Can the Initial History Predict Whether a Child With a Head Injury Has Been Abused?

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ABSTRACT. *Objective.* **Previous studies of child abuse have used the presenting history as part of the case definition of abuse. Thus, data from these studies cannot be used to determine the diagnostic utility of historical features for identifying cases of abuse. The objective of this study was to determine the diagnostic utility of certain historical features for identifying cases of abusive head trauma.**

Methods. **We retrospectively studied all children, aged 0 to 3 years, who had acute traumatic intracranial injury and were admitted to a tertiary care pediatric hospital from 1993 to 2000. Cases were categorized as either "definite abuse" or "not definite abuse" on the basis of radiologic, ophthalmologic, and physical examination findings, without regard to the presenting history.**

Results. **Forty-nine (30%) of 163 children met the criteria for definite abuse. Having no history of trauma had a high specificity (0.97) and positive predictive value (PPV; 0.92) for abuse. Among the subgroup of patients with persistent neurologic abnormality at hospital discharge ($n = 34$), having a history of no or low-impact trauma had a specificity of 1.0 and a PPV of 1.0 for definite abuse. Injuries were blamed on home resuscitative efforts in 12% of definite abuse cases and 0% of not definite abuse cases. The initial history of trauma was changed in 9% of definite abuse cases, as compared with 0% of not definite abuse cases.**

Conclusion. **Among young children with a head injury, certain historical features have high specificity and PPV for diagnosing child abuse.** *Pediatrics* **2003;111:602–607;** ***child abuse, craniocerebral trauma, history, infant.***

ABBREVIATION. PPV, positive predictive value.

When infants with a head injury are evaluated, it is generally accepted that certain features of the history, such as a changing history, a history of low-impact trauma, or a history of no trauma, suggest abuse.[1–10] However, the actual sensitivity and specificity of these historical factors for identifying abuse is unknown. Previous studies of abusive head trauma used features of the history as diagnostic criteria for defining which cases were abuse.[11–16] It is impossible, therefore, to use data from these studies to determine the sensitivity and specificity of these same historical features for identifying cases of abuse.

Our goal was to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value of certain historical features for identifying cases of abusive head trauma. We collected a sample of cases of abusive head injury using a case definition for abuse that did not depend on any historical features. We then evaluated the test characteristics of certain historical features for differentiating these abuse cases from cases of unintentional head trauma.

METHODS

Patients

Charts of all children who were aged 0 to 3 years and admitted to the inpatient services at Children's Hospital in Boston from 1993 to 2000 with traumatic intracranial hemorrhage were reviewed. Children's Hospital is a tertiary care center and level 1 pediatric trauma center. The study was approved by the institutional review board at Children's Hospital. Cases were identified by searching the hospital's electronic patient information systems for the following discharge diagnoses: subdural hematoma, epidural hematoma, subarachnoid hemorrhage, traumatic brain hemorrhage, extradural hemorrhage, intracranial injury, skull fracture, shaken infant syndrome, and child abuse. Cases with evidence of intracranial hemorrhage on computed tomography scanning were eligible for inclusion. Cases were excluded when they had any of the following: coagulation defects, perinatal brain injury or hemorrhage, or structural intracranial abnormality (cerebral abnormality, atriovenous malformation, tumor, previous neurosurgical procedure, or previous intracranial hemorrhage). For minimizing the chance of missed cases, the Children's Hospital Trauma Registry and records maintained by the hospital's child protection team were reviewed as well.

Data Collection

Data were recorded on a standardized data collection form. All chart abstraction was performed by the first author (J.H.), a board-certified pediatrician and a specialist in pediatric emergency medicine. For evaluating interrater reliability, the senior author (D.G.) independently reviewed a random sampling of 26 charts. Medical records were reviewed for the mechanism of injury reported at first presentation to medical care and the height of any reported fall. Fall heights were categorized dichotomously as either ≤ 3 or >3 feet, based on recorded height, if documented in the chart. When no height was recorded, estimates were made. Falls from the child's standing position, couch, or bed were considered to be ≤ 3 feet. Falls from tables, counters, or an adult's arms were considered to be >3 feet. Cases were recorded as having no history of trauma only when it was specifically stated that no trauma had occurred. Otherwise, mechanism of injury data were considered missing.

Several secondary features of the history were specifically noted when present. These secondary historical features included 1) the offering of additional possible mechanisms of injury after

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Data from this article were presented in abstract form at the Pediatric Academic Societies' Annual Meeting; May 2001; Baltimore, MD.

Received for publication Mar 7, 2002; accepted Aug 26, 2002.

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TABLE 1. Cases of Nonfall Trauma

Age	Description of Injury	Panel Decision of Low or High Impact	Categorization of Abuse by Criteria
High Impact			
1 mo	Bulletin board fell on head	High impact	Not definite abuse
3 mo	Sibling hit in head with flashlight	High impact	Not definite abuse
7 mo	Mother has been kicking child in head	High impact	Definite abuse
31 mo	Accidentally shot in head with handgun	High impact	Not definite abuse
3 mo	Hit in head with baseball at outdoor game	High impact	Not definite abuse
3 mo	Hit in face with baseball at outdoor game	High impact	Not definite abuse
3 mo	Mother has been "throwing child to God." Child has been landing on a variety of surfaces	High impact	Definite abuse
19 mo	Television fell on head	High impact	Not definite abuse
Low impact			
9 mo	Sibling's head bumped child's head	Low impact	Not definite abuse
4 mo	Head bumped against car door while getting out of car	Low impact	Definite abuse
1 mo	Parent's head bumped child's head	Low impact	Not definite abuse

the initial trauma history had already been given; 2) changes or retraction of the initial history of trauma (only when the medical record specifically stated that the initial history had been changed); 3) attribution of the injuries to home resuscitative efforts, such as cardiopulmonary resuscitation; or 4) statements that the traumatic injuries may have been caused by the patient's siblings. In addition, the time between injury (or onset of symptoms, if there was no history of trauma) and first medical care was recorded as "<24 hours" or "≥24 hours." Caregiver reports of certain symptoms, including lethargy, vomiting, apnea, or seizures, were also recorded.

Medical features of the hospitalization were recorded, including the patient's neurologic status on presentation and at discharge, results of radiologic studies, and findings of ophthalmologic examination, if performed. When present, social work and child protection notes were also reviewed for information on patient disposition, additional historical features, and reports to the Department of Social Services.

Study Definitions

Cases were defined as definite abuse when, in addition to intracranial hemorrhage, the patient had 1 or more of the following: witnessed or confessed abuse, retinal hemorrhages consistent with abuse,[17–19] high-specificity skin findings (pattern marks),[6,20] or moderate- or high-specificity fractures. As per the classification by Nimkin and Kleinman,[21] fractures considered to be of moderate or high specificity for abuse included fractures of the sternum, posterior rib, scapula, spinous process, metaphysis, epiphysis, vertebral body, or digit.[21] Fractures of different ages and multiple bilateral fractures were also considered to be of high or moderate specificity for abuse. All other cases were defined as not definite abuse.

Patients were considered to have history of low-impact trauma when they presented with a fall from ≤3 feet or with other low-impact nonfall mechanisms. Patients were considered to have a history of high-impact trauma when they presented with a fall from >3 feet or with other nonfall mechanisms assessed to be "high impact." When a nonfall history of trauma was given, 5 board-certified specialists in pediatric emergency medicine, who were blinded to other details of the case, were individually asked to categorize the reported mechanism as low impact or high impact. They were given only the information listed in Table 1 and were asked whether the mechanism given is a plausible explanation for intracranial hemorrhage. The results of their assessments for each case are presented in "Results."

Patients were defined as having a normal neurologic status when on presentation to medical care, a treating physician in the emergency department described the patient as "normal," "alert," "interactive," or "sleepy but arousable." Patients who presented with active seizures, pupillary abnormalities, focal neurologic abnormalities, or a mental status described by a physician as "lethargic" or "unresponsive" were considered to have initial neurologic abnormality. When any neurologic abnormality was noted on discharge from the hospital, patients were considered to have persistent neurologic abnormality.

Statistical Analysis

Descriptive statistics were calculated separately for the definite abuse and not definite abuse groups. The χ^2 test (or Fisher exact test, when appropriate) was used to compare rates of presenting symptoms, neuroradiologic findings, clinical neurologic status, reported mechanism of injury, and disposition of the 2 groups. Sensitivity, specificity, PPV, and negative predictive value for certain historical features as indicators of definite abuse were calculated and are presented with 95% confidence intervals. Correlation and κ statistics was performed to evaluate interrater reliability. All analysis was performed using SPSS version 10.0 for Windows (SPSS Inc, Chicago, IL) and Stata version 6.0 for Windows (Stata Corp, College Station, TX).

RESULTS

During the period 1993 to 2000, 219 children who were 0 to 3 years of age and had intracranial hemorrhage were admitted to the inpatient services of Children's Hospital. All 219 charts were reviewed. Fifty-six patients were excluded from our study: 28 with central nervous system abnormalities (cerebral malformation, tumor, previous intracranial hemorrhage, atriovenous malformation), 7 with neonatal intraventricular hemorrhage, and 21 with coagulation defects. Of the 163 remaining cases, 49 (30%) met criteria for definite abuse and 114 (70%) were categorized as not definite abuse.

The 49 cases of definite abuse included 20 (41%) cases with both retinal hemorrhages and moderate- or high-specificity fractures, 19 (39%) with retinal hemorrhages only, and 6 (12%) with moderate- or high-specificity fractures only. Three cases were defined as definite abuse because of high-specificity skin findings: 1 with a bite mark on the cheek, 1 with a slap mark on the face, and 1 with "10 red/blue linear discolorations over the thorax." One case was defined as definite abuse solely on the basis of a report of witnessed abuse. Only 1 case had retinal hemorrhages not consistent with abuse and was defined as not definite abuse. Of 114 not definite abuse cases, social work evaluation was performed in 92 (81%) cases, a skeletal survey was done in 31 (27%) cases, a dilated examination by an ophthalmologist was performed in 28 (25%) cases, and State Child Protective Services were notified in 11 (10%) cases.

Table 2 shows the clinical characteristics of the definite abuse and not definite abuse groups. Patients in the definite abuse group were more likely

TABLE 2. Characteristics of Patients in the Definite Abuse and Not Definite Abuse Groups

	Definite Abuse (n = 49)	Not Definite Abuse (n = 114)
Demographics		
Male	27 (55.1%)	65 (57.0%)
Mean (median) age (mo)	6.0 (4)	9.1 (5)
Presenting symptoms		
Vomiting	23 (46.9%)	23 (20.2%)*
Apnea	9 (18.4%)	3 (2.6%)*
Seizure	17 (34.7%)	5 (4.4%)*
Lethargy	25 (51.0%)	23 (20.2%)*
Neuroradiologic findings		
Subdural hematoma	43 (87.8%)	57 (50.0%)*
Subarachnoid hemorrhage	9 (18.4%)	29 (25.4%)
Epidural hematoma	2 (4.1%)	31 (27.2%)*
Parenchymal hemorrhage	6 (12.2%)	23 (20.2%)
Clinical neurologic status		
Initial neurologic abnormality	32 (65.3%)	28 (24.6%)*
Persistent neurologic abnormality	26 (53.1%)	8 (7.0%)*
Disposition		
Home with original caregivers	1 (2.0%)	110 (96.5%)*
Home with stipulation	8 (16.3%)	0*
Foster care	23 (46.9%)	1 (0.9%)*
Rehabilitation facility	10 (20.4%)	1 (0.9%)*
Deceased	4 (8.2%)	2 (1.7%)
Unknown	3 (6.1%)	0

* $P \leq .001$.

than patients in the not definite abuse group to present with apnea, seizure, vomiting, or lethargy. They were also more likely to have neurologic abnormalities and more likely to die or require rehabilitative care on discharge.

Tables 1 and 3 show the reported mechanisms of injury for the definite abuse and not definite abuse groups. No patients in the definite abuse group (except for 2 cases of witnessed abuse) had a reported high-impact mechanism of injury. Of the 39 cases of not definite abuse with history of low-impact trauma, 21 (54%) had subdural hematomas, 13 (33%) had epidural hematomas, 9 (23%) had subarachnoid hematomas, and 5 (13%) had hemorrhagic contusions. Thirty-four (69%) of 49 patients in the definite abuse group had no history of trauma, in contrast to 3 (3%) of 114 ($P < .001$) patients in the not definite abuse group.

The diagnostic test characteristics of having no history of trauma or a history of low-impact trauma for identifying cases of definite abuse are shown in Tables 4 and 5. Having no history of trauma had a high specificity and PPV for definite abuse; in children with persistent neurologic abnormality, the specificity and PPV were 1.0. Among all cases, having a history of no or low-impact trauma had more limited specificity and PPV for identifying cases of definite abuse. Among those patients with persistent neurologic abnormality, however, having a history of no or low-impact trauma again had perfect (1.0) specificity and PPV for identifying cases of definite abuse. Having a history of no or low-impact trauma also had a sensitivity of 1.0 for identifying cases of definite abuse.

TABLE 3. Reported Mechanisms of Injury

	Definite Abuse (n = 49)	Not Definite Abuse (n = 114)
Motor vehicle collision	0	8 (7.0%)
Fall <3 feet	12 (24.5%)	37 (32.4%)
Fall >3 feet	0	58 (50.9%)*
Other trauma (Table 1)	3 (6.1%)	8 (7.0%)
No history of trauma	34 (69.4%)	3 (2.6%)*

* $P < .001$.

Table 6 shows other historical characteristics of the patients in the definite abuse and not definite abuse groups. Histories that blamed injuries on home cardiopulmonary resuscitation and histories that changed were only observed in definite abuse cases.

Table 7 summarizes the clinical and historical features of discrepant cases. These include cases of not definite abuse that were reported to State Child Protective Services and cases of not definite abuse that presented with "no history of trauma."

Agreement between the 2 authors for all secondary historical items as well as for likelihood of abuse was assessed. For mechanism of injury, sibling involvement, delay in seeking care, and histories that changed, correlation and κ statistic both were 1.0. For histories in which additional mechanisms of injuries were offered, κ was 0.65 and correlation was 0.96. For injuries blamed on home resuscitative efforts, κ was not calculable and correlation was 0.96 (κ not calculable because 1 reviewer found no positive cases). Correlation and κ statistic both were 1.0 for case assignment to definite abuse versus not definite abuse.

DISCUSSION

Using a case definition of child abuse that does not include any information about the presenting history, we have been able to demonstrate a high specificity and PPV of certain historical features for identifying abuse in young children with head injury, especially when there are clinical neurologic signs.

TABLE 4. Diagnostic Test Characteristics of Having No History of Trauma for Identifying Cases of Definite Abuse

Patient Group	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	Negative Predictive Value (95% CI)
Normal neurologic status (n = 103)	0.65 (0.38–0.86)	0.99 (0.94–1.0)	0.92 (0.61–1.0)	0.93 (0.86–0.98)
Initial abnormal neurologic status (n = 60)	0.72 (0.53–0.86)	0.93 (0.76–0.99)	0.92 (0.79–0.99)	0.74 (0.57–0.88)
Persistent abnormal neurologic status (n = 34)	0.73 (0.52–0.88)	1.0 (0.64–1.0)	1 (0.82–1.0)	0.53 (0.27–0.79)
All cases (n = 163)	0.69 (0.55–0.82)	0.97 (0.83–1.0)	0.92 (0.78–0.98)	0.88 (0.82–0.99)

CI indicates confidence interval

TABLE 5. Diagnostic Test Characteristics of Having a History of No or Low-Impact Trauma for Identifying Cases of Definite Abuse*

Patient Group	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	Negative Predictive Value (95% CI)
Normal neurologic status (n = 101)	1 (0.78–1.0)	0.59 (0.48–0.70)	0.30 (0.18–0.45)	1 (0.93–1.0)
Initial abnormal neurologic status (n = 60)	1 (0.89–1.0)	0.71 (0.51–0.87)	0.80 (0.64–0.91)	1 (0.83–1.0)
Persistent abnormal neurologic status (n = 33)	1 (0.86–1.0)	1 (0.63–1.0)	1 (0.86–1.0)	1 (0.63–1.0)
All cases (n = 161)	1 (0.92–1.0)	0.62 (0.52–0.71)	0.53 (0.41–0.63)	1 (0.95–1.0)

* Two cases of witnessed abuse with history of high-impact trauma were excluded from analysis.

TABLE 6. Secondary Historical Characteristics in Definite Abuse Versus Not Definite Abuse Groups

	Definite Abuse (n = 49)	Not Definite Abuse (n = 114)
Injury >24 h ago	3 (6.1%)	12 (8.3%)
Additional history of trauma	21 (42.9%)	5 (4.5%)*
Sibling blamed	9 (18.4%)	10 (8.8%)
Home CPR blamed	6 (12.2%)	0*
History changed	9 (18.4%)	0*

CPR indicates cardiopulmonary resuscitation.

Although our findings are consistent with common teachings from the child abuse literature, data quantifying the diagnostic test characteristics of these historical features for identifying cases of abuse were not previously available.

The most highly predictive historical feature for abuse is having no history of trauma. In 3 recent series of young children with head injury, investigators also found that children who presented with head injury and no history of trauma were much more likely to have been abused.[13,14,22] Our study differs from these studies in that they used the history as part of their case definition of abuse, so it was not possible for them to evaluate the diagnostic value of the history.

Having a history of no or low-impact trauma was not predictive of abuse among all patients in our sample. However, among patients with persistent neurologic deficit, having a history of no or low-impact trauma was diagnostic of abuse. This finding is in keeping with the accepted notion that low-impact trauma may cause intracranial injury in young infants, but it is highly unlikely to lead to serious or lasting neurologic impairments.[22–27]

Similar to common teachings, we found a strong association between a change in initial history and abuse. One historical feature not commonly recognized as a predictor of abuse—trauma blamed on home resuscitative efforts—was found to be associated with abuse in our sample. Of interest, 1 historical feature that has been thought to be associated with abuse—delay in seeking care after an injury—was not more common in definite abuse cases in our sample. Injury blamed on siblings—a historical feature occasionally mentioned as predictive of abuse[28]—was more common among definite abuse cases, although the difference was not statistically significant.

Although our data show a very high association between concerning historical factors and abuse, the data are less compelling for the subset of children with normal neurologic status. Because there is no criterion standard for abuse, we created our own case definition. Our case definition was intentionally restrictive, to include only cases of unequivocal abuse. Because some cases of actual child abuse may be coded as not definite abuse in our sample, our calculated specificity and PPV may be falsely low. Even so, we found excellent specificity and PPV for children with clinical neurologic signs. We believe, therefore, that our data strongly support the diagnostic utility of these historical features in identifying cases of abusive head trauma, especially for more severely injured infants.

Although our a priori hypothesis focused on the specificity and PPV of concerning historical features, our data also demonstrate the high sensitivity of having a history of no or low-impact trauma for identifying cases of abuse. In other words, our data suggest that it is uncommon for an abused child with head injury to present with a history of high-impact unintentional trauma. Other investigators have observed this as well.[13,14,22]

Our sample of children with head injury seems to be representative of the types of patients treated at any pediatric referral center. The distribution of types of intracranial injuries and associated skeletal and ophthalmologic findings is similar to those reported by previous investigators.[13,15,29–32] Also consistent with previous studies, our data show abused

TABLE 7. Description of Discrepant Cases of Not Definite Abuse

Historical Features	Clinical Summary	Disposition
	Not Definite Abuse Cases Reported to State Child Protective Services	
1-mo-old fell 3.5 feet from a table	Subarachnoid and subdural hemorrhages, no retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Home with family
6-mo-old presented to primary care physician with scalp swelling and no initial history of trauma. Later history offered: fall from bench and/or caregiver dropped infant on head. Mom initially refused skeletal survey. History of corporal punishment.	Parietal skull fracture and small associated subdural hemorrhage. No retinal hemorrhages, no fractures on skeletal survey, no skin findings other than scalp swelling.	Home with family, family refused recommended psychiatric evaluation
5-mo-old fell 2 feet from bed	Subdural hemorrhage on head CT. No retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Home with family
11-mo-old tipped over in a walker by sibling (walker did not fall down stairs)	Patient arrived to emergency department with lethargy, bradycardia, and decreased right-sided movement. Epidural hematoma on head CT and liver contusion on abdominal CT. No retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Placed in foster care with relative
10-mo-old fell 1 foot in bathtub in the care of babysitter. Two previous visits for minor head trauma.	Subdural hemorrhage on head CT. No retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Home with family; unclear if legal action taken against babysitter
7-mo-old fell 2.5 feet from bed and 4 h later was hard to arouse. Similar fall at 3 mo of age.	Patient was lethargic upon arrival. Head CT showed epidural hemorrhage and old subdural hemorrhage. No retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Home with family
4-mo-old fell with mother when she slipped on ice while carrying child	Normal neurologic exam on arrival. Small epidural hemorrhage and question of old subdural hemorrhage on head CT. No retinal hemorrhages, no fractures on skeletal survey, no skin findings.	Home with family
	Cases of Not Definite Abuse Presenting With "No History of Trauma"	
10 mo-old with increasing head circumference noted by primary care provider. No history of trauma.	Head CT showed bilateral subacute subdural hematomas. No fractures on skeletal survey, no skin findings. Ophthalmologic exam not done. Social work assesment done, but no child protection team involvement.	Home with family
7-mo-old presented with vomiting and lethargy. No initial history of trauma. After head CT results discussed with family, dad said that she may have had a recent fall out of bed. It was later offered that a sibling may have inflicted trauma.	Patient arrived with lethargy and bradycardia. Head CT showed an epidural hematoma. No fractures on skeletal survey, no skin findings, no retinal hemorrhages. Hospital child protection team involved. Not reported to state.	Home with family
2-mo-old presented with seizure and no history of trauma. After head CT results discussed with family, mother offered that a 4-y-old sibling probably hit infant with a toy out of jealousy.	Patient was postictal upon arrival. Head CT showed 2 subdural hemorrhages. There were no retinal hemorrhages, no fractures on skeletal survey, and no skin findings. Not reported to the state.	Home with family; in subsequent follow-up visits, mother continued to suggest that other relatives (aunt, cousins) could be responsible for undisclosed trauma

CT indicates computed tomography.

children to have more severe injury and worse outcomes than nonabused children.[22,33,34] Nonetheless, we caution the reader to remember that the mix of cases in our sample may differ from that seen in other practice environments.

Limitations inherent to any retrospective study may have affected our data. Although we had very strong agreement between reviewers with respect to data abstraction, the medical record was often imprecise for areas of interest (exact height of fall, timing of trauma or symptoms, timing of disclosure of additional histories of trauma). This imprecision may have affected some of our results, such as our inability to detect a difference in the number of cases with delayed presentation. Also, because all cases were not investigated similarly for child abuse, there is a potential for ascertainment bias. For instance, we found that additional mechanisms of history were more common in abuse, but cases that were suspicious for abuse were more rigorously investigated, and thus the record in those cases is more likely to include details about all recent traumatic events. Ad-

ditional prospective studies with uniform investigation of all head injury cases could minimize this potential bias.

CONCLUSION

We have found that infants who have a head injury and present with no history of trauma are highly likely to be victims of child abuse. Similarly, infants with head injury and persistent neurologic injury and a history of low-impact trauma are highly likely to be victims of abuse. Cases in which the history changes or the injury is blamed on home resuscitative efforts are likely to represent abuse as well. Our data support the use of these historical features as diagnostic criteria for identifying cases of abuse.

ACKNOWLEDGMENTS

We thank Dr Andrea Vandeven for assistance with case identification and Dr Marc Baskin for thoughtful review of the manuscript.

REFERENCES

1. Brodeur A, Monteleone JA. *Child Abuse and Maltreatment: A Clinical Guide & Reference*. St. Louis, MO: GW Medical Publishing Inc; 1994
2. Johnson CF. *Nelson Textbook of Pediatrics*. 16th ed. Philadelphia, PA: WB Saunders; 2000
3. Tercier A. *Emergency Medicine: Concepts and Clinical Practice*. 4th ed. St Louis, MO: Mosby-Year Book Inc; 1998
4. Caffey J. Significance of the history in the diagnosis of traumatic injury to children. Howland Award Address. *J Pediatr*. 1965;67(suppl): 1008–1014
5. Feldman K. Evaluation of physical abuse. In: Helfer K, Krugman R, eds. *The Battered Child*. 5th ed. Chicago, IL: University of Chicago Press; 1997:176–177
6. Ellerstein N. *Child Abuse and Neglect: A Medical Reference*. New York, NY: Wiley Medical Publication; 1981:221–225
7. Leventhal JM, Thomas SA, Rosenfield NS, Markowitz RI. Fractures in young children. Distinguishing child abuse from unintentional injuries. *Am J Dis Child*. 1993;147:87–92
8. Bruce DA, Zimmerman RA. Shaken impact syndrome. *Pediatr Ann*. 1989;18:482–484, 486–489, 492–494
9. Bruce D. Neurosurgical aspects of child abuse. In: Ludwig K, ed. *Child Abuse: A Medical Reference*. 2nd ed. New York, NY: Churchill Livingstone; 1992:86–90
10. Levitt SA. Abusive head trauma. In: Reece R, ed. *Child Abuse: Medical Diagnosis and Management*. Philadelphia, PA: Lea & Febiger; 1994:12–14
11. Duhaime AC, Alario AJ, Lewander WJ, et al. Head injury in very young children: mechanisms, injury types, and ophthalmologic findings in 100 hospitalized patients younger than 2 years of age. *Pediatrics*. 1992;90: 179–185
12. Goldstein B, Kelly MM, Bruton D, Cox C. Inflicted versus accidental head injury in critically injured children. *Crit Care Med*. 1993;21: 1328–1332
13. Feldman KW, Bethel R, Shugerman RP, Grossman DC, Grady MS, Ellenbogen RG. The cause of infant and toddler subdural hemorrhage: a prospective study. *Pediatrics*. 2001;108:636–646
14. Reece RM, Sege R. Childhood head injuries: accidental or inflicted? *Arch Pediatr Adolesc Med*. 2000;154:11–15
15. Tzioumi D, Oates RK. Subdural hematomas in children under 2 years. Accidental or inflicted? A 10-year experience. *Child Abuse Negl*. 1998;22: 1105–1112
16. Hahn YS, Raimondi AJ, McLone DG, Yamanouchi Y. Traumatic mechanisms of head injury in child abuse. *Childs Brain*. 1983;10:229–241
17. Christian CW, Taylor AA, Hertle RW, Duhaime AC. Retinal hemorrhages caused by accidental household trauma. *J Pediatr*. 1999;135: 125–127
18. Green MA, Lieberman G, Milroy CM, Parsons MA. Ocular and cerebral trauma in non-accidental injury in infancy: underlying mechanisms and implications for paediatric practice. *Br J Ophthalmol*. 1996;80:282–287
19. Johnson DL, Braun D, Friendly D. Accidental head trauma and retinal hemorrhage. *Neurosurgery*. 1993;33:231–234; discussion 234–235
20. Richardson A. Cutaneous manifestations of abuse. In: Reece R, ed. *Child Abuse: Medical Diagnosis and Management*. Philadelphia, PA: Lea & Febiger; 1994:167–184
21. Nimkin K, Kleinman PK. Imaging of child abuse. *Pediatr Clin North Am*. 1997;44:615–635
22. Ewing-Cobbs L, Kramer L, Prasad M, et al. Neuroimaging, physical, and developmental findings after inflicted and noninflicted traumatic brain injury in young children. *Pediatrics*. 1998;102:300–307
23. Greenes DS, Schutzman SA. Clinical indicators of intracranial injury in head-injured infants. *Pediatrics*. 1999;104:861–867
24. Barlow B, Niemirska M, Gandhi RP, Leblanc W. Ten years of experience with falls from a height in children. *J Pediatr Surg*. 1983;18:509–511
25. Chadwick DL, Chin S, Salerno C, Landsverk J, Kitchen L. Deaths from falls in children: how far is fatal? *J Trauma*. 1991;31:1353–1355
26. Williams RA. Injuries in infants and small children resulting from witnessed and corroborated free falls. *J Trauma*. 1991;31:1350–1352
27. Rivara FP, Kamitsuka MD, Quan L. Injuries to children younger than 1 year of age. *Pediatrics*. 1988;81:93–97
28. Myers JEB. Medicolegal aspects of child abuse. In: Ludwig RMRS, ed. *Child Abuse: Medical Diagnosis and Management*. Philadelphia, PA: Lippincott; 2001:556
29. Dashti SR, Decker DD, Razzaq A, Cohen AR. Current patterns of inflicted head injury in children. *Pediatr Neurosurg*. 1999;31:302–306
30. Ewing-Cobbs L, Prasad M, Kramer L, et al. Acute neuroradiologic findings in young children with inflicted or noninflicted traumatic brain injury. *Childs Nerv Syst*. 2000;16:25–33; discussion 34
31. Duhaime AC, Gennarelli TA, Thibault LE, Bruce DA, Margulies SS, Wiser R. The shaken baby syndrome. A clinical, pathological, and biomechanical study. *J Neurosurg*. 1987;66:409–415
32. Ludwig S, Warman M. Shaken baby syndrome: a review of 20 cases. *Ann Emerg Med*. 1984;13:104–107
33. DiScala C, Sege R, Li G, Reece RM. Child abuse and unintentional injuries: a 10-year retrospective. *Arch Pediatr Adolesc Med*. 2000;154: 16–22
34. Billmire ME, Myers PA. Serious head injury in infants: accident or abuse? *Pediatrics*. 1985;75:340–342