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**Abstract:**

Abusive head trauma causes significant morbidity and mortality in infants and young children. The diagnosis of abusive head trauma can be difficult. Emergency medical providers frequently have initial contact with patients presenting with abusive head injuries. It is important for emergency medical providers to consider child abuse in the differential diagnosis of head trauma and to know how to perform a comprehensive evaluation when it is suspected. The pearls and pitfalls of diagnosing abusive head trauma are discussed in this article. Information on patient outcomes and the legal responsibilities of the medical provider are also described.

**Keywords:**

abusive head trauma; traumatic brain injury; retinal hemorrhages; child abuse

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# Pearls and Pitfalls for the Pediatric Emergency Medical Provider in the Evaluation of Abusive Head Trauma

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**A** 6-MONTH-old infant presents to an emergency department (ED) with a 1-day history of emesis and loose stools for the past 48 hours. The mother reports that the infant is in a daycare setting and that she was not informed of any recent illness outbreaks, but she states that the daycare provider described a very brief episode during which the infant "tensed up his body for a few seconds and shivered." He is developmentally normal for age and had immunizations in the past 48 hours. On examination, he is afebrile, nontoxic in appearance, but not very interactive. He has a purple circular contusion on his right cheek; no rash; and a quiet, nontender abdominal examination. He improves with intravenous hydration and is discharged home. He returns 5 days later with a history of resolved loose stools but with recurrent daily emesis. He is unable to take bottle feedings and has been progressively irritable for the past 2 days. On examination, he is afebrile and difficult to console, his facial contusion has resolved, and his gaze is diverted and appears unfixed on light or object. While being examined, he has a brief generalized tonic-clonic seizure. During stabilization and

further workup, the mother denies a history of prior seizures, trauma, or recent fever since the last encounter, but she was told by the daycare provider that the infant was very irritable and difficult to provide care for during the entire week since the apparent illness started. Computed tomography (CT) of the head shows bilateral mixed density subdural collections and hyperintense more acute appearing hemorrhage in the left temporal area (Figure 1). His mother asks the provider “What happened to my baby?”

The answer to this parent's question comes through the careful assessment for the diagnosis of abusive head trauma. As with all medical diagnoses, this starts with a detailed medical history, complete physical examination, and judicious use of laboratory and radiology studies. In the evaluation of possible abuse or neglect, a detailed social and family history is needed. This review will highlight both pitfalls and pearls for the emergency care provider in the evidence-based evaluation of abusive head trauma.

Head injury in the pediatric patient is a common presenting complaint to EDs in the United States. The Centers for Disease Control and Prevention estimate that over 400 000 children aged 0 to 14 years visit EDs for head injuries each year. Of this group, male children aged 0 to 4 years have the highest rates of ED visits, hospitalizations, and

deaths due to traumatic brain injury.<sup>1</sup> It has been estimated that approximately 24% of traumatic brain injuries in hospitalized young children are the result of abuse.<sup>2</sup> For the emergency care provider, this can pose unique diagnostic and management challenges. Several questions may arise: is there a best way to approach these types of patients diagnostically? How is risk stratified to determine the need for further workup and emergent intervention? Could an etiology for these injuries be child abuse?

## INCIDENCE

Head injury in children resulting from inflicted trauma has been known by many terms. The most widely known term is *shaken baby syndrome*, although other nomenclature used in the past includes whiplash-shaken infant syndrome, acceleration-deceleration injury, and shaken-impact injury. Decades of investigation and study to acquire a greater understanding of the diverse mechanisms and various clinical presentations of injury has prompted the American Academy of Pediatrics to recommend use of the more general and inclusive term *abusive head trauma (AHT)*, as it circumvents the dangers of suggesting a specific mechanism of injury.<sup>3</sup>

Acquiring accurate data regarding the incidence of AHT has proven to be a daunting task for several reasons. Variations in definitions and terminology to describe this group of child victims have confounded attempts to collect these data. Studies have examined a variety of different populations to attempt to establish epidemiologic data on AHT. For example, 1 prospective study conducted in North Carolina tracked children aged 2 years and younger who were admitted to pediatric intensive care or monitored step-down units at 9 area hospitals to calculate an incidence of AHT of 17 per 100 000 person-years for that defined population of children.<sup>4</sup>

A recent study assessed information obtained from the Kid's Inpatient Database to calculate an AHT incidence of approximately 30 per 100 000 infants. Authors point out that this estimation may be limited by an inability to obtain information on “missed cases” of children who either died before or were not admitted to hospitals for medical management.<sup>5</sup> Future epidemiologic studies will have to collect data from broad and diverse populations of children while devising methods to include those categories of children excluded from earlier studies.

Although the incidence of AHT may vary significantly between several studies, there is evidence



**Figure 1.** A 6-month-old male infant initially diagnosed with acute gastroenteritis and dehydration in the ED. The head CT obtained after he returned for seizures shows bilateral mixed density subdural collections with an area of acute hemorrhage in the left temporal area.

for an increased incidence within the first year of life as compared with the second year of life.<sup>6</sup> Young infants aged 2 to 6 months are revealed to be at particular risk in several studies. Several studies report age-related incidence curves of AHT that overlap with age-related incidence curves for crying, suggesting that the crying infant is a strong trigger for abuse.<sup>6-8</sup> Studies examining perpetrator admissions also reveal accounts of shaking and/or blunt force trauma in reaction to infant crying. Accounts from perpetrators indicate that infants may be harmed multiple times in various ways, suggesting that the pattern of maltreatment became a “learned” behavior to quell crying.<sup>9-12</sup>

## PRESENTATIONS OF ABUSIVE HEAD TRAUMA

As highlighted in the above case study, reaching a diagnosis of AHT in infants and toddlers can be quite complicated. The difficulty arises for several reasons. First, children with head injuries can present along a spectrum of symptoms ranging from mild, subtle, and nonspecific to severe, obvious, and more specific. Also, potentially obscuring a correct diagnosis is the variety of histories that a caregiver may provide. These accounts can range from vague or unusual stories of an accident to no history of trauma. Thus, reaching a correct diagnosis of AHT requires keen attention to detail, a thorough and consistent evaluative process, and a low threshold of suspicion.

Infants may present with nonspecific symptoms that may be easily attributed to another medical condition. Jenny et al<sup>13</sup> examined missed cases of AHT at an academic children's hospital. They found that approximately 31% of AHT cases were initially missed. Missed cases of abusive head trauma were more likely to have less severe symptoms such as vomiting and other gastrointestinal symptoms, sleep disturbances, and irritability. The most common initial diagnosis made instead of AHT was viral gastroenteritis. Other common misdiagnoses included nonspecific viral syndromes and accidental head injury. Conversely, cases of AHT were less likely to be misdiagnosed when the presentation was more severe, as in children who present with severely depressed mental status, respiratory arrest, or seizure activity. Jenny et al also noted sociocultural/racial bias in missed cases of AHT. Missed cases were more likely to be white children from homes in which both parents resided. Medical providers must be objective in their assessment for AHT and be aware that abuse can occur in all racial and socioeconomic groups.

Subsequent studies seeking to identify features that distinguish AHT from accidental head injuries illustrate the existence of a “continuum” of clinical symptoms and presentations. Abusive head trauma patients were also more likely to present with abnormal neurologic findings, depressed mental status, and seizures. This was contrasted with children diagnosed with accidental head injuries, who more frequently presented with scalp hematomas.<sup>14</sup> A finding of retinal hemorrhages on physical examination and rib fractures on diagnostic imaging was also determined to be more strongly associated with AHT.<sup>15</sup>

Another retrospective study revealed that patients with AHT were more likely to be younger than patients with nonabusive head trauma, and most of them were young nonambulatory infants. This study also found that children with AHT more often presented without a history of trauma by a caregiver and significant neurologic symptoms such as seizures, depressed level of consciousness or coma, and paralysis.<sup>6</sup> These findings highlight the importance of considering AHT in the differential diagnosis of serious neurologic symptoms in a young infant.

Infants presenting to EDs with a history of an apparent life-threatening event (ALTE) offer unique diagnostic dilemmas for medical providers. That is because an ALTE is typically characterized by nonspecific caregiver descriptions of apnea or altered breathing, color changes, alterations in muscle tone, and possible choking. The differential diagnosis for an ALTE is extensive. It includes more common conditions such as respiratory infections or gastroesophageal reflux, but it also includes more complex conditions such as cardiac disease, neurologic disorders, metabolic disorders, and AHT.

A recent study out of Utah found that children presenting with a chief complaint of an ALTE were more likely to be diagnosed with AHT in the ED when other physical examination findings more suggestive of abuse were found. These included bruising, retinal hemorrhages, or a bulging fontanel. The ALTE cases not initially recognized as AHT by ED providers all had a history of nonspecific symptom (vomiting and/or lethargy) or mild and unreliable physical findings. These cases were eventually diagnosed when presenting symptoms persisted, prompting a return to the ED or transfer to tertiary care for worsening of symptoms.<sup>16</sup>

Although less common, AHT can occur in older children. In a study describing presentations and findings of AHT in older children, the initial presenting symptoms were unresponsiveness, abnormal breathing, and other severe neurologic

symptoms.<sup>17</sup> Most of the children presented in this study also had associated injuries such as bruises, patterned cutaneous lesions, and burns. The investigators noted that rib and long bone fractures were uncommonly seen in older children with AHT.

## THE DIAGNOSTIC PROCESS

### History and Physical Examination

Like any other medical condition presenting to the ED, determining the diagnosis of AHT begins with a thorough medical history. Of course, priority is given to first stabilizing a severely injured child before conducting the remainder of the evaluation. Although caregivers may report incomplete, inconsistent, absent, or fabricated histories, efforts should be put forth to obtain details surrounding the events leading to the child's arrival at the ED. If possible, the history should include separate accounts from all caregivers present with the child. A description of the child's symptoms, both before and after he or she became abnormal, is important information to obtain. Because many children with AHT present for care after a symptomatic event such as a seizure or respiratory arrest, inquiring about a history of more subtle symptoms of head trauma is also important. Questions should be open ended. Helpful questions might include the following: Has the child had difficulty with feeds and vomiting? Has the child been fussier than normal? When was the child last seen as normal? What did you see? Then what happened? Inquiring about specific mechanisms of injury (ie, did you shake the baby?) is not recommended and is best left to investigators after a report is made.

Careful documentation is important. When appropriate, verbatim documentation of statements made by caregivers is preferred. Important information to elicit includes exactly what happened and whether trauma was observed. If a fall is described, information regarding the height of the fall, how the child landed, and the type of surface the child impacted should be elicited. Follow-up questions should focus on the child's symptoms after the event as well as any interventions the caregivers performed.<sup>18</sup>

The medical history should include the birth history, especially any birth trauma; any instrumentation used to assist in the delivery; or asphyxiation. Inquiring about a history of prior trauma, any bleeding disorders, metabolic or genetic disorders, congenital brain defects, connective tissue disorders, or other medical conditions that may lead to a similar clinical presentation is important. Similarly, the family history can help

eliminate or elucidate alternative medical conditions in the differential diagnosis of AHT. A comprehensive psychosocial history is needed to identify potential risk factors for abuse as well as potential triggers for abuse.<sup>18</sup>

The physical examination should proceed with assessment of vital signs, cardiopulmonary status, and the patient's neurologic status. Growth parameters should be plotted, with attention to signs of macrocephaly or microcephaly and malnutrition. Visual inspection of the entire body is essential to evaluate for additional signs of trauma, such as bruising, burns, occult abdominal injury, and skeletal trauma. Detailed inspection and palpation of the entire head, face, and scalp are particularly important with cases of head trauma to assess for signs of impact injury such as soft tissue swelling or underlying skull fractures.<sup>18</sup>

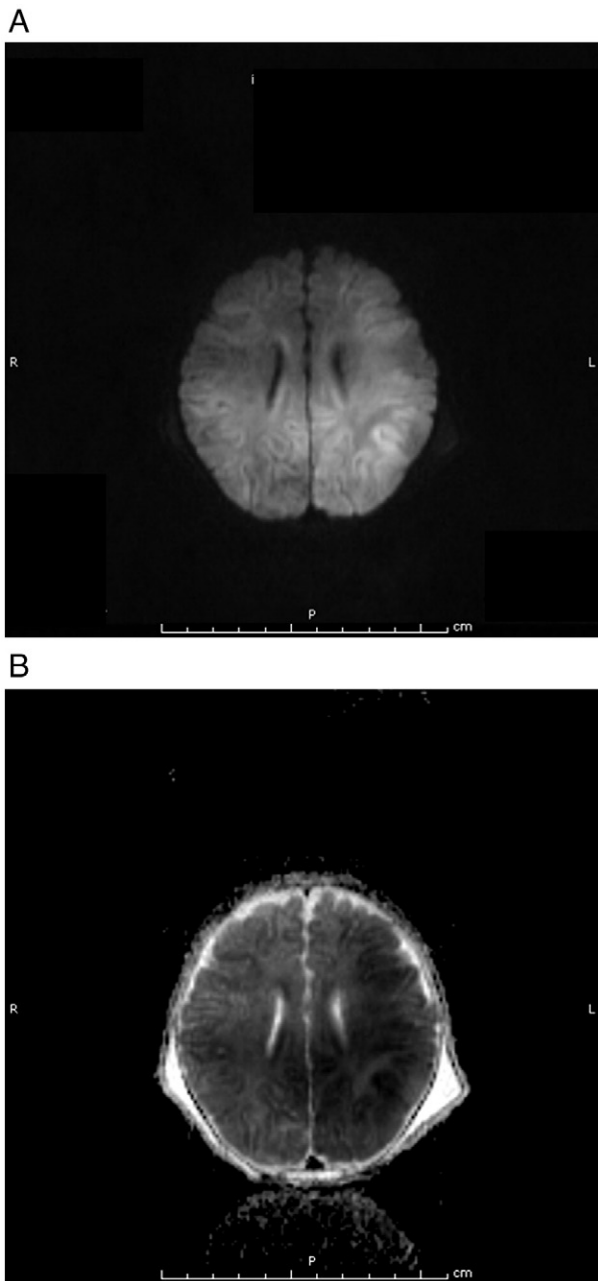
As a supplement to concise and accurate documentation of all visible injuries on the body, photo documentation of injuries is strongly advised. This will provide valuable information for additional medical providers and specialists involved with the patient evaluation. Photo documentation of injuries can also aid and augment court testimony by providing visual evidence.

Documentation of the medical impression should fully address the presenting history in conjunction with the child's injuries. Include discussion regarding whether the severity, age, and pattern of injury can be explained by the history provided. Note any psychosocial red flags elicited in the history. If evaluation for other medical conditions has been pursued, documentation should address the likelihood of alternative, comorbid, or coincidental diagnoses and what the primary diagnosis is in the context of the differential diagnostic possibilities.<sup>18</sup>

Prompt specialty consultation and collaboration are recommended to facilitate diagnosis and management of AHT. Fundoscopic examination by the ED medical provider should occur during the initial physical examination to identify the presence of retinal hemorrhages associated with AHT. This simple examination at the bedside can alert the ED medical provider to the likelihood of AHT and prompt further investigations to confirm this diagnosis. However, consultation by a pediatric ophthalmologist is standard of care and can provide additional detailed information regarding the severity and nature of the retinal hemorrhages above and beyond what is typically observable with a standard ophthalmoscope.

Evaluation by a multidisciplinary child protection team, if available, may involve assessment by a board-certified child abuse pediatrician or other





**Figure 2.** A and B, Brain MRI image of a 50-day-old obtained on admission day number 3 for AHT. Trace (2A) and apparent diffusion coefficient (2B) images show restricted diffusion in the bilateral parietooccipital lobes. There is also restricted diffusion of the frontal and temporal lobes, greater on the left than right.

trained medical professionals as well as medical social work. Multidisciplinary child protection teams offer benefits to the child abuse diagnostic process in several ways. Coordination with child protection teams helps to ensure that evaluation, diagnosis, and management are supported by current scientific knowledge. The child protection team also serves as a channel of communication

between hospital treatment teams and the investigational authorities.<sup>19</sup> In many cases, members of the child protection teams may assume the burden of responsibility for testifying in courts.

## The Diagnostic Workup

### Diagnostic Imaging

Any child presenting with acute symptoms of neurologic compromise and suspected AHT should undergo diagnostic imaging. The recommended initial evaluation for suspected AHT is head CT without intravenous contrast. Head CT provides a quick and sensitive method to detect acute subdural, subarachnoid, epidural, and intraparenchymal hemorrhages. Soft tissue swelling is also easily detected on CT, and when bone windows are available, the presence of skull and facial fractures can be assessed. For the critically ill child with a head injury, CT is a readily available means of diagnosis and can assist with the identification of patient requiring emergent surgical intervention.<sup>20</sup>

Magnetic resonance imaging (MRI) can provide additional information regarding extra-axial collections, intraparenchymal hemorrhages, contusions, shear injuries, and brain edema.<sup>20</sup> That being said, use of MRI in an acute ED setting is not practical for several reasons. MRI is relatively insensitive in the detection of acute hemorrhages when compared with CT. Most centers require sedation to complete an MRI because the scan time is much longer, making it difficult to perform efficiently in a young child. In addition, because of this long scan time, MRIs are not recommended for evaluation of an unstable or critically ill child.<sup>21</sup>

A basic MRI protocol typically entails use of T1- and T2-weighted sequences, gradient echo T2-weighted sequences (good for detection occult hemorrhage), and fluid attenuated inversion recovery imaging (for additional views of shear injury and fluid collections). Many institutions use MR venography as routine with brain MRIs to exclude venous thrombosis as a possible etiology of intracranial findings that present similarly to AHT.<sup>22</sup> Diffusion-weighted imaging protocols have become increasingly useful for further assessment of AHT as they are useful in the evaluation of stroke or other hypoxic injuries associated with AHT (Figure 2A and B). In some cases, diffusion-weighted imaging may detect brain pathology before parenchymal injuries become visible on CT or conventional MRI modalities.<sup>20,21</sup>

The dating of injuries by CT or MRI has been a subject of controversy. One study attempted to describe general time intervals for the evolution

injuries based upon their appearance on CT or MRI, but the scientific evidence for this method has not been validated.<sup>23</sup> Similarly, imaging modalities should not be used to infer the number of traumatic events a child has sustained. It is worthwhile to note that dating and evolution of subdural collections are influenced by the presence of many conditions, including anemia, coagulopathies, and mixture of blood with cerebrospinal fluid.<sup>24</sup>

The role of cranial ultrasound in the diagnosis of AHT has been debated. Ultrasonography of the head is relatively insensitive for identifying small acute subdural hemorrhages. It may be useful as an adjunct to CT in some cases to follow up on intracranial pathology.<sup>21</sup> In general, its use for the purposes of diagnosing AHT is not recommended.

Certain patients with other types of physical abuse injuries but no apparent neurologic symptoms should be screened with imaging to diagnose comorbid occult head injuries. Recommendations have been developed for high-risk infants. Rubin et al<sup>25</sup> found that occult head injuries were discovered in children younger than 12 months who presented with rib fractures, multiple fractures, or other facial injuries.

Children in whom AHT is considered should have a skeletal survey. The American Academy of Pediatrics policy statement on diagnostic imaging of child abuse asserts that a skeletal survey is indicated in all suspected cases of abuse in children younger than 2 years. The decision to order skeletal surveys on children older than 2 years should be made on a case-by-case basis depending upon clinical history, physical examination findings, or symptoms.<sup>20</sup>

A recent study by Duffy et al<sup>26</sup> provides evidence in support of this recommendation. They found that children younger than 6 months presenting with seizures, ALTE, and suspected AHT had the highest rates of fractures discovered on skeletal survey. Skeletal surveys may reveal skull fractures missed on CT due to their orientation or location in relation to the plane of the CT scanner.<sup>21</sup> The percentage of skull fractures in cases of nonaccidental trauma in children younger than 2 years has been reported to be as high as 33% in some studies. Characteristics of skull fractures suggestive of abuse include bilateral fractures, occipital fractures, complex fractures, fracture diastasis above 3 mm, fractures crossing suture lines, and fractures with depressed fragments.<sup>18,21,22</sup>

### **Ophthalmology Examination**

Retinal hemorrhages are a common finding associated with AHT. Retinal hemorrhages may be identified during the physical examination, especially in more severe cases of AHT. However,

consultation by a pediatric ophthalmologist, when possible, is preferred within 24 hours to obtain a detailed eye examination. Pediatric ophthalmologists can provide valuable interpretation and documentation regarding the anatomical location, nature, and severity of retinal hemorrhages as well as identify eye pathology. Pediatric ophthalmologists at some medical institutions may use digital technology systems to provide photo documentation of the retinal examinations.<sup>27,28</sup>

Caution should be taken not to rely on the presence of retinal hemorrhages alone to diagnose AHT. Although studies indicate that extensive, multilayered retinal hemorrhages and retinoschisis are highly specific for AHT, the diagnosis should never be made in the absence of a thorough and supportive history, physical examination, and diagnostic workup.<sup>27,28</sup> Retinal hemorrhages can be seen with major accidental trauma and various medical conditions such as severe coagulopathy, bacterial meningitis, vascular disease, leukemia, and other systemic disorders. Usually there are other medical findings to support an alternative diagnosis, and often, the nature and extent of injury do not compare with what is seen with AHT. Increased intracranial pressure, hypoxia, cardiopulmonary resuscitation, anemia, seizures, and vaccines are not associated with retinal hemorrhages in children.<sup>28,29</sup>

The dating or timing of retinal hemorrhages cannot be precisely ascertained. Retinal hemorrhages may vary in their evolution and resolution depending upon their nature, location, and overall severity of injury. One study sought to determine whether the pattern of brain injury in abused children affected the distribution of retinal hemorrhages. Results indicated that asymmetry and laterality of retinal hemorrhages were of higher magnitude when the eye examination was performed within 24 hours. The study also documented evidence that retinal hemorrhages may evolve over time or even emerge in areas that were previously free of hemorrhage in a hospitalized child, highlighting the pitfalls in attempting to date retinal hemorrhages and suggesting the utility of prompt ophthalmologic examination.<sup>30</sup>

### **Laboratory Evaluation**

Laboratory evaluation in pediatric patients presenting with concern for AHT is necessary to support the diagnosis, confirm or exclude comorbidities, assess for potential complications, and to assess for alternative medical diagnoses. At a minimum, the laboratory evaluation should include a complete blood count, serum electrolytes with

liver transaminases and pancreatic enzymes to screen for occult abdominal trauma, urinalysis, and basic coagulation screening tests. Additional laboratory evaluation should be directed by the history and physical examination and may include toxicology screening, screening for bleeding disorders, and screening for metabolic or nutritional disorders. In such cases, additional medical specialty consultation is warranted.<sup>18</sup>

Consideration should be given to disseminated intravascular coagulopathy screening tests in patients with suspected AHT. Altered coagulation can be a serious complication of head trauma and may include both hypercoagulable and hypocoagulable states. Derangements sometimes seen on screening include abnormal platelet counts as well as elevations in prothrombin time. Studies have shown that these derangements can be more significant in patients presenting with severe and ultimately fatal head injuries.<sup>31,32</sup>

## MANAGEMENT

The role of the emergency medical provider in the acute management of patients with AHT should follow standard trauma protocol. The foundation of management includes securing and supporting the airway with prompt intubation and ventilator support when indicated. This becomes especially important in cases of AHT, where often the mechanism of injury is unknown and evolution of secondary brain injury can be unpredictable.<sup>33</sup>

Acute assessment and management of cardiovascular status are also pivotal. Hypovolemia and shock may accompany intracranial injury in severe cases of AHT. Hypotension portends a poor outcome in patients with traumatic brain injury. If not rapidly corrected, cerebral perfusion pressure may be compromised.<sup>33</sup>

Emergent management should include assessment for cervical spine injury. For patients who present by ambulance, many arrive with their cervical spines stabilized with a collar. Consultation with pediatric trauma and neurosurgery specialists is prudent for cervical spine clearance.<sup>33</sup> Many centers now add cervical spine CT or MRI as part of AHT evaluations.

Seizures are a relatively common complication of AHT. Seizures can be the only presenting symptom in a case of AHT. Emergent seizure control is imperative to reduce the risk of compounding intracranial injury, as uncontrolled seizure activity increases the brain's metabolic rate, affects circulation and oxygenation, and can lead to increases in intracranial pressure. Observation for new or

subclinical seizures is imperative, especially within the first 48 hours of a serious AHT, as brain injury can worsen.<sup>33</sup>

## MEDICAL-LEGAL IMPLICATIONS

The emergency care provider is frequently the first professional to encounter a child abuse patient within the medical system. For this reason, it is imperative to recognize abusive injuries, to document carefully, and to report suspicious cases. As previously discussed, an implausible clinical history is the hallmark of a child abuse diagnosis. For example, it is not uncommon in cases of serious abusive head injury to obtain a trauma history of a short or minor fall. It is worth noting that, with the exception of arterial epidural hemorrhages and large space-occupying subdural hemorrhages, short falls (<1.5 m) are rarely fatal.<sup>34</sup> Therefore, a serious brain injury attributed to a minor fall should raise concern for abuse, in most clinical situations.<sup>35</sup>

The provider should objectively document why the case is suspicious and what information is reported by the caregiver. Quotes should be used when appropriate. It is prudent to ask open-ended questions and avoid suggesting theories regarding mechanism of injury if the caregiver does not offer a plausible explanation. Clear documentation in the medical record can help to establish history and to highlight any discrepant information. Clinical encounter notes may become a legal document.

The increasing use of electronic medical records (EMRs) by many medical institutions can offer advantages. Electronic medical records eliminate problems with legibility of documentation. They may make documentation more efficient and quick, and they can facilitate reviewing previous visits and diagnoses. However, EMRs can also provide a dangerous crutch. Documentation in EMRs should be thoroughly proofread before completion. Care should be taken not to rely too heavily on templated physical examinations or other portions of the history that auto-populate into a patient's note. Medical providers should also avoid cutting and pasting portions of previous notes by other authors.

Mandated reporting laws exist in all 50 states. Practitioners should be aware of individual state laws as well as system-specific protocols for reporting. Jones et al documented that providers frequently do not report abuse for various reasons; however, failure to report can result in legal charges or expose a provider to risk of malpractice.<sup>36</sup> Cooperation with professionals, including other medical providers as well as those from community agencies, is necessary. The sharing of information with investigating

authorities in the context of suspected child maltreatment takes precedence over Health Insurance Portability and Accountability Act (HIPPA) regulations in most situations.

Often, when suspected abuse is reported, medical providers are confronted with the possibility of court testimony. Many providers are not comfortable with this role. Although it is valuable to recognize one's limitations, there must be a balance with meeting professional and ethical responsibilities. The medical-legal interface cannot always be avoided. In addition, if a case is prosecuted, a provider may have to testify regarding the medical opinion. Careful documentation is helpful when a case is headed to court.

Law enforcement and child welfare professionals may have forensic questions regarding the medical details of a case. Issues regarding the timing of an injury or the biomechanics of a proposed mechanism may come up. Clinical information from x-rays, laboratories, and symptom history can be helpful in answering when a child was hurt.<sup>37</sup> It is generally accepted that patients with subdural hematoma from significant angular deceleration are symptomatic at the time of injury.<sup>38</sup> Given the spectrum of injury severity, symptoms may be nonspecific and/or not reported, sometimes making it difficult to assess the timing of injury. All of the information should be examined to provide a thorough opinion of the case. There are limits, however, to the extent in which the medical information can determine dating of injuries.

Fortunately, child abuse pediatric specialists are more commonly available to consult on cases, provide support for other subspecialists, and answer specific forensic questions. In fatalities, it is important that a forensic pathologist who is knowledgeable in the autopsy standards for suspected victims of child abuse perform the autopsy.<sup>39</sup> Despite these resources, it may not always be possible to avoid testimony. Some guiding principles may help alleviate concerns about court proceedings. In general, it is recommended that providers limit opinions to their particular field of practice and regarding the care provided. Investigative conclusions should be left to nonmedical professionals.

## OUTCOMES

In general, outcome data for patients with AHT are sparse. Patients are frequently lost to follow-up and when follow-up is possible, study sizes are small. Research in this area has improved with time; however, research efforts are needed. From the studies that have been completed, it is clear that

serious sequelae are common, although there is a wide spectrum of morbidity. Compared with patients with accidental head injury, AHT patients have longer hospital stays and worse outcomes.<sup>4,40</sup>

Surviving patients may not have obvious disability at time of hospital discharge. Others may manifest significant physical or developmental problems. Statistics vary, but studies have demonstrated that 11% to 33% will die.<sup>41</sup> Over half of patients will have some sort of permanent neurologic damage, such as cerebral palsy, blindness, hydrocephalous, and seizure disorders.<sup>41</sup> The severity of subsequent brain injury is correlated with initial neuroimaging.<sup>42</sup> Poor visual outcome is more often the result of brain injury than the presence of retinal hemorrhages.<sup>43</sup>

Perhaps least understood are the long-lasting cognitive effects of AHT. It is clear that behavioral and developmental problems have been associated.<sup>44</sup> More subtle deficits may be difficult to track and correlate. This issue is especially pertinent in patient cases where there is no obvious developmental delay noted immediately after injury. Such long-term effects of brain injury may not be revealed until a child is older or school-aged.

## SUMMARY

Infants and young children are at high risk for significant morbidity and mortality from AHT. The diagnosis of abusive injuries can be a very challenging task. It is important for ED medical providers to consider child abuse in the differential diagnoses of trauma or unexplained neurologic symptoms. Emergency medical providers must also recognize the legal responsibilities accompanying potential abuse cases. A multispecialty approach to the evaluation that uses the expertise of a child abuse pediatrics specialists, pediatric trauma surgery, neurosurgery, and pediatric ophthalmology can facilitate diagnosis and management. ☒

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