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Do All Infants With Apparent Life-Threatening Events Need to Be Admitted?

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ABSTRACT

OBJECTIVE. The goal was to identify criteria that would allow low-risk infants presenting with an apparent life-threatening event to be discharged safely from the emergency department.

METHODS. We completed data forms prospectively on all previously healthy patients <12 months of age presenting to the emergency department of an urban tertiary care children's hospital with an apparent life-threatening event over a 3-year period. These patients were then observed for subsequent events, significant interventions, or final diagnoses that would have mandated their admission (eg, sepsis).

RESULTS. In our population of 59 infants, all 8 children who met the aforementioned outcome measures, thus requiring admission, either had experienced multiple apparent life-threatening events before presentation or were in their first month of life. In our study group, the high-risk criteria of age of <1 month and multiple apparent life-threatening events yielded a negative predictive value of 100% to identify the need for hospital admission.

CONCLUSIONS. Our study suggests that >30-day-old infants who have experienced a single apparent life-threatening event may be discharged safely from the hospital, which would decrease admissions by 38%.

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Key Words

apnea, apparent life-threatening event, emergency department

Abbreviations

ALTE—apparent life-threatening event
ED—emergency department
SIDS—sudden infant death syndrome
HR—hospitalization required
HNR—hospitalization not required
OR—odds ratio
CI—confidence interval

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AN APPARENT LIFE-THREATENING event (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, but occasionally erythematous or plethoric), marked change in muscle tone (usually marked limpness), choking, or gagging."¹ It is unclear, however, whether an ALTE is a predictor of subsequent death, sudden infant death syndrome (SIDS), or some other serious disorder in infants. Therefore, the question of whether infants presenting with an ALTE require hospital admission for a thorough diagnostic evaluation remains controversial. Hoffman et al² suggested that infant apnea was a risk factor for SIDS. Steinschneider,³ Kelly et al,⁴ and Burchfield and Rawlings⁵ thought that infants who presented with ALTEs were at high risk for subsequent ALTEs and/or death resulting from SIDS. Others suggested that ALTEs may indicate underlying sepsis, pertussis, physical abuse, arrhythmias, metabolic diseases, seizures, or even cardiac tamponade.⁶⁻¹¹ The SIDS rate for infants with ALTEs who required cardiopulmonary resuscitation was found to be 10% in one study, and it increased to 28% with multiple ALTEs.¹¹ On the basis of these studies, it became common practice to view infants presenting with an ALTE as being at high risk, to admit them to the hospital for a diagnostic evaluation, and to consider discharge with home apnea/bradycardia monitoring.¹²

In contrast, Hodgman et al¹³ found that infants with ALTEs were not at increased risk for subsequent ALTEs. Southall et al¹⁴ studied 2-channel cardiorespiratory recordings for infants who died as a result of SIDS, and they found that SIDS could not be predicted on the basis of the presence of apnea or "abnormal" cardiorespiratory events. More recently, the Collaborative Home Infant Monitoring Evaluation Study found that infants with ALTEs had no more episodes of apnea than did control subjects and that serious cardiorespiratory events did not occur during the peak incidence of SIDS at 2 to 4 months of age.¹⁵ These studies cast doubt on the idea that ALTEs are precursors to SIDS or other serious disorders in infants. These conflicting results highlight the question of how infants with ALTEs should be treated when they present to the emergency department (ED).

Many well-written review articles on the topic of ALTEs exist, and consideration of inpatient admission is recommended strongly by some authors.^{7,16} However, no prospective study has established that ALTEs recur more frequently in the days immediately after an ALTE or that these infants require hospital admission. Few practitioners would question the need for admission of an infant who looks unwell or for whom a diagnosis requiring admission is made in the ED. However, when a child demonstrates normal physical examination results after a suspected ALTE at home, there is a paucity of literature data to support the psychosocial and eco-

nomie burden of a hospital admission. Therefore, we attempted to determine criteria that would allow risk stratification in the ED of patients with ALTEs, into a high-risk group of patients who required admission and a low-risk group of patients who could be discharged safely if reliable caretakers and follow-up care were ensured. Although a larger validation set will be required to substantiate this in the future, our goal was to create a set of high-risk criteria for patients with ALTEs, with a negative predictive value of >90%, that could determine the need for hospital admission.

METHODS

This study was a prospective observational analysis of consecutive patients with ALTEs who presented to the ED between July 2002 and April 2005. This study was approved by the institutional review board. The National Institutes of Health statement included in the introduction was used to define ALTEs for the purposes of this study.

Our hospital is a tertiary-care, freestanding, academic, pediatric facility with a dedicated ED (annual census: 60 000). Of all infants with ALTEs who present to our ED, most are admitted to the hospital, although some are not. The purpose of this study was to develop criteria that might predict whether admission was required. In determining which patients with ALTEs required admission, 2 primary questions were addressed, as follows. The first involved predictive criteria. What potential patient characteristics could be used to predict the risk of serious sequelae in infants with ALTEs? These were tested against outcome criteria to determine whether they predicted accurately the need for admission. To stratify risk, we analyzed factors assumed or debated in the literature to increase the risk of SIDS, including (1) family history of SIDS, (2) patient history of moderate prematurity (gestational age between 30 weeks and 37 weeks), (3) previous ALTEs, (4) patient age, (5) presence of upper respiratory infection symptoms, (6) child's color and tone during the ALTE, (7) duration of the ALTE, as estimated by observers, (8) interventions required, (9) appearance of the child in the ED, (10) suspicion of child abuse, and (11) multiple ALTEs within 24 hours.

The second question involved outcome criteria. What outcomes would be considered to mandate admission? We considered any of the following factors to require admission: (1) subsequent events requiring resuscitation during hospitalization, (2) any subsequent ALTEs and an identifiable pathologic condition that was treated during hospitalization, (3) a diagnosis made after admission that would have put the patient at risk with discharge and would normally necessitate admission if identified in the ED (eg, child abuse or serious neonatal bacterial infection), or (4) development of a life-threatening condition

(eg, hypoxemia or respiratory failure) during hospitalization.

Infants <12 months of age were included if they had a convincing history of an ALTE, as determined by the attending physician in the ED. Infants were excluded for a history of extreme prematurity (estimated gestational age of <30 weeks was chosen because of the high risk of persistence of apnea of prematurity for infants with estimated gestational ages of 24–28 weeks¹⁷), uncorrected cardiac disease, known seizure disorder, significant developmental delay, or chronic lung disease requiring treatment. Patients under the care of a neonatologist or pulmonologist because of previous ALTEs were also excluded. All charts were also reviewed by the principle investigator to ensure that the child met the definition of an ALTE and did not meet any exclusion criteria. If a child had an episode of apnea attributable to a clearly discernible disease diagnosed by the ED (ie, pertussis), these were not labeled as ALTEs, and the infants were not included. We included both well- and ill-appearing children. Institutional review board-certified personnel were present 7 days per week, 24 hours per day, to collect a consecutive sample of patients. No family refused consent.

Because this study was purely observational, no modifications were made to the patients' treatment or disposition because of the study. In the ED, the treating physician completed a form documenting the patient characteristics described above. Studies were performed and patients were admitted or discharged at the discretion of the attending physician. Discharged patients were contacted by telephone at 24 to 72 hours, and admitted patients were observed for additional episodes, results of testing, and final diagnosis during their hospital stay. Attempts were also made to contact all patients at 1 week, to obtain outcome data. Regardless of whether patients were actually admitted to the hospital, all patients were categorized as either hospitalization required (HR) or hospitalization not required (HNR), on the basis of the outcome criteria discussed above. Briefly, patients who required resuscitation during hospitalization, experienced subsequent events attributable to a condition identified during hospitalization, or were diagnosed as

having a condition that would have put the patient at risk of acute deterioration if he or she had been discharged were classified as HR. Admitted patients who were discharged without an imminently life-threatening diagnosis and experienced either no events or minor, self-resolved events during hospitalization were classified as HNR. Patients discharged from the ED were contacted at 24 to 72 hours and, if well and without subsequent events, were also placed in the HNR category.

Odds ratios (ORs) for the need for hospitalization were calculated by using univariate analyses. Multivariate analysis was not performed because of the small number of patients who ultimately required hospitalization in each subset. Significance was tested by using Fisher's exact tests. In addition, we attempted to develop criteria that would predict with nearly 100% negative predictive value that a child would not require hospitalization. The sample size goal was to enroll sufficient patients to provide a negative predictive value with the lower end of the 95% confidence interval (CI) at 90%. The sensitivity, specificity, and predictive values of these pooled criteria were calculated with CIs.

RESULTS

Sixty-four patients were enrolled, and 59 were included in the final analysis. Of the 5 eliminated, 1 did not meet the definition of an ALTE, 2 met exclusion criteria, and 1 was discharged from the ED and subsequently could not be reached; 1 was well without subsequent events when seen 45 hours into the hospital stay, but all subsequent records were lost and the treating physician could not be contacted. Of the 59 patients in the final analysis, 55 were actually admitted to the hospital, and 4 were discharged from the ED.

In our analysis, 8 (14%) of the 59 patients were placed in the HR category. These 8 patients were all admitted. Two required PICU transfer, 3 had multiple significant apneic episodes while hospitalized, 1 developed an oxygen requirement, and 2 required treatment for significant infectious or neurologic conditions. More information on the patients who required hospital admission is listed in Table 1. The remaining 51 patients did not experience an event or receive a diagnosis that

TABLE 1 Description of Children Requiring Hospitalization

Patient Age, wk	High-Risk Criteria	Reason for Admission/Hospital Course
0.5	Age	Multiple apnea/desaturation episodes with GERD, oxygen requirement
1	Multiple ALTEs, age	Became hypoxemic, oxygen requirement
1	Multiple ALTEs, age	Seizure, suspected nonaccidental trauma
3	Multiple ALTEs, age	Intubated because of apnea
4	Multiple ALTEs, age	Urinary tract infection
7.5	Multiple ALTEs	Multiple apnea/desaturation episodes with GERD
8	Multiple ALTEs	PICU for apnea, encephalitis
8	Multiple ALTEs	Multiple apnea/desaturation episodes with GERD

GERD indicates gastroesophageal reflux disease.

would have required hospitalization and thus were placed in the HNR category. Four of the HNR patients were discharged from the ED and subsequently contacted by telephone, and 47 were admitted.

The most common unifying features of the 8 HR patients were a history of multiple ALTEs within 24 hours of admission (7 of 8 patients) and age of ≤ 1 month (5 of 8 patients). Prematurity (gestational age of < 37 weeks) was also common (3 of 8 patients). When the HR and HNR groups were compared, a history of multiple ALTEs and prematurity proved to be significantly different. An intergroup comparison of the symptoms studied is listed in Table 2.

Because a history of multiple ALTEs and age of ≤ 1 month (defined as 30 days) were the most common features noted among the HR infants, we evaluated the utility of using either of these features as a criterion for admission. Admitting all patients with ALTEs who were < 1 month of age and/or had a history of multiple ALTEs would provide a sensitivity and negative predictive value of 100% to identify patients who require admission, according to our aforementioned outcome criteria. Because an adverse outcome was a rare event in our population, the CI for the sensitivity was large; however, the CI of the negative predictive value was 90% to 100%. Tables 3 and 4 contain the data and the sensitivity, specificity, and predictive values for this tool in identifying infants who require admission.

DISCUSSION

Our study shows that only 14% of the patients who presented to our ED with a diagnosis of ALTE had a condition or subsequent event necessitating hospitalization. The high-risk criteria (multiple ALTEs within 24 hours and age of ≤ 1 month) identified each of those patients with a negative predictive value of 100%, with

TABLE 2 Comparability of Patients With ALTEs Requiring Hospitalization and Not Requiring Hospitalization

Characteristic	No.	No. of Patients		P	OR for Requiring Hospitalization
		HR (n = 8)	HNR (n = 51)		
Mean age, wk		4.1	9.7	.149	
Age of < 1 mo, %	21	62.5	35.3	.127	3.3
Multiple ALTEs, %	14	87.5	13.5	.001 ^a	4
Prematurity, %	6	37.5	3.9	.009 ^b	14
Male, %	35	62.5	56.9	.765	1.3
Previous ALTE, %	8	12.5	11.8	.952	1.1
URI symptoms, %	23	37.5	35.3	.904	1
Turned blue, %	41	87.5	64.7	.198	4.2
Tone normal, %	17	37.5	23.6	.405	1.1
Duration of > 1 min, %	29	25	54.9	.134	0.27
Awake previously, %	44	75	72.5	.08	1.13
Stimulated, %	39	75	60.8	.445	1.9
Given CPR, %	7	12.5	11.8	.952	1.07

URI indicates upper respiratory infection; CPR, cardiopulmonary resuscitation.

^a Fisher's exact test, $P = .001$.

^b Fisher's exact test, $P = .015$.

TABLE 3 Test Characteristics of Age of < 1 Month or History of Multiple ALTEs to Identify Patients Who Required Hospitalization

Characteristic	% (95% CI)
Negative predictive value	100 (90–100)
Sensitivity	100 (69–100)
Positive predictive value	57
Specificity	27

TABLE 4 Data Used for Sensitivity, Specificity, and Predictive Values

	No. of Patients	
	HR	HNR
Met high-risk criteria	8	22
Did not meet criteria	0	29

a CI lower limit of 90%. Therefore, the possibility of being able to discharge safely a subset of well-appearing, low-risk patients with ALTEs exists, if the results of this pilot study are borne out in a larger, multicenter population of patients with ALTEs. In our small group of 59 infants, 26 (44%) who did not meet high-risk criteria could have been discharged safely from the ED.

Several additional patient characteristics were found to be predictive of subsequent events with calculation of ORs, most notably prematurity (OR: 14) and blue discoloration of the face during the ALTE (OR: 4). These were not included in our high-risk criteria, and all premature or cyanotic patients in our study population who required hospitalization also met the high-risk criteria. However, prudence suggests that prematurity should play a role in physician decision-making. Similarly, we did not include ill appearance in our criteria. Five patients looked ill at presentation, and all of those infants met the high-risk criteria regardless of appearance. Nonetheless, our personal practice continues to be that a child should be well-appearing and have follow-up care ensured to be discharged. No child in this study was admitted for social reasons or suspicion of nonaccidental injuries; however, these factors may be considerations for certain infants with apnea.

Previous studies suggested a higher incidence of SIDS for patients with a family history¹¹ and higher rates of subsequent events for children requiring resuscitation or experiencing multiple events at home¹¹ and those with prolonged apnea and normal muscle tone during the event.¹⁸ Our study was not powered specifically to assess this, but we found no association between the degrees of resuscitation perceived necessary by the parents or the muscle tone during the event and the need for hospitalization. Although it was not the focus of this study, because it would not affect an ED physician's decision to admit a patient in the short term, we attempted to obtain long-term follow-up data on the patients included. One third of the patients were contacted successfully at 3

months. Of those, 2 HNR patients experienced subsequent nonfatal ALTEs (one 3 weeks after discharge and one 6 weeks after discharge), and 1 HNR patient developed possible cardiomyopathy 3 months after admission.

Because the vast majority of our patients fared well throughout their admissions, the number requiring hospitalization was low, which yielded a large CI for the sensitivity of our criteria. However, this does support the rarity of subsequent events and life-threatening conditions for otherwise asymptomatic ALTE patients and the use of a negative predictive value to assess the utility of our work. Ideally, a larger validation set could be tested in a future multicenter study, to confirm our findings. Clearly, the specificity is unacceptably low to be useful; however, our goal was to ensure that all high-risk children are admitted, and we are willing to accept a low specificity to maintain adequate sensitivity and negative predictive value. The 1 patient who was lost to follow-up monitoring after being discharged from the ED presents an additional limitation. Although this child's outcome is not known, there is no record of a return visit to our ED or any complaint or legal action initiated within 2 years after the child's discharge.

CONCLUSIONS

Our study showed that only 14% of infants presenting with an ALTE to the ED had a subsequent clinical course that would have required hospitalization for diagnosis or protection from acute deterioration. All of these cases were predicted because the infants had multiple ALTEs before the ED visit and/or they were <30 days of age. We speculate that most infants who do not meet these high-risk criteria can be discharged safely from the ED.

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ERRATA

Patel JA, Nair S, Revai K, et al. Association of Proinflammatory Cytokine Gene Polymorphisms With Susceptibility to Otitis Media. PEDIATRICS 2006;118:2273–2279.

Errors occurred in the article by Patel et al, titled “Association of Proinflammatory Cytokine Gene Polymorphisms With Susceptibility to Otitis Media,” published in the December 2006 issue of *Pediatrics* (doi:10.1542/peds.2006-0764). In Tables 2 and 3 on pages 2275 and 2276, respectively, the authors reported the genotypes for TNF- α ⁻³⁰⁸ and IL-6⁻¹⁷⁴ incorrectly. For TNF- α ⁻³⁰⁸, footnote “c” should be assigned to “G/G” and footnote “d” should be assigned to “G/A or A/A.” For IL-6⁻¹⁷⁴, footnote “c” should be assigned to “G/G” and footnote “d” should be assigned to “G/C or C/C.” On page 2277, Discussion section, second paragraph, line 7, “IL-6⁻¹⁷⁴ GG polymorphism” should be replaced with “TNF- α ⁻³⁰⁸ AA/AG polymorphism.”

doi:10.1542/peds.2007-1095

Poehling KA, Szilagyi PG, Grijalva CG, et al. Reduction of Frequent Otitis Media and Pressure-Equalizing Tube Insertions in Children After Introduction of Pneumococcal Conjugate Vaccine. PEDIATRICS 2007;119:707–715.

An error occurred in the article by Poehling et al, titled “Reduction of Frequent Otitis Media and Pressure-Equalizing Tube Insertions in Children After Introduction of Pneumococcal Conjugate Vaccine,” published in the April 2007 issue of *Pediatrics* (doi:10.1542/peds.2006-2138). On page 715, reference 11 has an error in an author’s name. “Nuorti PJ” should be “Nuorti JP.”

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Claudius I, Keens T. Do All Infants With Apparent Life-Threatening Events Need to Be Admitted? PEDIATRICS 2007;119:679–683.

An error occurred in the article by Claudius and Keens, titled “Do All Infants With Apparent Life-Threatening Events Need to Be Admitted?” published in the April 2007 issue of *Pediatrics* (doi:10.1542/peds.2006-2549). On page 679, in the Results section of the Abstract, on lines 4-6, the authors wrote: “In our study group, the high-risk criteria of age of <1 year and multiple apparent life-threatening events yielded a negative predictive value of 100% to identify the need for hospital admission.” It should read: “In our study group, the high-risk criteria of age of <1 month and multiple apparent life-threatening events yielded a negative predictive value of 100% to identify the need for hospital admission.”

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