tissue injury
- Limited sequence (“rapid”) MRI
  - NPV and sensitivity > 99% for all injuries, 100% for unstable
- Sedation considerations

Take-aways

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Blunt cerebrovascular injury (BCVI)

BCVI

- **Not little adults!**
- **McGovern Score:**
  - **≥ 3 points → CTA**
  - GCS ≤ 8 (1 point)
  - Focal neurological deficit (2 points)
  - Petrous bone fracture (3 points)
  - Fracture through carotid canal (2 points)
  - Traumatic ischemia on noncon head CT (3 points)
  - MVC as mechanism of injury (2 points)
- **88.9% sensitive, 98.7% NPV**

NOT SUBTLE!!!

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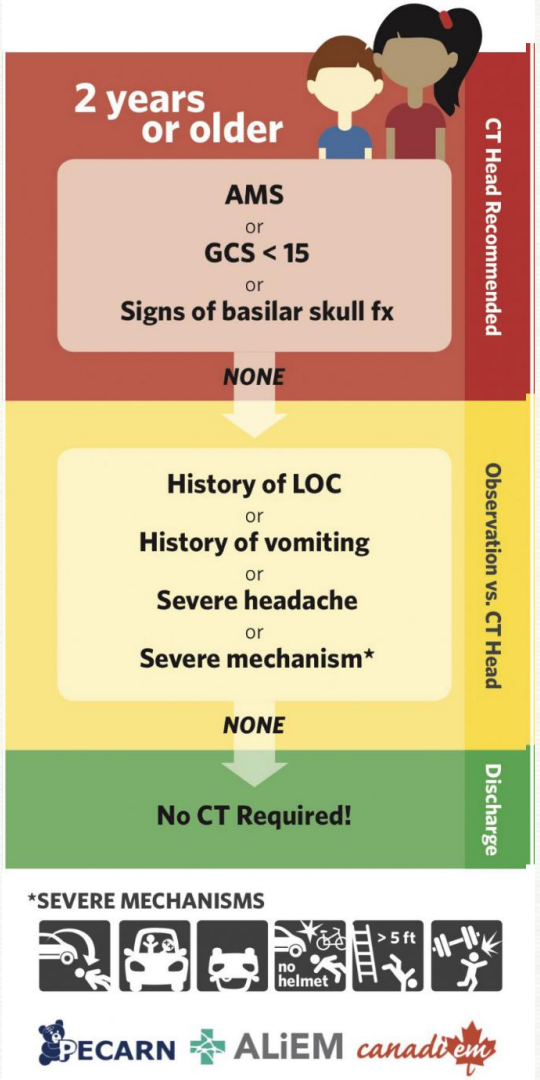
- **No correlation with seatbelt sign!**

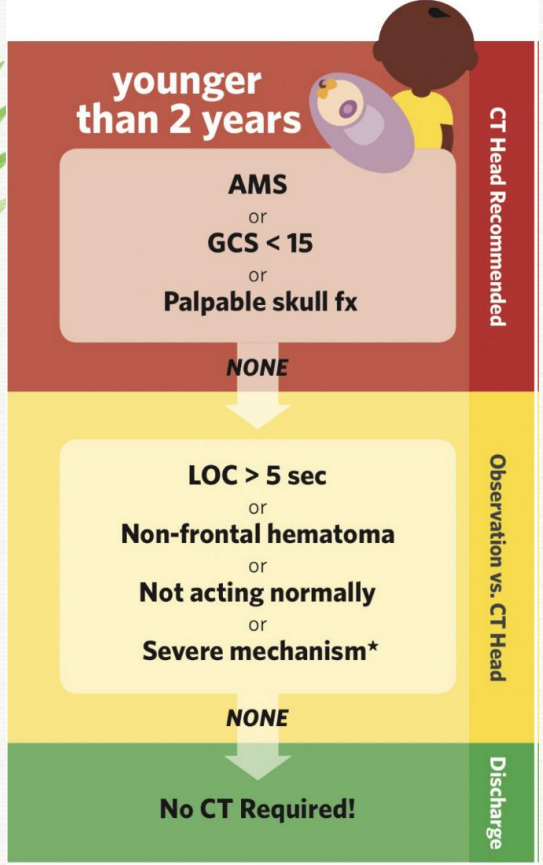
Seatbelt sign

- Higher proportions of BCVI if seatbelt sign ***and***:
  - ISS > 15 (OR 4.74)
  - Cervical spine fracture (OR 6.45)
  - Basilar skull fracture (OR 8.0)
- **87%** of kids with seatbelt sign did not have BCVI

Cases

A 15-month-old presents with a forehead bruise after being hit in the head with a toy firetruck. He's vomited twice since. He looks GREAT.





An 18-month-old was properly restrained in a rollover MVC; one adult was taken immediately to the OR with life-threatening injuries. The only exam finding is a small bruise over the neck from the carseat strap.

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  - MVC as mechanism of injury (2 points)
  - **2 points → no CTA!**

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Objectives

Now that you've attended the session, you can:

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Thank you!

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