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Abusive Head Trauma in Infants and Children

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abstract

Abusive head trauma (AHT) remains a significant cause of morbidity and mortality in the pediatric population, especially in young infants. In the past decade, advancements in research have refined medical understanding of the epidemiological, clinical, biomechanical, and pathologic factors comprising the diagnosis, thereby enhancing clinical detection of a challenging diagnostic entity. Failure to recognize AHT and respond appropriately at any step in the process, from medical diagnosis to child protection and legal decision-making, can place children at risk. The American Academy of Pediatrics revises the 2009 policy statement on AHT to incorporate the growing body of knowledge on the topic. Although this statement incorporates some of that growing body of knowledge, it is not a comprehensive exposition of the science. This statement aims to provide pediatric practitioners with general guidance on a complex subject. The Academy recommends that pediatric practitioners remain vigilant for the signs and symptoms of AHT, conduct thorough medical evaluations, consult with pediatric medical subspecialists when necessary, and embrace the challenges and need for strong advocacy on the subject.

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HISTORY

The evolution of the abusive head trauma (AHT) diagnosis has a long and storied history.[1–3] Earlier nomenclature included whiplash shaken infant syndrome, shaken impact syndrome, inflicted childhood neurotrauma, and shaken baby syndrome. The current term, AHT, was adopted by the American Academy of Pediatrics (AAP) in 2009 in recognition of the fact that inflicted head injury of children can involve a variety of biomechanical forces, including shaking. That change in terminology (from shaken baby syndrome), however, was misinterpreted by some in the legal and medical communities as an indication of some doubt in or invalidation of the diagnosis and the mechanism of shaking as a cause of injury. The AAP continues to affirm the dangers and harms of shaking infants, continues to embrace the "shaken baby syndrome" diagnosis as a valid subset of the AHT diagnosis, and encourages pediatric practitioners to educate

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community stakeholders when necessary.

PRESENTATION AND EVALUATION

AHT has an estimated incidence of 32 to 38 cases per 100 000 children per year in the first year of life and is fatal in nearly one-quarter of cases.[4,5] AHT presents with a wide spectrum of signs and symptoms. The clinical manifestations of AHT can be subtle (such as vomiting and fussiness) and are often missed. Sheets et al[6] found that more than one-quarter of children with severe physical abuse had previous sentinel injuries missed by physicians, and over 80% of those sentinel injuries were bruises. Bruising in infants should alert the physician to the possibility of abuse. Particular attention should be given to "TEN-4" bruising (bruising of the torso, ears, and neck in children younger than 4 years or any bruising in an infant younger than 4 months).[7] Oral injuries in infants, such as frenulum tears, may also accompany or precede AHT and should prompt consideration of abuse.[8] Thus, it is crucial for the pediatric practitioner to maintain high vigilance for subtle findings that can indicate AHT and perform a careful evaluation as dictated by the clinical presentation.

AHT is on the differential of common presenting complaints of infants and young children, such as fussiness, vomiting, or altered mental status. Medical diseases that can mimic the findings commonly seen in AHT are increasingly recognized, and screening is performed when indicated. A comprehensive medical evaluation, including a thorough skin examination, skeletal survey, head imaging, and a timely ophthalmology consultation, remains the cornerstone of AHT assessments.[9] As with all medical diagnoses, caregiver histories are important, and careful documentation of the reported history is needed.

Children with suspected intracranial injury should have a cranial computed tomography and/or MRI scan.[9,10] MRI of the spine should also be considered to assess for ligamentous injuries or spinal subdural hemorrhage.[10,11] Cranial ultrasonography is diagnostically insensitive for detecting AHT and should not be considered a sufficient diagnostic neuroimaging modality in cases of suspected AHT.[10] Although many cases of AHT do not demonstrate osseous injury, a complete skeletal survey should be performed in children younger than 2 years with concerns for AHT because occult fractures can occur in up to 42% of cases.[4] It is important that skeletal surveys conform to established guidelines of multiple views of the axial and appendicular skeleton.[10] A skeletal survey should be performed by technicians and read by radiologists who are experienced in these specialized imaging studies; otherwise, findings can be missed or misread, which can place both the pediatric practitioner at medicolegal risk and the patient at risk for further physical harm. Limited imaging, such as "babygrams," diminishes the diagnostic sensitivity of skeletal findings.[10]

Pediatric practitioners often find it helpful to consult a subspecialist in the field of child abuse pediatrics to ensure that the medical evaluation has been complete and that the diagnosis is accurate. Subspecialists in radiology, ophthalmology, neurosurgery, neurology, general pediatric surgery, and other fields should also be consulted when necessary to ensure a complete and accurate evaluation.

DIAGNOSIS AND OUTCOMES

Advancements in technology, research, and clinical experience have improved our current understanding of the etiologies, clinical features, and outcomes of AHT. Several recent systematic reviews have assisted in identifying clinical features more suggestive of abusive than accidental injury.[11–13] Features such as apnea, retinal hemorrhages, and "TEN-4" bruising are much more common in abusive than accidental injury.[7,12] Additionally, advancements in our clinical understanding of retinal hemorrhages have revealed that certain patterns of retinal hemorrhages (specifically too numerous to count in one or both eyes, present in all layers of the retina, and extending into the retinal periphery) are far more common in AHT than in accidental head injury.[13] Finally, traumatic retinoschisis (blood accumulating in the macula beneath the internal limiting membrane or deeper retinal layers, with or without surrounding circumlinear paramacular retinal folds) is highly suggestive of abusive trauma.[14]

Although there is not a particular pattern of cranial injury unique to AHT, certain findings, such as a subdural hemorrhage in certain locations (multiple, along the convexities, or interhemispheric), cerebral ischemia, cerebral edema, and skull fractures (co-occurring with intracranial injury), are more common in AHT than in accidental injury.[11] Additionally, recent studies have revealed spinal subdural hemorrhage to be more common in children with abusive (versus accidental) head trauma.[15]

Short falls (often defined as less than 1.5 m, or 5 ft)[16] continue to be a common historical explanation for injuries often seen in AHT. Although a few isolated case reports have identified the potential mortality of some short-fall events, numerous lines of clinical research have clarified the extreme rarity of short falls as a cause of severe neurologic injury or death in young infants. In a comprehensive review of short-fall literature, the estimated mortality rate of short falls affecting infants and

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young children is <0.48 deaths per 1 million young children per year.[16] Because short falls may be proffered in courts as a likely medical explanation for the findings commonly seen in AHT,[17] pediatric practitioners should be prepared to educate multidisciplinary colleagues on the relative improbability of serious injuries or death as a result of short falls.

Clinical prediction tools have been developed to determine the probability of AHT given specific combinations of physical examination and clinical, laboratory, and radiographic findings.[18,19] Additionally, early work using serum biomarkers to identify acute intracranial hemorrhage has shown promise in identifying infants with nonspecific clinical symptoms who warrant neuroimaging.[20] Although these diagnostic advancements show significant promise, their application to current-day pediatric practice is premature.

It is important for pediatric practitioners to recognize the significant morbidity and mortality that accompany AHT. Secondary brain injury from hypoxia, ischemia, and metabolic or inflammatory cascades contribute to poor outcomes.[21,22] Almost 70% of survivors of AHT have some degree of lasting neurologic impairment, including static encephalopathy, intellectual disability, cerebral palsy, cortical blindness, seizure disorders, behavior problems, and learning disabilities.[23,24] Endocrine dysfunction is common in survivors of AHT and may manifest years after injury.[25] Survivors of AHT should be referred at hospital discharge to medical homes where pediatricians can provide ongoing follow-up and prompt referral to pediatric medical subspecialists when indicated.[25]

BIOMECHANICS

The biomechanics of AHT is a complex topic. For obvious ethical reasons, scientific studies of the topic depend on the development and use of biofidelic models, either physical or computer generated. Throughout decades of clinical and laboratory research on infant head trauma, a number of biomechanical models have been used to assess the impact of various force parameters on the infant head and spine. Some early biomechanical models raised concerns about the ability of shaking events alone to generate sufficient forces to induce a variety of infant brain injuries, inferring that impact was a necessary prerequisite to induce infant head injury.[26] However, subsequent studies have highlighted the biofidelic limitations of that earlier work and have validated shaking alone as a mechanism for inducing infant brain injury.[27,28]

Additionally, in clinical studies, researchers continue to emphasize the importance of shaking as an injurious mechanism in many cases of AHT. In a study examining 112 cases of perpetrator admissions to AHT in court, shaking was a commonly reported mechanism of injury, with the shaking being described as violent in 100% of cases and being separate, repetitive incidents in 55% of the cases (with a mean repetitive incidence of 10 times).[29]

Some authors have postulated that evidence of significant cervical spine injury was a necessary finding before infant brain injury could be attributed to exclusive shaking events.[30] Although improvements in radiologic imaging have led to increased detection rates of ligamentous and other cervical spine injury in AHT cases, the biomechanical literature does not support the contention that bony, soft-tissue, or spinal cord injury must always be present in cases of AHT.[30]

All biomechanical models, whether physical or computer generated, have limitations and fall short of a precise representation of the complex pathophysiology of the human infant.[31] Clinicians and researchers acknowledge that although precise mechanisms for all abusive injuries remain incompletely understood, sound evidence-based literature supports the conclusion that both inflicted rotational and contact forces to the head can cause brain injury, intracranial hemorrhage, spinal hemorrhage and/or injury, and retinal hemorrhage.[31] Biomechanical research forms an important adjunct to the growing body of knowledge on pediatric traumatic brain injury. However, pediatric practitioners may need to educate multidisciplinary partners on the benefits and limitations of biomechanical literature in AHT.

PREVENTION

Prevention strategies to curtail the incidence of AHT have been developed and researched, and some states have mandated "shaken baby syndrome" education for parents of all newborn infants. Some hospital-based programs have shown success in some settings. Dias et al[32] demonstrated a decrease in AHT in a region of New York using written and video content about the dangers of shaking in addition to asking parents to voluntarily sign a commitment statement acknowledging and affirming receipt and understanding of the information. Their findings were replicated in another part of New York, but larger implementation across the state of Pennsylvania failed to demonstrate a reduction in AHT.[33,34] The Period of PURPLE Crying is a multifaceted program that aims to educate parents about infant sleeping, crying, and soothing behaviors. It involves an in-hospital postpartum implementation phase in which, in addition to the written and DVD education that parents receive, there is later education from public

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health nurses and annual community education. This program revealed a decrease in AHT incidence after implementation in British Columbia, but implementation in the state of North Carolina did not demonstrate a decrease in the incidence of AHT.[35,36]

Although it has been difficult to consistently demonstrate a decrease in AHT rates with educational interventions, some prevention programs have found other worthwhile results, including parental reports of improved understanding of infant crying, parental reports of improved emotional self-regulation, and an increase in parental knowledge of AHT.[37] Similarly, although the Nurse-Family Partnership, an in-home visitation program, has not demonstrated an effect on AHT rates specifically, the program has demonstrated a long-term decrease in child maltreatment and may be a useful approach in addressing AHT.[38] Providing economic support for families may be another prevention approach. Studies evaluating the impact of paid family leave and the earned income tax credit in California have demonstrated a reduction in AHT rates, although further research about generalizability is needed.[39,40] The AAP supports prevention efforts aimed at reducing the frequency of AHT and has called for continued research in this area.

LEGAL IMPACT

Few pediatric diagnoses have engendered as much debate in medicolegal circles as AHT. Because the diagnosis may result in children being removed from their homes and adults being imprisoned for their actions, the existence of a debate is understandable. However, the debate is a philosophical one, not a scientific one.

The debate arises from the legal requirement of physicians to subsequently express in court their degree of certainty of the AHT diagnosis (ie, to a "reasonable medical certainty"). Some authors have clarified that "reasonable medical certainty" is a pro forma legal expression required of physicians to assure courts that the opinions expressed are reasonable and nonspeculative.[41] Pediatric practitioners should understand that legal burdens of proof (ie, beyond a reasonable doubt) are not required for the diagnosis. Diagnosing AHT requires the same meticulousness, thoughtfulness, and comprehensiveness as any other medical diagnosis, no more and no less.

Because civil and criminal justice systems are often involved in cases of AHT, debates related to mechanism and causation of injury often are transferred to the courtroom. On occasion, a pediatric practitioner may be called on to testify in AHT hearings. The court may allow extraneous or pseudoscientific theories to be considered as explanations for findings of AHT, and a pediatrician who is called to testify should be sufficiently versed in these extraneous theories and in the scientific literature girding the AHT diagnosis so that he or she can present responsible, ethical testimony to the court.[17] In preparing for testimony, reviewing the literature with a child abuse pediatrician can be helpful.

The term "shaken baby syndrome" has become synonymous in public discourse with AHT in all its forms.[42] The term is sometimes used inaccurately to describe infants with impact injury alone or with multiple mechanisms of head and brain injury and is focused on a specific mechanism of injury rather than the abusive event that was perpetrated against a helpless victim. Legal challenges to the term "shaken baby syndrome" can distract from the more important questions of accountability of the perpetrator and/or the safety of the victim. The pediatric practitioner should be prepared to "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."[43]

THE ROLE OF THE PEDIATRICIAN

The diagnosis of child abuse has enormous social, psychological, and legal implications for families. The role of the pediatric practitioner is not to apportion blame or investigate potential criminal activity but to identify the medical problem, evaluate and treat the child's injuries, and offer honest medical information to parents, families, investigators, and attorneys and/or judges. When child protective services or law enforcement are involved in an investigation, the pediatric practitioner is often called on to interpret and communicate medical information for nonmedical professionals in an understandable manner that accurately reflects the medical data.

Pediatricians are mandated reporters, which means they are required to report suspected abuse and neglect to state child protective services, regardless of whether a definitive diagnosis of maltreatment has been made. As mandated reporters of suspected child abuse and neglect, pediatric practitioners carry the burden of recognizing and responding to medical manifestations of AHT. The diagnosis is sometimes obvious but can be missed by practitioners, particularly when infants present with subtle signs and symptoms.[4] Additionally, pediatric practitioners do not always report injuries that are highly suspicious for abuse to child welfare agencies, putting children at

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further risk for injury.[44,45] To protect infants who are abused and prevent future severe neurologic injury, pediatric practitioners must remain vigilant for the possibility of AHT in infants who present with both subtle and overt neurologic symptoms and take seriously the ethical and legal mandates to report suspected child abuse to child protective agencies for investigation.

As with any other diagnosis, pediatric practitioners have a responsibility to formulate a thorough differential diagnosis when presented with a patient with findings suggestive of AHT and to consider the possibility of abuse early in that process, with the understanding that a final medical diagnosis of AHT is made only after consideration of all the available clinical data.

On some occasions, the diagnosis is apparent early in the course of the evaluation because some infants and children have injuries to multiple organ systems that could only be the result of inflicted trauma. On other occasions, the diagnosis is less certain. In these less certain circumstances, the pediatric practitioner should carefully balance, both in verbal expression and written documentation, the need for child protection with ongoing medical evaluations. Pediatric practitioners should be cautious to not overstate the significance of particular medical findings, yet they should still effectively communicate the need for child safety when indicated. Because verbal and written communications with collaborative investigative agencies can be challenging, early consultation with a child abuse pediatrician may be prudent.

Providing a medical home for survivors of AHT is an important role for pediatricians because both short- and long-term complications can occur. Frequent monitoring and prompt referral to subspecialists when needed are key to achieving the best possible outcomes.

Finally, pediatric practitioners can work to prevent AHT by supporting prevention efforts in their clinical practices. Pediatric practitioners may help prevent AHT by carefully assessing for psychosocial risk factors often associated with abuse,[46] by providing anticipatory guidance to new parents about the dangers of shaking and impact, by providing methods for dealing with the frustration of a crying infant, and by providing access to prevention resources and supports. They can also stress the importance of leaving a young infant or toddler in the care of adults whom the parents trust will not harm their child and has been educated on the topic of AHT. Lastly, pediatric practitioners can work to advance evidence-based prevention efforts through research.

RECOMMENDATIONS

The AAP recommends the following:

1. Pediatric practitioners should remain vigilant for the signs, symptoms, and head injury patterns associated with AHT.
2. Pediatric practitioners should perform a thorough and objective medical evaluation of infants and children who present to medical care with signs and symptoms of potential AHT. Consultants in radiology, ophthalmology, neurosurgery, general pediatric surgery, and other subspecialties are important partners in the medical evaluation and can assist in interpreting data and reaching a diagnosis.
3. Pediatric practitioners should consider consulting a subspecialist in the field of child abuse pediatrics to ensure that the medical evaluation of the patient has been complete and that the diagnosis is accurate.
4. Pediatric practitioners should continue to 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.
5. Pediatric practitioners should report cases to child protective services when there is reasonable suspicion or reasonable cause to believe AHT has occurred and be prepared to educate investigative agencies on the medical information that forms the basis of the suspicion.
6. Pediatric practices should provide medical homes for survivors of AHT or refer them to medical homes to help achieve optimal rehabilitation and long-term monitoring for complications.
7. Pediatric practitioners who are called on to interact with legal and child protective agencies should be versed in the science underpinning AHT and be prepared to educate these stakeholders on both supported and unsupported theories of causation commonly proffered in court.
8. Pediatric practitioners should educate parents and caregivers about safe approaches to soothing an infant and coping with crying infants and about the dangers of shaking an infant, striking an infant, or impacting an infant's head against a surface.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
AHT: abusive head trauma

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Sandeep K. Narang, Amanda Fingarson, James Lukefahr and COUNCIL ON CHILD ABUSE AND NEGLECT

Pediatrics originally published online March 23, 2020;

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