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A Practical Approach to Infantile Apnea

Gregory Preston, MD*

The complaint that an infant has had "difficulty breathing" is unsettling to the physician because of the uncertain relationship between the control of breathing and the sudden infant death syndrome (SIDS). A practical approach to this complaint can clear some of the confusion but rarely leads to a satisfactory medical conclusion. The 1986 National Institutes of Health Consensus Panel on Apnea and Home Monitoring has attempted to offer guidelines for clinical practice by identifying the apparent life-threatening event (ALTE) as a key issue in the management of infantile apnea (1).

The ALTE is an episode characterized by some combination of apnea, choking or gagging, marked change in muscle tone, and color change. The event is frightening to witness, and observers sometimes fear that the infant has died (1). Two studies have correlated the type of ALTE with the relative risk for SIDS (2,3). These investigators concluded that infants who suffer one ALTE which requires either mild or vigorous stimulation (including cardiopulmonary resuscitation) and infants who experience more than one ALTE from which they arouse without stimulation are at higher risk for SIDS than the general population (Table 1) (2,3).

**Differential Diagnosis**

The approach for newborns to 1-year-old infants who are brought to medical attention because of an ALTE must include a careful evaluation of the event. Attention should also be directed to the extensive differential diagnosis of an ALTE (Table 2).

**Evaluation**

The history of the event should include answers to questions concerning color change (pallor, cyanosis, or flushing), muscle tone and activity (limp or struggling), respiratory effort (present or absent), heart rate (fast, slow, or absent), duration of the event, and intervention by the onlooker. Intervention is usually limited to touching or shaking the infant but may include chest compressions, blowing on the face, or rescue breathing. It is helpful to know the length of time that intervention was performed, whether intervention was really necessary, the infant's reaction upon perceived recovery (ie, whether the baby cried, vomited, struggled, or acted unusual), and whether the color change or breathing difficulty persisted.

The history of the present illness should also include details concerning the infant's condition prior to the event. Was the baby awake or asleep and how long asleep? What was the temporal relation to feeding? Has there been a recent change in sleeping or waking behavior? Does the infant have a stuffy nose, upper respiratory tract infection, or other illness, and is the infant being treated with any medication? Is this episode similar to any other events that this infant or other family members have experienced?

The family history should include detailed information about any similar episodes or deaths in siblings or first-order relatives such as first cousins, aunts, or uncles. Risk factors identified in the birth history include: maternal smoking of more than six cigarettes daily, maternal hemoglobin less than 10 g/dL at any time during the pregnancy, and gestational age less than 36 weeks (4).

Awake infants who experience obstructive episodes with oxygen desaturations (cyanosis) and bradycardia are at increased risk to suffer dangerously prolonged apneic episodes that can result in cardiac arrest (4). Even infants who present with this complaint but who appear to be perfectly normal at the time of the examination should be treated with the same concern as those found flaccid and pale with apnea who survive to be brought to medical attention.

A complete physical examination including respiratory rate, heart rate, blood pressure, and temperature should be performed. Initial laboratory investigations should include a capillary or arterial blood gas determination, electrolytes, glucose, calcium, BUN, complete blood count with differential, and if indicated toxicology screen of the blood, urine, and gastric contents.

Chest radiography is often useful especially during winter respiratory virus epidemics. An electrocardiogram may be indicated particularly if the cardiac examination shows an abnormality of rate or rhythm. Infants with a significant episode of hypoxia related to the ALTE or an underlying respiratory illness often have hypobicarbonatemia (5) and a compensated metabolic acidosis. Low PaO₂ may persist to the time of the examination if a significant lower respiratory tract illness is present.

Additional investigations should be performed based on specific clinical suspicions raised by the history and physical examination. Radiologic evaluation of the airway by barium swallow or a milk scintiscan with a 24-hour delayed count over the lung fields is indicated to demonstrate suspected gastroesophageal reflux and aspiration. Exotic studies such as screens for metabolic diseases should be obtained at the time of initial contact if
severe metabolic acidosis, hypoglycemia, or anion gap exists, if the problem is recurrent, if there are physical findings, or if a urinalysis suggests a metabolic etiology.

All infants who experience an ALTE should be admitted to the hospital for 24 to 48 hours for evaluation and for monitoring of possible subsequent episodes (6). A 12-hour sleep pneumocardiogram should be performed at this time, and the infant should be monitored by continuous pulse oximetry during the hospital stay if possible to detect episodes of desaturation during sleep and feeding. Despite its many shortcomings, the sleep pneumocardiogram remains the conventional tool to study the control of breathing in these infants (7). The electroencephalogram may be helpful in those cases where a seizure disorder is suspected.

Treatment

Information concerning treatment of apnea in infants arises from experience with apnea of prematurity. Maintenance of serum theophylline levels of 2 to 15 $\mu$g/mL has been helpful in reducing the frequency of episodes of apnea of prematurity (8,9). Doxapram, a potent stimulant of respiration, is available only as an intravenous preparation and is not useful for chronic therapy. Treatment of other causes of apnea may be helpful. Successful anticonvulsant therapy of infants who experience an ALTE as a result of a convulsion has not been studied concerning the subsequent incidence of SIDS. Medical or surgical management of gastroesophageal reflux that occurs in infants who have suffered an ALTE may reduce the incidence of subsequent events, but this has not been studied. Medical management of gastroesophageal reflux may not even be effective in managing the primary problem (10). Protection of infants at risk for SIDS from pertussis, respiratory syncytial virus, or other respiratory tract infections may reduce the incidence of SIDS (11). Surgical management of obstructive apnea includes removal of tonsils and/or adenoids, reconstructive surgery, and tracheostomy (12), but this has not been studied in relation to SIDS.

The Pneumocardiogram

The pneumocardiogram uses a noninvasive device to detect the breathing rate and heart rate over a 12-hour period. At least eight hours of quiet sleep time are required for adequate assessment. The quiet sleep time need not be continuous and is cumulative during the recording period.

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Type of ALTE</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0*</td>
<td>No event</td>
<td>1.4-3.4/1,000</td>
</tr>
<tr>
<td>1</td>
<td>Requires no stimulation</td>
<td>Same as general population</td>
</tr>
<tr>
<td>Sibling of SIDS victim or recurrent event</td>
<td>Twofold increase</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Requires mild stimulation</td>
<td>Threefold increase</td>
</tr>
<tr>
<td>3</td>
<td>Requires vigorous stimulation up to 2 CPR</td>
<td>Threefold to fourfold increase</td>
</tr>
</tbody>
</table>

*See Reference 2.

*General population of healthy infants.

The recording devices consist of a sensor and signal processor, with the capability to store and display collected information. The most common noninvasive sensors used for home monitoring detect alterations of breathing. Electrodes attached to the chest wall detect changes in current across the thorax as well as electrical activity of the heart. A commonly used sensor is a soft strain gauge which surrounds the infant's chest or abdomen and detects changes in circumference with breathing. Separate electrodes are required to detect heart rate.

Home monitors are ordinarily designed with apnea and heart rate alarms, giving both visual and auditory signals. Information may be displayed in various ways, and processed information can be stored electronically, printed, or transmitted to another location for evaluation. Most alarms can be set to signal after a predetermined delay in breathing and at high and low heart rates.

The pneumocardiogram detects periods of apnea, bradycardia, excessive periodic breathing for age, disorganized breathing, and the heart rate (Figure). Because these findings may represent risk factors for the occurrence of subsequent ALTEs, the test is recommended for initial evaluation of children who are suspected of having apnea or who are at risk for SIDS.

Home Monitoring

Infants who are stable following a significant ALTE (groups 2 and 3, Table 1) regardless of the pneumocardiogram results or who have been treated for an underlying disorder that has precipitated such an ALTE should be discharged on a home monitor. Infants who experience a so-called mild ALTE (group 1, Table 1) and had normal investigations initially but who suffered subsequent events should also be monitored. Asymptomatic infants who are at high epidemiologic risk (Table 3) may require monitoring (4,13) as may tracheotomy patients (14), especially those who have not achieved good head control. The NIH Developmental Conference on Infantile Apnea and Home Monitoring concluded that parental concern alone is not an indication for home monitoring (1). The presence of risk factors with or without an abnormal pneumocardiogram is the indication for home monitoring. An abnormal pneumocardiogram simply represents another risk factor for SIDS that when present becomes an indication for home monitoring.
Parents and respite caretakers of monitored infants should be trained in cardiopulmonary resuscitation (CPR) as soon as possible after the infant’s admission to the hospital. The infants should not be discharged until all caretakers demonstrate proficiency in CPR and the handling of monitoring equipment. The families should have access at all times to a home care representative and a physician familiar with their problems. Local emergency medical services should be made aware that this infant resides in their area. The family should return to a clinic periodically for physical evaluation, to review CPR, and to discuss home monitoring.

Current recommendations state that monitoring can be discontinued following two to three months without the occurrence of a subsequent ALTE (1,6,15). Before monitoring is discontinued it may be helpful to know that the infant has experienced at least one significant respiratory tract infection without the occurrence of an ALTE. A repeat pneumocardiogram may be useful before discontinuing home monitoring if 1) the alarm has been signaling but no ALTE has been witnessed, 2) the previous pneumocardiogram showed an abnormality, or 3) the family demonstrates an unusual degree of anxiety about discontinuing home monitoring despite attempts to desensitize them to this event during the monitoring period.

The death rate for SIDS has not changed in the 20 years that statistics have been kept (16). Electronic monitoring and CPR training may reduce the incidence in high-risk groups, but this has not been clearly demonstrated (2,4,15). Despite the incredibly high cost of medical care for these infants (1), we remain dependent on this approach until more definitive tools for diagnosis and management become available.

References