

Prevalence of Retinal Hemorrhages and Child Abuse in Children Who Present With an Apparent Life-Threatening Event

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ABSTRACT. *Objective.* Child abuse (CA) can present with a spectrum of signs and symptoms. Apparent life-threatening events (ALTEs) may be a subtle presentation of CA. Retinal hemorrhages (RHs) are a well-described finding in some patients with CA. We hypothesized that screening children who present with a chief complaint of an ALTE for RH would detect an otherwise occult presentation of CA.

Methods. Children who were younger than 24 months of age and presented to the emergency department between March 1, 1997, and February 28, 1999, with signs and symptoms consistent with the National Institutes of Health's definition of an ALTE were studied prospectively. Children were excluded when it was readily apparent on presentation that the child was a victim of CA. Demographic data, a complete blood count with differential, venous blood gas, carboxyhemoglobin level, and urine toxicological screen were collected. A pediatric ophthalmologist performed a dilated fundoscopic examination; patients who were found to have RH underwent a noncontrast computerized tomographic scan of the head and skeletal survey to evaluate for occult injury. Evaluations by social services or Children, Youth and Families, the results of all diagnostic tests obtained, and the final discharge diagnosis were recorded. Medical records of all patients were reviewed at 1 year; subsequent visits, hospitalizations, and evaluations by social services or Children, Youth and Families were recorded.

Results. A total of 128 patients presented to the emergency department with an ALTE during the study period. No patients were excluded. Mean age was 2.1 months (median: 1.27; range: 0.07–16.0; standard deviation: 2.1). Fifty-seven (44.5%) were boys; 86 (67.2%) were white, and 36 (27.9%) were black. A total of 26 (20.3%) of 128 patients had a history of an ALTE, 4 (3.4%) of 117 had a family history of an ALTE, and 15 (12.8%) of 117 had a family history of sudden infant death syndrome. Dilated fundoscopic examination was performed on 73 (57.0%) of 128 patients; RH was detected in 1 patient (1.4%). Four children, including the patient with RH, underwent an eval-

uation for suspected abuse; 3 (2.3%) of 128 were determined to have been abused.

Conclusions. RH was detected in 1 (1.4%) of 73 patients in our population of infants with ALTEs and 1 of 3 patients who were victims of CA and presented with an ALTE. CA was detected in 2.3% of patients who presented with an ALTE. The diagnosis of CA should be seriously considered in patients who present with an ALTE. The evaluation of ALTEs should include fundoscopic examination as ALTEs and RHs are associated with CA. *Pediatrics* 2002;110:557–562; *apnea, apparent life-threatening events, retinal hemorrhages, child abuse.*

ABBREVIATIONS. ALTEs, apparent life-threatening events; CA, child abuse; RH, retinal hemorrhage; ED, emergency department; CT, computed tomography; CPR, cardiopulmonary resuscitation; CYF, Children, Youth and Families; TBI, traumatic brain injury.

Apparent life-threatening events (ALTEs), as defined by the 1986 National Institutes of Health Consensus Panel on Infantile Apnea, are events that are characterized by some combination of apnea, color change, marked change in muscle tone, choking, or gagging and that are frightening to the observer.¹ In some cases, the observer fears that the infant has died.¹ The exact incidence of ALTEs in children has not been clearly defined. Many children with an ALTE probably do not present for medical attention, especially episodes characterized primarily by choking. Reported estimates of the incidence of ALTEs in children vary between 0.5% and 3%.^{2–4}

ALTE is not considered a diagnosis but is rather a description of an event. In as many as half of all events, no discernible cause will be found.⁵ Documented causes of ALTEs include infection, gastroesophageal reflux, seizures, and metabolic disturbances. An ALTE may also be a secondary manifestation of child abuse (CA), specifically from a smothering attempt, an intentional poisoning, or shaken infant-impact syndrome.^{6–9} However, diagnosing CA in a child who presents with an ALTE may be difficult, as readily apparent signs of trauma may not be visible.

Documenting the presence of retinal hemorrhages (RHs) in children who present with an ALTE may help to identify children who have been abused. However, the routine performance of dilated fundoscopic examination to document the presence of RH in children who present with an ALTE is not currently recommended or likely practiced.

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Recent experience with 2 children who presented to our emergency department (ED) with a chief complaint of an ALTE and later received a diagnosis of being CA victims was the impetus for this study. The first, a 4-week-old normal-appearing male infant who was transported to our institution after an ALTE, was found to have RH on dilated funduscopic examination. A subsequent computed tomography (CT) scan of the head revealed an interhemispheric subdural hematoma. The child subsequently received a diagnosis of being a victim of CA. The second child was a 4-week-old male infant who initially was seen for a chief complaint of limpness associated with shallow breathing. Physical examination was normal, and the child was discharged to home. A funduscopic examination either was not performed or was not recorded. The infant returned 2 days later with seizure activity. ED evaluation revealed bilateral RH. A CT scan of the head revealed both subarachnoid and intraventricular hemorrhage. The child subsequently received a diagnosis of being a victim of CA.

Because of these 2 patients, we instituted a clinical pathway for the evaluation of all children who present to our ED after an ALTE that included the performance of dilated funduscopic examinations. Our objective was to facilitate the treatment of children with a chief complaint of an ALTE, determine the prevalence of CA, determine the prevalence of RH in children who present with an ALTE, and determine the clinical utility of performing routine dilated funduscopic examinations on all such children.

METHODS

Children who were younger than 24 months of age and presented to the ED between March 1, 1997, and February 28, 1999, with signs and symptoms consistent with the National Institutes of Health's definition of an ALTE were evaluated prospectively.¹ Children were excluded when it was readily apparent on presentation that the child was a victim of CA (nonocult CA, defined as physical injuries of a type and pattern readily identified as caused by nonaccidental trauma, such as "loop" marks resulting from whipping by a belt). Demographic data, a complete blood count with differential, venous blood gas, carboxyhemoglobin level, and urine toxicological screen were collected during the initial evaluation in the ED. A patient was noted to have received cardiopulmonary resuscitation (CPR) if during their event they received mouth-to-mouth resuscitations and chest compressions. A pediatric ophthalmologist was consulted to perform a dilated funduscopic examination to look for the presence of RH.

Patients who were found to have RH or other signs and symptoms suggestive of CA underwent a noncontrast CT scan of the head and a full skeletal survey to search for additional injuries. All patients were followed throughout their hospitalization. Evaluations by social services or Children, Youth and Families (CYF) were noted as well as the results of all diagnostic tests and the final diagnosis. Children received a diagnosis of being a victim of CA when 1) a perpetrator confessed to the crime and/or was found guilty in a court of law or 2) no perpetrator was found but the pattern of injuries was consistent with the diagnosis (ie, RHs/subdural hematoma without history of a significant traumatic event) and the child was taken out of his or her home environment and placed into foster care. Medical records of all patients were reviewed at 1 year after discharge to review for subsequent visits and hospitalizations.

All patients presenting to the ED during the study period with a chief complaint consistent with an ALTE were enrolled in the study. However, portions of the study protocol, in particular the dilated funduscopic examination, could be refused by the patient's

private physician. In addition, physicians could have obtained additional laboratory and radiographic testing for patients outside of study guidelines (eg, liver function tests, electroencephalograms, noncontrast CT scans of the head).

Clinical and demographic characteristics of patients who were enrolled in the study are reported as mean values or proportions. The number of patients who were found to have RHs on funduscopic examination is presented as a proportion. Comparisons between patients who had a dilated funduscopic examination performed and those who did not were made using Student *t*, Mann-Whitney *U*, χ^2 with Yates' correction, or Fisher exact test. *P* \leq .05 was considered significant. Statistical tests were conducted using Statistical Program for the Social Science, Windows 95 (SPSS Inc, Chicago, IL).

The hospital's Human Rights Committee approved this study. Patients' caregivers were informed that the performance of laboratory, radiographic, and funduscopic examinations were considered part of the evaluation of all children who presented to our ED with an ALTE.

RESULTS

From March 1, 1997, to February 28, 1999, 128 patients presented to the ED with an ALTE, as defined by the National Institutes of Health Consensus Panel on Infantile Apnea.¹ Demographic and clinical characteristics of the patients are shown in Table 1. Sixty-nine patients presented with apnea alone, and 44 presented with apnea associated with choking. Twelve patients presented solely with choking. Three patients had neither choking nor apnea but were noted to be limp and cyanotic. One patient had color changes and a change in muscle tone, but his respiratory effort was not observed.

One patient was readily identified as a victim of CA on presentation to the ED after an ALTE. The patient was a 7-week-old boy who presented to the ED with episodes of apnea associated with color changes. He was immediately intubated because of

TABLE 1. Demographic and Clinical Characteristics of the Study Population

Characteristic	N
Age (mo)	128
Mean	2.1
Median	1.27
Gender (M:F)	57:71
Race (%)	128
White	67.2
Black	28.1
Other	2.3
Unknown	2.3
Previous ALTEs (%)	20.8
Family history of ALTEs (%)	3.4
Family history of SIDS (%)	12.8
Observer (%)	128
Mother	82.8
Father	5.5
Other	9.4
Unknown	2.3
Smokers in home (%)	57.9
Time from last feeding (min; mean)	93.9
Apnea (%)	91.9
Choking episode (%)	45.2
Stimulated (%)	67.1
CPR performed (%)	20.3
Occurred during sleep (%)	24.6
Position during sleep (%)	32
Prone	25
Supine	15.6
Unknown	59.4

SIDS indicates sudden infant death syndrome.

respiratory distress and failure. Initial physical examination revealed a marked deformity of the left femur but no bruising. Radiographs of the left femur confirmed the presence of a fracture, and a chest radiograph obtained after intubation demonstrated multiple rib fractures. The diagnosis of CA was immediately suspected. A skeletal survey revealed a right femur fracture, right tibial fracture, right radial and ulna fractures, and a compression fracture of the first lumbar vertebrae. A CT scan of the head demonstrated bilateral frontal contusions. No RHs were found on funduscopic examination. It is interesting that the patient had undergone a rule-out sepsis evaluation for "respiratory difficulty" in the ED 1 week earlier but had had no fever.

Laboratory and radiographic results are presented in Table 2. Of 64 patients who had a carboxyhemoglobin level drawn, 55 (85.9%) had a level >1 ; 15 (23.4%) had levels >3 . A carboxyhemoglobin level of 1.4 was detected in the child who was found to have RHs. Eleven patients had an abnormal toxicology screen. Five patients had a screen positive for ephedrine/pseudoephedrine, 5 for caffeine, and 1 for diphenhydramine.

Four patients had an abnormal CT scan of the head. One patient, who subsequently received a diagnosis of being a victim of CA, was found to have subdural hematomas. A second patient who received a diagnosis of being a victim of CA was found to have bilateral frontal contusions. A patient with enteroviral sepsis developed cerebral edema and was found to have evidence of hypoxic insults on CT scan. One patient was found to have prominent bifrontal subdural and subarachnoid spaces. These ab-

normalities were ultimately thought to be congenital in origin, although suspicion was raised of the possibility of abuse.

Of the 128 patients who presented to the ED during the study period, 73 patients (57.0%) had a dilated funduscopic examination. Seventy-one examinations were performed by a pediatric ophthalmologist, and 2 were performed by 1 of the primary investigators. A pediatric ophthalmologist was unavailable to perform the examination for these 2 patients. One patient (1.4%) was found to have RH, as diagnosed by a pediatric ophthalmologist.

To detect a selection bias in patients who underwent funduscopic examination compared with those who did not, we compared demographic and clinical characteristics of these 2 groups. Patients who had a funduscopic examination performed had a longer mean time interval between their last feeding and their ALTE (125.6 minutes vs 50.1; $P = .006$). There were no other significant differences found between patients who had a funduscopic examination performed and those who did not. Likewise, the results of laboratory and radiographic studies for patients who had a funduscopic examination and those who did not were compared. Patients who underwent funduscopic examination were more likely to have had a skeletal survey obtained (10 of 74 vs 0 of 55; $P = .005$). However, they were no more likely to have an abnormal result.

Four patients (3.1%) were evaluated by our hospital CA team and CYF for suspected abuse, and 3 (2.3%) were determined to be victims of abuse. Of the 4 patients evaluated for abuse, 3 had a funduscopic examination performed and 1 was positive. One of the 3 children who ultimately were determined to have been abused did not have a funduscopic examination. Demographic and clinical characteristics, as well as laboratory and radiographic results, of patients who were found to be victims of abuse are presented in Table 3. A review of all medical records at 1 year after initial patient evaluation did not identify any additional children who received a diagnosis of being a victim of CA.

Patient 1 was a 2-week-old infant who presented after an episode of apnea associated with color changes. There was no history of choking. The infant was alert, active, and afebrile but underwent a rule-out sepsis evaluation and was admitted to the hospital. Because of her age and presenting chief complaint and despite a normal funduscopic examination, a CT scan of the head was obtained and revealed acute and chronic subdural hematomas. A more detailed physical examination identified a small sublingual abrasion and a possible old bruise on the face (described as faint and yellow). The patient had not had a difficult birth and had not been delivered via the use of forceps. CYF was notified, and a diagnosis of CA was confirmed.

Patient 2 was a 6-week-old infant who presented to the ED after an episode of apnea, not associated with color changes, and limpness. There was no history of choking. The child was awake and alert in the ED, and her physical examination was normal. Dilated funduscopic examination revealed bilateral

TABLE 2. Laboratory and Radiographic Test Results of Patients

Laboratory and Radiographs		N
WBC		114
Mean	12	
Range	3.3–29.2	
HGB		114
Mean	12.4	
Range	7.2–19.4	
HCT		114
Mean	36.1	
Range	21.4–55.7	
Venous pH		71
Mean	7.36	
Range	7.18–7.5	
Venous HCO ₃		88
Mean	23.1	
Range	15–33	
Venous base excess		71
Mean	0.29	
Range	(–)8–(+)8	
COHGB		64
Mean	2.1	
Range	0–6.2	
Toxicology screen		66
Abnormal (%)	16.7	11
CT		10
Abnormal (%)	40	4
Skeletal survey		9
Abnormal (%)	11.1	1

WBC indicates white blood cells; HGB, hemoglobin; HCT, hematocrit; COHGB, carboxyhemoglobin.

TABLE 3. Summary of Patients Who Were Found to Have Been Abused

Patient	Age (Months)	Gender	Race	Past Medical History	Previous ALTEs	Family History of SIDS/ALTEs	Stimulated CPR	Focal Findings	RHs	WBC	HGB	HCO ₃	COHG	Toxicology Screen	Venous pH	Skeletal Survey	CT	Disposition
1	0.5	F	White	N1	No	No	Yes	No	No	12.9	18	23	Not done	Not done	Not done	Negative	Subdural	Foster care
2	1.5	F	Other	N1	No	No	No	Yes	Yes	12.6	7.2	24	1.4	Not done	7.39	Positive	Subdural	Foster care
3	3	M	White	N1	No	No	Yes	No	Not done	11.2	32.3	22	Not done	Not done	7.41	Not done	Not done	Foster care

RH. CT scan revealed bilateral subdural hematomas. Skeletal survey revealed healing rib fractures, a compression fracture of the distal femur fracture, a corner fracture of the distal tibia fracture, a nondepressed skull fracture, and old, healing fractures of the distal shafts of the right radius and ulna. Follow-up interviews with both parents resulted in the father's confessing to having vigorously shaken the infant multiple times during the preceding weeks.

Patient 3 was a 6-month-old infant who had a history of multiple visits to the ED and hospitalizations for apneic episodes and ALTEs. There was no history of choking. He was subsequently identified as a victim of Munchausen syndrome by proxy when an ED physician observed his mother attempting to smother him with her body.

A fourth patient was evaluated by CYF, but a diagnosis of CA was not made. The patient was a 3-month-old infant who had a history of recurrent episodes of apnea and was brought to the ED after an episode not associated with color changes. There was no history of choking. Although results of fundoscopic and physical examinations were normal, social concerns that were related to the mother (perceived lack of concern for child, known drug and alcohol abuser) resulted in a report to CYF of suspected CA. After evaluation by CYF, the patient was discharged to home in the care of his mother.

Table 4 lists the final diagnosis of patients who were seen during the study period at the time of their event. χ^2 revealed no relationship between final diagnosis and whether fundoscopic examination was performed ($P = .081$).

DISCUSSION

Children who present to the ED with a chief complaint of an ALTE can represent a diagnostic challenge. Although many events most likely are caused by gastroesophageal reflux, the underlying cause of other events may not be as apparent.⁵ CA can be particularly difficult to identify. Current recommendations for the evaluation and management focus on identifying the common causes of ALTEs.⁵ However, these same recommendations often do not include an evaluation for identifying CA.⁵ We hypothesized that performing dilated fundoscopic examinations in all children who present with an ALTE to look for RH, a sign that is often found in victims of CA,

TABLE 4. Discharge Diagnosis of Study Patients

Diagnosis	N	%	% Fundoscopic Exam
GERD	51	39.8	62.7
Apnea/ALTE/cyanotic episode	38	29.7	57.9
Choking episode	11	8.6	18.2
Infection	6	4.7	50
Bronchiolitis	5	3.9	20
URI	5	3.9	100
Seizure	4	3.1	75
Abuse	3	2.3	66.7
Swallowing disorder	3	2.3	66.7
Breathholding spell	2	1.6	50

GERD indicates gastroesophageal reflux disease; URI, upper respiratory infection. Pearson χ^2 ; $P = .081$.

would aid in the identification of children with otherwise occult abuse. One child in our study was found to have RH, and 3 children were found to have been abused. Although only 1 of 73 patients who had a dilated fundusoscopic examination performed was found to have RH, the clinical utility of a test is directly related to the potential benefit generated for each patient. Even detecting 1 patient with RH, which led to a diagnosis of CA, should be considered clinically important.

In our study population, 3 children (2.3%) were identified as being victims of CA. The exact incidence of CA in children who present with an ALTE, however, has not been clearly defined. The first reports of CA presenting as an ALTE occurred in 1979.⁶ Since then, multiple publications have documented an association between CA and ALTEs. For example, Meadow⁷ recently described the clinical features of 81 children who were judged by criminal and family courts to have been killed by their parents. Seventy-five had a history of unusual or unexplained events, most commonly apnea, cyanosis, appearing dazed, or twitching. In addition, Jenny et al⁹ reported in their study of children with abusive head trauma that 31.2% of children had been seen previously for nonspecific signs and symptoms and misdiagnosed.

Certainly, many children who present with an ALTE have vague signs and symptoms and CA can be easily missed. Performing routine dilated fundusoscopic examinations and identifying RHs would help to identify a portion of these abused children. RHs are often considered pathognomonic of intracranial head injury, and their presence in a young infant with no history of trauma is consistent with shaken-infant impact syndrome.

It is interesting that RHs seem to be more likely to occur after inflicted brain injury as compared with noninflicted. Ewing-Cobbs et al¹⁰ prospectively evaluated 20 children with inflicted and 20 children with noninflicted traumatic brain injury (TBI). RHs were present in 70% of the inflicted TBI group but were not noted to follow noninflicted TBI ($P < .001$). Duhaime et al¹¹ prospectively analyzed 100 consecutively admitted children who were 24 months old or younger and had a head injury. Twenty-four patients were found to have inflicted injuries; 9 patients were found to have RHs. Of 76 patients with noninflicted head injury, only 1 was found to have RH.

Although identifying RHs in children may aid in the diagnosis of CA, some investigators have reported that hemorrhages occur during forceful vaginal delivery, in carbon monoxide poisoning, and possibly after vigorous CPR.^{12–15} Unfortunately, many children who present with an ALTE are young infants and many have received either CPR or back and abdominal blows. In such cases, controversy may be raised over the exact cause of the identified RH. As a screening test for CA, if RHs occurred after CPR or were unable to be differentiated from those caused by a vigorous vaginal delivery, then the predicted specificity of the test would be low.

Several investigators have looked at the incidence of RHs after CPR. Kanter¹⁴ performed fundusoscopic examinations on 54 patients after CPR. In 45 patients

in whom CPR was not precipitated by a traumatic event, 1 patient was found to have RHs. Gilliland and Luckenbach¹⁶ reviewed 169 cases of pediatric deaths in children in which postmortem ocular examination was performed. RHs were found in 70 of 169 children, 61 of whom had been resuscitated. Preexisting pathology explained all RHs found. No RHs were found in 99 children, 70 of whom had been resuscitated. Odom et al¹⁷ prospectively studied 43 patients who underwent at least 1 minute of chest compressions and survived long enough for retinal examination. One patient, who had a coagulation disorder, was found to have RHs. RHs are unlikely to occur as a result of chest compressions or CPR, and their presence should raise the possibility of inflicted TBI.

RHs are present in 20% to 50% of vaginally delivered newborns and in 0.8% who are born by cesarean section.¹⁸ Postpartum RHs will normally resolve within 2 to 3 weeks of delivery and are not known to be associated with intracranial injuries.^{19,20} Flame-shaped hemorrhages, the most common type of birth RHs, usually resolve in 3 to 5 days.²¹ RHs as a result of vigorous vaginal delivery may be distinguished by an experienced ophthalmologist from those as a result of trauma, although this remains controversial. In addition, such hemorrhages are not known to be associated with intracranial injury.²⁰

A screening test should be considered safe and easy to perform to be considered clinically useful. Dilated fundusoscopic examinations in children are considered a safe procedure and are performed frequently by emergency physicians. Adverse reactions have been reported, generally as a result of the sympathomimetic and parasympatholytic actions of the mydriatic and cycloplegic drugs used for the procedure.²² Adverse reactions include local irritation, facial flushing, elevated heart rate or blood pressure, blurred vision, photophobia, and behavioral changes.²³ Precipitation of acute angle-closure glaucoma is a rare occurrence and occurs almost exclusively in older patients.²⁴ A dilated fundusoscopic examination should not be performed in children with altered mental status so that signs of herniation can be observed. In our study, no complications related to the performance of a dilated fundusoscopic examination were noted.

It is possible that the frequency of RHs is underestimated in this study because 43% of patients did not have a fundusoscopic examination. The decision to deviate from the clinical pathway and not perform a fundusoscopic examination was made most commonly by the child's private pediatric attending physician. Although it is not clear the reasons that physicians had for not performing a fundusoscopic examination, it may be that physicians were reluctant to consider a diagnosis other than gastroesophageal reflux in children who presented with choking episode or other signs and symptoms of reflux. Supportive of this is that in our study, children who had a fundusoscopic examination performed had a longer time interval between their last feeding and their event. A review of medical records at 1 year after presentation did not identify additional victims of CA.

Results of this study may not be generalizable to other institutions in regard to the demographic characteristics of the study population. In addition, the study was performed at an academic center with ready access to a pediatric ophthalmologist. All but 2 funduscopic examinations were performed by a pediatric ophthalmologist. To be useful as a screening test for occult abuse, the funduscopic examination would have to be performed by ED physicians, who may not be as proficient as an ophthalmologist. However, most emergency physicians are familiar with the procedure and perform it with some regularity to identify evidence of hemorrhage.

CONCLUSION

We recommend considering the diagnosis of CA in all patients who present with an ALTE. Accordingly, in addition to a detailed social and family history and a complete physical examination, we strongly recommend performing a dilated funduscopic examination on children who present to the ED after an ALTE.

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FIRST COMMERCIAL EGG BANK

"Egg freezing is a difficult and delicate technology. . . Egg freezing is rarely covered by insurance. The process requires daily shots for approximately 10 days to stimulate the ovaries to produce as many eggs as possible, which can run from \$2000 to \$3000 for one cycle.

Then, retrieving the eggs from the ovaries involves an in-office surgical procedure that will add \$9000 to the bill. The first year's storage is included in that price, but afterward, CHA will charge \$500 a year to continue storing the eggs. (At some Manhattan clinics, storage costs run as high as \$1200 a year.)"

Marcus AD. *Wall Street Journal*.

Noted by JFL, MD