

1



2



3

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

4

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

5

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

6

Case 4

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

7

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

8

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

9

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

10

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

11

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

12

Traumatic Brain Injury

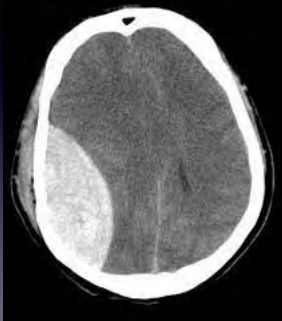
- Leading cause of death and disability worldwide
- 600,000 emergency department visits
- 60,000 hospital admissions
- 7400 deaths

13

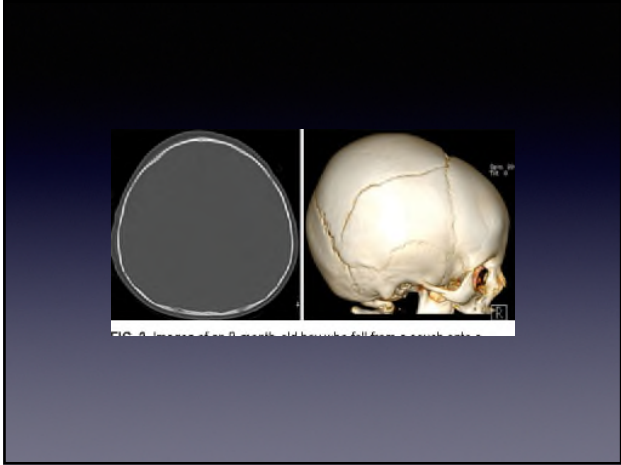
Evaluation

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

14



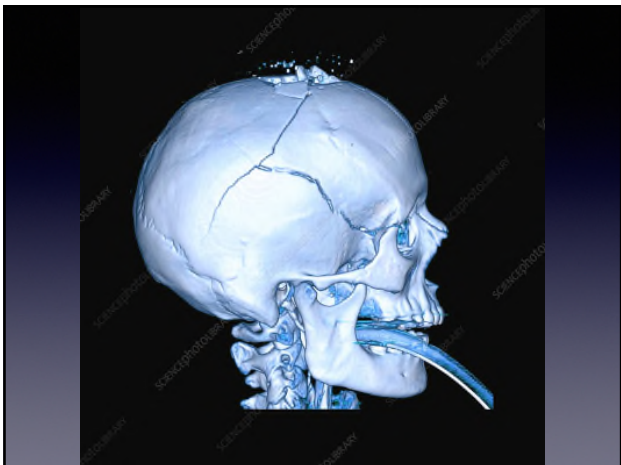
15



16



17



18

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

19

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

20

PECARN

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

21

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

22

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

23

Outcomes

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

24

Follow up

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

25

Analysis

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

26

Analysis

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

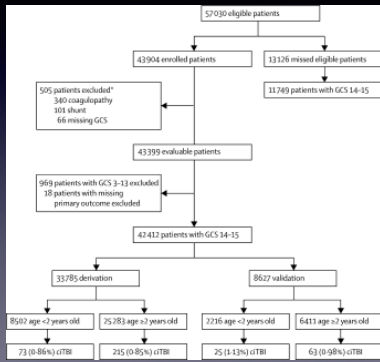
27

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

28

Results



29

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

30

Altered mental status

- Agitation
- Somnolence

31

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

32

Age 2 or greater

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

33

Altered mental status

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

34

Signs of basilar skull fracture

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

35



36



37



38

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

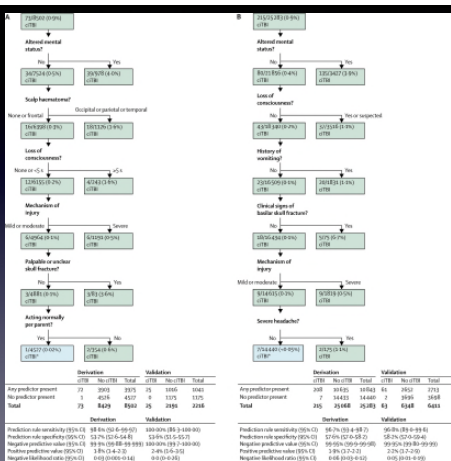
39

- 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

40

- 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

41



42

Results

- Patients with no risk factors have <math><0.05\%</math> 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%

43

Results

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

44

Results

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

45

Results

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

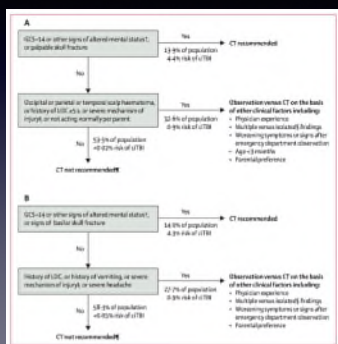
46

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

47

Decision making



48

Decision making <2

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

49

Decision making 2 and up

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

50

Decision making

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

51

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

52

Age 2 or greater

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

53

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

54

Observation

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

55

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

56

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

57

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

58

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

59

Case 4

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

60

Case 4

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

61

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

62

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

63

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

64

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

65

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

66

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

67

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

68

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

69

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

70

Isolated vomiting

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

71

Results

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

72
