

Abusive Head Trauma

WI CAN EDUCATIONAL SERIES
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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

Center for Disease Control and Prevention. Ten leading causes of injury deaths: highlighting violence. <http://www.cdc.gov/injury/wisqars/leadingCauses.html>
Christian CW, Block R. Committee on Child Abuse and Neglect. American Academy of Pediatrics. Abusive head trauma in infants and children. *Pediatrics*. 2009;123(5):1409-1411.

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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
- Severe force rotation and/or impact
- Most of the severe associated injuries are from severe rotation (angular forces) with acceleration/deceleration

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CDC – definitions 2013

- Broad – injury to the skull or contents of the skull in a child < 5 y/o due to inflicted blunt impact and/or violent shaking
 - Includes skull fractures from abuse without brain injury
- Narrow - This lecture is focused on this topic that requires diffuse primary brain injury

When considering a bruise . . .

- In pre-cruising infants, bruising is not normal and is unexpected
- Most injury incidents cause only 1 bruise
- Most accidental bruises are on the front of the body over bony prominences – forehead, knees and shins
- Accidents rarely cause bruises on the ears, neck and genitalia. Rarely on buttocks, upper arm, back of the legs or feet

Childhood bruising distribution observed from eight mechanisms of unintentional injury Owen Hibberd, Diane Nuttall, Rifarrnon E Watson, et al. Arch Dis Child. 2017

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.)

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)

Risk factors + Trigger → Shaking and/or severe impact

Trigger =
Infant
Crying!



Quick Review - What Are Sentinel Injuries?

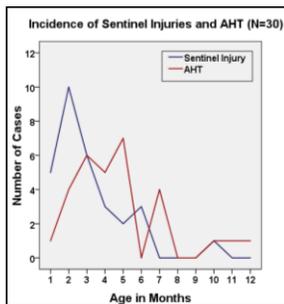
- Sentinel Injuries are bruises or mouth injuries in pre-cruising infants. They are unexpected and should usually raise a concern for abuse.
- When recognized and responded to, escalation of abuse to fractures, head trauma and infant homicide might be prevented
- In AHT cases, a history of sentinel injury is present in 30% of cases

Infant crying

- Normal developmental stage – peaks around 6 weeks of age (Hunziker, U. A., & Barr, R. G. (1986). Increased crying reduces infant crying: A randomized controlled trial. *Pediatrics*, 77, 641–648)
- May indicate something is wrong but not always
- Often causes stress and anxiety for caregivers- feelings of frustration, inadequacy, anger
- Abusive caregivers – sometimes unable to regulate stress (McCarne, T. R., & Hagstrom, A. H. (1996). Physiological hyperactivity 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, kicked or thrown
- Shaking involves impact (chest) and/or sudden starts/stops
- 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)

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.
- Often presence/absence impact unknown

Starling, et al. Arch Pediatr Adolesc Med. 2004;158:454-459

Shaking and AHT

- Can shaking alone cause AHT?
- Remember "shaking alone" has sudden stops/starts and often impact against the chest/back
- 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 low or injury thresholds
 - Lamb studies by Finney (2010) produced similar syndrome
- Confession studies
- **Compelling evidence that "shaking alone" can cause AHT**

What Parts of the Head are Vulnerable to These Injuries?

- The subdural veins 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**

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 due to healing!
- Jenny, C et al- Up to 31% of AHT babies were initially missed when they presented for medical care! JAMA. 1999;281:621-626

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

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

Recommendation

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

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

How Vulnerable?

- A 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

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**

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%

But you also need:

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

Timing

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

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



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/quadruplegia
- Cerebral atrophy
- Blindness/Deafness
- Seizures
- Hydrocephalus

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Outcomes

- An interval without apparent disability or developmental delay must be interpreted with caution.

Some References

- Note references within presentation
- Jenny C, Hymel et al. Analysis of missed cases of abusive head trauma. *JAMA* 1999;281(7):621-626
- Dias MS, Smith K, et al. Preventing Abusive Head Trauma Among Infants and Young Children: A Hospital-based, parent education program. *Pediatrics*. 2005;115:470-477
- Shaken baby syndrome: rotational cranial injuries-technical report. AAP Committee on Child Abuse and Neglect. *Pediatrics*. 2009; 108;1;206-210
- Narang S and Clarke J. Abusive Head Trauma: Past, Present, and Future. *J of Child Neurol*. 2014;29(12):1747-1756



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