

Abusive Head Trauma

WI CAN Educational Series
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Objectives

Following this presentation, the attendee will:

- **List common symptoms of abusively head injured children**
- **Be aware of common injuries in abusively head injured children**
- **Understand the basic biomechanics of injuries typically seen in abusively head injured children**
- **Understand the importance of recognizing sentinel injuries (more minor abusive injuries)**

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Outline

- Scope of the Problem
- Case study
- Biomechanics of AHT
- Symptoms and Injuries of AHT
- Outcomes and prevention

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Scope of the Problem

- Head trauma is the leading cause of disability and death among abused infants and children.
- Approximately 50% of brain injuries in children <1 year of age are inflicted

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Scope of the Problem

- In the United States, an *estimated* 2,000 infants become victims of SBS each year.
- Approximately 20 cases are seen each year at CHW
 - 27 - 2006
 - 17 - 2007
 - 30 - 2008
 - 15 - 2009
 - 21 - 2010
 - 18 - 2011
 - 18 - 2012
 - 21 - 2013
 - 24 - 2014

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2009 AAP Policy Report

- Abusive head trauma (AHT) is the preferred terminology over Shaken Baby Syndrome
- Given that crying is the most common trigger, it recommended that prevention should focus on coping with crying

Christian et al. *Pediatrics* 2009;123:1409–1411

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What is Abusive Head Trauma?

- A type of severe physical abuse
- Seen almost exclusively in infants and toddlers, but can be seen up to age 5 years
- Often involves shaking, often with impact
- Most of the severe associated injuries are from severe rotation (angular forces) with acceleration/deceleration

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Risk factors for AHT

- **Stress** in the home
 - Poverty or financial stress
 - Relationship stress
 - Intimate partner violence
- Young, immature caretaker
- Social isolation
- First Child
- Risk of fatal child abuse increases 6-50x when mother lives with boyfriend (Schnitzer, P and Ewigman, B. in 2008 *Journal of Nursing Scholarship*. 40(1):91-97 and *Pediatrics* 2005;116:e687-e693.)

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Risk factors for AHT

- Mental health issues in caregiver
- Caregiver abused as child
- Alcohol and drug abuse
- Premature & low birth weight infants
- Infants with chronic medical problems
- Colic- Multiple visits/calls signal possible problems!
- Multiples (twins, triplets, etc)

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Risk factors + Trigger → Shaking and/or Slamming

Infant
Crying!

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Quick Review- What Are Sentinel Injuries?

- Sentinel Injuries are abusive precursor injuries to more serious abuse
- Some severely abused infants are abused in milder ways before bones are broken or they are shaken/slammed
- When recognized and responded to, escalation of abuse to fractures, head trauma and infant homicide might be prevented
- In AHT cases, a history of sentinel injury is present in 30% of cases

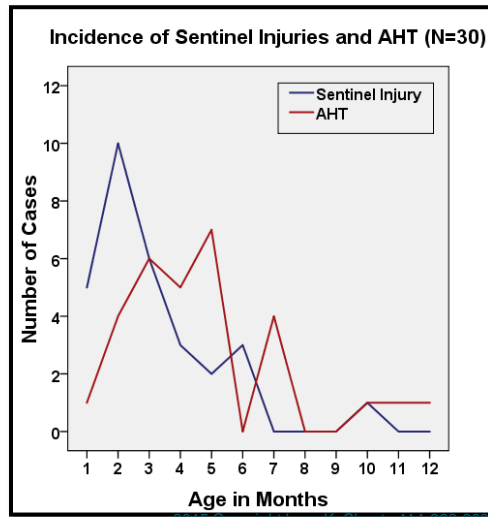
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Infant crying

- Normal developmental stage – peaks around 6 weeks of age (Hunziker, U. A., & Barr, R. G. (1986). Increased carrying reduces infant crying: A randomized controlled trial. *Pediatrics*, 77, 641-648)
- May indicate something is wrong but not always
- Causes stress and anxiety for caregivers- feelings of frustration, inadequacy, anger
- Abusive caregivers – unable to regulate the stress that is elicited by infant crying (McCanne, T. R., & Hagstrom, A. H. (1996). Physiological hyperreactivity to stressors in physical child abusers and individuals at risk for being physically abusive. *Aggression and Violent Behavior*, 1, 345-358.)
- 89% of parents contacted the PCP because of excessive crying prior to AHT (Talvik, I., Alexander, R. C., & Talvik, T. (2008). Shaken baby syndrome and a baby's cry. *Acta Paediatrica*, 97, 782-785)

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Infant Crying



Sentinel Injuries for abusive head trauma (Sheets & Leach et al, 2008)

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The Trauma Event

- Usually triggered by persistent crying in infants or other annoying/frustrating behaviors
- Caregiver grabs child (usually by arms or around chest)
- Child is shaken violently back and forth and/or slammed
- Severe rotational (inertial) forces with acceleration/deceleration act on the head to cause injuries

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How does severe rotation/impact cause injury?

- Tissues move in response to shaking/slamming
- Different tissues move at different rates
- The mass of the tissue affects how each tissue moves
- Injury is usually seen at tissue interfaces, where two different types of tissues come together but are attached (sliding, slipping, shear injuries)

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Shaking vs. Impact

- Impact increases forces significantly (approximately 50X) through sudden deceleration
- Evidence of impact includes soft tissue injury and skull fracture
- Does the lack of contact injury mean that no impact occurred?
 - No; impact against a broad, soft surface may leave no skin injury or skull fracture
 - In Starling, et al (2004) 40% of those with confessed impact had no contact injuries. Findings confirmed in other confession studies.

Starling, et al. *Arch Pediatr Adolesc Med.* 2004;158:454-458




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Can Shaking Alone, Cause AHT?

- Some “experts” allege that shaking alone cannot cause diffuse brain injury and SDH
- Animal and doll models support the theory that impact is needed but models lack bio-fidelity and do not consider the effect of repetitive events.
 - Pig studies by Raghupathi (2004) support that repetitive events lower injury thresholds
 - Lamb studies by Finney (2010) produced similar syndrome
- Confession studies
- **Likely that shaking alone can produce AHT injuries but impact “ups the ante!”**

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What Parts of the Head are Vulnerable to These Injuries?

- The subdural veins/dural border cells that bridge between the brain and the membrane covering the brain (dura)
 **Subdural hemorrhage**
- The junction between the gray matter (neuron cell bodies) and the white matter (the axons or connections made by the neurons)  **Diffuse brain injury**
- The eye ball and the “jelly” (vitreous) that fills the eye ball
 **Retinal hemorrhages**

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Primary and Secondary Injury

- **Primary**: Diffuse primary brain injury leads to poor function
 - Concussion- functional injury to brain cells
 - Diffuse primary brain injury, bleeding on the surface of the brain
- **Secondary**: Results from poor respiratory effort, low blood flow and a cascade of tissue reactions.
- Analogy: Sprained ankle

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What about symptoms?

- Symptoms are immediate- shaking “works”- Perpetrators sometimes report using it to quiet babies
- 2.6% of parents shake their infants and toddlers (2008 Runyan Am J Prev Med)
- Remember that symptoms can subside!
- Jenny, C et al- Up to 31% of AHT babies were initially missed when they presented for medical care! JAMA. 1999;281:621-626

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Case of missed AHT

- 5-month-old: Bumped head against chair leg when she rolled over. She cried then was fine
- She took a long nap then awakened vomiting
- 4 hours later, mother came home and baby was “out of it” and vomited again. Took baby to ED but left without being seen (5 hour wait).
- Seemed better next day but vomited again 2 days later
- CT in ED showed bleeding on surface of brain but baby was normal. Sent home to follow up outpatient
- Brought back 4 days later- Still “fine” but evaluation showed multiple retinal hemorrhages and a healing rib fracture.
- Father pled guilty and was sentenced to 4 years

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Symptoms of Abusive Head Trauma

- A shaken/slammed baby may have any combination of the following symptoms:
 - Breathing problems
 - Arching back; stiff arms, legs
 - Seizures
 - Does not focus or track movements
 - Pupils of eyes unequal in size
 - Eyes gazing in one direction for prolonged time

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Brain Injury Symptoms

- Irritable, with prolonged crying
- High-pitched or different cry
- Sleepy or fussy
- No longer interacts with caretaker
- Poor feeding or vomiting
- Bulging fontanelle (soft spot)
- Coma, death or brain death

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Another case of missed AHT

- 5 month old seen for well baby check
 - Underweight
 - Liver enzymes elevated
 - Subtle bruising of the scalp
- History of some vomiting off and on since birth and unusual diet (oatmeal, fruit and very little formula)
- At 3 months, he had a spell of refusing to eat, vomiting, pallor, decreased responsiveness, and eyes rolled back. Taken to the ED where he took Pedialyte and was discharged home.

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Recommendation

- **All** infants/toddlers reportedly shaken should be medically evaluated
- Infants can heal/get better on their own then later die of escalating abuse!

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Why Are Infants and Small Children Vulnerable?

- Proportion of head mass to body weight is greater in infants than adults
- Large head and weak neck muscles
- Brain is more susceptible to injury
- Tiny blood vessels are fragile
- Lack of protective reflexes

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How Vulnerable?

- Abusive head trauma is a violent act.
- This is not tossing an infant in play; it is not “jiggling” and infant to awaken him/her; it is not bouncing an infant in play

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Other Injuries That May Be Present

- Bleeding within the brain
- Optic nerve sheath hemorrhages- bleeding where the optic nerve attaches to the eye
- Neck injuries (soft tissue and spinal)
- Soft tissue injuries of the scalp
- Bruising
- Fractures (broken bones) such as of the skull, long bones or ribs
- **Absence of other injuries does not affect the diagnosis**

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Bleeding Inside the Eyes

- Retinal Hemorrhages (bleeding inside the eyes) present in 85% of abusive head trauma cases:

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Retinal Hemorrhages

- Present in 30-50% of babies born by SVD
- Classic pattern: multiple, extend to periphery and involve multiple retinal layers
- Rarely seen in accidents

How is AHT Diagnosed?

- Basic criteria:
 - Subdural/Subarachnoid hemorrhage (bleeding around the brain)
 - Primary diffuse brain injury (clinically and/or on radiographs)
 - Retinal hemorrhages in 85%

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But you also need:

- Absence of adequate accidental history to explain them
- No evidence of a disease that could explain the findings

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Timing

- Presently, our best tool for estimating the timing of pediatric head trauma is the careful documentation of the onset and progression of the child's clinical signs and symptoms.
- Very likely, the child was injured just before he/she became *clearly and persistently symptomatic*.

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Timing

- This implies injury occurred at some time AFTER the child was last seen to be behaving normally.
- Therefore, extensive medical history focuses on details of the infant's behavior over time (**a careful timeline**) as described by caregivers

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When Talking With Caregivers

- Avoid giving clues about timing or biomechanics
- **Avoid suggesting shaking as a possible cause**
- Inquire about all accidents and injuries. If one is disclosed, make sure you ask about how the baby behaved before, during and after the event:
 - Previous rough play, falls, undisclosed (concealed) accidents
 - Suspected falls
 - Suspected rough handling
 - Suspicions of
 - Birth injury

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Prognosis

- Approximately $\frac{1}{4}$ die, $\frac{1}{4}$ are devastated, and $\frac{1}{2}$ are affected
- Can't judge the outcome based upon early developmental tests
- ALL have brain injury and permanent alteration of their life course trajectory!

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Long-term Sequelae of AHT

- Developmental delay/mental retardation
- Spasticity
- Hemiplegia/quadraplegia
- Cerebral atrophy
- Blindness/Deafness
- Seizures
- Hydrocephalus

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Outcomes

- An interval without apparent disability or developmental delay must be interpreted with caution.
- No final favorable prognosis can be given before the age of six years old, or perhaps even later.

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Court “Controversies” in Perspective

- Controversies- both real and false are used in court
 - Real- gaps in knowledge/areas of active research
 - False- myths perpetuated by defense
- Divide and create reasonable doubt strategy:
 - Focus on each injury separately
 - Defense theories rarely explain the **entire** clinical presentation and the full scope of injuries

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Example

- Man running to catch a bus and missteps thus injuring his ankle
- What are all of the causes of ankle pain?
- What are all of the causes of bruising?
- What are all of the causes of swelling?
- But. . .when the history and the findings are taken together do we need to run tests on all of the other possibilities????!!

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Summary of Controversies

- True controversies arise from gaps in knowledge
- Some gaps will never be resolved because the research is not ethical
- Some defense expert “controversies” represent ploys that may contain a thread of true controversy
- There is excellent research data to reliably allow diagnosis of AHT based upon the clinical history and injuries in many cases

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