Program Handouts
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Pediatric Puzzlers in the Emergency Department

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Disclosure Statement
• I do not have any conflict of interest or will be discussing any off-label product use.
• This class has no commercial support or sponsorship, nor is it co-sponsored.

Objectives
• Discuss presentation, etiologies and work-up for neonatal/young infant febrile illness
• Identify pediatric patients at risk for serious brain injury
• Understand when to utilize CT for pediatric head injury
First case!

Case #1: 5 day old male w/difficulty feeding

- Went to a local ED
  - "we don't do babies"
  - Took infant's temp (axillary), found to be afebrile
  - Sent to Seattle Children's

ED triage vitals:
- Temp: 38.4°C (101.1°F)
- HR: 164
- RR: 44
- BP: 83/60
- Infant described as:
  - "irritable, grunting infant"
Case #1: History of Present Illness (HPI)

- Term infant
- Had been doing well until night prior to ED visit
- "Laid back" baby, now cranky and fussy
- Not breast feeding well
- Mom notes "overflow" milk in his mouth but no real vomiting noted.

Case #1: 5 day old male w/difficulty feeding

- No fever noted at home
- No one sick in the home
- No congestion/rhinorrhea
- No eye drainage
- No diarrhea
- No cough
- Decreased urine output since last night

Case #1: 5 day old male w/difficulty feeding

- Prenatal/birth history:
  - Mom negative for beta-strep
  - Pediatric Pearl: If mom was positive—did she receive antibiotics prior to delivery??
  - No prenatal difficulties
  - VBAC birth
  - No post-natal issues
  - Home with mom
**Slide 10**

**Differential Diagnosis?**

- What do you think???

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**Slide 11**

**Differential Diagnosis: What I thought**

- Serious bacterial illness
  - Bacteremia
  - UTI
  - Menigitis
- Viral illness
- Congenital heart disease
  - But fever makes this less likely

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**Slide 12**

**Case #1: 5 day old male w/difficulty feeding**

- Provider exam:
  - Infant with good tone but quiet infant
  - Tachypneic without increased WOB
  - Umbilical without erythema, healing well
  - Lungs CTA
  - No murmur, peripheral pulses equal

- Which equates to "fever without a source"
Case #1: What we did:

- Septic Work-up
  - Blood culture, CBC
  - LP
  - Cath Urine
- Started antibiotics
  - Pediatric Pearl: Generally use Ampicillin and Cefotaxime at SCH, point being to use two broad spectrum drugs to encompass the most common bacteria seen in this age group
  - Admitted to the hospital for observation and ongoing IV antibiotics

Case #1: ED course

- Vital sign trend:
  - Triage: 36.4 – 36.6 – 36.4 – 36.3
  - Entally into ED room: RR 60-70
  - 90° later: 38.1 – 36.4 – 40 to 150
  - 40° later: 37.5 (36.4 – 36.8 – 39.9)
  - (patient asleep with above vitals)
  - 60° later: 191-91 (crying) 97/58
  - SpO2: 100% in room air
  - On transfer BP: 93/67

Case #1: Lab results

- CBC
  - Hct 53.4 (42-66)
  - WBC 4.6 (5-21)
  - 49% polys (15-50%)
  - 8% lymphs (15-70%)
  - 21% monos (0-10%)
  - 22% bands (0-9%)
  - Platelets 173K (200-400)

- (absolute count of 1012)
Lab results, continued:

- Serum Glucose: 88
- CSF:
  - RBC 27, nucleated cells 5 (0-30)
  - Glucose 43, protein 55 (0-120)
- UA: unremarkable

Case #1: Lab results

- VBG: 7.39—44—49—+1, bicarb 27
  - ??? Why did I obtain this???
- Sent Viral FA
  - ??? How come???

Case #1: ED treatment

- Two normal saline bolus's
  - Total 40 ml/kg
- Gave Ampicillin/Cefotaxime
- I hovered…
Case #1: End Result

- Blood culture grew E. coli within 12 hours
- Infant received 14 days of IV Cefotaxime
- Infant was stable during hospital course
- CSF, UA negative
- Viral FA negative

Neonate or young infant with fever

- What is fever?
  - 38°C or 100.4°F
  - Taken rectally
  - "Felt hot" is not a fever

Okay, fever in a baby...

- Taken very seriously
- Neonates cannot localize a source of infection well
- Neonates have immature immune system
- Serious bacterial infection (SBI) can have devastating consequences
  - Meningitis
  - Sepsis with multi-system organ failure
**Neonatal SBI:**

- Tend to be perinatally acquired if in the first week of life
  - Think: Beta-strep, E-Coli
- Tend to be community or hospital acquired if after the first week of life
  - Think H-Flu, Streptococcus Pneumoniae
- Don’t forget about late-onset beta strep SBI in neonate!

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**Serious Bacterial Infection**

- Overall incidence of SBI in infants under 3 months is 6-10%
- Infants with a confirmed viral infection such as RSV are at a lower risk of SBI
  - However, fairly good incidence of UTI in that subset of patients
- At SCH, most young infants with fever and viral URI have a cath urine obtained

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**Meningitis: Isn’t what it appears to be**

- Nuchal rigidity is present in only 27% of infants under 6 months who have meningitis
- Bulging fontanel is a late sign
- Which is why lumbar punctures are indicated in all febrile infants < 28 days, and many infants < 60-90 days presenting with fever without a source
  - Pediatric Pearl: Especially those who aren’t immunized
Presentation matters

- Decreased oral intake and acute change in sleep patterns in young infants and neonates can indicate serious illness

- Other symptoms of interest:
  - Irritability
  - Inconsolability
  - Poor perfusion
  - Poor tone
  - Decreased activity
  - Lethargy

"Really, she was lethargic at home!"

Neonatal fever work-up:

- Blood culture, CBC
- Urine analysis AND culture from catheter specimen
  - Bagged urines are not acceptable!
  - Don’t go just by the UA for indications of infection
- Lumbar puncture
  - In addition to usual studies...
  - Send CSF for enteroviral PCR in summer months
  - Think of sending CSF for HSV/Var if infant appears unwell, has had a seizure, or has lesions
Fever protocols: 28 to 90 days of age

- Rochester Criteria: Low risk
  - WBC 5000 - 15,000; with absolute band count < 1500
  - < 10 WBC's per hpf on urine microscopy
  - < 5 WBC's per hpf in stool (if diarrhea)

- Boston Criteria: Low risk
  - CSF with 0 WBC
  - < 10 WBC's per hpf on urine microscopy
  - Negative Gram stain
  - No infiltrate on CXR if obtained

- Philadelphia Criteria: Low risk
  - Well appearing
  - WBC < 15,000 with Band - Neutrophil ratio of < 0.2
  - < 10 WBC's per hpf on urine microscopy
  - No blood and few or no WBC's on smear
  - CSF with < 8 WBC and negative gram stain finding
  - No infiltrate on CXR if obtained

Low risk: what does that mean?
- If the infant meets the criteria of low risk with the various studies, the incidence of SBI is very low
- Most providers will obtain blood culture and urine culture (cath) on febrile infants 29 days of age to 2 or 3 months

The need for a Lumbar puncture in the 1 to 2 month age group is debated amongst many
- LP's can be obtained after antibiotics are given
  - The cell count can help to determine if meningitis is present
  - But it's preferred to obtain all studies prior to delivery of antibiotics
Neonatal/young infant with fever

- Should be prioritized in triage to "emergent" to be seen and assessed quickly
- Congenital heart disease can mimic sepsis with tachycardia, poor perfusion
- Septic work-up when indicated
- Treat aggressively when ill appearing
  - They aren’t kidding around when they look sick!

Questions??

Next on the docket: Closed Head Injury
Case #2: Closed Head Injury

- 7 yr old male
- Playing soccer at school and ran into a brick wall
- Injury occurred around 12:30
- No LOC, mom called to pick him up
- Nice hematoma on forehead

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Case #2: Closed Head Injury

- Child taken home, took a nap ~ 2 pm
- Woke up around 2:45 pm, "wasn’t himself"
- Seemed disoriented
- c/o headache and nausea
- Around 4:30, vomited "a lot"
- Taken to ED for eval, arrived at 5:23 pm

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Case #2: Closed Head Injury

- Triage vital signs:
  - Temp 37
  - HR 110
  - RR 20
  - BP 92/66
  - Sats 99%
  - Described as "alert, answers questions appropriately"
  - Coma scale = 15
Case #2: Closed Head Injury

- Provider eval:
  - Awake, alert, answering questions
  - Looks dazed, says he remembers incident
  - States HA was occipital
  - Currently denies headache or nausea
    - Pediatric pearl: Afraid of a "yes" answer???
  - No visual issues identified
  - Neuro exam normal
  - Child wants a cheeseburger!

Case #2: Closed Head Injury

- To CT or not to CT???

Case #3: Closed Head Injury

- 16 yr old male
- Playing soccer
  - Around 3:30 pm, during a "free kick", pt tried to "head" the ball, goalie did too, they collided. If goalie’s elbow hit his head or head to head contact
Case #3: Closed Head Injury

- Unconscious for 15-20 seconds
- Able to walk off the field
- Then started to run back into the field like going back to play
- Family and friends convinced him otherwise (and escorted him off the field)
- Brought to ED for eval

Triage vital signs @ 1620:
- 36.9
- HR 92
- RR 12
- BP: 127/86
- Sat 95%

Described as: “orient x 3, no memory of today prior to CHI and yesterday, c/o pain on top of head, no neck or back pain”
- Coma scale: 15

Provider exam:
- Alert, no acute distress
- No blood in nares (there was question of a possible nasal injury)
- Talkative, sitting in bed
Case #3: Closed Head Injury

- To CT or not to CT???

Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study

- Pediatric Emergency Care Applied Research Network (PECARN)
- Published 9/15/2009

The data

- Enrolled 42,412 children (< 18 yrs)
- Glasgow coma scales 14-15
- Obtaining a CT was at Provider discretion
- Study divided into two parts:
  - Derivation: Coming up with "rules"
  - Validation: Seeing if the rules would have applied if utilized
**Why study this?**

- About 50% of children assessed in ED's undergo head CT
- Between 1995 and 2005, CT use more than doubled
- Risk of lethal malignancies from radiation
  - Estimated to be 1 in 1000 to 1 in 5000 patients undergoing head CT may develop a lethal malignancy
  - Younger the child, the higher the risk

**Inclusion criteria**

- Under 18 years of age
- Glasgow coma scale 14-15
- Presenting within 24 hrs of injury
- Essentially these were patients with MINOR head trauma

**Glasgow Coma Scale:** range of 3 to 15

<table>
<thead>
<tr>
<th>Points</th>
<th>Eye opening</th>
<th>Best verbal response</th>
<th>Best motor response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No response</td>
<td>No response</td>
<td>No response</td>
</tr>
<tr>
<td>2</td>
<td>Opens in response to pain</td>
<td>Incomprehensible incoherent words</td>
<td>Extension</td>
</tr>
<tr>
<td>3</td>
<td>Opens in response to speech</td>
<td>Inappropriate words</td>
<td>Flexion withdrawal</td>
</tr>
<tr>
<td>4</td>
<td>Agitated</td>
<td>Agitated and coherent</td>
<td>Flexion localized</td>
</tr>
<tr>
<td>5</td>
<td>Agitated and coherent</td>
<td>Agitated and coherent</td>
<td>Flexion localized</td>
</tr>
<tr>
<td>6</td>
<td>Obeys</td>
<td>Obeys</td>
<td>Obeys</td>
</tr>
</tbody>
</table>
Modified Glasgow Coma Scale for infants: Range of 3-15

<table>
<thead>
<tr>
<th>Score</th>
<th>Eye Opening</th>
<th>Best Verbal Response</th>
<th>Best Motor Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No response</td>
<td>No response</td>
<td>No response</td>
</tr>
<tr>
<td>2</td>
<td>Opens in response to pain</td>
<td>Moans in response to pain</td>
<td>Abnormal extension in response to pain</td>
</tr>
<tr>
<td>3</td>
<td>Opens in response to speech</td>
<td>Cries in response to pain</td>
<td>Abnormal flexion in response to pain</td>
</tr>
<tr>
<td>4</td>
<td>Spontaneous</td>
<td>Irritable cries</td>
<td>Withdraws in response to pain</td>
</tr>
<tr>
<td>5</td>
<td>Coos, babbles</td>
<td>Withdraws to touch</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Moves spontaneously and purposefully</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Exclusion criteria for study:
- Trivial injury (ground level falls, no sign/symptom of CHI other than scalp abrasions/lassos)
- Penetrating trauma
- Known brain tumors, pre-existing neurologic conditions, neuro-imaging at outside hospital prior to transfer
- Separate study: GCS < 14, pt's with VP shunts and those with bleeding disorders

Definition of “clinically important TBI”:
- Death from TBI
- Need for neurosurgery
- Intubation for > 24 hrs
- Hospital admission of 2 nights or more associated with TBI on CT scan
Demographics
• Divided into two groups:
  • Pre-verbal: ≤ 2 yrs
    • Greater sensitivity to radiation
    • Minimal ability to communicate
  • Verbal: > 2 yrs
    • Different mechanisms of injury

Results
• Mean age 7.1 yrs
  • 25% were younger than 2 yrs
  • 90% had isolated head trauma
  • 97% had GCS of 15

Injury mechanisms:
• 27%: Fall from height
  • 17%: Fall from ground level or ran into stationary object
  • 9%: MVA
  • 7%: head struck by object
  • 7%: Sports related
  • 7%: Assault
  • 7%: Fall down stairs
Injury mechanisms, cont:

- 4% Bicycle collisions or fall
- 3% Car vs ped
- 2% Other wheeled transport crash
- 1% Car vs bicycle

The data

- CT’s obtained in 35.3% (14,969)
- 5.2% (780) had evidence of traumatic brain injuries on CT scan
- Clinically important traumatic brain injuries (TBI) occurred in 376 (0.9%)
- Of the patients with clinically important TBI, 60 (0.1%) underwent neurosurgery

Predictors to look at: < 2 yrs

- Altered mental status
- Presence of scalp hematoma
- Loss of consciousness
- Mechanism of injury
- Palpable or unclear skull fracture
- Acting normally per parents

- NO predictors present = very unlikely to have clinically important TBI = no CT needed (25% of study population)
Predictor rules in patients < 2 yrs WITH clinically important TBI (ciTBI)

- Altered mental status
  - NO: 0.5%
  - YES: 4%

- Presence of scalp hematoma
  - NO: 0.3%
  - YES: 1.6%

- Loss of consciousness
  - NO: 0.2%
  - YES: 1.6%

- Mechanism of injury
  - NO: 0.1%
  - YES: 0.5%

- Palpable or unclear skull fracture
  - NO: 0.1%
  - YES: 3.6%

- Acting normally per parents
  - NO: 0.6%
  - YES: 0.02%

Predictors to look at: > 2 yrs

- Altered mental status
- Loss of consciousness
- History of vomiting
- Mechanism of injury
- Clinical signs of basilar skull fracture
- Severe headache

NO predictors present = very unlikely to have clinically important TBI = no CT needed (20% of study population)

Predictor rules in patients > 2 yrs WITH clinically important TBI (ciTBI)

- Altered mental status
  - NO: 0.4%
  - YES: 3.9%

- Loss of consciousness
  - NO: 0.2%
  - YES: 1.1%

- History of vomiting
  - NO: 0.1%
  - YES: 1.1%

- Mechanism of injury
  - NO: 0.1%
  - YES: 0.6%

- Clinical signs of basilar skull fracture
  - NO: 0.2%
  - YES: 7.5%

- Severe headache
  - <0.05%
  - YES: 1.1%
**Slide 61**

CT recommendations, age < 2 yrs

- **Yes:** CT recommended
- **No:** Consider other imaging modalities

**CT recommendations, age > 2 yrs**

- **Yes:** CT recommended
- **No:** Consider other imaging modalities

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**Slide 62**

Observation vs CT, age < 2 yrs:

- Physician experience
- Multiple vs isolated findings
- Worsening signs/symptoms after ED observation
- < 3 months of age
- Parental preference

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**Slide 63**

CT recommendations, age > 2 yrs:

- **Yes:** CT recommended
- **No:** Consider other imaging modalities

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Observation vs CT, age > 2 yrs

- Physician experience
- Multiple vs isolated findings
- Worsening symptoms or signs after ED observation
- Parental preference

CT or not to CT

- "The small risk of clinically important TBI after minor head trauma should be balanced against the risks of ionizing radiation of CT."
- [www.imagegently.org](http://www.imagegently.org)
- Website with information about radiation risk with imaging tests
- For parents as well as health care providers

Predictor rules for 7 yr old: Head vs wall

- Altered mental status: YES (initially, none now)
- Loss of consciousness: NO
- History of vomiting: YES
- Mechanism of injury: +/- (could be argued)
- Clinical signs of basilar skull fracture: NO
- Severe headache: NO
CT recommendations, age > 2 yrs: 7 year old in ED

- CT obtained: Normal
- History of LOC: No
- Worsening of injury: No
- Severe headache: No
- Mechanism of injury: +/-
- Clinical signs of basilar skull fracture: No
- History of vomiting: Yes
- Altered mental status: Yes (initially)
- Loss of consciousness: Yes
- Initial LOC: Altered
- Initial exam: Poorly responsive
- Initial CT: No

Patient: 7 year old in ED
Initial CT: No
Be exam: Poorly responsive
Initial CT: No

CT obtained: Normal
History of LOC: No
Worsening of injury: No
Severe headache: No
Mechanism of injury: +/-
Clinical signs of basilar skull fracture: No
History of vomiting: Yes
Altered mental status: Yes (initially)
Loss of consciousness: Yes
Initial LOC: Altered
Initial exam: Poorly responsive
Initial CT: No

May 6, 2010
Karen Kilian, MN, ARNP, CCRN
Pediatric Nursing Grand Rounds

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Predictor rules for 16 yr old: Head vs Head

- Altered mental status: Yes (initially)
- Loss of consciousness: Yes
- History of vomiting: No
- Mechanism of injury: +/-
- Clinical signs of basilar skull fracture: No
- Severe headache: No
- CT obtained: Normal

CT recommendations, age > 2 yrs: 16 yr old in ED

- CT obtained: Normal
- History of LOC: No
- Worsening of injury: No
- Severe headache: No
- Mechanism of injury: +/-
- Clinical signs of basilar skull fracture: No
- History of vomiting: Yes
- Altered mental status: Yes (initially)
- Loss of consciousness: Yes
- Initial LOC: Altered
- Initial exam: Poorly responsive
- Initial CT: No

Patient: 16 year old in ED
Initial CT: No
Be exam: Poorly responsive
Initial CT: No

CT obtained: Normal
History of LOC: No
Worsening of injury: No
Severe headache: No
Mechanism of injury: +/-
Clinical signs of basilar skull fracture: No
History of vomiting: Yes
Altered mental status: Yes (initially)
Loss of consciousness: Yes
Initial LOC: Altered
Initial exam: Poorly responsive
Initial CT: No
To CT or not to CT:

- 7 yr old did not get CT
- 16 yr old did get CT
- Neither had serious brain injury

House Bill 1824: Zackery Lystedt Law

- Bill passed in 2009 legislature
- No child who has sustained a concussion or symptoms of a head injury in a practice or game is allowed to play until cleared by a licensed health care provider
- Written documentation is required by the health care provider

House Bill 1824: Zackery Lystedt Law

- Law was passed in honor of Zackery who sustained a 2nd impact concussion and is now neurologically impaired for life
- It's not the first concussion or head injury that may give you problems, but the second...
Conclusions

• Always treat a neonate with fever with urgency
• Evaluate young infants carefully with high index of suspicion for serious bacterial illness
• Utilize the CHI protocol to help determine who should get a head CT
• Always trust your gut 😊

References

  • Fever in the Infant and Toddler
  • Excellent review of fever protocols, antibiotics
• House Bill 1824 - Zachery Lystedt Law
• Review of patient charts