ORIGINAL CONTRIBUTION

Analysis of Missed Cases of Abusive Head Trauma

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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.

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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.

For editorial comment see p 657.

METHODS

We studied cases of AHT in children younger than 3 years evaluated at the Children's Hospital, Denver, Colo, from January 1, 1990, through December 31, 1995. The Children's Hospital is an academic medical center affiliated with the University of Colorado School of Medicine. It is a referral center for Colorado, Wyoming, Montana, and western Nebraska.

The children in this study were evaluated by the hospital's Child Advocacy and Protection Team (CAP Team). The CAP Team is a multidisciplinary group that consults on cases of suspected child abuse and neglect. The team is led by pediatricians whose clinical focus is child abuse. Social workers, nurses, psychologists, child psychiatrists, and attorneys also participate. The team routinely interviews caretakers

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Table 1. Types of Injuries Sustained by Study Population

Types of Injury	No. (%)
Head injuries	173 (100)
Subdural hematoma	150 (86.7)
Diffuse parenchymal brain injury	77 (44.5)
Localized brain contusions or shearing injuries	64 (37.0)
Skull fracture	55 (31.8)
Epidural hemorrhages	4 (2.3)
Retinal hemorrhages	114 (65.9)
Facial or scalp trauma	98 (56.6)
Trauma to parts of body other than head or face	63 (36.4)
Fractures other than skull fractures	60 (34.7)

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*.[4-6] 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 nonintentional 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 *reinjured*. 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 χ^2 testing to assess the independence of 10 variables on the outcome variable of a correct diagnosis of head trauma. Variables resulting in χ^2 $P \leq .25$ 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.[7] 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).[8]

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 (95% 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 χ^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 χ^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 were transformed to dichotomous 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

Symptoms	No. (%) Recognized	No. (%) Missed	χ^2 Test	*P* Value
Facial and/or scalp injuries	78/119 (65.5)	20/54 (37.0)	12.293	<.001
Other bodily trauma (not head or face trauma)	53/118 (44.9)	10/54 (18.9)	10.664	.001
Mental status				
Awake and alert	35/119 (29.4)	35/54 (64.8)	31.397	<.001
Sleepy and/or lethargic	31/119 (26.1)	17/54 (31.5)		
Comatose and responsive to pain	21/119 (17.6)	1/54 (1.9)		
Comatose and unresponsive to pain	32/119 (26.9)	1/54 (1.9)		
Mental status by group				
Awake and alert	35/119 (29.4)	35/54 (64.8)	19.326	<.001
Depressed or comatose	84/119 (70.6)	19/54 (35.2)		
Respiratory status				
Normal breathing	45/119 (37.8)	44/54 (81.5)	33.778	<.001
Compromised	20/119 (16.8)	8/54 (14.8)		
Requiring resuscitation or ventilation	54/119 (45.4)	2/54 (3.7)		
Respiratory status by group				
Normal	45/119 (37.8)	44/54 (81.5)	28.354	<.001
Abnormal (compromised or requiring resuscitation or ventilation)	74/119 (62.2)	10/54 (18.5)		
Seizures at first visit	55/119 (46.2)	8/54 (14.8)	15.820	<.001
Vomiting at first visit	42/111 (37.8)	30/54 (55.6)	4.637	.03
Irritable at first visit	53/111 (47.7)	34/52 (65.4)	4.426	.04

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*

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

*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*

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

*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.

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

COMMENT

It is difficult to study the cases of child abuse that clinicians do not recognize. In 1972, Jackson[9] 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 al[10] reported a series of 110 battered children in 1973. Eighty percent of those children had signs of prior injury. Alexander et al[11] found physical evidence of previous head trauma in 8 of 24 children evaluated for head injury due to shaking. Ewing-Cobbs et al[12] 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."[14] 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. Caffey[15] 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 5. Radiological Errors in Cases of Missed Abusive Head Trauma*

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

*CT indicates computed tomography.

more likely to have private insurance (Pearson χ^2, 23.953; $P<.001$). In addition, white families were much more likely to have private insurance than minority families (Pearson χ^2, 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 faces or heads 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 symptoms. One study of bruising in healthy, nonabused children found no bruises on children who were not yet strong enough to pull to standing.[17] 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.

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Table. Transaminase Values of Patients at Discharge*

Enzyme	Patients With Normal Transaminase Levels at Admission: Normal	≤1.25-Fold Elevation	1.26- to 2-Fold Elevation	>2-Fold Elevation
ALT (n = 1330)	1249 (93.9)	42 (3.1)	26 (2.0)	13 (1.0)
AST (n = 1413)	1392 (98.5)	10 (0.7)	11 (0.8)	0
γ-GT (n = 1248)	1210 (96.9)	17 (1.4)	21 (1.7)	0

	Patients With Elevated Transaminase Levels at Admission: ≤Admission	≤1.25-Fold of Admission	1.26- to 2-Fold of Admission	>2-Fold of Admission
ALT (n = 120)	89 (74.1)	14 (11.6)	16 (13.2)	1 (1.1)
AST (n = 37)	28 (75.7)	4 (10.8)	4 (10.8)	1 (2.7)
γ-GT (n = 202)	168 (83.1)	20 (9.9)	11 (5.5)	3 (1.5)

*ALT indicates alanine aminotransferase; AST, aspartate aminotransferase; and γ-GT, γ-glutamyltransferase. All data are presented as number (percentage) of patients.

of the 1507 patients consuming Chinese herbs. Two of the 14 patients also had temporary clinical symptoms (nausea and vomiting in 1 patient, itching in the second patient). Based on assessments by 2 independent physicians reviewing the records, a causal relationship of elevated ALT levels with Chinese drug therapy seemed possible in 13 patients and likely in 1. All patients were also receiving non–Chinese drug treatment, and, for some of the drugs used (for example, minocycline, mesalazine, and diclofenac), liver enzyme elevations are listed as possible adverse effects.[4] Thirteen patients had started these treatments with non–Chinese drugs before their hospital stays, and the dosages had been kept constant or diminished.

Follow-up values of ALT obtained within 8 weeks of hospital discharge were normal in 11 patients (6 of them had continued to take traditional Chinese drugs) and nearly normal in the remaining 3. In 5 patients there were indications of previous liver function abnormalities. The 14 patients with increased ALT levels had received a total of 115 different traditional Chinese drugs. When the frequency of drugs used in these cases was compared with the frequency in patients who had normal liver enzyme values, an increased risk was observed for formulas containing *Glycyrrhizae radix* and *Atractylodis macrocephalae rhizoma*.

Comment. In the population and setting studied, clinically relevant liver enzyme elevations occurred in about 1 in 100 patients treated with traditional Chinese drugs who also were receiving non–Chinese drug treatments. Based on these findings, we recommend that liver function be monitored in patients receiving traditional Chinese drugs, especially in patients with possible previous liver disease or risk of decreased liver function.

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CORRECTIONS

Incorrect Description: In the Editorial entitled "Understanding Parkinson Disease" published in the January 27, 1999, issue of THE JOURNAL (1999;281:376-378), selegiline was identified as an MAO type A inhibitor rather than a type B inhibitor. On page 377, the sentence should have read, "Selegiline is a monoamine oxidase type B inhibitor that limits the formation of free radicals derived from oxidation of dopamine, and application of this agent in clinical trials suggests an effect on disease progression consistent with a neuroprotective action.[23-25]"

Incorrect Byline and Affiliation: In the Original Contribution entitled "Analysis of Missed Cases of Abusive Head Trauma," published in the February 17, 1999, issue of THE JOURNAL (1999;281:621-626), the third author's name was misspelled in the byline on page 621. It should have read "Arlene Ritzen, MD, JD." Additionally, in the author affiliations on the same page, Dr Ritzen's affiliation should have read "Department of Pediatrics, Oregon Health Sciences University, Portland."

Author Omitted: In the Reply Letter entitled "Talking With Patients About Screening for Prostate Cancer" published in the January 13, 1999, issue of THE JOURNAL (1999;281:133), the first author was inadvertently omitted. Scott Stern, MD, should have been listed above Wendy Levinson, MD. Both authors are affiliated with the University of Chicago.