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Apparent Life-threatening Events (ALTEs) and the Role of Home Monitors

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Author Disclosure
Drs Fu and Moon did not disclose any financial relationships relevant to this article.

Objectives After completing this article, readers should be able to:
1. Recognize a child who has an apparent life-threatening event (ALTE).
2. Know the differential diagnosis of ALTE.
3. Discuss the appropriate management of ALTE.
4. Describe the role of home monitoring in the care of children who have ALTE.
5. List the limitations of home monitoring in following children who have ALTE.
6. Characterize the psychosocial issues surrounding the use of home monitors.

Case
A previously healthy 1-month-old boy who was born at term is brought to the emergency department by ambulance. His mother reports that he stopped breathing for 20 seconds and appeared limp and blue around his lips. Once she picked him up, he began to cry and breathe normally. On physical examination, the baby is well-perfused and in no apparent distress. The infant is admitted for observation and evaluation for an apparent life-threatening event (ALTE). The evaluation includes a complete blood count, urine culture, computed tomography scan of the head, cardiorespiratory monitoring, and pH probe. The pH probe results demonstrate significant gastroesophageal reflux; other findings are unremarkable. The child has no additional episodes after 48 hours in the hospital. After his mother is given information for basic life support courses and educated on sudden infant death syndrome (SIDS) prevention, the child is discharged on antireflux medications. He has no more concerning episodes.

Definitions
ALTE refers to a constellation of unexpected physiologic events in an infant that is witnessed by and distressing to a caregiver. In 1986, an expert panel sponsored by the National Institutes of Health developed the now widely accepted definition of ALTE 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.” The expert panel rejected prior associations made between ALTE and SIDS by stating that older terminology such as “near-miss SIDS” and “aborted crib death” no longer should be used. (A discussion about SIDS and its relationship with apnea appears in this issue of Pediatrics in Review on page 209.) The expert panel defined the term apnea of infancy as “an unexplained episode of cessation of breathing for 20 seconds or longer, or a shorter respiratory pause associated with bradycardia, cyanosis, pallor, and/or marked hypotonia.” This term includes cases of idiopathic ALTE.

Because ALTE is a diagnosis based on symptomatology rather than pathophysiology, the differential diagnosis and medical evaluation can be broad. In this article, we review the possible underlying causes of ALTE and its evaluation and management.

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Epidemiology
The incidence of ALTE has been described as being 0.6 to 2.46 per 1,000 live births and representing 0.6% to 0.8% of all emergency visits for children younger than 1 year of age. These figures may underestimate the true incidence of ALTE because studies may miss cases in which the underlying cause eventually is identified and ALTE is removed from the list of discharge diagnoses. The average age of infants experiencing an ALTE is approximately 8 weeks, and events occur equally among boys and girls. Several studies have found that maternal smoking is a risk factor for ALTE, but studies conflict as to whether prematurity also puts infants at increased risk. Notably, prone sleeping, which is a significant risk factor for SIDS, is not associated with ALTE.

Differential Diagnosis
In approximately 50% of all cases diagnosed as ALTE, no apparent cause for the event ever is found. In the other 50% of cases, a comorbid condition eventually is identified. The three most common comorbid conditions, gastroesophageal reflux (GER), seizure, and lower respiratory tract infection, account for approximately 50% of all diagnoses eventually made. In addition to these three conditions, a wide array of other less common but potentially very dangerous or treatable conditions are associated with ALTE, including aspiration, metabolic abnormality, nonaccidental trauma, apnea of infancy, and cardiac dysrhythmia (Table).

Clinicians should be cautious when considering possible causes for ALTE, especially in infants who have GER. From a pathophysiologic standpoint, it is well established that GER can cause apneic episodes that may appear very dramatic to caretakers. Nevertheless, reflux is an extremely common occurrence without sequelae in most healthy infants. According to one study, 50% of all healthy infants 0 to 3 months of age have an episode of regurgitation at least once a day. Therefore, it is uncertain whether GER is a frequent cause of ALTE or just a common incidental finding in infants who experience an ALTE. Because of the ambiguity, unless there is a clear history of recent feeding or visible milk in the mouth by a caretaker at the time of the ALTE, a history of GER should not preclude the search for other underlying causes.

Nonaccidental trauma always should be considered in the infant who presents with ALTE. In a study of infants who had head injury, one third had documented apnea either on history or at the time of admission. Apnea at presentation was strongly associated with death or severe morbidity. Because child abuse can take many forms, such as inflicted head injury, poisoning, and smothering—all of which often are difficult to diagnose—it is possible that some cases of ALTE that have no attributable cause actually are cases of abuse. Clinicians should have a high index of suspicion in infants who experience severe ALTE because in one study involving covert video surveillance, abuse accounted for almost one third of all diagnosed cases in which initial resuscitation was needed.

Evaluation
Infants who experience an ALTE may be asymptomatic by the time they are brought to medical attention and may have normal physical findings. As a result, initiating the evaluation for ALTE sometimes can be a confusing task. Nevertheless, it is possible to approach the evaluation systematically.

History and Physical Examination
Evaluation begins with a history, ideally from the caretaker who observed the event, because this is the only person who can describe the incident reliably. After beginning with an open-ended question assessing the caretaker’s memory of the event, inquiry should be directed toward characterizing the severity of the event. The clinician must determine whether the respiratory component qualifies as true apnea according to the definition of ALTE. A common concern of new parents is shallow breathing or periodic breathing by the newborn (defined as three or more respiratory pauses of greater than 3 seconds’ duration with fewer than 20 seconds of respiration between pauses). However, shallow breathing, short episodes of central apnea lasting less than 15 seconds, and periodic breathing can be normal events as long as they are not associated with cardiac instability.

The clinician next should assess the severity of other aspects of the event. Did the infant’s color change? Was there the change plethoric, acrocyanotic, or centrally cyanotic? Parents may not realize that flushing and acrocyanosis may be consistent with normal changes in perfusion. Was the ALTE self-resolving or did resolution require stimulation or even resuscitation? Assessing the episode’s severity can assist the clinician in deciding whether to admit the infant for observation and evaluation of ALTE, initiate outpatient evaluation, or simply provide the caretaker with reassurance and education about a normal infantile event.

Medical conditions that can present as an ALTE may be categorized by whether the apnea they induce is purely central (referring to a lack of respiratory effort) or whether an obstructive component (commonly due to
upper airway blockage) also is involved. Central apnea suggests an underlying neurologic, cardiac, metabolic, or infectious cause, such as a seizure, intracranial hemorrhage, QTc prolongation, hypoglycemia, or meningitis. Obstructive apnea or mixed central and obstructive apnea suggest GER, respiratory tract infection, foreign body in the upper airway, suffocation, or airway anatomic anomaly. The clinician can distinguish between purely central apnea and apnea with elements of obstruction by asking whether the apnea was effortless or associated with coughing, choking, gasping, or stridor. Depending on the caretaker’s response, more specific questioning about the event can focus the differential diagnosis further.

Just as important as a complete historical account in the evaluation of an ALTE is a thorough head-to-toe examination of the infant. The infant must be examined

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fully unclothed. Vital signs should include an assessment of pulse oximetry. The infant’s general appearance, including any features consistent with a genetic or metabolic syndrome, should be noted. The clinician should look carefully for evidence of trauma, such as head injury, retinal hemorrhage, hemotympanum, acute abdomen, contusion, or a painful extremity. Because respiratory infection, especially with respiratory syncytial virus (RSV) or Bordetella pertussis, is a relatively frequent cause of ALTE, examining the lungs for wheezes, stridor, rales, or rhonchi is essential, as is assessing nasal congestion. The nose and mouth should be examined for the presence of gastric contents, which would support the diagnosis of GER. During the cardiac examination, the infant’s heart rate, rhythm, quality of femoral pulses, and the presence of any murmurs should be noted. Finally, a neurologic examination is important. Depressed mental status or extreme irritability is a concerning sign, as is abnormal tone or reflexes.

**Diagnostic Studies**

Recently, several different decision trees for diagnostic testing for ALTE have been published. Some algorithms recommend more testing than others. Although the algorithms are all evidence-based, none has been tested in a randomized, controlled trial. Accordingly, the breadth and depth of evaluation for ALTE generally is based on the clinician’s own degree of suspicion and comfort level and, therefore, may not be consistent from case to case.

Discharging the patient after educating the caretaker about techniques to prevent and treat additional episodes may be reasonable if several conditions are met: 1) the episode is an infant’s first ALTE; 2) the episode was brief, nonsevere, and self-resolving; 3) there is a probable cause that is nonprogressive (such as GER or nasal congestion); and 4) the infant has no significant medical history and appears well at the time of evaluation. On the other hand, if any aspects of the historical account or physical examination are concerning or if the caretaker has a high level of anxiety about bringing the infant home, the infant should be admitted to the hospital for continuous cardiorespiratory monitoring with pulse oximetry. Further evaluation should be initiated as indicated.

If details of the history or physical examination suggest a probable diagnosis, investigative studies should be focused on that disorder. If, however, no diagnosis is suggested by the initial presentation, a broader scope of diagnostic testing may be ordered. In a retrospective study that included 33 occult causes of ALTE (ie, causes that eventually were diagnosed but not initially suggested by presentation), all occult causes eventually were diagnosed by one of five tests: screening for GER, urine analysis and culture, brain neuroimaging, pneumogram (a recording of cardiorespiratory activity), and white blood cell count. Such diagnostic tests likely provide the highest yield, and the evaluation for infants who have ALTE and nonsuggestive presentations should start with these five tests. The evaluation may expand to include other tests such as measurement of C-reactive protein, electrolytes, blood gases, ammonia, lactate, and pyruvate as well as blood culture, toxicology screen, electrocardiography, electroencephalography, and washings for pertussis and RSV if nasal secretions are present. Important factors to weigh when deciding the breadth of evaluation include severity of the event, patient discomfort, and cost of analyses, keeping in mind that an underlying cause is never found in about 50% of all cases of ALTE.

**Home Cardiorespiratory Monitors**

Typical home cardiorespiratory monitors, also known as apnea monitors, are designed to alert caregivers to episodes of apnea and bradycardia. The monitors can be set to alarm at any given minimum and maximum threshold of respiratory rate and heart rate. More advanced monitors also assess blood oxygen saturation and have event recorders. Infants wear the device at all times or at least when they are sleeping or not observed directly by a caretaker. False alarms can occur when the device’s sensors inadvertently are shifted out of position.

Widespread use of apnea monitors for ALTE started in the 1970s, when researchers postulated that apnea was a precursor to SIDS and that monitors could be used to prevent lethal events. Since the 1970s, no convincing evidence has linked prolonged apnea to SIDS. Furthermore, there is no evidence that apnea monitors effectively prevent SIDS. Results of the multicenter Collaborative Home Infant Monitoring Evaluation (CHIME), a longitudinal study of 1,079 infants on home cardiorespiratory monitors, underscore this point. The CHIME study demonstrated that apnea and bradycardia lasting more than 20 seconds were relatively common occurrences, experienced by 43% of infants in the study, including healthy children. Episodes of apnea or bradycardia occurred as frequently among healthy infants as among infants who had had idiopathic ALTE requiring vigorous stimulation or cardiopulmonary resuscitation. The number of extreme events lasting more than 20 seconds also was similar between the groups.

Despite the lack of evidence and the frustration of using apnea monitors, many parents of infants who have...
had an ALTE place considerable faith in the devices’ capabilities. Multiple studies have shown that parents of infants who are given a monitor for ALTE typically use the device for more than 50% of each day. In one study, parents reported that they felt the monitor was helpful and that it made them feel more secure. Although parents in this study reported positive feelings about apnea monitors, psychological testing revealed that the monitors may have been extracting an emotional toll. The parents in this same study reported increased depression and hostility within the first 2 weeks of their infants coming home with a monitor, unlike the parents of infants discharged without a monitor. In addition to the emotional toll, apnea monitors are costly. The average monthly price of operation per monitor has been estimated to be $300 to $400, excluding physician fees.

Home monitors do have a role in the management of apnea, but only for a select group of patients. In 2003, the American Academy of Pediatrics Committee on Fetus and Newborn recommended that monitoring may be appropriate for two groups: 1) preterm infants who are at high risk of recurrent episodes of apnea, bradycardia, and hypoxemia after hospital discharge; and 2) infants who are technology-dependent, have unstable airways, have rare medical conditions affecting regulation of breathing, or have symptomatic chronic lung disease. All monitors prescribed should have event recorders. For preterm infants, monitoring should be limited to 43 weeks postmenstrual age or until after a period of no recorded episodes of extreme apnea, whichever occurs later. The Committee specifically advised that monitoring not be prescribed for prevention of SIDS.

Future Areas of Research
The most difficult aspects of studying ALTEs are that identification of cases relies on the subjective assessment of nonclinician historians and that there are a multitude of underlying causes, some benign and others life-threatening. Future research should be directed at specifying further which aspects of the historical account or physical examination are associated with a high probability of a negative outcome or with modifiable factors that can make future episodes less likely. Research also is needed to determine a simple, cost-effective means of distinguishing pathologic GER from normal infant regurgitation. Finally, randomized, controlled trials are warranted to test the effectiveness and cost-benefit ratios of the various algorithms for evaluation of cases of ALTE that have nonsuggestive presentations.

Summary
Strong research evidence suggests that apnea and bradycardia are common occurrences in healthy infants. (1) Further, strong research evidence suggests that the three most common comorbid conditions associated with ALTE are GER, seizure, and lower respiratory tract infection. (2) According to some research evidence, evaluation for cases of ALTE that have nonsuggestive presentations should begin with screening for GER, urinalysis and culture, brain neuroimaging, pneumogram, and white blood cell count. (3) Based on strong research evidence, home cardiorespiratory monitors should be used only for preterm infants or children who are either dependent on technology, have unstable airways, have medical conditions that involve disordered respiratory control, or have symptomatic chronic lung disease. (4)

References

Suggested Reading
PIR Quiz

Quiz also available online at www.pedsinreview.org.

1. Which of the following statements regarding apparent life-threatening events (ALTEs) is true?
   A. An apparent cause almost always is discovered during the detailed history and physical examination.
   B. Home event monitors have been shown to reduce the incidence of ALTEs.
   C. Infants who have a history of ALTE are at higher risk of SIDS.
   D. Many infants who experience an ALTE have normal physical examination findings when brought to medical attention.
   E. Preterm infants are proven to be at higher risk for ALTEs than are term infants.

2. Which of the following is a risk factor for ALTE?
   A. Family history of ALTE.
   B. Female sex.
   C. Maternal smoking.
   D. Pacifier use.
   E. Prone sleeping position.

3. A worried mother brings in her 3-week-old son because he turned blue for 30 seconds and appeared not to be breathing during that time. Your history reveals that he is a slow eater who often sweats during feedings. Physical examination reveals mild tachycardia and slightly weakened peripheral pulses. Of the following, the test that is most likely to reveal the cause of his ALTE is:
   A. Complete blood count.
   B. Computed tomography scan of the head.
   C. Echocardiography.
   D. Multichannel pneumogram.
   E. Urine culture.

4. A young couple brings their 4-week-old daughter to the emergency department because she stopped breathing while feeding. They report that they initiated cardiopulmonary resuscitation but were unable to get a response from her. The infant is apneic, cyanotic, and limp. You also note on physical examination that her left arm and left leg are bruised. After you intubate her and gain intravenous access, you consider the differential diagnosis of apnea. Of the following, the test that is most important to obtain to determine the cause of the infant's apneic event is:
   A. Ammonia measurement.
   B. Chest radiography.
   C. Computed tomography scan of the head.
   D. Electrocardiography.
   E. Upper gastrointestinal radiographic series.

5. You are evaluating a 6-week-old boy who was brought to your clinic by his mother after a choking episode several hours earlier. She reports that shortly after feeding, he coughed and appeared to be choking and gasping for breath for 5 seconds. The episode resolved, and he has been breathing normally since. He is a well-appearing, alert infant who has normal vital signs and no fever. Except for mild nasal congestion, his physical examination findings are normal. His mother reports that he spits up occasionally. Of the following, the most appropriate management of this patient's ALTE is:
   A. Admission to the hospital for a 48-hour observation without laboratory evaluation.
   B. Admission to the short-stay unit for 24 hours of continuous cardiorespiratory and pulse oximetry monitoring.
   C. Discharge from the clinic with an apnea monitor for 2 months.
   D. Education of the mother and discharge from the clinic with gastroesophageal reflux precautions.
   E. Full sepsis evaluation, including lumbar puncture, and admission to the hospital for administration of intravenous antibiotics.
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