

# Diagnosing abusive head trauma: the challenges faced by clinicians

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**Abstract** This article highlights five important aspects of the clinical problem of evaluating young children who are suspected of having abusive head trauma: 1) the clinical questions to be addressed, 2) challenges when evaluating young children with suspected abuse, 3) key aspects of clinical practice and data collection, 4) a framework for decision-making and 5) key articles in the literature that can help inform a sound clinical decision about the likelihood of abuse.

**Keywords** Clinical diagnosis · Non-accidental injury · Non-accidental head trauma · Child

## Introduction

Although much has been written about the diagnosis of abusive head trauma (AHT), including mechanisms of head injury, differential diagnosis, data collection, types of injuries and prognosis [1–4], there is little information about the challenges faced by clinicians in evaluating children with concerns about AHT. Therefore, the purpose of this commentary is to highlight five aspects of the clinical problem:

1. The clinical questions to be addressed
2. Challenges when evaluating young children with suspected abuse
3. Key aspects of clinical practice and data collection
4. A framework for decision-making
5. Key articles in the literature that can help inform a sound clinical decision about the likelihood of abuse.

## Clinical questions

Two important questions need to be addressed when evaluating a child for suspected abuse. First, are the child's findings due to trauma or a medical problem (or a combination of the two)? Second, if trauma, are the injuries due to abuse as opposed to neglect, an unintentional (or accidental) cause or birth trauma? The answer to these questions and the level of certainty can change during the evaluation as more information is obtained. This additional information might be obtained from family members, radiographic studies such as the skeletal survey, or an investigative social worker from child protective services (CPS). Even when all the data are collected, the clinician might not be certain about the likelihood of abuse. For example, in a recent study comparing ICD-9-CM diagnoses with the clinicians' ratings of the likelihood of abuse for children with a variety of injuries (not just head injuries), in 19% of cases, the child abuse consultant rated the likelihood of abuse as uncertain [5].

Identification of abuse as the cause of trauma is also relevant to those who are charged with protecting children, such as CPS workers, and those who investigate crimes, such as police officers. Clinicians who evaluate and diagnose abusive injuries, therefore, may be asked to answer two additional, related questions. First, is it safe for the injured child to go home? The decision about safety is made by CPS and is influenced by the information about the suspected perpetrator. Second, if abuse occurred, when did the abuse occur? An understanding of the timing of the injury can help answer the question of who hurt the child, which, in turn, affects whether an alleged perpetrator will be arrested and prosecuted.

The importance of answering these clinical questions accurately is underscored by the fact that a new subspecialty of pediatrics, known as child abuse pediatrics, was recently approved by the American Board of Pediatrics, with the first subspecialty certifying exam in 2009. Child abuse

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pediatricians receive specific training and develop expertise in the evaluation of injuries, such as head trauma, and can be a valuable resource in the clinical setting.

### Key challenges when evaluating young children for suspected abuse

When evaluating children who are suspected of having AHT or other types of serious injuries where abuse is suspected, there are at least six key challenges – three of which relate to making the correct diagnosis and three of which relate to interacting with the family.

The first challenge is that the children who are being evaluated for suspected abuse tend to be young and nonverbal and, therefore, are not able to provide information about what happened to them. A second and related challenge is that the history of what happened is usually provided by the caregivers, who may be lying about what happened. Since clinicians rely on histories to guide work-ups and make diagnoses, the caregiver's false history about what happened may misdirect the clinician's evaluation and interfere with the clinician's ability to make the correct diagnosis. Third, clinicians have biases that might influence whether abuse should be considered in a specific case. For example, in a study of missed cases of AHT, the diagnosis of abuse was more likely to be missed in very young white children whose parents were married [6].

The fourth challenge concerns family members and their willingness to consider that abuse has occurred. It can be especially challenging when family members reject this possibility. In these cases, instead of asking the caregiver about what happened and whether the caregiver may have hurt the child, family members often support the denials of the responsible adult and become angry at the clinicians who suggest that the child was hurt by a caregiver. A fifth challenge occurs when families receive dissimilar information from different clinicians about the likelihood of abuse. When some clinicians tell families that they are concerned about abuse and other clinicians indicate that abuse is being ruled out or that the child is cleared, families may not only become confused, but also have a tendency to split the clinicians into good and bad ones. These inconsistencies in how clinicians discuss the likelihood of abuse with families help to reinforce the view that the caregiver did nothing wrong and that the physicians cannot even decide if the child was abused.

The final challenge relates to how families learn about abuse and other medical conditions that may be confused with abuse. With easy access to the Internet, even when an infant is in the pediatric intensive care unit and sometimes before clinicians have finished the evaluation, parents are asking whether the child has enlarged subarachnoid spaces or a bleeding disorder or whether the child's recent vaccines caused the problem. While it might be helpful for families to

have information from the Internet, it is difficult for them to sort out what is reasonable. Also, it is likely that information about alternative diagnoses to abuse will be of the most interest to a family who is not open to the possibility that abuse has occurred.

### Key aspects of clinical practice and data collection

Publications [1, 2, 4] have outlined the kinds of data that should be collected concerning the history, physical exam, laboratory/radiology data, scene investigation, and interviewing of others by CPS and police. Therefore, we will highlight ten points that we believe are especially salient to clinical practice and data gathering in cases of suspected abuse and not review all aspects of data collection:

1. When a child abuse pediatrician is available for consultation to help evaluate the likelihood of abuse for an injured child, it is important that caregivers understand the role of that pediatrician. Ideally, the clinician who first suspects abuse should explain to the caregivers why there is a concern about abuse and why a consultation is being requested. When the child abuse consultant becomes involved, a good place to begin is to determine what the caregivers have been told about the consultation, as well as what their understanding is of the child's condition and the cause. In addition, when the consultant takes the history from a child's caregivers, it can be helpful to have another clinician, such as the nurse or social worker, present to listen and make observations about the caregivers and their responses.
2. It is important to ask about what happened and let the parents provide the history without interrupting them. After hearing their story in full, one can then review each aspect of the history to learn more details.
3. It is helpful to know when the child was last noted to be normal or at his or her baseline state, who noted this and what behaviors were noted (e.g., feeding, laughing or playing with blocks) that were considered normal. It is useful to know who was present when the child became symptomatic, especially if the symptoms occurred rapidly and during a short period of time. This information can help determine who may have hurt the child and guide the clinician in evaluating medical possibilities other than abuse. Making an actual written timeline of events, symptoms and caregivers may be useful to the clinician during the history gathering.
4. How the caregiver responded when the child became symptomatic is important information related to the concerns about abuse. It helps to know what the adult did to help the child, whom the caregiver called, and whether and when 911 was called. Sometimes, many phone calls

are made to family or friends to get advice about the child's serious symptoms, or there is a substantial delay between the onset of life-threatening symptoms and calling 911. It also helps to know whose decision it was to call 911 or seek medical care. Delays in calling 911 sometimes raise suspicions that the caregiver was hoping that the child would revive on his or her own because if medical care were sought, the abuse would be identified.

5. It is important to know about the child's developmental milestones, especially if the injuries are attributed to the child's activities. Has the child rolled over in the past and does that developmental skill fit with the child's behavior as described in the history?
6. Questions about any recent trauma or falls allow one to consider previous events as a cause for the child's symptoms. It is also important to ask about previous injuries, bruises or bleeding from the mouth or nose; who was caring for the child when these occurred, and whether medical care was sought for any of these. Recently, Sheets et al. [7] highlighted the importance of "sentinel" injuries (perceived "minor" injuries that preceded serious abuse). This study noted that of the 100 infants hospitalized for AHT, 30% had at least one sentinel injury compared to 0% of 101 infants who were hospitalized with injuries but no concerns for abuse.
7. As part of the social history, we ask caregivers about their own childhood and concerns about maltreatment and also about previous CPS involvement for the child or family, domestic violence, use of alcohol or drugs, mental health problems and troubles with the law. These data can shed light on the parents' perceptions of parenting and risk factors that can affect parenting, and help to identify areas in the family unit that may benefit from services.
8. Information from others, including the child's pediatrician, the first responders, the clinicians in the emergency department, the CPS investigator and the police often provides a more complete perspective of the child's injury and its cause. This information can then be used to examine inconsistencies in the history provided or changes in the history as obtained over time.
9. A complete physical exam is important, with a focus on identifying injuries, including scalp hematomas, subconjunctival hemorrhages, tears of the frena and bruises (especially of the torso, ears and neck) [8], and evidence of enlargement of the liver or abdominal tenderness.
10. The specifics of diagnostic imaging related to AHT will not be reviewed here, but we have three comments about working with radiologists. First, it is important to review all imaging studies with the appropriate radiologists, who can focus specifically on the concerns of suspected

abuse. Second, we have found it very helpful to review the neuroimaging studies with a single neuroradiologist who can review all the CTs and MRIs and thus note changes in the findings as opposed to relying on the individual readings of each study. Third, it has been helpful to have each skeletal survey reviewed by two pediatric radiologists who need to agree on the findings before the reading is official. This approach has minimized the likelihood of missing an important finding and also means that any positive findings are peer reviewed.

### A framework for decision-making

A critical challenge facing clinicians is using the data to make a decision about the likelihood that the child's condition or injury is due to abuse. Physicians often think in terms of the degree of certainty on a scale from "definite abuse" to "definite not abuse." The scale involves words such as "consistent with abuse," "very likely abuse," "probable abuse," "possible abuse" and "uncertain whether abuse or accidental."

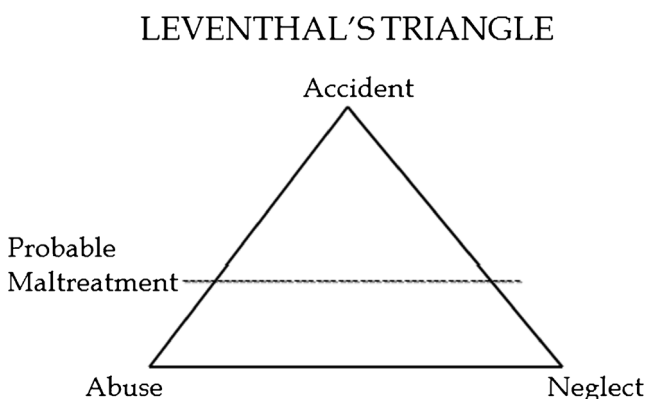
When making a decision about the likelihood of abuse vs. an alternative diagnosis, such as an accidental injury, the clinician links the history and the details provided with the specifics of the child's findings in terms of three critical variables: 1) mechanism, 2) severity and 3) timing. Do the details of the history provide a clear mechanism to explain the child's findings, do the details explain the severity of the child's findings and do the details fit in terms of the timing of the injury? For example, consider the case of an 8-month-old who rolled off a 20-in.-high bed and landed on the tile floor and had no loss of consciousness. The evaluation revealed a scalp swelling, a linear parietal skull fracture and a small extra-axial collection of acute blood beneath the parietal skull fracture. In terms of the three variables, the clinician might say that the history provides a clear mechanism for the injuries (a fall off the bed in a child who can roll), the severity of the injury is within the range of expectations for a fall off a bed (contact injury that requires relatively low force), and the timing of a recent injury from a fall is consistent with the scalp swelling and the acute blood on the CT scan.

In contrast, if a similar history were provided but the child was apneic, had facial bruises, acute subdurals over the convexities and in the interhemispheric region, extensive retinal hemorrhages involving two layers and two healing rib fractures, then the consideration of the three variables would be very different. The fall from the bed would not be considered a reasonable mechanism to explain the injuries and the fall should not result in the severity of the findings. In addition, the fall could not explain both the acute injuries and the healing rib fractures. The fall may have occurred, but the fall was not the cause of all the child's injuries.

The likelihood of abuse vs. an alternative diagnosis, such as an accident, can be schematically shown in the figure of “Leventhal’s Triangle.” The clinician may be deciding between three etiologies: abuse, neglect or accident as represented by the points of the triangle (Fig. 1). Along the line from “Accident” to “Abuse” can be plotted to the clinician’s degree of certainty concerning the likelihood of abuse in a specific case. The likelihood would extend from “definite abuse” at one end of the line to “definite accident” at the other end. The dashed line in the figure shows the clinician’s assessment of the likelihood of abuse; in the example in Fig. 1, the likelihood is plotted as “probable maltreatment” (or probable abuse). A clinical assessment that is plotted above the dashed line and closer to the point of the triangle labeled “Accident” would indicate that the clinician is less worried about abuse, while an assessment that is more certain about the likelihood of abuse would be plotted below the dashed line and closer to the point labeled “Abuse.”

If the clinician is not concerned about abuse, but instead the assessment is between an accident and neglect, the line from “Accident” to “Neglect” can be used to plot the clinician’s degree of certainty between these two points. Since the dashed line indicates an assessment of “probable maltreatment” (or probable neglect), the clinician’s assessment above this line would indicate less worry about neglect, and an assessment below this line would indicate an increased likelihood.

When discussing a case, two clinicians can each plot his or her degree of certainty, and if these are placed at different points on a line the clinicians can discuss why they disagree and what data each used to make a decision. It is important to highlight the importance of peer support for the clinician evaluating these cases. Working through the case details and discussing any unclear issues with a knowledgeable, experienced second clinician can be invaluable.



**Fig. 1** Leventhal’s triangle for plotting the likelihood of maltreatment

## Key articles in the literature

There are many articles that provide helpful information to the clinician when deciding on the likelihood of abuse in a specific case. We will briefly review four of these articles we have found especially helpful. The first addresses the question “Can shaking cause AHT?” and the other three address the question “Do children with accidental head injuries differ from children with AHT?”

The article by Adamsbaum et al. [9] indicated that violent and repetitive shaking can cause AHT. This study focused on 112 children with AHT who were referred to the French courts for forensic investigation. Of these 112 cases, there were 29 with detailed confessions by the perpetrators; 93% of these 29 children were <1 year of age, 10% had skull fractures and 31% died. The clinical characteristics of these 29 were similar to the 83 cases in which there were no confessions. The perpetrators who confessed included fathers or stepfathers (45%), mothers (27%), child minders (21%) and others (7%).

All of the perpetrators described shaking the infant violently. The perpetrators reported taking the children under the arms and shaking violently, sometimes with verbal abuse. The shaking was described as resulting in exhaustion of the infant, who stopped crying. It was striking that 45% of the perpetrators reported shaking the child on more than one occasion. This study confirmed what other studies of confessions have reported, namely that shaking is an important mechanism of abusive injury [10, 11].

The second article examined the presence and location of retinal hemorrhages in a consecutive sample of children < 24 months of age who were admitted to a single hospital for evaluation and treatment of a head injury [12]. The determination of whether the child was abused was based on specific criteria, and these criteria were independent of the eye findings. All children received a dilated retinal exam, and the eye findings were compared in two groups: abuse vs. accident.

In the 15 cases of abuse, the mean age was 6.5 months compared to 9 months in the 67 children with accidental head injuries. Compared to the accidental group, the abuse group was more likely to have a subdural hematoma (80% vs. 27%), less likely to have a skull fracture (27% vs. 60%), and more likely to have retinal hemorrhages (60% [9/15] vs. 10% [7/67]). Of the seven accidental cases with retinal hemorrhages, six affected one eye only, three had a single retinal and the hemorrhages did not extend to the periphery in any of the cases. In contrast, of the nine cases of single retinal hemorrhage in the abuse group, the hemorrhages were bilateral in six and the hemorrhages extended to the periphery in four.

Although the sample was relatively small, the results highlight differences in the extent and location of retinal hemorrhages in the two groups. The results are consistent with those from other studies of young children with accidental head

injuries – namely that retinal hemorrhages occur infrequently and often are unilateral [13–15].

The third article [16] compares cases of AHT with confessions to cases of witnessed accidents. By selecting such cases, Vinchon et al. [16] focused on the “certain” cases of abuse and the “certain” cases of accidents. The question being addressed was “Are there clinical characteristics that distinguish AHT vs. accidental head injuries?” The cases were collected prospectively; there were 45 cases of AHT and 39 cases of accident. In the abuse group, the mean age was 3.8 months; 30 cases were labeled as shaken baby syndrome and 15 as “beaten baby syndrome.” In the accident group, the mean age was 8.1 months; 19 of the cases involved a car accident and 16 involved a fall (e.g., from a window, arms of an adult or shopping cart). There were key differences in the two groups. For example, evidence of impact on the head occurred more frequently in the accident group (87% vs. 38%), whereas subdural hematomas occurred more frequently in the abuse group (82% vs. 44%), as did retinal hemorrhages (84% vs. 17%).

The authors also examined the sensitivity, specificity, positive predictive value and negative predictive value of four key findings: subdural hematoma, absence of scalp swelling, brain ischemia and severe retinal hemorrhages. The positive predictive value is the likelihood that the outcome (AHT) is present given the presence of a specific finding or set of findings. The positive predictive value of the four findings for AHT were as follows: subdural hematoma (68%), absence of scalp swelling (83%), brain ischemia (92%), severe retinal hemorrhages (96%), and the combination of subdural hematoma and severe retinal hemorrhage without scalp swelling (100%). This study highlights the importance of individual clinical predictors and combinations of clinical predictors that can help distinguish AHT vs. accidental head injuries. Clearly, a diagnosis is not based on a single finding in a child.

The final study extends the previous study and combines the results of six studies to examine predictors of AHT in 1,053 children <3 years of age (348 with AHT and 705 non-AHT) [17]. Maguire and colleagues [17] examined the positive predictive value of six findings in children with intracranial injury: apnea, bruising of head or neck, rib fractures, long-bone fractures, seizures and retinal hemorrhages. The article shows the positive predictive value for each finding individually and every combination of the six findings. For example, any combination of three or more of the six findings resulted in a positive predictive value for AHT of >85%. Like the smaller study by Vinchon [16], this study provides important data to the clinician about the constellation of findings and can be used to compare the findings of a specific child to the pooled data. An important limitation of this study is that specific details of some of the clinical findings were not included in the predictive models. For example, in the model, retinal hemorrhages were considered as either present or absent, but clinically the number and location of the retinal

hemorrhages are important. In AHT, retinal hemorrhages are often too numerous to count, multilayered and extend to the ora serrata [18].

## Conclusion

Making or refuting a diagnosis of abusive head trauma is challenging. The stakes are always high in medical decision-making for children, but in the case of abuse, an incorrect diagnosis has potential implications in the social and community arenas that are not faced by other medical providers. When abuse is mistaken for an accidental injury or medical diagnosis, a child may be hurt again or killed if allowed to remain in the same unsafe environment. When abuse is wrongly diagnosed and an alternative explanation for a child’s presentation exists, the child may be removed from his or her family with profoundly negative implications for the child and his or her caregivers. Caregivers who are falsely labeled as abusive may be unable to work in their chosen profession, such as child care or teaching, and may be wrongly prosecuted and incarcerated for a crime that they did not commit.

In the face of the high stakes and challenges that confront clinicians who evaluate children who may have been abused, it is important that clinicians keep an open mind about what may have happened to the child and use a clear approach to decision-making that makes use of high-quality, relevant literature. It is equally crucial for these clinicians to recognize that medical decision-making informs not only medical treatment but also the work of child protective services and the legal system. A careful approach that incorporates attention to a clear and thorough data-gathering plan, sources of bias and an epidemiologically valid assessment of the likelihood of abuse is the clinician’s best strategy to arrive at the correct diagnosis in one of medicine’s most challenging arenas.

**Conflicts of interest** Dr. Leventhal is the PI on grants to Yale University that support the Child Abuse Programs and Child Abuse Prevention Programs. He is on the International Advisory Board of the National Center on Shaken Baby Syndrome. Drs. Leventhal, Asnes, Pavlovic and Moles testify in court regarding child abuse cases

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