Analysis of Missed Cases of Abusive Head Trauma

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Abusive head trauma (AHT) is a dangerous form of child abuse. More child abuse deaths occur from head injuries than any other type of injury.1 Infants and toddlers who survive AHT often have serious neurologic sequelae.2,3

Head injury in infants and toddlers can be difficult to diagnose because symptoms are often nonspecific. Vomiting, fever, irritability, and lethargy are common symptoms of a variety of conditions seen in children, including head trauma. When caretakers do not give a history of injury and the victim is preverbal, an abusive head injury can be mistakenly diagnosed as a less-serious condition.

In March 1995, we evaluated a 14-month-old child who had sustained an abusive head injury 4 months previously. Shortly after his initial injury, he had been examined by his physician and his new-onset seizures were attributed to his history of prematurity. During the next 4 months, the child had 7 physician visits and 2 cranial imaging studies. At each visit, the diagnosis of AHT was not recognized. When we examined him 4 months later, he had multiple old and new fractures and healing brain injuries, including extensive brain atrophy and healing brain infarctions. This case encouraged us to review our experience with AHT cases to determine if the appropriate diagnosis had been previously missed. We also examined factors that may have contributed to the unrecognized diagnosis of AHT.

Context Abusive head trauma (AHT) is a dangerous form of child abuse that can be difficult to diagnose in young children.

Objectives To determine how frequently AHT was previously missed by physicians in a group of abused children with head injuries and to determine factors associated with the unrecognized diagnosis.

Design Retrospective chart review of cases of head trauma presenting between January 1, 1990, and December 31, 1995.

Setting Academic children’s hospital.

Patients One hundred seventy-three children younger than 3 years with head injuries caused by abuse.

Main Outcome Measures Characteristics of head-injured children in whom diagnosis of AHT was unrecognized and the consequences of the missed diagnoses.

Results Fifty-four (31.2%) of 173 abused children with head injuries had been seen by physicians after AHT and the diagnosis was not recognized. The mean time to correct diagnosis among these children was 7 days (range, 0-189 days). Abusive head trauma was more likely to be unrecognized in very young white children from intact families and in children without respiratory compromise or seizures. In 7 of the children with unrecognized AHT, misinterpretation of radiological studies contributed to the delay in diagnosis. Fifteen children (27.8%) were reinjured after the missed diagnosis. Twenty-two (40.7%) experienced medical complications related to the missed diagnosis. Four of 5 deaths in the group with unrecognized AHT might have been prevented by earlier recognition of abuse.

Conclusion Although diagnosing head trauma can be difficult in the absence of a history, it is important to consider inflicted head trauma in infants and young children presenting with nonspecific clinical signs.

JAMA. 1999;281:621-626 www.jama.com

For editorial comment see p 657.
to document medical history and the history of the acute injury, review previous medical and social service records, review prior radiological studies, perform a careful physical examination, and order appropriate new diagnostic studies. In all cases, organic illnesses that mimic AHT are ruled out. Confirmation that head trauma was inflicted requires multidisciplinary team consensus.

Head trauma cases were identified from the log records of the CAP Team and charts were reviewed in depth. To ensure concurrence, study cases were reviewed by at least 2 of the authors (including C.J.) and radiological imaging studies were reviewed by a pediatric radiologist (T.C.H.). Permission for the anonymous chart review was granted by the hospital’s human subjects committee. Information gathered included demographics, social and family data, details of the children’s injuries, presenting complaints, clinical course, and details of previous medical visits related to head trauma, if applicable.

We limited the study to children with head injuries who were younger than 3 years for 2 reasons. First, children older than 3 years are not as likely to sustain severe injury when struck in the head or shaken. Second, children older than 3 years are more likely to be able to articulate their experiences. Hence, AHT is much less likely to be missed as the appropriate diagnosis.

Abusive head trauma was defined as inflicted cranial injury. Researchers debate whether shaking alone or shaking and impact cause the signs and symptoms commonly referred to as shaken baby syndrome. The mechanism of injury cannot always be accurately determined in child abuse cases. Because shaking, impact, to the head, or both are all potentially harmful to infants and toddlers, we grouped all head injuries caused by abuse into the single category of AHT.

Factors considered by the multidisciplinary team in reaching the diagnosis of AHT (rather than unintentional head injury) included: (1) confession of intentional injury by an adult caretaker; (2) inconsistent or inadequate histories given by caretakers (the history given did not explain the nature and severity of the injuries); (3) associated unexplained injuries, such as fractures or intra-abdominal injuries; and (4) delay in seeking care.

Cases of AHT were defined as missed if review of medical records and radiological studies confirmed the following predefined criteria: (1) Prior to the diagnosis of AHT, a physician evaluated the child (on ≥1 occasions) for nonspecific clinical sign(s) compatible with head trauma (ie, recurrent vomiting, irritability, facial and/or scalp injury, altered mental status, abnormal respiratory status, and/or seizures). (2) The medical evaluation(s) for these nonspecific clinical sign(s) did not result in a diagnosis of AHT. (3) Thereafter, 1 or more of the following scenarios occurred: (a) The child improved clinically, later experienced (repeat) acute trauma confirmed as abusive, and underwent diagnostic imaging that revealed old cranial injuries and other new injuries. (b) The child remained symptomatic or experienced worsening clinical signs until head trauma was recognized, verified by cranial imaging studies, and confirmed as abusive. (c) The person who injured the child later admitted to abusing the child shortly before the onset of the child’s nonspecific clinical sign(s). In all cases, the estimated age of the cranial injuries documented by imaging studies was consistent with the prior time of onset of the child’s nonspecific clinical sign(s).

All remaining cases of AHT evaluated during the study period were considered recognized. Children who sustained any new inflicted injuries during the period of diagnostic delay were classified as recognized. Study patients whose medical records after their inflicted head trauma revealed abnormal head growth, recurrent seizures, psychomotor delays, chronic anemia, vomiting, weight loss, and/or sensory deficits were classified as having medical complications of AHT.

We examined data to determine what factors were associated with a missed vs recognized diagnosis. We used χ² testing to assess the independence of 10 variables on the outcome variable of a correct diagnosis of head trauma. Variables resulting in χ² P ≤ .25 or less were entered into an initial multivariate logistic regression model. We then used Wald and likelihood ratio testing to iteratively remove noncontributory variables from the model. Analysis was performed using Stata software, Version 5.0 (Stata Corp, College Station, Tex).

### RESULTS

A total of 232 children with suspected head injuries were evaluated by the CAP Team from January 1990 through December 1995. Fifty-nine children did not meet study criteria. Of these, 8 were eliminated because they were aged 3 years or older. It was determined that 38 were not abused. The medical records of 13 children could not be located. The remaining study sample included 173 abused children with head injuries.

The mean age of the 173 children was 247 days (range, 10 days to 2.9 years). Ninety-five (55%) of the children were male and 78 (45%) were female. The boys’ ages at the time they were first seen for symptoms of AHT were not significantly different than the girls’ ages. In our study sample, minorities were overrepresented (33.5% minority) compared with the racial distribution of the Denver metropolitan area (19.7% minority).

The types of injuries noted in the children are shown in Table 1. Many of the children sustained more than 1 type of injury. Eighty-nine children (51.4%) were covered by Medicaid-funded insurance programs. Twenty-seven children (15.6%) were uninsured. The remainder had private health insurance.
Missed vs Recognized AHT

In the 173 children with AHT, 54 cases (31.2%) were classified as missed. For children with missed AHT, the mean number of physician visits before the trauma was recognized was 2.8 (range, 2-9 visits).

For children in whom the diagnosis of AHT was missed, the mean length of time to diagnosis of head trauma from the day of the first visit was 7 days (range, 0-189 days). In 5 cases, the children were seen twice in the same day and the diagnosis was made on the second visit; hence, the designation of 0 days until diagnosis in some cases of missed AHT.

When missed cases were compared with recognized cases, several factors were found to be significantly different.

Age

Children with missed AHT were much younger than those in whom the diagnosis was recognized on the first physician visit. The mean age of missed AHT cases at the time of their first medical visit for head injury symptoms was 180 days (93% confidence interval [CI], 125-236). The mean age of the recognized cases was 278 days (95% CI, 228-328). The mean ages of children with missed and recognized AHT were significantly different (independent samples t test, P = .02).

Race

Abusive head trauma was missed significantly more often in white children than children of minority races. In white children, 43 (37.4%) of 115 cases of AHT were missed and in minority children, 11 (19%) of 58 were missed (Pearson $\chi^2$, P = .01).

Family Composition

Abusive head trauma was more likely to be missed in families in which both parents lived with the child. Thirty-seven (40.2%) of 92 cases were missed in intact families. In families in which the mother and father of the child were not living together, 14 (18.7%) of 75 cases were missed (Pearson $\chi^2$, P = .003).

Severity of Symptoms at Initial Visit

Not surprisingly, the more severely symptomatic children were more likely to be recognized as having head trauma at first visit to the physician. Table 2 summarizes the number and percentage of children who were missed and recognized as having AHT compared with their symptoms and signs. At the first visit, children who were comatose, whose breathing was compromised, who were having seizures, or who had facial bruising were more likely to be accurately diagnosed. Conversely, children who presented with irritability or vomiting at the first visit were less likely to be identified as having AHT.

Factors Not Significantly Different

Several factors were found not to differ between children with missed vs recognized AHT. These included whether the parents were employed, whether the parents had private insurance coverage, the sex of the child, the birth weight of the child, and whether the child had been born prematurely (<37 weeks' gestation).

Factors Associated With Missed Diagnosis of AHT

Nine variables were found to be significantly associated with missing the diagnosis of AHT by univariate analysis. These variables and entered into a logistic regression model. They included age younger than 6 months, minority race, parents not living together, and 6 signs and symptoms noted at the first visit, including facial injury, seizures, decreased mental status, abnormal respiratory status, vomiting, and irritability. Of these 9 variables, 4 were retained in the multivariate logistic model. These 4 independent variables predicting the correct diagnosis of AHT at the first visit included (1) abnormal respiratory status (odds ratio [OR], 7.23; 95% CI, 2.4-21.3; P < .001); (2) seizures present (OR, 6.67; 95% CI, 2.5-17.3; P < .001); (3) facial and/or scalp injury present (OR, 4.81; 95% CI, 2.1-11.0; P < .001); and (4) parents not living together (OR, 2.49; 95% CI, 1.1-5.7; P = .03).

Applying the logistic regression model constructed from the data, we found that if none of these 4 factors were present, the probability that a physician would make the correct diagnosis of AHT was P = .20. That is, if a child had normal respirations, had no seizures, had no facial or scalp injury, and came from an intact family, the probability that AHT would be recognized was less than 1 in 5.

### Table 2. Missed and Recognized Abusive Head Trauma Cases: Severity of Presenting Symptoms

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>No. (%) Recognized</th>
<th>No. (%) Missed</th>
<th>$X^2$ Test</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial and/or scalp injuries</td>
<td>78/119 (66.5)</td>
<td>20/54 (37.0)</td>
<td>12.293</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Other bodily trauma (not head or face trauma)</td>
<td>53/118 (44.9)</td>
<td>10/54 (18.9)</td>
<td>10.664</td>
<td>.001</td>
</tr>
<tr>
<td>Mental status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awake and alert</td>
<td>35/119 (29.4)</td>
<td>35/64 (54.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleepy and/or lethargic</td>
<td>31/119 (26.1)</td>
<td>17/54 (31.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comatose and responsive to pain</td>
<td>21/119 (17.6)</td>
<td>1/54 (1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comatose and unresponsive to pain</td>
<td>32/119 (26.9)</td>
<td>1/54 (1.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal breathing</td>
<td>45/119 (37.8)</td>
<td>44/54 (81.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compromised</td>
<td>20/119 (16.8)</td>
<td>8/54 (14.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Requiring resuscitation or ventilation</td>
<td>54/119 (45.4)</td>
<td>2/54 (3.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory status by group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>45/119 (37.8)</td>
<td>44/54 (81.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal (compromised or requiring resuscita</td>
<td>74/119 (62.2)</td>
<td>10/54 (18.5)</td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Seizures at first visit</td>
<td>55/119 (46.2)</td>
<td>8/54 (14.8)</td>
<td>15.820</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Vomiting at first visit</td>
<td>42/111 (38.7)</td>
<td>30/54 (55.6)</td>
<td>4.637</td>
<td>.03</td>
</tr>
<tr>
<td>Irritable at first visit</td>
<td>53/111 (47.7)</td>
<td>34/52 (65.4)</td>
<td>4.426</td>
<td>.04</td>
</tr>
</tbody>
</table>

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UNRECOGNIZED CASES OF ABUSIVE HEAD TRAUMA

Misdiagnoses Applied to Children With AHT

The 54 children with missed AHT received 98 diagnoses other than AHT during their 98 patient visits. Table 3 lists the diagnoses applied to the children with missed AHT. The most common diagnoses made were for viral gastroenteritis and accidental head injury. In some cases, the diagnoses were correct, even though coexistent head trauma was not recognized. For example, in 1 case an infant was accurately assessed to have a retropharyngeal abscess, but the accompanying subdural hematoma, retinal hemorrhages, and skull fracture were not recognized. In other cases, the symptoms of head trauma were attributed to conditions other than AHT. In 10 cases, the wrong diagnosis was applied more than once to the same child. We did not count these repeated diagnoses on our frequency table.

Outcome and Consequences

Twenty-five (14.5%) of the 173 children died as a result of their head injuries. Of the recognized AHT cases, 20 (16.8%) of 119 children died. In the missed AHT cases, 5 (9.3%) of 54 children died. The percentage of children in the missed AHT group who died was not statistically different than in the recognized AHT group ($\chi^2 = 1.712; P = .19$). In our estimation, 4 of the 5 deaths in the missed AHT group might have been prevented by earlier recognition of abuse (Table 4).

Of the missed AHT cases, 15 (27.8%) of the 54 children were known to have been reinjured because of the delay in diagnosis. Twenty-two children (40.7%) had medical complications related to the delay in diagnosis. These conditions included seizure disorders, chronic vomiting, and increasing head size because of increasing untreated subdural hematomas.

Radiological Misdiagnosis

In 7 of the children whose diagnosis of AHT was missed, radiological errors contributed to the delay. These 7 children had 8 studies in which trauma was missed, including 6 computed tomography scans of the head, 1 skeletal survey, and 1 long-bone radiograph of the arm. The 2 longest delays in diagnosis (141 days and 174 days) and 6 of 25 cases in which the diagnosis of AHT was missed for longer than 7 days involved radiological misreadings. Table 5 summarizes the nature of the errors made and

Table 3. Frequent Erroneous Diagnoses Made in Cases of Missed Abusive Head Trauma*

<table>
<thead>
<tr>
<th>Diagnosis Made</th>
<th>No. of Times Diagnosis Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viral gastroenteritis or influenza</td>
<td>14</td>
</tr>
<tr>
<td>Accidental head injury</td>
<td>10</td>
</tr>
<tr>
<td>Rule out sepsis</td>
<td>9</td>
</tr>
<tr>
<td>Increasing head size</td>
<td>6</td>
</tr>
<tr>
<td>Nonaccidental trauma (not head injury)</td>
<td>4</td>
</tr>
<tr>
<td>Otitis media</td>
<td>5</td>
</tr>
<tr>
<td>Seizure disorder</td>
<td>5</td>
</tr>
<tr>
<td>Reflux</td>
<td>3</td>
</tr>
<tr>
<td>Apnea</td>
<td>3</td>
</tr>
<tr>
<td>Upper respiratory tract infection</td>
<td>2</td>
</tr>
<tr>
<td>Urinary tract infection or pyelonephritis</td>
<td>2</td>
</tr>
<tr>
<td>Bruising of unknown origin</td>
<td>2</td>
</tr>
<tr>
<td>Hydrocephalus</td>
<td>2</td>
</tr>
<tr>
<td>Meningitis</td>
<td>2</td>
</tr>
</tbody>
</table>

*Incorrect diagnoses made only once included anxiety, bronchiolitis, colic, complications of prematurity, constipation, failure to thrive, fever of unknown cause, hemiparesis, milk allergy, myositis, pneumonia, postmeningitic subdural effusion, retropharyngeal abscess, rule out osteomyelitis, sudden infant death syndrome, torticollis, urticaria, viral encephalitis, and vomiting of unknown cause.

Table 4. Clinical Presentations of 4 Potentially Preventable Deaths With Missed AHT*

<table>
<thead>
<tr>
<th>Patient Age, mo</th>
<th>Time Between Visits</th>
<th>Documented Clinical Signs</th>
<th>Evaluation Results</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>First visit, vomiting, sleepy, normal respirations, facial bruising</td>
<td>None</td>
<td>Influenza</td>
<td></td>
</tr>
<tr>
<td>7 Days after first visit, vomiting, alert and responsive, normal respiration, new bruising</td>
<td>None</td>
<td>Otitis media</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Days after first visit, vomiting, coma, unresponsive to pain, respiratory arrest</td>
<td>Retinal hemorrhages, subdural hemorrhage, focal brain injury, diffuse brain injury, noncranial trauma</td>
<td>AHT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>First visit, failure to thrive, vomiting, alert and responsive, normal respiration, bruising to face and chest</td>
<td>Normal computed tomography result with missed subdural hemorrhage and brain shearing tears</td>
<td>Apnea</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>141 Days after first visit, seizures, coma, unresponsive to pain, respiratory arrest</td>
<td>Retinal hemorrhages, skull fracture, subdural hemorrhage, diffuse brain injury, noncranial trauma, old cranial trauma</td>
<td>AHT</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>First visit, vomiting, irritability, sleepiness, normal respiration, &quot;went limp&quot;</td>
<td>None</td>
<td>Anxiety secondary to new day care</td>
<td></td>
</tr>
<tr>
<td>6 Days after first visit, vomiting, diarrhea, irritability, alert and responsive, normal respiration</td>
<td>None</td>
<td>Acute gastroenteritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Days after first visit, vomiting, irritability, coma, unresponsive to pain, seizures, cardiorespiratory arrest</td>
<td>Retinal hemorrhages, subdural hemorrhages, diffuse brain injury</td>
<td>AHT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>First visit, vomiting, irritability, alert and responsive, normal respiration, dehydration</td>
<td>None</td>
<td>Acute gastroenteritis</td>
<td></td>
</tr>
<tr>
<td>8 Days after first visit, coma, unresponsive to pain</td>
<td>Retinal hemorrhage, subdural hemorrhage, diffuse brain injury, old brain injury, old cranial trauma</td>
<td>AHT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*In all cases of missed abusive head trauma (AHT), the estimated age of cranial injuries documented by imaging studies was consistent with the time of onset of the child’s nonspecific clinical sign(s) before his/her first physician visit.

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the time in delay of diagnosis attributed to the radiological mistreading.

COMMENT

It is difficult to study the cases of child abuse that clinicians do not recognize. In 1972, Jackson9 reviewed traumatic injuries in children at King’s College Hospital in London, England, and found 18 of 100 cases to have been missed cases of child abuse. O’Neill et al10 reported a series of 110 battered children in 1973. Eighty percent of those children had signs of prior injury. Alexander et al11 found physical evidence of previous head trauma in 8 of 24 children evaluated for head injury due to shaking. Ewing-Cobbs et al12 discovered signs of preexisting brain injury in 45% of children with inflicted traumatic brain injury compared with none in children with accidental traumatic brain injury.

Incidental cases of missed child abuse have been published.13 In their study of abusive head injuries, Benzel and Hadden mention that 9 of 23 abused children with head injuries...were known to have been seen by other physicians because of similar problems or other injuries consistent with child abuse. Since then, an increased awareness of child abuse has occurred, but similar studies have not been reported.

We do not know how many cases of AHT are never detected. Surely, the injuries occurring from impact or shaking represent a range of severity, from no injuries to mild concussion or small subdural hemorrhage, severe brain damage, extensive intracranial bleeding, and cerebral edema. Caffey15 speculated in 1972 that many children who are found to have mild neurologic abnormalities and learning disabilities may have been victims of AHT.

Parents who confess to shaking or hitting the heads of their children frequently report doing the same thing previously. In 1 study case, an infant was hospitalized 3 times before someone witnessed the child being shaken violently. On 1 occasion, he was evaluated and treated for possible sepsis. The other 2 hospitalizations were for apnea and reflux, respectively. The child’s father admitted to multiple episodes of shaking that led to the infant’s various illnesses.

In the current study, we found that 31.2% of children who were clinically symptomatic after AHT were misdiagnosed as having other conditions. Infants have few ways to demonstrate illness or injury. Nonspecific signs, such as vomiting, fever, and irritability, are seen in a myriad of conditions, including many benign, self-limited illnesses. The difficulty, then, is to be able to discern when these signs and symptoms indicate potentially serious or fatal pathology.

The possibility exists that in some of the visits we classified as missed, the child had not yet been injured. However, in another study by our group, we found that patients became symptomatic immediately after their injuries in 37 cases in which perpetrators admitted to causing head injuries in infants.16 To guard against misclassification, we examined the medical records extremely carefully to correlate clinical and radiological findings.

Not surprisingly, the infants and toddlers in our study whose head injuries were misdiagnosed were overall less ill than those whose head injuries were recognized. The fact that they were not as ill made the diagnosis of AHT difficult. Also, the children whose AHT was missed were, as a group, younger. The difficulty of diagnosing serious illness or injury in young infants is complicated by the limited range of their normal behavior. With less-sophisticated behavioral and neurologic signs to assess, the changes in young infants with head injuries are more difficult to detect.

Striking differences were seen in the race and family composition of infants with missed and recognized injuries. Infants with recognized AHT were more likely to be minority children or children whose mothers and fathers were not living together. We speculate that this may represent a subtle bias in decision making based on the physician’s assessment of risk. A physician examining a white child from an intact family may be less likely to think about the possibility of child abuse. Another hypothesis is that perhaps minority and single-parent families were more likely to obtain care from public clinics or hospital emergency departments, where physicians may be more attuned to abuse issues. In the current study, the children of intact, 2-parent households were much

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Visit No. in Which Radiological Error Was Made</th>
<th>Nature of Misdiagnosis</th>
<th>Length of Delay in Diagnosis Due to Radiological Error, d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>First visit of 2</td>
<td>Result of CT of head read as normal; CT showed subdural hemorrhage and shearing tears of the parenchyma</td>
<td>141</td>
</tr>
<tr>
<td>2</td>
<td>Third visit of 4</td>
<td>Result of CT of head read as consistent with internal hydrocephalus; CT showed subdural hemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Second visit of 3</td>
<td>Result of CT of head read as normal; CT showed subdural hemorrhage</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>First visit of 2</td>
<td>Result of skeletal survey read as normal; child had a metaphyseal fracture of the tibia and unilateral periosteal elevation of the same bone</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>Second visit of 3</td>
<td>Result of CT of head read as normal; CT showed subdural hemorrhage</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>First visit of 2</td>
<td>Result of CT of head read as normal; CT showed subdural hemorrhage</td>
<td>51</td>
</tr>
<tr>
<td>7</td>
<td>Second visit of 9</td>
<td>Result of CT of head read as normal; CT showed subdural hemorrhage and shearing tears of the parenchyma</td>
<td>174</td>
</tr>
<tr>
<td>Fifth visit of 9</td>
<td>Long-bone radiographs of both arms read as consistent with myositis; x-ray film showed extensive periosteal reaction of both humeri and metaphyseal fractures of proximal humeri bilaterally</td>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

*CT indicates computed tomography.
more likely to have private insurance (Pearson χ², 23.953; P<.001). In addition, white families were much more likely to have private insurance than minority families (Pearson χ², 5.148; P = .02). However, we did not collect data on the practice setting in which missed and recognized diagnoses were made.

Are missed cases of AHT inevitable? If a child’s caretakers cannot or will not give an accurate history, making the correct diagnosis is extremely difficult. Physicians cannot obtain cranial computed tomographic scans for every infant and toddler who presents with vomiting, irritability, and fever. Based on this study and on our experience with these cases, we make the following suggestions to facilitate the diagnosis of AHT.

1. Be alert for bruises or abrasions on the face or head of children presenting with nonspecific symptoms. In 20 of 54 missed AHT cases in this study, facial or head bruising was attributed to accidental injury unrelated to the presenting illness. One study of bruising in healthy, nonabused children found no bruises on children who were not yet strong enough to pull to standing.15 The presence of bruises in infants raises the possibility of inflicted injury.

2. When evaluating infants and toddlers with nonspecific symptoms, such as vomiting, fever, or irritability, consider head trauma in the differential diagnosis. Perform a head-to-toe physical examination, palpate the fontanelles, measure the head circumference, and be alert for signs of trauma.

3. When collecting spinal fluid in cases of suspected infantile sepsis, examine any bloody cerebrospinal fluid for xanthochromia. A supernatant of a spinal fluid contaminated by blood secondary to a traumatic procedure should be clear in color if the specimen is examined shortly after it is collected. Xanthochromic spinal fluid can represent old blood in the cerebrospinal fluid from previous trauma, although it is not specific for an intracranial bleed.18-20

4. Pediatrically trained radiologists should be consulted to interpret x-ray film and computed tomographic images in cases of suspected child abuse.

In addition to these suggestions, other as yet unvalidated strategies to detect occult abuse could be considered. Dilated retinal examinations in infants and children with nonspecific symptoms of illness could increase the recognition of retinal hemorrhages. Retinal hemorrhages have been reported in the majority of children who are victims of AHT.21 Other possibilities need further research. Some markers of brain trauma are known to cross the blood-brain barrier, such as the BB fraction of creatine kinase. If rapid tests were available for such markers, a simple blood test possibly could be done to detect occult trauma. In a recent study by Hymel and colleagues,22 children with traumatic parenchymal brain injury were frequently noted to have prolonged prothrombin and partial thromboplastin times. These tests are generally available and inexpensive to run. Their sensitivity and specificity as screening tests for head trauma in infants are not known.

There are other ways for AHT to present clinically that we did not see in this group of patients. The list of signs and symptoms we examined is not universally inclusive. Another limitation of our method is that the study was done retrospectively through record review. However, this seems to be the only option we currently have for examining diagnostic errors. Finally, information concerning the training, experience, or practice setting of the physicians evaluating these patients was not obtained.

Although it is difficult to detect all serious AHT in the clinical setting, an awareness of the nonspecific nature of the signs and symptoms of AHT, particularly in less-serious cases, could increase the likelihood that more cases will be detected.

Disclaimer: The opinions and conclusions in this article are those of the authors and are not intended to represent the official positions of the US Air Force, US Department of Defense, or any other governmental agency.
When considering patient selection criteria and care planning, clinicians must further recognize the importance of having an experienced team. Comparing this study with their earlier work, it appears that results improved when the intervention was strengthened from 2 to 4 weeks and home visits were added. Since it is hard to predict which patients will continue to have an unstable course, one wonders whether continued involvement would have additional value. More studies are needed to address this question.

The need for improved discharge planning and postacute care management has been well recognized, yet limited medical oversight and lack of active physician participation during transitional care and ongoing chronic care remain a serious problem. Efforts must extend beyond simply creating hospital discharge plans. Acute care must be truly linked with postacute care. Naylor et al show that value is gained when medical decision makers, in this case advanced practice nurses, work closely with patients, caregivers, and other practitioners during the transition, then visit patients' homes and maintain continuity. This solid case management connection also promotes efficiency by allowing many problems to be handled by telephone. Integration into the care process creates the opportunities for effective intervention.

Finally, this study recalls important observations drawn from large community care demonstrations in the 1970s and 1980s. To be most cost-effective, interventions must be targeted to specific populations and efforts must be made to control the ongoing cost of interventions. Those seeking to replicate this approach should heed these observations.

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The Challenges of Recognizing Child Abuse

Seeing Is Believing

John M. Leventhal, MD

Almost 4 decades have passed since Kempe and colleagues’ published in the JOURNAL their landmark description of the battered child syndrome. There were 2 major findings in that study. The first was a clinical description of children who had been physically abused by their parents. Although the abuse and misuse of children had been recognized for centuries and radiographic findings in children thought to be caused by deliberate injuries had been described, publication of the article by Kempe et al in JAMA made it clear that injuries caused by physical abuse were clinical problems that required the attention of physicians. The second finding was the result of an epidemiological survey in which 749 abused children—many of whom either had been killed or had sustained permanent brain damage—were identified by 71 hospitals and 77 district attorneys in the United States. This large number of cases suggested that serious child abuse was unlikely to occur frequently. However, no one in 1962 would have predicted that in the United States in 1997, almost 3.2 million reports of child maltreatment would be made to child protective service agencies. Of these reports, approximately 1 million were confirmed, including neglect (54%), physical abuse (22%), sexual abuse (8%), emotional abuse (4%), and other (12%).

That parents could physically hurt their children was a frightening notion for clinicians concerned with the health and welfare of children, yet the astute observations and clinical descrip-

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JAMA, February 17, 1999—Vol 281, No. 7 657
tions of Kempe et al and the research that followed changed the way injuries in children were viewed. Clinicians no longer would readily accept certain histories provided by parents as truthful and, instead, would consider the possibility of child abuse.

There have been numerous challenges for the field of child abuse since 1962, including gaining an understanding of the extent of the problem and how abuse occurs in families, the development of statewide systems of protective services to evaluate suspected maltreatment and help ensure the safety of maltreated children, the development of treatment programs for children and families and for adults who were maltreated as children, and the development of prevention programs to help children and families before maltreatment occurs. A cornerstone for all these activities is the appropriate recognition of the abused child and, concomitantly, the appropriate recognition of injuries that are truly unintentional. Although recent media attention and court cases have suggested that physicians are overdiagnosing child abuse, the true problem continues to be one of underrecognition. For example, since the early 1970s, repeated unexplained deaths of infants in a family usually were believed to be due to recurrent sudden infant death syndrome (SIDS); however, recent evidence has indicated that some cases of recurrent SIDS are, in fact, homicides.

Although the recognition of abuse can be relatively straightforward (eg, a young child with fresh bruises, healing fractures, and no history that explains the injuries), there are many times when recognition is difficult. Why is it so difficult to recognize an abused child? The first problem is the false or misleading history that is often provided. In the usual clinical encounter, the physician is accustomed to a truthful (if sometimes minimized or exaggerated) history. Because diagnostic reasoning is often shaped by the history provided, a misleading history can misdirect the diagnostic process and result in an incorrect diagnosis. In a study of fractures in children younger than 3 years, examination of the initial histories in 52 abused children revealed that in only 1 instance did a parent indicate that the child had been hurt by an adult. Instead, the most common presenting histories were a report by a caretaker of an abnormality (eg, a seizure or decreased movement of a limb) in 52% of cases, a fall in 27%, being hit by an older child in 10%, and a self-inflicted injury in 6%. Of course, young children cannot speak for themselves, but even older children often learn very early the importance of keeping family secrets and telling physicians, teachers, social workers, and others a false story (eg, they tripped and fell) to explain an injury to the face that was caused by abuse.

A second set of factors that influence the likelihood of recognition of abuse are personal biases related to the physician’s education, experience, attitudes, and beliefs. Unfortunately, most medical students receive little education—often only 1 or 2 lectures—about abuse or family violence. Physicians who provide care to children may have had little formal education about child abuse and limited clinical experience during their residencies in evaluating suspected abuse. Attitudes and beliefs also can interfere with making a correct diagnosis. Physicians often have difficulty believing that abuse can occur in families in which the parents appear to be caring and interact well with the physicians. In fact, some of the most difficult cases to diagnose can be those in which parents have characteristics much like the physicians who are conducting the evaluations. For instance, instead of considering possible child abuse to explain fresh bruises on the arms of a 6-month-old infant, the physician asks only about a family history of bleeding disorders. Sometimes, physicians do not ask about abuse because they do not want to offend or falsely accuse the family or because they want to be certain about the diagnosis before discussing it. And sometimes, physicians do not want to get involved, although in every state, laws mandate that physicians report suspected (not necessarily confirmed) child maltreatment.

Progress has been made in helping physicians recognize injuries that may indicate abuse. For example, studies on the biomechanics of injuries and characteristics that distinguish abusive injuries from those that are unintentional have been helpful. Also helpful has been the increasing number of physicians who have pursued careers focusing on the problem of abuse despite the limited opportunities for funding and fellowship training, both of which fall far short of what is needed, based on the extent of the problem.

Although learning from errors in diagnosis is always difficult, physicians are accustomed to such an approach. In this issue of The Journal, Jenny et al present an important study on the failure of physicians to recognize head injuries that were due to child abuse. During a 6-year period, 31% of 173 children younger than 3 years with the final diagnosis of a head injury due to abuse had made at least 1 prior visit to a physician at which the diagnosis of child abuse had been missed. The authors note substantial consequences to missing the diagnosis: 28% of the children were reinjured because of a delay in diagnosis and 4 deaths might have been prevented by earlier diagnosis.

The diagnoses made at these initial visits to physicians included the range of possibilities in young children who present with a false or misleading history and symptoms of central nervous system disease, including gastroenteritis, unintentional head injury, colic, or otitis media. Errors in the interpretation of computed tomographic scans of the head (ie, failure to identify subdural hematomas) and radiographs of bones (ie, failure to identify metaphyseal fractures) contributed to missing the correct diagnosis and are an important reminder that the correct diagnosis of child abuse often relies on collaboration with specialists, such as radiologists, orthopedic surgeons, and neurosurgeons.

Not surprisingly, at the initial presentation to the physician, children who had milder symptoms (no seizures, normal respiratory status, and no facial or scalp injury) were more likely to have the diagnosis missed. Also, children whose parents were living together were more likely to have the correct diagnosis missed, which suggests that in the absence of a truthful history, physicians’ attitudes and beliefs influenced the likelihood of a correct diagnosis.
This study does not address a related and important type of missed diagnosis, namely, labeling a child's unintentional injury as abuse. Such an incorrect diagnosis can cause substantial harm to the child and family, especially if the child is removed from the home.

Can physicians do better at recognizing injuries caused by abuse and thereby reduce the frequency of delayed diagnoses? Jenny et al provide sound, specific recommendations to improve the likelihood of making a correct diagnosis, such as performing a complete examination on young children with nonspecific symptoms (ie, vomiting or irritability) and being suspicious of bruises or abrasions on the face or head of infants. As part of the evaluation of an infant with such nonspecific symptoms and facial marks, the physician should ask the parent directly about how the facial injuries occurred and about the possibility that someone may have hurt the child and should consider obtaining a computed tomography scan of the head and a skeletal survey.

To make the correct diagnosis of abuse, physicians need to be suspicious for its possible occurrence. Injuries in young children (except those that occur from normal activities, such as bruises on the shins of toddlers, or those that occur from common unintentional events, such as a short, linear, parietal skull fracture from a fall off a bed) need careful evaluation. When a clinician is concerned about the mechanism of how the injury occurred, the extent of the injury, or the timing, child abuse should be considered. It is helpful to review the history with the person(s) who actually witnessed the event; if concerns persist, the physician should report the case to protective services and obtain the appropriate diagnostic tests (eg, skeletal survey, computed tomography scan of the head, or ophthalmologic evaluation). It may be necessary for the physician to get help obtaining a more detailed social and family history and hospitalize the child to complete the evaluation.

Two general recommendations deserve mention. First, all physicians who see children, not just those in primary care, should receive education about child abuse. This education should begin in medical school, be incorporated into residency training programs, and be extended through continuing medical education courses. Second, collaboration among physicians and other professionals, including protective service workers, should be improved because it is necessary to solve the diagnostic puzzle of child abuse. For instance, the radiologist who is made aware of the child's bruises and the pediatrician's suspicions would certainly be more alert to signs of abuse on the radiographs. Although making the correct diagnosis of child abuse will continue to be a challenge and reducing missed or delayed diagnoses to zero is unlikely, physicians can do better. The key, of course, is “seeing” clearly. When that happens, seeing will become believing, even if what is seen correctly is painful to all—that sometimes adults can hurt children in serious and deadly ways.

REFERENCES
Recognizing Abusive Head Trauma in Children

To the Editor: The article by Dr Jenny and colleagues1 raises a critical question: how can practicing physicians improve their ability to recognize inflicted head trauma in young children? Unfortunately, their study does not provide enough information to solve the practitioner’s constant question: what is the predictive value of the symptom or sign at hand? Jenny et al address the question of if a child has an inflicted head trauma, then what is the chance the child will have facial bruising, nonspecific vomiting, fever, or irritability? In fact, these probabilities reported in their article were high enough to be of interest.

However, the practitioner needs to know if a child has facial bruising, nonspecific vomiting, fever, or irritability, then what is the chance the child has sustained inflicted head trauma? The data presented by Jenny et al in no way answer this critical question. For instance, if a child has vomiting that cannot be fully explained, is the risk that the child has been abused high enough to justify a formal evaluation for abuse, including head neuroimaging, ophthalmology consultation, and alerting the child protection authorities? The same question can be raised for the child presenting with facial bruising, irritability, and fever. The conclusion that the authors reach extends beyond the data they presented.

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To the Editor: As Dr Jenny and colleagues1 point out in their analysis of missed cases of abusive head trauma in children, abusive head trauma can be difficult to diagnose because of the lack of external evidence of trauma. However, their article failed to emphasize that abusive head trauma often results in dramatic ophthalmic manifestations.2,3

Examining small infants can be done easily in the hospital. Vision can be assessed by close observation of fixation and following patterns. The pupillary reflexes should be examined carefully for sluggish pupils or a defect in the afferent pupillary response. Externalsigns of periorbital edema, ecchymosis, or lid lacerations may be seen. Palpation of the orbital rim may reveal the characteristic step-off of a previous orbital floor fracture. A traumatic sixth-nerve palsy may result in esotropia. A variety of anterior segment findings, including conjunctival lacerations, corneal abrasions, traumatic cataract, or hyphema with attendant intraocular pressure changes, may be noted.

The hallmark ophthalmic finding in shaken-baby syndrome is that of posterior segment hemorrhages.4,5 All infants with suspected abusive head trauma should have a thorough dilated funduscopic examination with an indirect ophthalmoscope to view the entire posterior pole and the retinal periphery. Abusive head trauma characteristically produces multiple, layer hemorrhages, although vitreous, preretinal, intraretinal, or subretinal hemorrhages also may be present.5 Peripheral dome-shaped hemorrhagic lesions with white retinal borders may represent peripheral retinoschisis. The retina can even be folded in a circumferential manner around the macula. While many retinal hemorrhages resolve without sequelae, involvement of the optic nerve or macula can produce profound lifelong visual loss.

While none of the reported ocular findings is pathognomonic, these eye findings along with the associated medical history and other medical conditions give strong evidence for abusive head trauma. An ophthalmic examination is associated with no morbidity, can be quickly and easily performed, and can often confirm this difficult diagnosis. We recommend that clinicians have a low threshold for ordering ophthalmic consultation in cases of suspected abusive head trauma.

Herbert Becker, MD
Balaji K. Gupta, MD
University of Illinois at Chicago

To the Editor: Any diagnosis requires sound criteria to be defensible. However, 3 of the 4 factors used by Dr Jenny and colleagues1 to determine that intentional injury in a child had been “missed” are questionable. A confession typically is obtained only after a suspect has been repeatedly confronted with the allegation that “you shook your child” or after the caretaker has been offered a plea to a reduced charge with a limited jail sentence, given a deadline for accepting the offer, and threatened with an upward sentencing departure if there is a conviction on the original charges. Such a confession should not be used as evidence that nonintentional injury occurred, and may lead to incarceration of an innocent person.2,3 Furthermore, the history may be inadequate if the caretaker does not know what happened, or may be considered inconsistent if the team members evaluating child abuse are unfamiliar with the biomechanics of head injury. (Too often, any history other than “I did it” is considered inadequate.) Moreover, a delay in seeking care cannot be proved by assuming that an injury occurred at a certain time, and especially not by inferring that a child with a head injury never had a lucid interval.

If trained health care professionals have a difficult time recognizing severity of injury, why should a parent or caretaker be expected to do any better? The diagnosis of abusive head trauma is difficult at best. However, what special insight does a multidisciplinary team, as suggested by Jenny et al, “led by

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pediatricians” and including “social workers, nurses, psychologists, child psychiatrists, and attorneys” have to allow it to conclude by the criteria given that a head injury in a child is inflicted or unintentional? Where are those who understand the psychology of a false confession? Where are the biophysicists? Where are those who know the limitations of injury dating based on biochemical, radiological, or physical observation? Is “multidisciplinary team consensus” the “gold standard” for “confirmation that head trauma was inflicted”? The danger is for such a group to become a de facto star chamber, unencumbered by accountability or self-doubt. The judicial weight of a medical conclusion of abuse is too great to allow this to occur.1

The study by Jenny et al does not address the mislabeling of a child’s unintentional injury as abuse, and, as Dr Leventhal pointed out, an “incorrect diagnosis can cause substantial harm to the child and family, especially if the child is removed from the home.” However, the greater harm, in my opinion, is for someone to be charged and convicted and spend many years in prison or be executed for a crime that never occurred.2 The criteria for a medical diagnosis of abuse must be based on standards other than those used by Jenny et al. Physicians and other health care professionals must humbly admit in some and, perhaps, many cases, and especially in children with an isolated head injury, that we simply do not know if the trauma was unintentional or inflicted.

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In Reply: Dr Lavin points out that the practicing physician faces the dilemma that effective “screening tests” to rule out head trauma have not been tested. More research is needed to give physicians the tools they need to make an accurate assessment of nonspecific symptoms such as vomiting and irritability in preverbal children.

We agree with Drs Becker and Gupta that ophthalmologic findings in cases of abusive head trauma are common and often dramatic. More frequent use of ophthalmologic consultation most likely would lead to more accurate diagnosis.

Dr Plunkett takes issue with the criteria we used to define abusive head trauma. First, he states that confession by a perpetrator is likely to be coerced. For many years, we have asked the caretakers of injured young children a simple question: “What happened?” In response, some caretakers confess to injuring their children by shaking, striking, or slamming them. These confessions of inflicted pediatric head trauma are uniformly deeply emotional, guilt-ridden, and usually tearful. The accounts of extreme stress, the infant’s prolonged crying, a momentary loss of control, and the sincere desire to take back the moment when the event occurred evoke our deepest sympathy for these caretakers, their families, and their victims. Plunkett’s assumption that confessions of inflicted head trauma predominately follow threats and coercion minimizes the tangible sincerity of these confessors. He is not familiar with the cases we reported, and knows nothing of the circumstances of the confessions.

A conclusion that the caretaker’s history is inconsistent or inadequate typically arises when severe or fatal pediatric cranial injuries are reported to have resulted from a simple fall. An extensive body of literature about injuries sustained in witnessed pediatric falls leads us to the conclusion that substantial force and distance are required to seriously injure children.3,4 When presented with this information, many caretakers begin to change their account of the circumstances of the pediatric head injury. Although not diagnostic, an evolving or frequently changing history is more suggestive of inflicted trauma.

Despite Plunkett’s assertion to the contrary, we recognize that pediatric victims of head trauma may initially present with minimal symptoms. In contrast, most pediatric victims of “fatal” blunt head trauma reveal immediate and severe clinical signs of neurologic deterioration.3,5

Finally, Plunkett does not seem to realize that the abuse of children is a widespread problem. Our multidisciplinary team works from an assumption of innocence. Our decisions are based on the best available research. To refer to a thoughtful, careful multidisciplinary team as a “de facto star chamber” does not add to the scientific discourse on this extremely complicated issue.

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Disclaimer: The opinions and conclusions in this letter are those of the authors and are not intended to represent the official positions of the US Air Force, US Department of Defense, or any other governmental agency.


Electron Beam Computed Tomography to Detect Coronary Artery Disease

To the Editor: Drs Siegel and Evens1 note that electron beam computed tomography (EBCT) is being used to diagnose atherosclerosis. However, their statement, “At best, however, there