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ARTICLE

Death, Child Abuse, and Adverse Neurological Outcome of Infants After an Apparent Life-Threatening Event

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What's Known on This Subject

ALTEs are thought to be a risk factor for SIDS, child abuse, and adverse neurological outcomes, but there are minimal data to support these possibilities.

What This Study Adds

This study is a comprehensive evaluation of short- and long-term outcomes of infants after an ALTE.

ABSTRACT

OBJECTIVES. Apparent life-threatening events in infants constitute a significant challenge for health care providers. Apparent life-threatening event evaluation and management are poorly defined, and outcomes have not been clearly determined. Our objectives were to characterize short- and long-term risks for death, child abuse, and abnormal neurological outcomes of infants after an apparent life-threatening event and to identify clinical features that are predictive of these outcomes.

METHODS. We collected data from infants ages birth to 12 months of age who were hospitalized after an apparent life-threatening event during a 5-year time period. Patients were evaluated for subsequent death, child abuse, or adverse neurological outcome (chronic epilepsy or developmental delay).

RESULTS. A total of 471 patients met inclusion criteria and were followed an average of 5.1 years. Two patients died after developing chronic epilepsy and severe developmental delay. Fifty-four (11%) patients were diagnosed as being a victim of child abuse, but only 2 were identified at initial presentation. There were 23 (4.9%) patients with adverse neurological outcomes, including 17 (3.6%) with chronic epilepsy and 14 (3.0%) with developmental delay. Of those who developed chronic epilepsy, 71% returned within 1 month of the initial apparent life-threatening event with a second event. Neurological evaluation at the time of the apparent life-threatening event had low yield for predicting those who would develop chronic epilepsy.

CONCLUSIONS. Infants who suffer an apparent life-threatening event are at risk for subsequent child abuse and adverse neurological outcomes. Deaths were uncommon and only occurred in the setting of severe developmental delay and seizure disorders. Neurological evaluation during hospitalization for a first apparent life-threatening event is of low yield, but close follow-up is essential. *Pediatrics* 2008;122:125–131

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Key Words
ALTE, EEG, MRI, CT, seizures, SIDS, child abuse

Abbreviations
ALTE—apparent life-threatening event
SIDS—sudden infant death syndrome
CNS—central nervous system
GERD—gastroesophageal reflux disease
ICD-9-CM—*International Classification of Diseases, Ninth Revision, Clinical Modification*
EDW—Enterprise Data Warehouse
EEG—electroencephalogram
OR—odds ratio
PPV—positive predictive value
NPV—negative predictive value
CI—confidence interval
CT—computed tomography

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APPARENT LIFE-THREATENING EVENTS (ALTEs) in infants less than 1 year of age pose a significant challenge for evaluation and management. An ALTE is defined as "an episode that is frightening to the observer and that is characterized by some combination of apnea (central or occasionally obstructive), color change (usually cyanotic or pallid), marked change in muscle tone, choking, or gagging. In some cases, the observer fears that the infant has died."[1] The incidence of ALTEs has been estimated at between 0.6 and 9.4 in 1000 of live-born infants, and they account for 0.6% to 0.8% of emergency department visits for children <1 year of age.[2,3] Near–sudden infant death syndrome (SIDS), seizures, central nervous system (CNS) abnormalities, cardiac problems, and child abuse are major concerns when an infant presents with an ALTE.[2,4,5]

There is no consensus on what diagnostic evaluation is necessary or indicated for the child who presents with an ALTE,[2,6–8] in part because of the lack of outcomes data. Although the most common discharge diagnoses for ALTEs

have been reported (gastroesophageal reflux [GERD], unknown causes, seizures, and lower respiratory tract infections),[2] no long-term follow-up studies in patients with an ALTE have been performed.

The purpose of our study was to determine the immediate and long-term risks for death, child abuse, or adverse neurological outcome (defined as chronic epilepsy or developmental delay) after an ALTE. In addition, we sought to identify clinical characteristics that are predictive of these outcomes.

METHODS

Study Design

We reviewed the medical charts of all infants <12 months of age who had been admitted for an ALTE between January 1, 1999, through December 31, 2003. The study was performed at a children's hospital that serves as the sole tertiary pediatric center for an estimated pediatric population of >1 million children,[9] as well as the primary children's hospital in an urban area with >270 000 children.[10] The hospital is operated by a large vertically integrated not-for-profit health care system (Intermountain Healthcare). The study was approved by the institutional review boards of the University of Utah and the Utah Department of Human Services.

We attempted to identify all patients who presented with an ALTE over the 5-year time period. Because ALTE is not a codeable diagnosis, we searched records of children <12 months of age by using a computer-based screen from 3 sources: key words from emergency department chief complaint diagnoses, *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes from pediatric neurology consultation, and hospital discharge diagnoses. The key words and diagnoses were ALTE, altered mental status, apnea, breath-holding spell, choking, GERD, hypotonia, lethargy, other convulsions, other neurology diagnosis, other respiratory diagnosis, pallor, seizures, sleep apnea, stiff, syncope, and unresponsiveness (ICD-9-CM codes were 327.23, 530.81, 719.5, 770.81, 780.01, 780.09, 780.2, 780.39, 780.57, 780.79, 780.99, 781.3, 782.5, 782.61, 782.62, 784.9, 786.03, 786.9, 933.1). Discharge diagnoses were obtained from the diagnosis assigned to the patient by the medical housestaff or attending physician. A total of 1148 possible patients were identified; 7 charts could not be located (Fig 1). We reviewed all 1141 charts to determine if a patient met the inclusion and exclusion criteria (see below). If a patient was admitted more than once for an ALTE, only the first admission was included for analysis.

Patients were included if they were ≤12 months of age and had a clinical history of an ALTE. An ALTE was defined as a sudden event consisting of 1 or more of the following that was concerning to the caregiver: (1) breathing irregularity (including apnea, choking, gagging); (2) color change (including cyanosis and pallor); (3) altered muscle tone (including hypotonia, hypertonia); (4) abnormal movements (including clonus); or (5) altered mental status (including unresponsiveness).

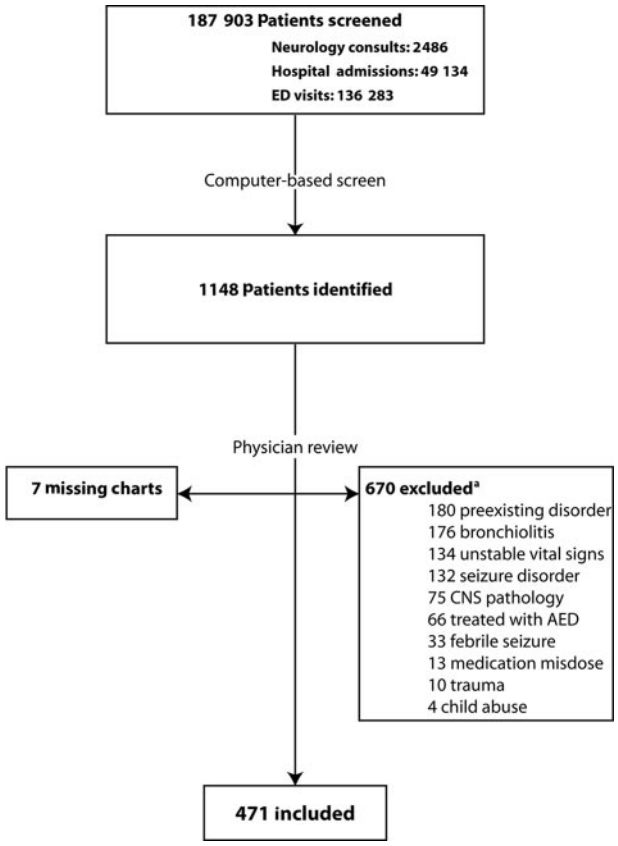

FIGURE 1
Patient enrollment. Potential patients with ALTE were identified from a computer-based key word and ICD-9-CM code search of the databases of pediatric neurology consultation diagnoses, hospital discharge diagnoses, and emergency department chief complaint diagnoses for the study time period (see "Methods" for a listing of diagnoses and key words). A total of 1148 potential patients with ALTEs were identified. Of those in this group, 7 charts could not be located, and 670 patients were excluded (see "Methods" for our exclusion criteria); 471 patients made up the final ALTE cohort for analysis. AED indicates antiepileptic drug; ED, emergency department. [a] Some excluded patients had >1 reason for exclusion.

Patients were excluded from the study for 2 categories of reasons: (1) if they had a known past medical history that could explain their ALTE (such as a seizure disorder) or (2) if at their presentation to the emergency department or admitting hospital doctor there was an apparent diagnosis that could explain their ALTE (such as bronchiolitis). The complete exclusion criteria (listed in Table 4, which is published as supporting information at www.pediatrics.org/content/full/122/1/125) consisted of at least 1 of the following: preexisting disorder; bronchiolitis; unstable vital signs; seizure disorder; CNS pathology; treated with an antiepileptic drug; febrile seizure; medication misdose or overdose; trauma; and child abuse.

Data Collection

Clinical data were abstracted from the charts. Data abstracted from Intermountain Healthcare's computerized database (Enterprise Data Warehouse [EDW]) included age, total hospitalization cost and charges, and length of stay.[11,12] Hospital cost incurred was adjusted to 2003 US

TABLE 1 Selected Demographic, Hospitalization, and Follow-up Characteristics of Infants With an ALTE

Characteristic	Value
Gender, *n* (%)	
Male	233 (49)
Female	238 (51)
Age, d	
Mean	66
Median	40
Race, *n* (%)[a]	
White	372 (79.0)
Hispanic	64 (14.0)
Pacific Islander	6 (1.3)
Black	4 (0.9)
Native American	3 (0.6)
Asian	2 (0.4)
Unknown	7 (1.4)
Premature (<37 wk gestation), *n* (%)	105 (22)
Mean length of stay, d	2.4
Mean hospitalization cost, $	3460
Average length of follow-up, d (y)	1851 (5.1)

The total number of patients was 471.

[a] Racial distribution is consistent with the racial distribution of the Utah population.[28]

TABLE 2 Death, Child Abuse, and Adverse Neurological Outcomes in the ALTE Cohort

Outcome	*n* (%)
Death	2 (0.42)
Child abuse	54 (11.0)
Physical abuse	4 (0.9)
Sexual abuse	6 (1.3)
Abuse within 1 y of ALTE	17 (3.6)
Chronic neurological problems	23 (4.9)
Chronic epilepsy	17 (3.6)
Developmental delay	14 (3.0)

The total number of patients was 471. Eight patients had both chronic epilepsy and developmental delay.

dollars by applying a yearly consumer price index for hospital services.[13]

Outcomes

All patients in the ALTE cohort were followed for outcomes of death, child abuse, or adverse neurological outcome. The time for follow-up included the original enrollment period (January 1, 1999, through December 31, 2003), as well as 2.5 years of additional follow-up (January 1, 2004, through August 31, 2006).

Deaths were identified through both the EDW and state health death records (Utah State vital records) by cross-matching patients using a unique electronic patient identification number.

Child abuse was identified by using the EDW and also by cross-referencing the ALTE cohort to the Utah Division of Child and Family Services records on the basis of name and date of birth. Child abuse is defined by the State of Utah Division of Child and Family Services as "actual or threatened nonaccidental physical or mental harm, negligent treatment, sexual exploitation, or sexual abuse."[14] All cases included in the analysis had been substantiated through a standardized and formal process.[14]

Adverse neurological outcome was defined as developmental delay or chronic epilepsy. Developmental delay was defined if a patient was diagnosed with developmental delay, static encephalopathy, or language delay in the records of the study center pediatric neurology clinic by a pediatric neurologist. Chronic epilepsy was defined as any seizure disorder persisting for >2 years and requiring continued treatment with an antiepileptic drug. Adverse neurological outcomes were determined by evaluating charts from computer records for other hospital admissions and diagnoses (both at the children's hospital and for any other admissions or emergency department visits in the 20-hospital Intermountain Healthcare system), by review of pediatric neurology clinic charts, and by review of electroencephalogram (EEG) results. A positive outcome for a pediatric neurology consult was defined for the outcome of developing chronic epilepsy by whether an antiepileptic drug was started and/or follow-up in a neurology clinic was arranged.

Statistical Analyses

Descriptive statistics were used to characterize the study cohort. Univariate analyses were performed to compare predictor variables with the dichotomous outcome variables of death, child abuse, or adverse neurological outcome. Wilcoxon rank-sum tests were performed for nonnormal continuous predictors such as age. χ^2 tests were performed for dichotomous predictors (eg, family history of seizure) and to calculate odds ratios (ORs). The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and exact binomial 95% confidence intervals (CIs) were calculated for each of the clinical tests (obtaining a neurology consult, EEG, or CNS imaging or starting the patient on an antiepileptic drug) against the outcome of chronic epilepsy. SAS 9.1.3 (SAS Institute, Inc, Cary, NC) was used for analyses.

RESULTS

Baseline Characteristics and Follow-up

The identification of the study population is shown in Fig 1. From a total of 187 903 patients, we identified 1148 patients with an ALTE, of whom 471 patients met our inclusion criteria.

Demographics of the 471 patients are displayed in Table 1. Average age at presentation was 66 days (range: 1–364 days). The average length of hospitalization was 2.4 days. Average length of follow-up for the study cohort was 5.1 years (range: 2.6–7.6 years). Discharge diagnoses are shown in Table 5, which is published as supporting information at www.pediatrics.org/content/full/122/1/125).

Study Outcomes

The results regarding death, child abuse, and adverse neurological outcomes are summarized in Table 2.

Two patients died. Both deaths were related to

TABLE 3 **Yield of In-Hospital Neurological Management of Patients With an ALTE**

	n (%)	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)
Neurology consult obtained	137 (29)	71.0 (44.0–90.0)	73.0 (68.0–77.0)	8.8 (4.6–15.0)	99.0 (96.0–100.0)
Neurology consult positive	52 (11)	42.0 (15.0–72.0)	62.0 (53.0–71.0)	9.6 (3.2–21.0)	92.0 (84.0–97.0)
EEG abnormal ($N = 156$)	6	15.0 (2.0–45.0)	97.0 (93.0–99.0)	33.0 (4.3–77.0)	93.0 (87.0–96.0)
CNS imaging abnormal ($N = 199$)	5	6.7 (0.2–32.0)	98.0 (95.0–100.0)	25.0 (0.6–81.0)	93.0 (88.0–96.0)
Antiepileptic drug prescribed	23 (4.9)	30.0 (10.0–56.0)	96.0 (94.0–98.0)	22.0 (7.5–44.0)	9.07 (95.0–99.0)

Sensitivity, specificity, and PPVs and NPVs for patients in the ALTE cohort who went on to develop chronic epilepsy ($n = 17$). "Neurology consult positive" was for the outcome of chronic epilepsy and was positive if an antiepileptic drug was prescribed and/or follow-up was arranged in pediatric neurology clinic.

chronic respiratory problems and bulbar insufficiency associated with their underlying seizure disorders and severe developmental delay. Death occurred 18 months and 5.5 years, respectively, after the initial ALTE hospitalization in these children. Their ALTE discharge diagnoses were "bronchiolitis" and "abnormal movement." Neither infant had been started on an antiepileptic drug at their initial ALTE presentation. In our ALTE cohort, there were no cases of SIDS.

Fifty-four (11%) of the 471 patients were ultimately found to be victims of child abuse, including 4 (0.9%) patients who were physically abused and 6 (1.3%) who were sexually abused. The remaining 44 patients had other types of abuse including domestic violence exposure, child endangerment or improper supervision, drug exposure, sibling with child abuse, emotional maltreatment, and Munchausen by proxy. Seventeen (3.6%) patients were diagnosed as having been victim of abuse within 1 year of their ALTE hospitalization. For 2 patients the diagnosis of physical abuse was made during the first admission.

Adverse neurological problems developed in 23 (4.9%) patients, including 17 patients with chronic epilepsy and 14 with developmental delay (8 patients had both).

TABLE 4 **Exclusion Criteria**

1. Preexisting disorder
   a. Genetic or metabolic disorder with CNS involvement
   b. Cardiac disease
   c. Pulmonary disease requiring home oxygen therapy
   d. Known GERD on treatment with a clinical history at presentation consistent with vomiting or reflux
2. Bronchiolitis or pneumonia
   a. Cough and/or congestion at presentation
   b. An abnormal chest radiograph at presentation
3. Unstable vital signs in the emergency department
   a. Hypoxia
   b. Bradycardia
   c. Hypotension
   d. Respiratory failure requiring intubation
   e. Fever with at least 1 of the following: cerebrospinal fluid pleocytosis, abnormal urinalysis, or abnormal complete blood count results
4. Seizure disorder
   a. Known history of seizures
   b. Seizure in the emergency department
   c. History for seizure convincing to the emergency department physician, and age >6 mo
5. CNS pathology
   a. Known history of intracranial or CNS pathology
   b. Ventriculoperitoneal or ventriculoatrial shunt placement
   c. Hydrocephalus
   d. Structural brain abnormalities
6. Previous treatment with antiepileptic drug
   a. Including benzodiazepines administered before hospital admission, either in the emergency department or by paramedics
7. Febrile seizure (seizure associated with fever and age >6 mo)
8. Medication misdose
   a. Known ingestion
   b. Medication overdose
9. Trauma
10. Known child abuse
   a. Imaging results at the time of admission consistent with child abuse

Clinical Predictors of Outcomes

Figure 2 presents the associations between the clinical characteristics at presentation and child abuse, adverse neurological outcome, or chronic epilepsy.

For child abuse within 1 year of the ALTE, there were no clinical features that were predictive. Significant predictors of adverse neurological outcome (developmental delay and/or chronic epilepsy) were a family history of seizures and male gender (ORs: 4.5 [95% CI: 1.9–11.1] and 2.4 [95% CI: 1.1–5.3], respectively). The only sig-

TABLE 5 **Discharge Diagnoses of Patients With an ALTE**

Diagnosis	*n* (%)
GERD	190 (40.00)
Apnea	79 (17.00)
ALTE	42 (8.90)
Bronchiolitis	28 (5.90)
Convulsion	28 (5.90)
Cyanosis	20 (4.30)
Spell	14 (3.00)
Seizure	14 (3.00)
Choking	7 (1.50)
Infection[a]	6 (1.30)
Periodic breathing	5 (1.10)
Abnormal movement	4 (0.85)
Hypocalcemia	4 (0.85)
Not listed	4 (0.85)
All other categories (each <0.85%)[b]	26 (5.50)

The total number of patients was 471.

[a] Includes 1 case each of bacterial meningitis, pertussis, sepsis, urinary tract infection, respiratory syncytial virus, and viral infection.

[b] Includes ≤3 cases each of basal ganglia hemorrhage, benign infantile torticollis, breath-holding spell, cardiac dysrhythmia, dyspnea, hypotonic episode, hypoxia, lethargy, malaise, medication reaction, myoclonus, normal neonatal movements, nonaccidental trauma, pyloric stenosis, respiratory problem, sleep myoclonus, and syncope.

TABLE 6 **ORs, 95% CI, and *P* Values for Clinical Characteristics That Predict Child Abuse, Adverse Neurological Outcome, or Chronic Epilepsy**

Clinical Characteristic	Child Abuse		Adverse Neurological Outcome		Chronic Epilepsy	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age	2.3 (0.77–6.6)	.20	1.6 (0.67–3.7)	.39	1.4 (0.54–3.9)	.63
Male gender	1.2 (0.46–3.4)	.80	2.4 (1.1–5.3)	.0047	1.8 (0.84–3.7)	.085
Preterm	0.49 (0.11–2.2)	.54	0.97 (0.35–2.7)	1.0	0.45 (0.10–2.0)	.38
Family history	1.4 (0.38–4.9)	.71	4.5 (1.9–11.1)	.0018	4.5 (1.6–12)	.0060
Previous event	0.86 (0.27–2.7)	1.0	0.71 (0.26–1.9)	.64	0.79 (0.25–2.5)	.79
Rescue breaths	0.90 (0.88–0.93)	.38	1.5 (0.42–5.2)	.47	0.59 (0.077–4.6)	>.99
Call 911	1.4 (0.48–4.2)	.56	0.85 (0.31–2.3)	1.0	0.65 (0.18–2.3)	.77

ORs were calculated for infants who were abused within 1 year of their ALTE, infants with adverse neurological outcome (developmental delay and/or chronic epilepsy), or chronic epilepsy, as compared with the nonaffected ALTE cohort. ORs were calculated by comparison of the affected group with the unaffected remaining patients in the cohort. ORs for age were calculated by comparison of the median of the affected group with the median age of the entire ALTE cohort (minus the affected patients). "Family history" indicates family history of seizures; "call 911" indicates that parents called 911 at the time of the ALTE.

nificant predictor of chronic epilepsy was a family history of seizures (OR: 4.5 [95% CI: 1.6–12.2]).

In-Hospital Management

The primary findings and outcomes of the inpatient neurological evaluation of the ALTE cohort are shown in Table 3.

Of the 471 patients, 137 (29%) had a neurology consultation. Twelve of these patients went on to develop chronic epilepsy. Obtaining a consultation had a sensitivity of 71% (95% CI: 44%–90%) for predicting those who would develop chronic epilepsy, but the PPV was low (8.8% [95% CI: 4.6%–15%]). The outcome of the neurology consult was less sensitive and specific than the actual request for the consult.

One hundred fifty-six (33%) patients had an EEG, of which 6 (1.3%) showed abnormal results. Two of the patients with an abnormal EEG result developed chronic epilepsy, but 11 of the patients who developed chronic epilepsy had normal EEG results. This yielded a sensitivity of 15% (95% CI: 2%–45%) and PPV of 33% (95% CI: 4.3%–48%) of an EEG.

CNS imaging studies, including head computed tomography (CT), brain MRI, and head ultrasound tests, were performed on 199 (42%) patients. CNS imaging results were abnormal for 4 patients, including 2 patients for whom child abuse (nonaccidental trauma) was diagnosed and 1 patient who developed chronic epilepsy. The sensitivity and PPV of abnormal CNS imaging for predicting chronic epilepsy was 6.7% (95% CI: 0.2%–32%) and 25% (95% CI: 0.6%–81%), respectively.

In no case did an MRI reveal a previously undetected abnormality. Although the MRI, in some cases, did clarify the underlying CNS pathology (eg, cortical dysplasia), MRI did not have any additional sensitivity (compared with CT) for detecting novel pathology.

Twenty-three (4.9%) patients were started on an antiepileptic drug, 5 of whom developed chronic epilepsy. Prescription of an antiepileptic drug at the first ALTE had

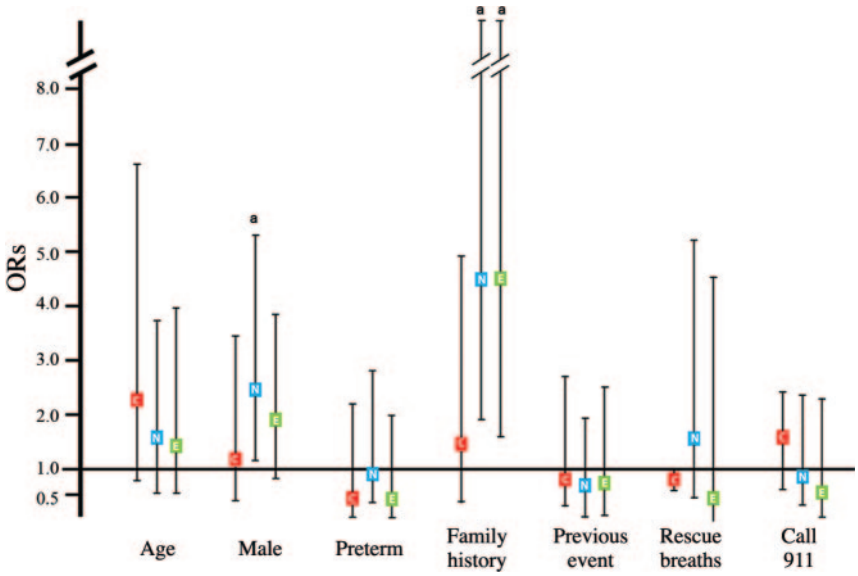

FIGURE 2
ORs for clinical characteristics that predict child abuse, adverse neurological outcome, or chronic epilepsy. ORs were calculated for infants who were victims of child abuse within 1 year of their ALTE (C, red), infants with adverse neurological outcome (developmental delay and/or chronic epilepsy) (N, blue), or chronic epilepsy (E, green), as compared with the nonaffected ALTE cohort. [a] $P < .001$. Ranges for the 95% CIs are shown. "Call 911" refers to parents who called 911 during the ALTE event. See Table 6, which is published as supporting information at www.pediatrics.org/content/full/122/1/125), for a complete listing of ORs, 95% CIs, and *P* values.

low sensitivity (30% [95% CI: 10%–56%]) and PPV (22% [95% CI: 7.5%–44%]) for predicting the development of chronic epilepsy. Of the patients who developed chronic epilepsy, 5 had been placed on an antiepileptic drug during their first hospitalization. Overall, 71% were diagnosed within 1 month of their first presentation because they returned with a second event and were placed on an antiepileptic drug (unpublished data).

DISCUSSION

This study had 4 major findings. First, for patients with an ALTE who appear well when they present, 1 in 9 will subsequently suffer from child abuse and 1 in 20 will develop an adverse neurological outcome. Second, inpatient neurological evaluation has a low yield for predicting adverse neurological outcome. Third, a majority of patients who develop chronic epilepsy will present again within 1 month of their initial ALTE. Fourth, an ALTE did not seem to be a risk factor for SIDS. To our knowledge, this study presents the single largest ALTE cohort with the most extensive follow-up after hospital discharge to date.

In our study, 11% of the patients went on to have substantiated child abuse, including 0.9% with physical abuse. The risk for physical abuse is markedly above the published background rate (0.02%) of physical child abuse[15] and is similar to other published results on ALTEs.[4,16] Similarly, rates of adverse neurological outcome, including chronic epilepsy and developmental delay, are significantly elevated above reported background rates.[17,18] Other ALTE studies have shown similarly elevated rates of adverse neurological outcomes.[19–22]

These elevated rates of abuse and adverse neurological outcome occurred in our study despite the exclusion of patients with a known preexisting explanatory diagnosis (such as a known seizure disorder) and patients in whom a diagnosis was apparent at presentation (including sepsis, electrolyte abnormalities, or otherwise unstable patients). For these patients, there is minimal diagnostic dilemma, and their management is significantly directed by past history or obvious clinical findings. Instead, our ALTE cohort consisted of well-appearing infants with no apparent clinical abnormalities at presentation. Our study demonstrates that there are still significant short- and long-term risks for those well-appearing patients.

The optimal approach for inpatient ALTE management with regards to abuse requires additional study. Although we are not able to determine causality between an ALTE and abuse, our data suggest that patients who present with ALTE are "at risk." Head CT scans, dilated fundoscopic examinations, or the use of a hospital-based child protection team offer possible management options for patients after an ALTE.[4,23,24]

The inpatient neurological evaluation of patients with an ALTE is of low sensitivity and low yield at the first presentation. The only clinical predictor for adverse neurological outcome and chronic epilepsy was a family history of seizures. However, the association between obtaining a neurology consultation and the subsequent development of chronic epilepsy suggests that subtle clinical factors are present, which lead to the request for a consult. It is interesting to note that the consult recommendations had low sensitivity and predictive value for the likelihood to develop chronic epilepsy. Because most patients with an ALTE who develop chronic epilepsy have a second event within 1 month of their initial presentation, delaying antiepileptic drug initiation would avoid potential morbidities associated with unnecessary exposure to these medications.

Death was an infrequent outcome in our ALTE cohort and only occurred in patients who developed chronic epilepsy and static encephalopathy. There were no cases of SIDS, which is in concordance with results of other recent studies.[3,25,26]

Strengths of this study include the large cohort size and the extended follow-up (>5 years). Also, we had the ability to comprehensively track and identify patients for subsequent outcomes, because a significant majority of pediatric patients in Utah are cared for by the same health care system, which maintains records (including admissions, emergency department visits, clinic visits to pediatric neurology, EEG results, and radiology results) in an electronic chart format for its 20 hospitals. In addition, the study hospital is the sole tertiary care pediatric hospital in Utah and receives referrals from Wyoming, Idaho, Montana, and parts of Nevada, Colorado, and Arizona. We were also able to track patients by their referrals to the pediatric neurology clinic (there is only 1 other pediatric neurologist in Utah). Finally, we were able to link our cohort to the Utah state health department databases to evaluate for death and child abuse.

There are several limitations to this study. First, the data were collected retrospectively. Second, because ALTE is not a codeable diagnosis, we used proxy key words and diagnoses to identify patients and potentially missed cases. Third, our follow-up was limited to patients who presented again to the same health care system or to the pediatric neurology clinic. Patients may have been lost to follow-up if they moved to a different state or if they presented to a different health care system. Fourth, it was difficult to generate a meaningful control group for comparison of outcomes (such as child abuse), given the strict inclusion criteria for the ALTE cohort.

CONCLUSIONS

We found that patients with an ALTE are at increased risk for child abuse and adverse neurological outcomes but are at minimal risk of death, and only as related to their development of chronic epilepsy and severe developmental delay. Our study suggests that for ALTE management, a high level of suspicion for the possibility of abuse should be maintained, and screening tests should be considered. Inpatient neurological evaluation for a first ALTE, including pediatric neurology consultation, an EEG test, and CNS imaging, is of low yield. We recommend close communication with the primary care provider regarding the risks for child abuse or adverse neurological outcome.

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