Apparent Life Threatening Events and Abusive Head Trauma

CARE Team Presentation
February 16, 2015
Elizabeth Wisner, MD HO-III
Objectives

• Review the definition of ALTE
• Discuss AHT as a potential cause of ALTE
• Recognize factors which may aid in correct dx for AHT
• Understand which imaging modalities to use when suspecting AHT
• Know that SDH can be a normal finding in newborns
• Maintain a high index of suspicion for AHT
ALTE

- Definition:
  - “An episode that is frightening to the observer and that is characterized by some combination of apnea, color change, marked change in muscle tone, choking, or gagging”
- 0.6%-0.8% of all ER visits for children <1 yr
- No cause found in ½
- 3 most common comorbid conditions:
  - GER, Seizure, LRTI
- AHT 1-3% of all cases
History

• 19th century Dr. Ambroise Tardieu
  • Described physical and sexual injuries

• Dr. John Caffey
  • 1946 Chronic subdural hemorrhages and long bone fractures
  • 1972 “shaking injuries”

Tidbits

• External findings commonly absent
• “Shaken baby syndrome” replaced with AHT
Why is the diagnosis so tricky? Are we missing any?

• Social and legal consequences
• Abuse rarely witnessed
• Accurate history rarely offered
• No single test!
AHT History Taking

• Details regarding reported injury history
  • Witnesses, timing, mechanism
  • Environment
• Developmental history
• Medical history
• Family medical history
  • Childhood deaths, bleeding disorders, fx, etc.
• Social history
Evaluation:

• Suspected cases:
  • Retinal examinations
  • Skeletal surveys
  • CT head
  • Evaluation for bleeding disorders, predisposition to fractures, abdominal injury

• Especially consider imaging if:
  • Confusing, varying, or changing history
  • Delay in seeking medical care
  • Vomiting, irritability
  • Call to 911
  • Recurrent ALTEs in families w/ prior histories of apnea
  • Previous SIDS victims
AHT Differential Diagnosis

- Metabolic disorders
- AV malformations
- Coagulopathies
- Neoplasms
- Infections
- AI disorders
- Common misdiagnoses:
  - ALTE, AGE, AOM, Seizure disorder
  - Beware of provider bias
MANDATORY REPORTING

THAT MEANS YOU!
Analysis of Missed Cases of Abusive Head Trauma

Jenny C, Hymel K, Ritzen A, Reinert S, Hay T.

- Children’s Hospital in Denver, CO
- 1990-1995
- Children < 3 yrs
- AHT = inflicted cranial injury

**Missed cases:**

1. Pt previously evaluated ≥1 times for nonspecific clinical signs (vomiting, irritability, facial and/or scalp injury, AMS, seizures)
2. With the above signs, medical evaluation did not result in dx of AHT
3. Thereafter, one or more of the following occurred:
   - Child improved → later experienced repeat acute trauma (and imaging revealed old cranial injuries and other new injuries)
   - Child remained symptomatic or had worsening signs until trauma was recognized (verified by imaging)
   - Person admitted abusing the child shortly before onset of clinical signs
Analysis of Missed Cases of Abusive Head Trauma: Results

Jenny C, Hymel K, Ritzen A, Reinert S, Hay T.

- 173 children evaluated by CAP team for AHT
  - Mean age 247 days, 55% male, 45% female
  - 54 cases (31.2%) missed
    - Mean # of prior visits = 2.8 (2-9)
    - Mean length of time to dx = 7 days (0-189)

- Missed vs. Recognized Cases
  - Younger Age
    - Missed (180 days) vs Recognized (278 days)
  - Race
    - 37.4% whites missed vs 19% minority missed
  - Family Composition
    - 40.2% missed in intact families vs. 18.7 %
  - Severity of Symptoms at Initial Visit
## Analysis of Missed Cases of Abusive Head Trauma: Results

Jenny C, Hymel K, Ritzen A, Reinert S, Hay T.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>No. (%) Recognized</th>
<th>No. (%) Missed</th>
<th>$\chi^2$ Test</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial and/or scalp injuries</td>
<td>78/119 (65.5)</td>
<td>20/54 (37.0)</td>
<td>12.293</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Other bodily trauma (not head or face trauma)</td>
<td>53/118 (44.9)</td>
<td>10/54 (18.9)</td>
<td>10.664</td>
<td>.001</td>
</tr>
<tr>
<td>Mental status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awake and alert</td>
<td>35/119 (29.4)</td>
<td>35/54 (64.8)</td>
<td>31.397</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sleepy and/or lethargic</td>
<td>31/119 (26.1)</td>
<td>17/54 (31.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comatose and responsive to pain</td>
<td>21/119 (17.6)</td>
<td>1/54 (1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comatose and unresponsive to pain</td>
<td>32/119 (26.9)</td>
<td>1/54 (1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental status by group</td>
<td></td>
<td></td>
<td>19.326</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Awake and alert</td>
<td>35/119 (29.4)</td>
<td>35/54 (64.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depressed or comatose</td>
<td>84/119 (70.6)</td>
<td>19/54 (35.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory status</td>
<td></td>
<td></td>
<td>33.778</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Normal breathing</td>
<td>45/119 (37.8)</td>
<td>44/54 (81.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compromised</td>
<td>20/119 (16.8)</td>
<td>8/54 (14.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring resuscitation or ventilation</td>
<td>54/119 (45.4)</td>
<td>2/54 (3.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory status by group</td>
<td></td>
<td></td>
<td>28.354</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Normal</td>
<td>45/119 (37.8)</td>
<td>44/54 (81.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal (compromised or requiring resuscitation or ventilation)</td>
<td>74/119 (62.2)</td>
<td>10/54 (18.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seizures at first visit</td>
<td>55/119 (46.2)</td>
<td>8/54 (14.8)</td>
<td>15.820</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vomiting at first visit</td>
<td>42/111 (37.8)</td>
<td>30/54 (55.6)</td>
<td>4.637</td>
<td>.03</td>
</tr>
<tr>
<td>Irritable at first visit</td>
<td>53/111 (47.7)</td>
<td>34/52 (65.4)</td>
<td>4.426</td>
<td>.04</td>
</tr>
</tbody>
</table>
Analysis of Missed Cases of Abusive Head Trauma: Results
Jenny C, Hymel K, Ritzen A, Reinert S, Hay T.

- 9 Variables Significantly associated with missing dx of AHT
  1. Age younger than 6 months
  2. Minority race
  3. Parents not living together ★
  4. Facial or scalp injury ★
  5. Seizures ★
  6. Decreased mental status
  7. Abnormal respiratory status ★
  8. Vomiting
  9. Irritability

- ★ = 4 independent variables predicting correct diagnosis of AHT at the 1st visit
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• Outcome and Consequences of missed cases of AHT
  • 5 (9.3%) died
    • 4/5 might have been prevented by earlier recognition
  • 15 (27.8%) were reinjured because of delay in diagnosis
  • 20 (40.7%) suffered medical complications due to delay in dx
    • Seizure disorders
    • Chronic vomiting
    • Increasing head size (untreated SDH)

• 7 of missed AHT cases had radiologic errors
  • 8 studies missed: CT scans, skeletal survey, long-bone radiograph of arm
## Analysis of Missed Cases of Abusive Head Trauma: Results

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### Table 4. Clinical Presentations of 4 Potentially Preventable Deaths With Missed AHT*

<table>
<thead>
<tr>
<th>Patient Age, mo</th>
<th>Time Between Visits</th>
<th>Documented Clinical Signs</th>
<th>Evaluation Results</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>First visit</td>
<td>Vomiting, sleepy, normal respirations, facial bruising</td>
<td>None</td>
<td>Influenza</td>
</tr>
<tr>
<td>7</td>
<td>7 Days after first visit</td>
<td>Vomiting, alert and responsive, normal respiration, new bruising</td>
<td>None</td>
<td>Otitis media</td>
</tr>
<tr>
<td>11</td>
<td>11 Days after first visit</td>
<td>Vomiting, coma, unresponsive to pain, respiratory arrest</td>
<td>Retinal hemorrhages, subdural hemorrhage, focal brain injury, diffuse brain injury, noncranial trauma</td>
<td>AHT</td>
</tr>
<tr>
<td>2</td>
<td>First visit</td>
<td>Failure to thrive, vomiting, alert and responsive, normal respiration, bruising to face and chest</td>
<td>Normal computed tomography result with missed subdural hemorrhage and brain shearing tears</td>
<td>Apnea</td>
</tr>
<tr>
<td>7</td>
<td>141 Days after first visit</td>
<td>Seizures, coma, unresponsive to pain, respiratory arrest</td>
<td>Retinal hemorrhages, skull fracture, subdural hemorrhage, diffuse brain injury, noncranial trauma, old cranial trauma</td>
<td>AHT</td>
</tr>
<tr>
<td>5</td>
<td>First visit</td>
<td>Vomiting, irritability, sleepiness, normal respiration, “went limp”</td>
<td>None</td>
<td>Anxiety secondary to new day care</td>
</tr>
<tr>
<td>6</td>
<td>6 Days after first visit</td>
<td>Vomiting, diarrhea, irritability, alert and responsive, normal respiration</td>
<td>None</td>
<td>Acute gastroenteritis</td>
</tr>
<tr>
<td>9</td>
<td>9 Days after first visit</td>
<td>Vomiting, irritability, coma, unresponsive to pain, seizures, cardiorespiratory arrest</td>
<td>Retinal hemorrhages, subdural hemorrhages, diffuse brain injury</td>
<td>AHT</td>
</tr>
<tr>
<td>3</td>
<td>First visit</td>
<td>Vomiting, irritability, alert and responsive, normal respiration, dehydration</td>
<td>None</td>
<td>Acute gastroenteritis</td>
</tr>
<tr>
<td>8</td>
<td>8 Days after first visit</td>
<td>Coma, unresponsive to pain</td>
<td>Retinal hemorrhage, subdural hemorrhage, diffuse brain injury, old brain injury, old cranial trauma</td>
<td>AHT</td>
</tr>
</tbody>
</table>

*In all cases of missed abusive head trauma (AHT), the estimated age of cranial injuries documented by imaging studies was consistent with the time of onset of the child’s nonspecific clinical sign(s) before his/her first physician visit.
Analysis of Missed Cases of Abusive Head Trauma: Conclusions

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• Be alert for bruises and abrasions
  • 20/54 cases of missed AHT bruising attributed to accidental injury unrelated to presenting symptoms
• Consider head trauma in DDx for nonspecific symptoms: vomiting, fever, irritability
  • Palpate fontanelles, head-to-toe PE, measure HC
• CSF: examine for xanthochromia
  • Xanthochromic CSF can represent old blood
• Pediatric radiologists should interpret films
Abusive Head Injury as a Cause of Apparent Life-Threatening Events in Infancy
Altman R et al. [2003]

- Westchester Medical Center
- 243 infants <12 months admitted for ALTE
- 32 month prospective study (1996-1999)
- Criteria included:
  - Breathing irregularity
  - Color change indicative of decreased oxygenation
  - Altered tone or mental status
- 35 different discharge diagnoses
  - 6 (2.5%) with AHT
    - Evidence of intracranial hemorrhage and retinal hemorrhages, unexplained fractures, abrasions, ecchymoses
- 39 discharged without diagnoses
Abusive Head Trauma in Children Presenting with an Apparent Life-Threatening Event

Elisabeth Guenther, MD, MPH, Annie Powers, MD, PhD, Rajendu Srivastava, MD, FRCP, MPH, and Joshua L. Bonkowsky, MD, PhD [2010]

- Infants <12 mo presenting with ALTE between 1999-2003
  - 627 patients with ALTE met inclusion criteria
  - Mean age 2.8 months, 47% male
  - 9 (1.4%) dx with AHT
    - 5 w/abnormal PE: bruising, bilateral retinal hemorrhages, bulging AF
    - 4 w/ normal PE: 2 had SDH and 1 w/ rib fx, 48h after d/c a 3rd with SDH, 4th child with false negative CT
  - Odds of AHT 27x greater if pertinent PE findings reported
  - Story discrepancy high marker (149x more likely)
  - No difference for age, sex, history of prematurity, ethnicity, seizures, reported rescue breaths
  - More children with AHT had documented 911 call, history of vomiting, irritability
Diagnostic Imaging

- Ultrasound
  - Differentiates subdural from subarachnoid
  - Subcortical white matter tears
  - Insensitive for small SDH
  - Need CT or MRI
- CT without contrast
  - High sensitivity and specificity for acute hemorrhage
  - Readily available and fast
  - Skull fx, soft tissue swelling, facial fx
- MRI
  - Best modality
  - Positive CT findings and in normal CT with strong suspicion
  - Highest sensitivity and specificity for subacute and chronic injury
Comparison of Accidental and Nonaccidental Traumatic Head Injury in Children on Noncontrast Computed Tomography
Tung G et al.

- Homogeneous hyperdense SDH $\rightarrow$ Accidental head trauma
- Mixed-density SDH more common in NAHI
  - Can be seen within 48h of accidental head trauma
FIGURE 2
Noncontrast head CT scan on 4-month-old child performed 1 day after AHT demonstrates right frontal and parietal convexity SDH (arrow) that is homogeneous and hyperdense in attenuation.

FIGURE 3
Noncontrast CT scan on 6-month-old child after NAHI shows bilateral homogeneous SDHs (arrow) that are lower in radiodensity compared with adjacent cerebral cortex but higher in density than CSF in subarachnoid space (curved arrow) and lateral ventricles.

FIGURE 4
Noncontrast CT scan performed on 13-month-old child who had sustained NAHI shows heterogeneous left frontal convexity and anterior interhemispheric (arrowhead) SDH. Left frontal convexity SDH contains both hyperdense (arrow) and hypodense (curved arrow) blood products.
Mortality in ALTE

- NIH estimates 0-6%
  - Meta-analysis 0.8%
- Parker and Pitetti: Children’s Hospital or Pittsburgh
  - Children <24 months following ALTE (563) followed 12 months over period of 9 years
  - 11 patients (2%): child abuse, most with PE abnormalities (54%)
    - 1/11 (9%) mortality rate of child abuse victims presenting w/ ALTE
  - 3 total deaths in ALTE (mortality rate 0.5%)
    - One from child abuse (asphyxia), 2 from SIDS
A Case: Lucy

- Lucy is 6-day-old full-term infant who presents to the local pediatric emergency department (PED) after her mother noticed Lucy staring off to the right, in association with pedaling type movements of her legs.
- Mrs Edwards (Lucy’s mom) has noted 2 such episodes today and each has lasted about 1 minute. Lucy seemed to be back to normal immediately after the events and continued to follow her usual routine of eating every 3 hours and sleeping in between feeds, prior to coming to the PED.
What questions do you have?

Lucy’s History

• **Birth History:**
  • 28 yo G1P1 mother w/ gestational diabetes
  • FT
  • + shoulder dystocia
  • Forceps-assisted
  • Apgar scores 9,9
  • Went home w/ Mom
  • Vitamin K + Hep B

• **Diet History:**
  • 3 oz q3; one scoop formula to 2 oz H2O

• **ROS:** No fever, rash, vomiting

• **Social:**
  • Lives with Mom, Dad, 22-mo brother
Lucy’s CT and Ophtho Exam

http://childabuse-headtrauma.pedialink.courses.aap.org/script/abusive-head-trauma-introduction?req=20150209223712243
Retinal Hemorrhages

• 2013 systematic review of newborn retinal hemorrhages
• 25.6% of spontaneous vaginal deliveries
• 35.5% instrumented deliveries
• Disappear by 2 weeks of age
• More numerous or severe persist to 6 weeks
Birth-Related Subdural Hematomas

- Common and asymptomatic
  - Up to 40% of infants
  - Predominantly posterior
    - Falx cerebri, posterior cerebrum, posterior fossa
  - Can be multiple
  - Majority resolve by 4 weeks, all by 3 months
- C-section or forceps
- Small rebleeds occur; no clinical change
  - Atrophied brains make for more room!
- CT not reliable for dating; mixed densities? Get MRI.
Subdural Hematoma
Epidural Hematoma
Glutaric aciduria type 1 (GA-1)

- Similar findings as in AHT
- AR metabolic disorder
  - Glutaryl-CoA dehydrogenase
- Neuronal loss
  - Encephalopathy within 1st 2 years
  - Increased HC
  - Cerebral atrophy → expansion of arachnoid and subdural spaces
- Retinal hemorrhages
- Evaluation
  - NBS
  - Urine quantitative organic acids
    - High levels of glutaric acid or 3-hydroxyglutaric acid
What does the AAP Policy want us to know?

- Be alert to signs, symptoms, head injury patterns associated with AHT
- Thorough and objective medical evaluation of infants and children with potential AHT
- Consult with subspecialists if necessary
- Use the term “abusive head trauma”
- Educate parents and caregivers
References


