

# Pediatric Head Injury

Joey Gassen, MD

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# Disclosures

I have no financial disclosures

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# Case 1

- 22 mo female fell from bed on tile
- Brief LOC of 2-3 seconds
- One episode of vomiting
- Acting normally
- Neuro exam unremarkable
- 3 cm swelling to right forehead with no appreciated step off

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## Case 2

- 15 yo male slipped on ice and hit back of head
- No LOC
- No vomiting
- No swelling or step off
- A&O x4 but requires repeated questioning
- Neuro exam otherwise unremarkable

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## Case 3

- 4 mo male fell 2 feet from carrier
- No LOC
- One episode emesis
- Abrasion to vertex with no swelling or step off
- GCS 15
- Unremarkable neuro exam

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## Case 4

- 12 yo female fell 4.5 feet from counter
- Brief LOC 2-3 seconds
- No vomiting
- Mild occipital swelling
- Normal neuro exam

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## Case 5

- 11 mo male fell 4 feet from mom's shoulders
- No LOC or vomiting
- 2 cm frontal hematoma without step off
- Normal neuro exam

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## Case 6

- 8 yo female fell from trampoline
- No LOC or vomiting
- Mild tenderness and swelling to occiput
- Bright red blood from right ear but has tube in place. No obvious canal laceration but blood obscures exam
- Normal neuro exam

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## Case 7

- 16 yo female in MVC 50 mph
- Unrestrained in back seat but no ejection
- No LOC or vomiting
- Right parieto-occipital swelling with no step off
- Unremarkable neuro exam

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## Case 8

- 14 yo male helmet to helmet hit
- No LOC or vomiting
- No swelling or tenderness
- GCS 14-confused
- Remainder of neuro exam unremarkable

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## Case 9

- 20 mo male fell 1 foot from swing
- No LOC or vomiting
- Moderate swelling to occiput with possible step off
- Neuro exam unremarkable

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## Traumatic Brain Injury

- Leading cause of death and disability worldwide
- 600,000 emergency department visits
- 60,000 hospital admissions
- 7400 deaths

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# Evaluation

- CT is modality of choice
- Excellent for diagnosing skull fracture or intracranial hemorrhage
- Quick and readily available
- Does not require sedation
- Easy to read

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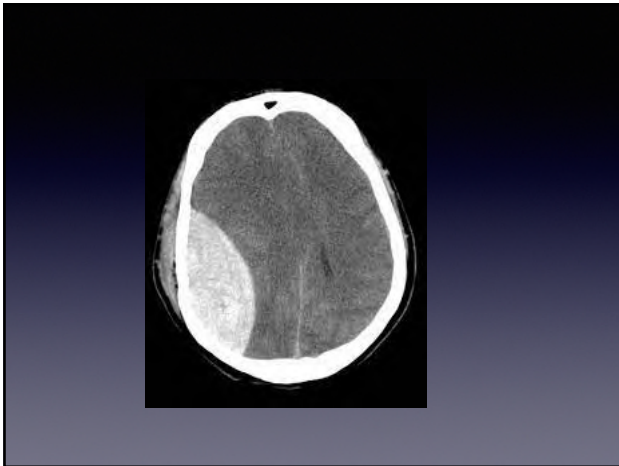
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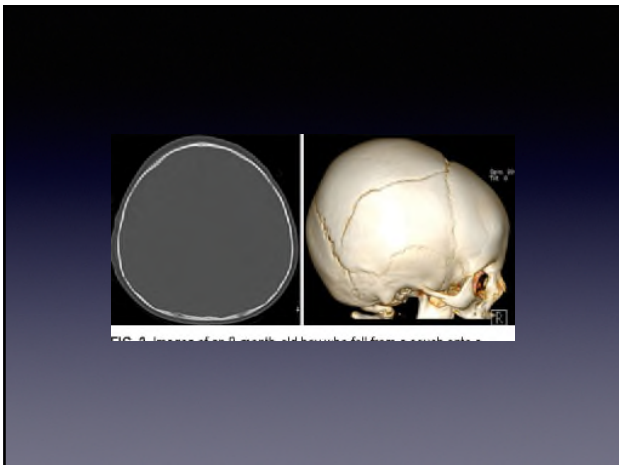
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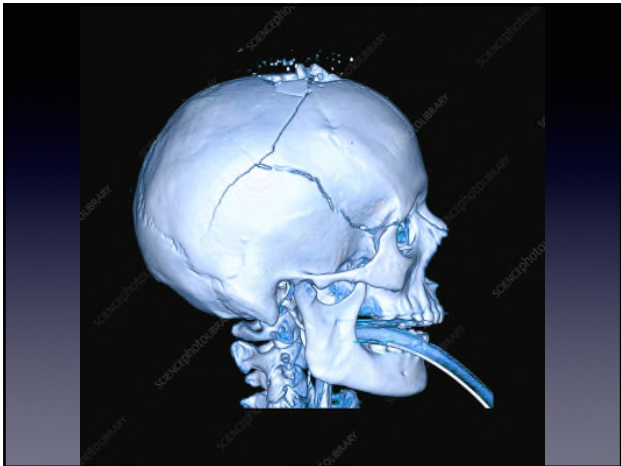
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## Radiation

- Estimated rate of lethal malignancies is between 1 in 1000 and 1 in 5000 pediatric cranial CTs
- Risk increases as age decreases
- Lower dose scanners are available but usually in Children's hospitals

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## Statistics

- Half of children seen in North American emergency departments for head injury receive CT scans
- Minor head trauma patients are the most frequently assessed
- Less than 10% of the patients have traumatic brain injury
- Even smaller number have clinically important injuries

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## PECARN

- Pediatric
- Emergency
- Care
- Applied
- Research
- Network

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## Study

- Prospective cohort study of patients less than 18 years presenting within 24 hours of head trauma
- 25 pediatric emergency departments
- Over almost 2 years
- Surpassed 2 years with validation period
- 42,412 patients enrolled and analyzed

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## Exclusion criteria

- Trivial injury mechanisms with only abrasion or laceration
- Penetrating trauma
- Known brain tumors
- Pre-existing neurological disorders
- VPS, bleeding d/o and GCS <13 separated

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## Outcomes

- Clinically important traumatic brain injury
- Death
- Neurosurgical procedure
- Intubation longer than 24 hours
- Admission 2 nights or more

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## Follow up

- Admitted patients had entire chart reviewed
- Discharged patients were contacted by telephone for 7-90 days following discharge

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## Analysis

- It was decided to group patients less than 2 years separately
- More sensitive to radiation
- Minimal ability to communicate
- Different mechanisms

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## Analysis

- Goal was to identify patients at very low risk for clinically important traumatic brain injury
- Aimed to maximize negative predictive value and sensitivity

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## Analysis

- Excluded GCS less than 14 as this would artificially increase rule performance
- Excluded asymptomatic patients with trivial mechanisms as to not overinflate negative predictive value

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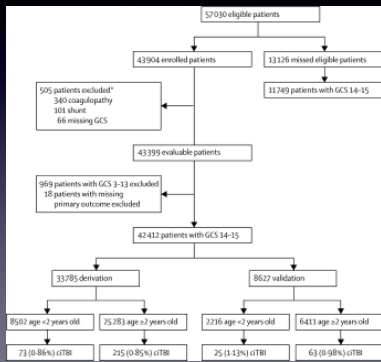
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# Results



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## Age less than 2

- GCS 14 or altered mental status
- Palpable skull fracture
- Occipital, parietal or temporal hematoma
- LOC 5 seconds or longer
- Severe mechanism
- Not acting normally per parent

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## Altered mental status

- Agitation
- Somnolence

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## Severe mechanism

- MVC with patient ejection, death of another passenger or rollover
- Pedestrian without helmet struck by motorized vehicle
- Bicyclist without helmet struck by motorized vehicle
- Falls more than 3 feet
- Head struck by high impact object

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## Age 2 or greater

- GCS 14 or altered mental status
- Signs of basilar skull fracture
- LOC
- Vomiting
- Severe mechanism
- Severe headache

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## Altered mental status

- Agitation
- Somnolence
- Repetitive questioning
- Slow response to verbal communication

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## Signs of basilar skull fracture

- Battle's sign
- Raccoon eyes
- Hemotympanum
- CSF otorrhea
- CSF rhinorrhea

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## Severe mechanism

- MVC with patient ejection, death of another passenger or rollover
- Pedestrian without helmet struck by motorized vehicle
- Bicyclist without helmet struck by motorized vehicle
- Falls more than 5 feet
- Head struck by high impact object

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- Two highest risk signs and symptoms are altered mental status or signs of skull fracture. What is the % risk of cITBI in these patients?
- A. <5
- B. 25
- C. 50
- D. >80

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- Two highest risk signs and symptoms are altered mental status or signs of skull fracture. What is the % risk of cITBI in these patients?

A. <5 (4.4 and 4.3%)

- B. 25
- C. 50
- D. >80

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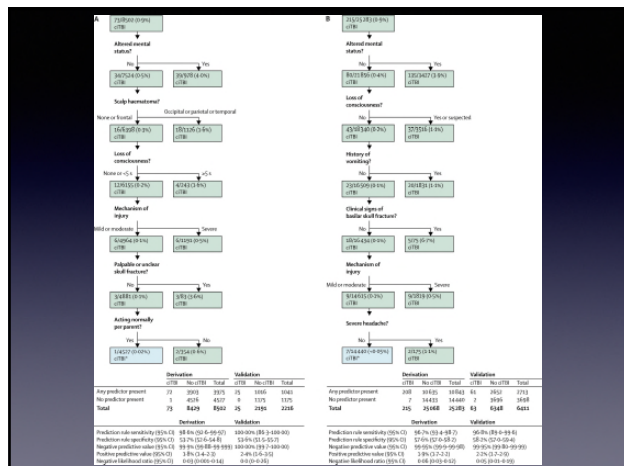
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## Results

- Patients with no risk factors have <0.05% risk of cITBI
- Even more importantly, patients with normal GCS and mental status with no signs of skull fracture with any of the other four risks factors, the risk of cITBI is less than 1%

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## Results

- <2 yrs 100% sensitivity and 100% NPV for ciTBI
- 2 yrs and older 96.8 % sensitivity and 99.95% NPV for ciTBI
- <2 yrs 100% sensitivity and 100% NPV for TBI
- 2 yrs and older 94% sensitivity and 98.4% NPV for TBI

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## Results

- During the validation, no patients were missed <2yrs with ciTBI
- Only 2 patients age 2 or greater were missed and neither needed neurosurgery

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## Results

- Non helmeted bicyclist with multisystem trauma including substantial pulmonary injuries with moderate headache and large frontal scalp hematoma
- Small frontal subdural

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# Results

- Non helmeted inline skater fell down ten steps with moderate headache and large frontal scalp hematoma
- Occipital lobe contusions and a linear fracture
- Admitted for 2 nights

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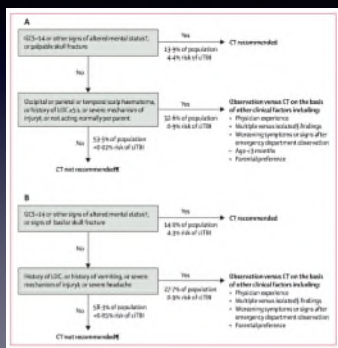
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# Decision making



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# Decision making <2

- GCS 14 or other signs of altered mental status
- Palpable skull fracture
- CT recommended

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## Decision making 2 and up

- GCS 14 or other signs altered mental status
- Signs of basilar skull fracture
- CT recommended

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## Decision making

- If patient meets none of the 6 risk criteria
- No CT recommended

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## Age less than 2

- GCS 14 or altered mental status
- Palpable skull fracture
- Occipital, parietal or temporal hematoma
- LOC 5 seconds or longer
- Severe mechanism
- Not acting normally per parent

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## Age 2 or greater

- GCS 14 or altered mental status
- Signs of basilar skull fracture
- LOC
- Vomiting
- Severe mechanism
- Severe headache

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## Decision making

- Any patient not falling in either group is low risk but not very low risk
- Observation vs CT
- No guidelines given for observation but generally 6 hours in ER vs some combination of ER and home

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## Observation

- Physician experience
- Multiple versus isolated findings
- Worsening symptoms or signs after observation period
- Age <3 months
- Parental preference

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## Case 1

- 22 mo female fell from bed on tile
- Brief LOC of 2-3 seconds
- One episode of vomiting
- Acting normally
- Neuro exam unremarkable
- 3 cm swelling to right forehead with no appreciated step off

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## Case 2

- 15 yo male slipped on ice and hit back of head
- No LOC
- No vomiting
- No swelling or step off
- A&O x4 but requires repeated questioning
- Neuro exam otherwise unremarkable

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## Case 2

- 15 yo male slipped on ice and hit back of head
- No LOC
- No vomiting
- No swelling or step off
- A&O x4 but *requires repeated questioning*
- Neuro exam otherwise unremarkable

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## Case 3

- 4 mo male fell 2 feet from carrier
- No LOC
- One episode emesis
- Abrasion to vertex with no swelling or step off
- GCS 15
- Unremarkable neuro exam

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## Case 4

- 12 yo female fell 4.5 feet from counter
- Brief LOC 2-3 seconds
- No vomiting
- Mild occipital swelling
- Normal neuro exam

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## Case 4

- 12 yo female fell 4.5 feet from counter
- **Brief LOC 2-3 seconds**
- No vomiting
- Mild occipital swelling
- Normal neuro exam

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## Case 5

- 11 mo male fell 4 feet from mom's shoulders
- No LOC or vomiting
- 2 cm frontal hematoma without step off
- Normal neuro exam

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## Case 5

- 11 mo male **fell 4 feet** from mom's shoulders
- No LOC or vomiting
- 2 cm frontal hematoma without step off
- Normal neuro exam

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## Case 6

- 8 yo female fell from trampoline
- No LOC or vomiting
- Mild tenderness and swelling to occiput
- Bright red blood from right ear but has tube in place. No obvious canal laceration but blood obscures exam
- Normal neuro exam

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## Case 6

- 8 yo female fell from trampoline
- No LOC or vomiting
- Mild tenderness and swelling to occiput
- **Bright red blood from right ear** but has tube in place. No obvious canal laceration but blood obscures exam
- Normal neuro exam

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## Case 7

- 16 yo female in MVC 50 mph
- Unrestrained in back seat but no ejection
- No LOC or vomiting
- Right parieto-occipital swelling with no step off
- GCS 15
- Unremarkable neuro exam

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## Case 8

- 14 yo male helmet to helmet hit
- No LOC or vomiting
- No swelling or tenderness
- GCS 14-confused
- Remainder of neuro exam unremarkable

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## Case 8

- 14 yo male helmet to helmet hit
- No LOC or vomiting
- No swelling or tenderness
- *GCS 14-confused*
- Remainder of neuro exam unremarkable

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## Case 9

- 20 mo male fell 1 foot from swing
- No LOC or vomiting
- Moderate swelling to occiput with possible step off
- Neuro exam unremarkable

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## Case 9

- 20 mo male fell 1 foot from swing
- No LOC or vomiting
- *Moderate swelling to occiput with possible step off*
- Neuro exam unremarkable

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## Isolated vomiting

- PECARN went back to look at isolated vomiting and the risk of ciTBI
- Data from the original study was used
- Vomiting is not included as a decision factor for less than age 2

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## Results

- 0/567 patients aged <2 had ciTBI with isolated vomiting
- 10/1,501 (0.7%) aged 2-18 had ciTBI with isolated vomiting
- 5 of those 10 patients required neurosurgery

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