

Abusive Head Trauma in Infants and Children

**Dr. Hani Jahshan MD,
Senior Forensic Pathologist
Bahrain Defense Force**

www.jahshan.com



Classification of Head injuries

- 1) **Impact** (the head moving against an object, an object moving against the head, or both).
- 2) **Shaking** (repetitive shakes are required at human force levels).
- 3) **Shaking and Impact.**
- 4) **Penetrating injuries** can occur at both high (e.g. firearms) and low speeds (e.g., knives).
- 5) **Brain insult** due to interruption of blood flow (e.g., strangulation, acute blood loss), lack of oxygen (e.g., suffocation, carbon monoxide poisoning), or both.

Classification of Traumatic Brain Injuries by Mechanism

◆ Focal injuries:

◆ Contact

- ◆ Soft tissue
- ◆ Skull fracture or deformation
- ◆ Epidural hematoma
- ◆ Subdural hematoma
- ◆ Superficial cortical contusion
- ◆ Laceration
- ◆ Penetrating injuries

◆ Translational inertia

- ◆ Cortical contusion (contrecoup)
- ◆ Laceration
- ◆ Intracerebral hematoma
- ◆ Subarachnoid hemorrhage
- ◆ Subdural hematoma
- ◆ Petechial hemorrhage

◆ Diffuse injuries:

◆ Rotational inertia

Subdural hematoma **SDH**

Diffuse axonal injury **DAI**

Concussion

Subarachnoid hemorrhage

Petechial hemorrhage

Contusional tear

◆ Secondary injuries:

◆ Hypoxic-ischemic

Cerebral edema (vasogenic, cytotoxic)

Infarction

Metabolic derangement

◆ Pressure

Infarction

Herniation

Variety of Terms

- ◆ Abusive head trauma (AHT).
 - ◆ Shaken baby syndrome (SBS).
 - ◆ Cranio-cerebral trauma.
 - ◆ Neuro-trauma in infants
 - ◆ Blunt head injury.
 - ◆ Inflicted neuro-trauma.
 - ◆ Non accidental head injuries.
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- ◆ [American Academy of Pediatrics](#) on 2009 recommends:
 - ◆ {... pediatricians should use the term '**abusive head trauma**' rather than a term that implies a single injury mechanism, such as **shaken baby syndrome**, in their diagnosis and medical communications.} (Christian and Block 2009). ‡

‡


[Pediatrics](#). 2009 May;123(5):1409-11. doi: 10.1542/peds.2009-0408.

Abusive head trauma in infants and children.

[Christian CW](#), [Block R](#); [Committee on Child Abuse and Neglect](#); [American Academy of Pediatrics](#).

Challenges

- ◆ Inconsistency in **definitions** of Abusive Head Trauma
- ◆ **Controversy** about (AHT) in spite of being the leading cause of infant morbidity and mortality.
- ◆ **Diagnosis** and **Management** are difficult:
 - ◆ careful **history**, **physical examination**, and **radiologic** and **laboratory testing** are essential. No single test available.
 - ◆ **Many medical professionals involved**: (pediatrics, neurology, neurosurgery, ophthalmology, critical care medicine, radiology, neuroradiology, mental health, forensic pathology, neuropathology, Public health)
 - ◆ **Professionals from other sectors are needed**: social, law enforcement, and judiciary.
- ◆ Limitations of **data** and **research**.

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- ◆ **Failure**:
 - ◆ to measure **incidence and prevalence** of AHT
 - ◆ **to monitor** the problem over time (public health issue)
 - ◆ identifying groups **at highest risk**.
 - ◆ to **measure the effectiveness** of prevention and intervention activities (Saltzman et al. 2002).

History of CAN & AHT

Over 26000 Citations
in PubMed 2008

Silverman FN:
emphasized the
repeated, inflicted
nature of the trauma,
despite denial by
caregivers.

1953

Henry Kempe et al:
"battered child" medical
and legal communities
took action.

1962

Henry Kempe et al:
Sexual Abuse,
Another Hidden
Pediatric Problem

1978

1980

Annotated
bibliography
containing
350 pages

1967

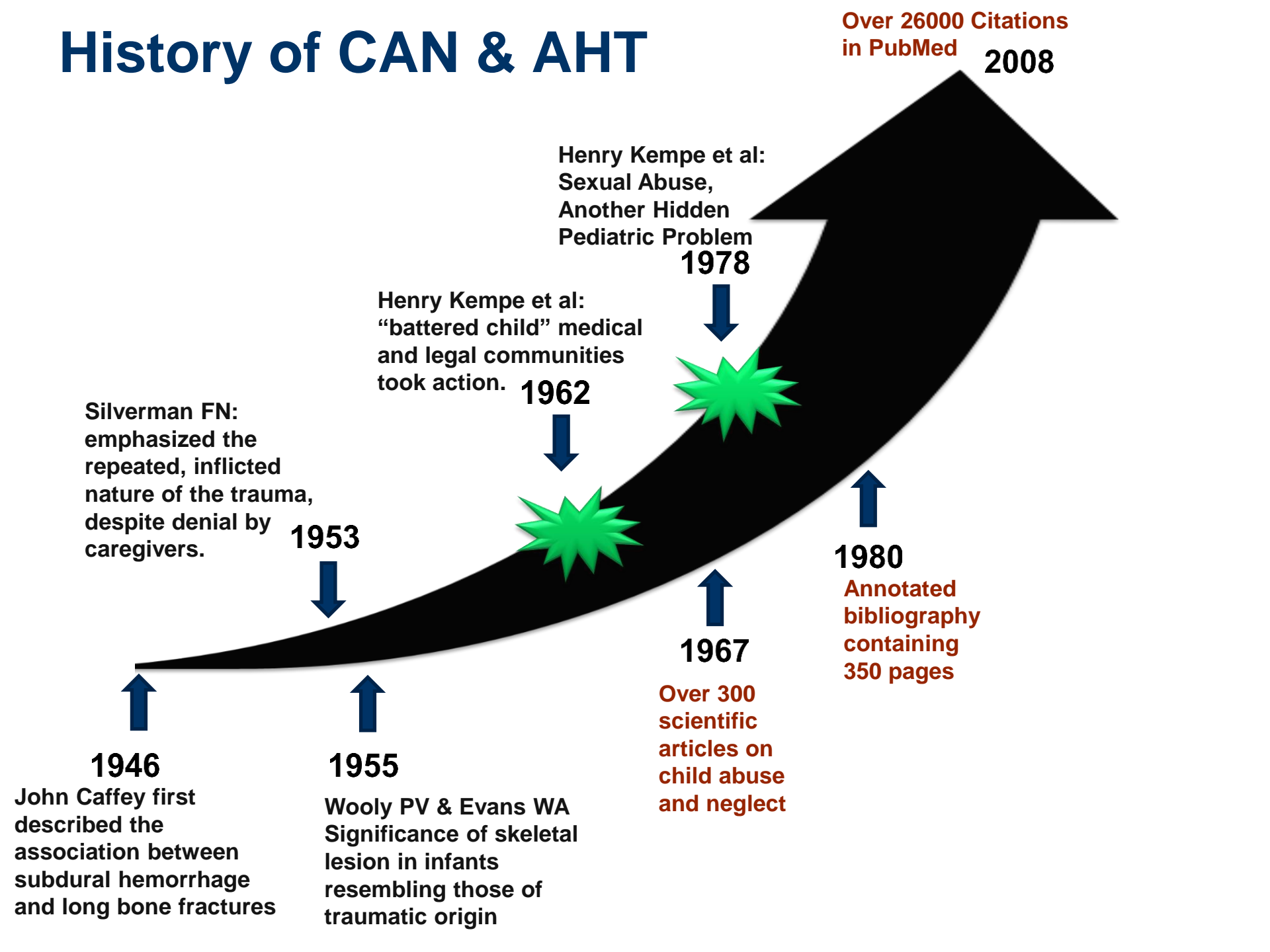
Over 300
scientific
articles on
child abuse
and neglect

1946

John Caffey first
described the
association between
subdural hemorrhage
and long bone fractures

1955

Wooly PV & Evans WA
Significance of skeletal
lesion in infants
resembling those of
traumatic origin



History of AHT

- ◆ In the 1860s, pathologist **Ambrose Tardieu** described children who were fatally physically abused, including some with subdural hemorrhages.

Tardieu A. Etude medico-legale sur les services et mauvais traitements scerces sur les engants. *Ann D Hyg Publ Med-Leg.* 1860;13:361-398.

- ◆ In 1946, pediatric radiologist **John Caffey** described children with a characteristic set of findings consisting of long-bone fractures and intracranial hemorrhages, which he stated was the result of trauma rather than metabolic or infectious processes.

Caffey J. Multiple fractures in long bones of infants suffering from chronic subdural hematoma. *Am J Roentgenol.* 1946;56:163-173.

- ◆ In 1971 neurosurgeon **Norman Guthkelch** first linked the mechanism of repetitive violent shaking with intracranial bleeding, and retinal hemorrhages, defining in what has come to be known as SBS.

Guthkelch AN. Infantile subdural hematoma and its relationship to whiplash injuries. *Br Med J.* 1971;2:430-431.

- ◆ In 1972 **John Caffey** described these findings as a syndrome.⁹ and.

Caffey J. On the theory and practice of shaking infants. Its potential residual effects of permanent brain damage and mental retardation. *Am J Dis Child.* 1972;124:161-169.



CDC **Definition** of Pediatric Abusive Head Trauma

- ◆ [an injury to the skull or intracranial contents of an infant or young child (< 5 years of age) due to inflicted blunt impact and/or violent shaking.]
- ◆ The following are **excluded** from the case definition:
 - ◆ Unintentional injuries resulting from **neglectful supervision**
 - ◆ **Gunshot wounds** - **stab wounds** - **penetrating trauma**
- ◆ Using **ICD 9** and **ICD 10** to document
 - (1) **definitive** or **presumptive** abusive head trauma
 - (2) **probable** abusive head trauma.

Arabic:

مؤكدة

مشبهة

محتملة



American Academy of Pediatrics (AAP)

AHT... Does it Exist?

- ◆ 50 years¹⁷ of clinical experience and reasoning by thousands of physicians leave no doubt that AHT exist.
- ◆ hallmarks of child abuse and AHT
 - ◆ **Subdural hematomas (SDHs)**, **brain injury**, and **retinal hemorrhages (RHs)**, with or without spinal,²³ skin, and skeletal injuries,^{24,25}
 - ◆ Individually of these findings are not specific for the diagnosis.
 - ◆ Clinical **findings are variable**;
 - ◆ AHT should be considered in all children with **neurologic signs and symptoms**, with no or only mild trauma is disclosed.

Subdural Hematoma (SDH)

- ◆ **Definition:** Bleeding inside the skull but outside the brain, result of tearing of the bridging veins that join the surface of the brain to the dura.
- ◆ Most common type of intracranial bleeding with a reported incidence of 82–92% in cases of AHT.
- ◆ Majority of neurologically symptomatic SDHs identified in infants and toddlers are the result of child abuse.²⁸
- ◆ **Location in AHT:** in more than one site, bilateral; chronic; of mixed density (implying repeated episodes of bleeding); or in the posterior fossa. Interhemispheric subdural hemorrhages are usually posterior.
- ◆ **Location in accidental:** limited to the cerebral convexities, occur at the site of impact, associated with an overlying fracture.
- ◆ **Differential Diagnosis:** SDHs can result from accidental or abusive trauma and secondary to medical disease.
 - ◆ Accidental trauma are caused MVA, or fall from a significant height.
 - ◆ Disease...

Hypoxic Ischemic Encephalopathy (HIE)

- ◆ **Definition:** lack of oxygen and blood flow to the brain and it is associated with cerebral edema.
- ◆ Injury multifocal and widespread
- ◆ HIE is a common feature of AHT, and it is largely responsible for the poor outcomes of victims.
- ◆ **Mechanism:** multifactorial (1) traumatic axonal injury to the brainstem and spinal cord, (2) apnea due to injury, (3) seizures, (4) blood vessels abstraction (5) cerebral edema.
- ◆ **Differential Diagnosis:** birth asphyxia, accidental trauma or suffocation, infection, metabolic disease, congenital anomalies, drowning, and choking.
- ◆ **Imaging:** MRI, particularly diffusion-weighted imaging, detects hypoxic-ischemic change earlier and more frequently than CT alone (Sato et al., 1989).

Diffuse Axonal Injury (DAI)

- ◆ **Definition:** diffuse microscopic tearing of axons in the white matter of the brain, caused by movement of the brain within the skull.
- ◆ Mechanism: extreme forces of angular deceleration.
- ◆ Responsible for prolonged coma in many patients after severe head injury.
- ◆ Coexist with SDH.

Retinal Hemorrhages (RHs)

- ◆ **Characteristics** of Retinal hemorrhages in AHT:
 - ◆ Involve multiple layers of the retina.
 - ◆ Vary in size, number, and location.
 - ◆ Extend anteriorly to the “ora serrata”
 - ◆ Folding of the retina.
 - ◆ Retinoschisis: splitting of retina from neurosensory layer.
- ◆ **Mechanism** traction forces on the retina
- ◆ RHs are seen in a number of medical and traumatic conditions in children. Clinical and pathological studies have shown strong **associations of severe RH with AHT**.^{8,39}
- ◆ The following failed to identify any association with severe RH
 - ◆ cardiopulmonary resuscitation
 - ◆ seizures
 - ◆ Valsalva pressure from coughing or vomiting
 - ◆ increased intracranial pressure attributable to medical disease.
- ◆ There is no published literature that disproves the association of severe RH and AHT.

Other Brain Injuries

- ◆ **Extradural Hemorrhage (EDH):** not typically associated with AHT; when present, it usually occurs at the site of a focal impact and in association with depressed skull fractures and cortical contusions.
- ◆ **Subarachnoid Hemorrhage (SAH):** Mechanism: (1) rupture of subependymal veins due to rotational forces (2) Injury to the corpus callosum, (3) extension of an intraparenchymal bleed. Most commonly into the lateral ventricles. Differential diagnosis: vascular malformation, coagulopathy, or as a surgical complication.
- ◆ **Brain Contusions:** multiple petechial hemorrhages or multifocal hemorrhagic contusions and are caused by shearing forces at the time of impact.

Skull Fractures

- ◆ AHT Studies: fractures in 9–31% cases.
- ◆ The parietal bone is the skull bone most commonly fractured in both AHT and non-AHT
- ◆ Complex fractures (multiple, bilateral, diastatic, or depressed) have historically been associated with AHT
- ◆ Accidental falls at home are rarely associated with injury more serious than a linear skull fracture.
- ◆ Fall studies: (28%) had skull fractures, but only 1.8% had an SDH.

Extracranial Skeletal Fractures

- ◆ Extracranial Skeletal Fractures 20 to 50% of victims.
- ◆ 87% of them had multiple bony injuries
- ◆ Type of fracture:
 - ◆ **Rib fractures**: pressure on chest while shaking the child. Posterior ribs fractures, are highly specific for child abuse
 - ◆ **Metaphyseal avulsion fractures** (torsion and traction of limbs while striking the child)
 - ◆ **Long bone**, twisting or pulling the child

External Trauma

- ◆ **External Signs:** Half of children (54%) with AHT present without evidence of external trauma.
 - ◆ Grip bruising in upper or lower limbs
 - ◆ Skin bruising due to striking or being hit by blunt object
 - ◆ Scalp laceration.
 - ◆ deformity of the shape of head
- ◆ **Scalp:** occult head injuries: scalp injury (74%), skull fracture (74%), and intracranial injury (53%) by CT or MRI but not on physical examination.
- ◆ **Subgaleal Hematoma:** is bleeding into the potential space between the fibrous layers of the scalp and the skull. Subgaleal hematomas are associated with blunt injury to the head, but have also been reported from hair-pulling during an abusive event.

Triad of AHT

- ◆ It is a **controversy** and not diagnostic AHT.
- ◆ The triad is a **myth** created for legal arguments against the diagnosis in the courtroom.
- ◆ Diagnosis of AHT
 - ◆ is made by detailed medical examinations and investigation and is not made automatically on the basis of the presence of these 3 findings.
 - ◆ can not be excluded if one or more of these elements is missing.

Triad of SIS

Shaken infant/shaken impact syndrome

- ◆ SIS is a subgroup of AHT,
- ◆ Mechanism
 - (1) shaking of the child alone
 - (2) shaking and blunt impact
- ◆ Clinical features of SIS include
 - (1) subdural and/or subarachnoid hemorrhage,
 - (2) occult fractures (especially involving the skull, ribs and long bones), and
 - (3) retinal hemorrhages.
- ◆ One-third of patients exhibit all three clinical features.

Epidemiology of AHT

- ◆ Traumatic Brain Injury (TBI) :100/100000 US children younger than 6 years, leading to death or hospitalization.
 - ◆ More than one third due to abuse.
 - ◆ Results insignificant morbidity and mortality.
- ◆ Abuse 30 to 53% of all TBI (Heather 2003) up to 95% in infants.
- ◆ Abuse is the third leading cause of all head injuries, after falls and motor vehicle crashes (CDC USA 2006).
- ◆ First year of life, the majority of serious head injuries result from abuse (Alexander, Levitt and Smith 2001).

Epidemiology of AHT

◆ Incidence:

- ◆ range from 20 to 30 cases per 100,000 children under one year of age (Ellingson, Leventhal and Weiss 2008).
- ◆ 16 to 33 cases per 100,000 children per year in the first 2 years . ‡
- ◆ Infants (one year) 29.7/100000/year verses second year 3.8/1000000/year. Boys 21.0 verses Girls 13.0 /100000/year (Heather 2003)
- ◆ Decrease with increasing age (Duhaime 2008).
- ◆ Risk increase: younger mother, multiple birth

◆ Incidence relation to crying:

- ◆ Episodes of prolonged, devastated, and unpredictable crying trigger shaking behavior among parents and caregivers.
- ◆ Crying increase in the first month after birth, peak in the second month, and decrease thereafter. (Barr 2006; Lee et al. 2007).
- ◆ the peak incidence of AHT is typically found from 2-3 months.

‡

[J Child Neurol](#). 2014 Dec;29(12):1747-56. doi: 10.1177/0883073814549995. Epub 2014 Oct 14.

Abusive head trauma: past, present, and future.

Epidemiology of AHT

Perpetrators ‡

- ◆ Perpetrators are primarily male
- ◆ Fathers 37.0%
- ◆ Mothers Partner 20.5%
- ◆ Female sitters 17.3%
- ◆ Mothers 12.6%

‡ (Duhaime, 2008; Graupman & Winston, 2006; Starling et al., 2004).

Epidemiology of AHT

Consequences

- ◆ **Death** rate for abusive head trauma 23 – 63%.
 - ◆ peak at 1 to 2 months of age due to higher physiologic vulnerability during early infancy.
 - ◆ Resilience and survival increase with age.
- ◆ **Disability** in nearly two-thirds of the survivors (Chiesa and Duhaime 2009).
- ◆ long-term consequences
- ◆ **Behavioral**, neurologic, and cognitive sequelae have been observed in all victims of abusive head trauma (Chiesa and Duhaime 2009).
- ◆ **Economical** cost:
 - ◆ Serious brain injury in children has been estimated to consume billions of dollars in health care costs each year (Bishop 2006),
 - ◆ Significantly higher costs for abused versus non-abused children (Ettaro, Berger and Songer 2004).

Mechanism

Anatomy of Infant Head

◆ Brain

- ◆ **Unstable Heavy** on **Weak neck muscles** permit greater movement (brain of 2-year-old child is approximately 75% the weight adult).
- ◆ **relatively soft** with high water content and a jelly-like texture.
- ◆ central nervous system is **not completely myelinated**

◆ Skull

- ◆ Vault is thinner and bendable, transferring impact force more effectively.
- ◆ Base is relatively flat, easier sliding.

◆ Subarachnoid Space

- ◆ is larger than that in adults, contributing to this increased transfer of forces.

Mechanism

Child weight

- ◆ Adults are 10 to 20 times larger than infants and are therefore able to pick up infants and shake them violently.
- ◆ It is harder to lift and shake an 18-kg 4 year old.
- ◆ Nearly impossible to shake an adult-sized person.
- ◆ Age:
 - ◆ Majority are younger than 1 year of age.
 - ◆ Some are between 1 and 2 years of age.
 - ◆ Lesser number are 2 year olds, and even fewer are 3 years old.
 - ◆ Four-year-old victims are rare.
 - ◆ children older than 5 years are almost never victims.
 - ◆ Report of an 8-year old victim was described. ‡
 - ◆ Several reports of adult victims exist, but they are exceptionally unusual. “shaken adult syndrome)” β

‡

Mierisch RF, Frasier LD, Braddock SR, Giangiacomo J, Berkenbosch JW. Retinal hemorrhages in an 8-year-old child: an uncommon presentation of abusive injury. *Pediatric Emerg Care.* 2004;20:118-120.

β

Pounder DJ. Shaken adult syndrome. *Am J Forensic Med Pathol.* 1997;18:321-324.

Carrigan TD, Walker E, Barnes S. Domestic violence: the shaken adult syndrome. *J Accid Emerg Med.* 2000;17:138-139.

Mechanism

American Academy of Pediatrics “position paper”

"the act of shaking leading to shaken baby syndrome is so violent that individuals observing it would recognize it as dangerous and likely to kill the child“ ²⁵

- ◆ shaking alone can cause serious or fatal injuries.
- ◆ Mortality rate for young children falling from second-, third-, or fourth-story balconies is less than 1 %, the rate is 25% in SBS. ‡
- ◆ Timing: Onset of symptoms is usually immediate:
 - ◆ By a careful timeline in history.
 - ◆ Radiological and Pathological evidence typically provides wider windows of time estimation.

‡

J Trauma. 1991 Oct;31(10):1353-5.

Deaths from falls in children: how far is fatal?

Chadwick DL¹, Chin S, Salerno C, Landsverk J, Kitchen L.

Mechanism

The act of shaking

- ◆ a child with a body mass of 3.8–4.5 kg must be shaken 40–50 times over 20 s in order to suffer serious brain injury (Levitt, Sutton, Goldman, Mikhail, & Christopher, 1994).
- ◆ Shaking at a rate of about 2 to 3 complete oscillations per second is more than the body can tolerate.
 - ◆ an injury from a single shake would equivalent to motor vehicle force.
 - ◆ It is far beyond what a human could accomplish.
- ◆ Rapid accumulation of forces that occurs during repetitive shaking leads to serious or fatal injury.
- ◆ Lack of external injuries is a finding in perhaps half of all cases,¹⁵
- ◆ Retinal hemorrhages almost invariably result from shaking but rarely from falls (Billmire & Myers, 1985).

Precipitating Cause

- ◆ **Crying** is the precipitating cause in nearly **all cases** in victim is less than 1 year. ¹¹
- ◆ Infants aged **2 to 3 months** cry between **2 to 3 hours a day** for nonnutritive reasons. This crying decreases markedly by 4 to 6 months of age. ²²
- ◆ Infant crying **is a normal developmental process** across all cultures and throughout history, it is often **upsetting to parents**.
- ◆ For some caregivers, their frustration with a crying child leads to hitting, slapping, yelling, or shaking.
- ◆ Prevention Programs coping with crying. ²⁴
- ◆ Other situations trigger shaking are **toileting** and **feeding difficulties**.

Presentations

- ◆ Death
 - ◆ **Immediate death:** injury occurs directly to vital centers in the brain stem that control respiration and blood pressure. Autopsy: no signs of intracranial bleeding or brain swelling.
 - ◆ **Late Death:** the child lives long enough for substantial cerebral edema, intracranial bleeding, and retinal bleeding to occur.
 - ◆ Survivals: Approximately 75% of children diagnosed with AHT survive beyond the diagnosis.

Presentations of Survivals

- ◆ **Previous Shaking** was proved in 33 - 40% of cases at the time of diagnosis.^{16,17}
 - ◆ In most cases, shaking is an ongoing and apparently escalating activity that eventually results in sufficient injuries to be diagnosed as SBS.
- ◆ **Brain Damage in all survivors.**
 - ◆ even if it is not apparent on brain imaging or developmental testing.
- ◆ **Neurological deficits (moderate to major)** in almost all survivors in 1 or more of 3 major areas:
 - (1) motor skills
 - (2) Vision
 - (3) cognitive skills.

Presentations – Long term

- ◆ **Motor skill deficits:** vegetative state, cerebral palsy, paralysis, clumsiness.
- ◆ **Visual deficits:** involve the visual cortex with varying degrees of visual acuity problems, eye muscle coordination and retinal injuries (e.g., detachment, vitreous hemorrhage)
- ◆ **Cognitive deficits:** range in severity from primitive reflexes only to mental retardation to learning deficits. 17 18
 - ◆ Sometimes only evident when the child enters school.
 - ◆ Two years after initial diagnosis: small percentage has minor deficits.

The Medical Diagnosis of AHT: Physician Approach

- ◆ Tasks for the physician:
 - ◆ Recognize patterns that suggest possible child abuse.
 - ◆ Elucidate all pertinent historical, examination, laboratory, and imaging findings.
 - ◆ Identify alternative medical explanations or recognize traumatic etiology.
 - ◆ Reach a sound assessment of the nature, severity, and timing of trauma.
 - ◆ work with appropriate agencies to establish abuse and identify abusers.

Subjective Assessment: The History

- ◆ Each caregiver should be interviewed separately.
 - ◆ Unstructured request for explanation
 - ◆ Specific request for explanation of identified trauma
 - ◆ Past medical history, including birth, illnesses, neurological complaints, trauma, and growth and development
 - ◆ Family history of heritable medical conditions
 - ◆ Family history of violence, substance use, and past involvement with child protective services
 - ◆ Family stressors, family composition, and people with access to the child
 - ◆ After interview:
 - Review of systems
 - If inconsistencies exist, coordination with agencies to confront each historian

Objective Assessment

- ◆ Complete physical examination
- ◆ Detailed examination of head, face, neck, ears, oral cavity, skin surfaces, genitals, and anus
- ◆ Acute head CT scan
- ◆ Delayed head MRI scan
- ◆ Skeletal radiograph survey, both acute and 2 weeks later
- ◆ Abdominal CT scan if unresponsive, if multiple trauma, or if indicated by laboratory tests
- ◆ Laboratories: CBC, PT/INR, PTT, basic chemistry panel, AST, ALT, amylase, urinalysis; consider serial testing
- ◆ Dilated indirect ophthalmoscopy by an ophthalmologist

The Medical Social Worker as Part of a Multidisciplinary Team

- ◆ Performs a psychosocial assessment of parents and families of a hospitalized patient.
- ◆ Coordinates and assists in reports to child protective services and law enforcement.
- ◆ Provides supportive services to families in crisis.
- ◆ May assist in discharge planning.
 - ◆ Supports families if foster care is planned
 - ◆ Coordinates ongoing skilled nursing care to children with new chronic medical needs.

Collaborative Medical & Mental Health Issues

- ◆ AHT results in extreme stress to the family structure.
- ◆ Mental health professionals may assess cognitive, social, and emotional functioning of parents, regardless of whether they are the abusers.
- ◆ Risk factors may be assessed to assist in determination of parental competencies and risk of recurring abuse or inability to protect from further abuse.
- ◆ An understanding of how a parent's behavior contributed to the abuse may assist in future treatment.
- ◆ The child victim may have specific mental health needs that can be identified and treated.
- ◆ Siblings of an abused child may also need specific assessment and mental health interventions.

Neurodevelopmental Outcomes

- ◆ Many of the surviving victims of AHT are left with moderate to severe neurologic and development sequelae.
- ◆ Contact injuries may have better outcomes than rotational (shaking) injuries.
- ◆ More subtle neurodevelopmental problems may not be known until a child is school-aged.
- ◆ All children who suffer AHT need careful and close developmental follow-up.

Poor Prognostic Outcome: The Acute Injury

- ◆ Severity of acute injury:
 - ◆ Severe injury usually predicts more severe outcome.
 - ◆ Less severe presentation does not necessarily predict less severe outcome.
- ◆ CT findings:
 - ◆ Midline shift
 - ◆ Compression of basilar cisterns
 - ◆ Parenchymal injury
 - ◆ Diffuse brain swelling
 - ◆ Reversal sign
 - ◆ Posttraumatic infarctions

Basal cistern is a wide cavity where the arachnoid extends across between the two temporal lobes

White cerebellum sign, also called reversal sign or dense cerebellum sign, is encountered when there is a diffuse decrease in density of the supratentorial brain parenchyma, with relatively increased attenuation of the thalami, brainstem and cerebellum

Poor Prognostic Indicators

- ◆ MRI findings:
 - ◆ Diffusion restriction
 - ◆ White matter shearing tears (may also be seen on CT)
- ◆ Cerebral atrophy
- ◆ Laboratory findings on presentation:
 - ◆ Hyperglycemia (generalized from TBI data)
 - ◆ Coagulopathy
- ◆ Other measures:
 - ◆ Low cerebral perfusion pressure
 - ◆ Early post traumatic seizures (within 1 week of injury)

Blood glucose is associated with brain tissue acidosis in patients with major head injury

Retinal Findings

- ◆ The severity of neurologic injury correlates with the severity of the retinopathy.
- ◆ Vitreous hemorrhage, subhyaloid hemorrhage, and diffuse retinal hemorrhages correlate with a more severe neurologic outcome.

Long-Term Sequelae of AHT

- ◆ Cerebral atrophy resulting in microcephaly
- ◆ Posttraumatic epilepsy
- ◆ Cognitive delays
- ◆ Motor impairment
- ◆ Emotional problems
- ◆ Behavioral issues
- ◆ Visual impairment (usually cortical)

Prevention & Education

- ◆ An understanding of **who injures children** and **why**
- ◆ This understanding is necessary to the development of prevention strategies.
- ◆ One study has estimated that each victim of AHT costs society upwards of 1 million dollars in his or her lifetime.
- ◆ The most severely injured will have the greatest long-term expenses.

Target Audiences for Prevention Efforts

- ◆ Men – Fathers
 - ◆ Difficult to reach, should target this population
- ◆ Childcare providers
 - ◆ In nurseries, preschools, etc.
- ◆ New parents
 - ◆ Prenatal classes
 - ◆ Maternity ward education programs
- ◆ Mothers
 - ◆ Conduits for education of others (eg, the men and the childcare facility)
- ◆ Medical providers
 - ◆ Need to recognize early the signs and symptoms of AHT to prevent further morbidity and mortality
 - ◆ Can provide resources and support for parents in clinical settings, and are therefore a valuable target audience.