

Sudden Infant Death Syndrome

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Author Disclosure

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

Objectives After completing this article, readers should be able to:

1. Describe possible etiologic mechanisms for sudden infant death syndrome (SIDS).
2. Identify the risk factors for SIDS.
3. Understand the relationship between apnea and SIDS.
4. Discuss the American Academy of Pediatrics SIDS Task Force recommendations and underlying rationale.

Definition

Sudden infant death syndrome (SIDS) is defined as the sudden unexplained death of an infant younger than 1 year of age. It usually occurs in a previously healthy infant, and the cause of death remains unexplained despite a thorough case investigation, including a complete autopsy, death scene investigation, and review of the clinical history.

Epidemiology

Every year in the United States, approximately 2,500 infants die from SIDS. Risk factors have been identified through epidemiologic studies. SIDS is more likely to occur in male infants (3:2 ratio). Other risk factors include prone and side sleeping positions, maternal smoking during pregnancy, environmental tobacco smoke, overheating, soft bedding, inadequate prenatal care, young maternal age, prematurity or low birthweight, and African-American or American Indian/Alaskan Native heritage.

For many years, apnea was believed to be the predecessor of SIDS, and home apnea monitors have been used in an attempt to prevent SIDS. However, studies such as the Collaborative Home Infant Monitoring Evaluation (CHIME) have demonstrated that apnea neither precedes nor predicts SIDS. Although apnea monitors may be useful in selected patients who have experienced apparent life-threatening events (ALTEs), there is no evidence that they are useful in reducing the risk of SIDS, and the American Academy of Pediatrics (AAP) recommends against using monitors as a SIDS prevention technique. (A more detailed discussion of ALTEs appears in this issue of *Pediatrics in Review* on page 203.)

In 1992, the AAP first published its recommendation that infants should sleep in a nonprone position to reduce the risk of SIDS, and a national public education campaign, “Back to Sleep,” was launched in 1994. Since that time, the percentage of infants sleeping prone has decreased from 70% to less than 15%, and the rate of SIDS has decreased from 1.2 deaths per 1,000 live births to 0.57 deaths per 1,000 live births in 2002 (Fig. 1). Despite this decline, SIDS remains the third leading cause of death in infancy and the most common cause of death between 1 month and 1 year of age. In recent years, the rate of SIDS has continued to decline, although more slowly. In addition, the rate of other sudden unexpected infant deaths has risen (Fig. 2). A diagnostic shift in recent years is likely, with deaths that would have been ascribed to SIDS 10 years ago now being ascribed to other causes, usually suffocation, asphyxia, or undetermined.

In addition, a racial disparity continues in the occurrence of SIDS. African-Americans and Native Americans at all socioeconomic levels experience SIDS at two to three times the

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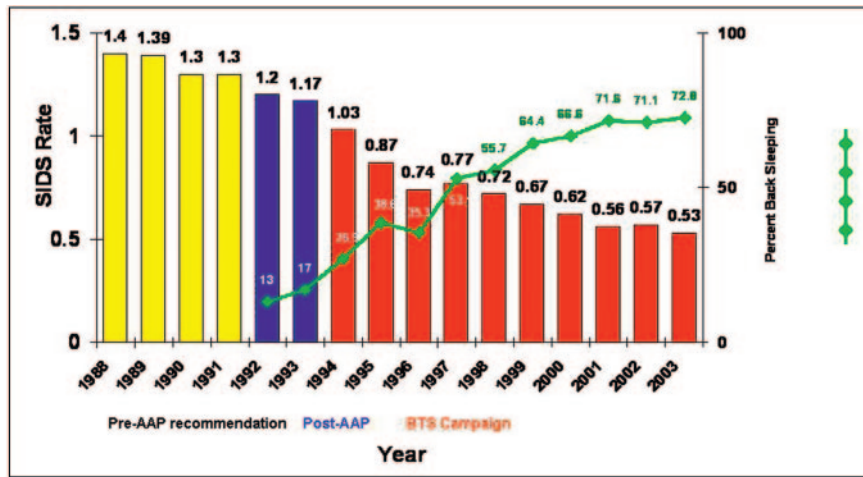


Figure 1. SIDS rate and sleep position, 1988–2003 (deaths per 1,000 live births). As the rate of supine sleeping has increased since 1992 (line graph), the rate of SIDS has declined (bar graph). In recent years, the rates have changed very little. AAP=American Academy of Pediatrics, BTS=Back to Sleep. Sleep position source: National Institute of Child Health and Human Development Household Survey. SIDS rate source: National Center for Health Statistics, Centers for Disease Control and Prevention.

rate of the general population. Although it is likely that biologic differences (such as racial differences in tobacco metabolism) may explain the disparity partially, there also are differences in behavior. For example, African-Americans are twice as likely to place infants prone and twice as likely to share beds.

Pathophysiology

The most recent research indicates that SIDS is a poly-genic, multifactorial condition in which genetic, environmental, and behavioral/sociocultural factors play roles (Fig. 3). Arousal may play an important role in SIDS. The re-breathing theory suggests that infants who lie

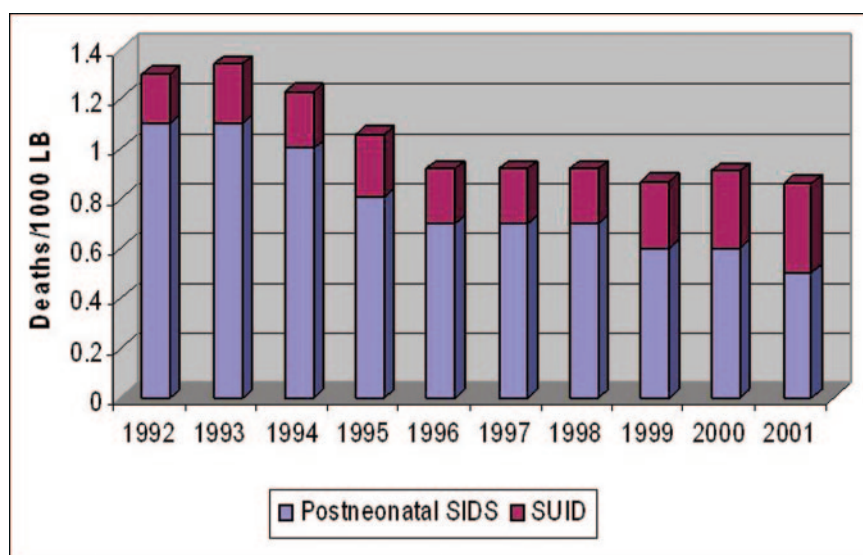


Figure 2. Although SIDS rates have continued to decline, the rates of other sudden unexpected infant death (SUID) diagnoses have increased. SUID refers to infant deaths that occur suddenly and unexpectedly and for which a cause of death is found during the postmortem examination. The total number of SUIDs per year has remained stable over the last several years, which raises the possibility of a diagnostic shift.

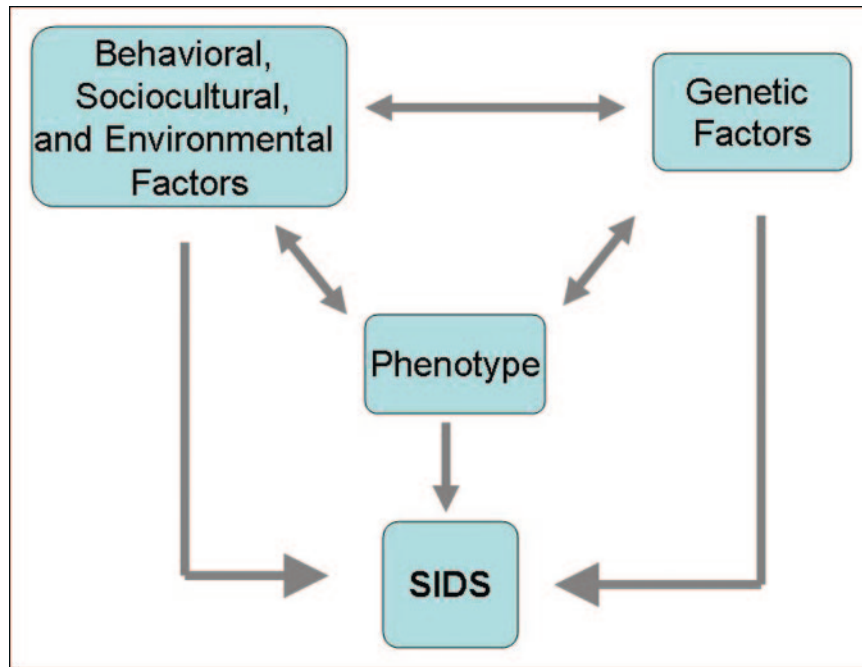


Figure 3. SIDS is a polygenic condition, and expression of the phenotype (ie, sudden death in infancy) depends on genetic, environmental, sociocultural, and behavioral factors.

prone are more likely to trap exhaled carbon dioxide around the face, particularly when they are lying face down or on soft bedding. For infants, re-breathing exhaled carbon dioxide can lead to hypercarbia and hypoxia and subsequent death if arousal responses are not appropriate. When Kinney and colleagues examined postmortem brainstems of infants who died of SIDS and other causes, they found serotonin receptor abnormalities throughout the ventral medulla in the SIDS victims. This finding may represent a network dysfunction that affects arousal and cardiorespiratory responses. When infants who have serotonin receptor abnormalities are asleep, they may not arouse appropriately to episodes of hypoxia or hypercarbia.

Several studies have demonstrated polymorphisms in the promoter region of a serotonin transporter protein gene known as *5-HTT*. Alleles that increase promoter effectiveness, which increases serotonin transporter activity and subsequently reduces serotonin concentrations at nerve endings, are found more often in infants who have SIDS.

Polymorphisms also have been found in other genes that may be pertinent in SIDS, such as *SCN5A*, a sodium channel gene that is related to prolonged QT interval, and genes affecting autonomic nervous system development (*PHOX2a*, *RET*, *ECE1*, *TLX3*, *EN1*). Thus, it

appears that certain infants may be genetically predisposed to SIDS, which becomes manifest with some type of environmental challenge, such as prone positioning or tobacco exposure (Fig. 4).

Differential Diagnosis

Because SIDS is a diagnosis of exclusion, other conditions must be ruled out by autopsy, death scene investigation, and review of the clinical history. Illnesses that should be considered in the differential diagnosis include sepsis, pneumonia, myocarditis, cardiomyopathy, congenital heart defect, arrhythmia, prolonged QT syndrome, accidental or nonaccidental trauma, suffocation, adrenal hypoplasia, and inherited metabolic disorders such as fatty acid oxidation disorders.

If a family is experiencing a second SIDS death, inherited disorders should be ruled out. A family who has experienced one SIDS death has a 2% to 6% risk of a second SIDS death. Homicide is a rare but important consideration, particularly with a subsequent sudden unexpected infant death in a family or with a single caregiver. Therefore, although a subsequent sudden unexpected infant death within a family is most likely to be of natural causes, an autopsy, death scene investigation, and review of the medical history are important to rule out

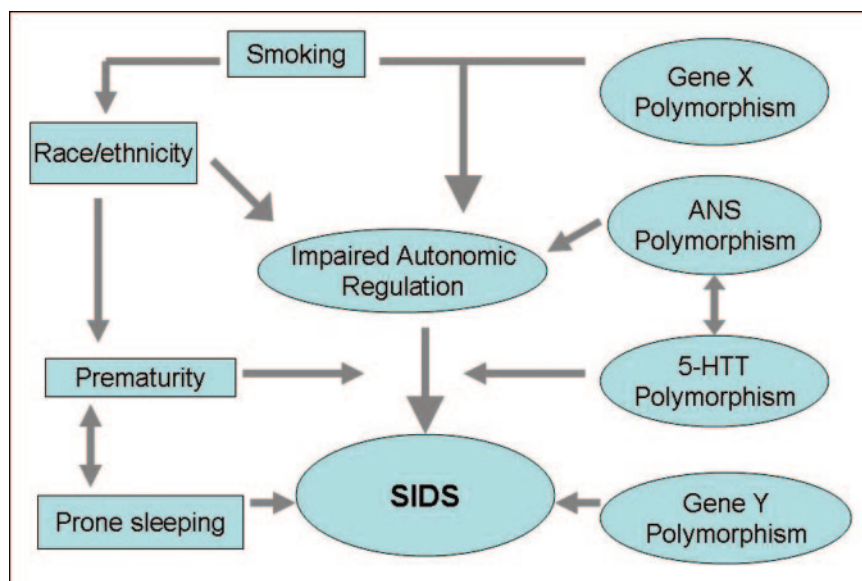


Figure 4. A schematic illustration of some interactions between adverse environmental and genetic risk factors potentially associated with SIDS. Gene X and Gene Y represent yet-unidentified genetic factors. Reprinted from Hunt CE. Gene-environment interactions: implications for sudden unexpected deaths in infancy. *Arch Dis Child*. 2005;90:48–53 with permission from the BMJ Publishing Group.

other causes, including genetic and metabolic disorders, abuse, neglect, and homicide.

Risk Reduction

SIDS risk reduction strategies have focused on eliminating risk factors that are associated with SIDS in epidemiologic studies.

Infants should be placed in the supine position every time they are laid down for sleep. In the past, the AAP has recommended back or side positions, but multiple studies have demonstrated that the side position places the infant at higher risk for SIDS than does the back position. In fact, recent studies have found that the risk of SIDS is similar for side and prone positions, and the contribution of side position to SIDS risk has increased in recent years. Much of this risk is due to the instability of the side sleep position; a large proportion of infants placed on the side roll to the prone position, which carries an extremely high risk of SIDS relative to the back position.

Secondary caregivers (grandparents, relatives, child care providers) are more likely to place infants prone, which also increases the risk of SIDS, particularly if the infant is unaccustomed to sleeping prone. Use of commercial positioning devices, such as wedges, is not recommended. Supine positioning should begin in the newborn nursery within a few hours of birth. For preterm infants, prone positioning may be used to improve respi-

ratory dynamics, but infants should begin to sleep supine as soon as they are medically stable and well before hospital discharge. Prone positioning when the infant is awake and observed, often referred to as “tummy time,” should be encouraged to enhance motor development and to prevent positional plagiocephaly or head molding. Other strategies to decrease plagiocephaly include avoidance of excessive time in car seats and bouncers, alteration of supine head position while asleep, and encouragement of upright “cuddle” time while awake.

Prenatal and postnatal exposures to tobacco are well-established risk factors for SIDS. With the decrease in prone positioning, the relative risk of SIDS associated with maternal smoking has doubled, and this risk is greater for nonprone sleepers than for prone sleepers. Tobacco exposure can result in decreased birthweight, decreased lung growth and elasticity, and increased infections in infants. In addition, there is evidence that infants exposed prenatally to tobacco are more likely to have arousal defects.

Infants dying from SIDS are more likely to have used a pillow or soft mattress and to have been found with the nose and mouth covered by bedding. Soft bedding increases the risk of SIDS fivefold, and the combination of soft bedding and prone position increases the risk more than 20-fold. A firm crib mattress, covered by a single sheet, should be used for all infants. No soft materials or

objects should be placed under the infant, and no soft objects or loose bedding should be in the crib. If bumper pads are used, they should be firm, thin, securely attached to the railings, and not pillowlike. If a thin blanket is used, the blanket should be tucked in on three sides so it cannot shift above the level of the infant's chest. A sleep sack or sleeper can be used as an alternative to blankets. Overheating should be avoided; the room temperature should be comfortable for a lightly clothed adult, and infants should not be overbundled.

Studies have demonstrated consistently a protective effect of pacifiers on SIDS, with as much as a 90% reduced risk. The mechanism is unknown, but it is hypothesized that pacifier use lowers arousal thresholds in sleeping infants. Disadvantages of pacifiers include potential dental malocclusion, increased risk for otitis media, and reduced breastfeeding duration. Dental malocclusion generally resolves when pacifier use is discontinued, and the incidence of otitis media is low in the first 6 postnatal months, when the risk of SIDS is highest. Pacifier use can reduce the duration of breastfeeding if the pacifier is introduced in the first postnatal week, but there is no evidence that pacifier use affects breastfeeding duration if the pacifier is introduced after breastfeeding is well established.

Pacifier use should be considered for infants at sleep time during the first year after birth. It should not be introduced until 1 month of age in breastfed infants to assure firm establishment of breastfeeding. The pacifiers should not be coated in any sweet solution and should be cleaned often and replaced regularly. In addition, the pacifier should not be forced on an infant who does not wish to take it and does not need to be reinserted if it falls out after the infant is asleep.

Bed-sharing has long been a common practice in many cultures. In the United States, bed-sharing by infants and parents has become increasingly popular, particularly among breastfeeding families. The rate of bed-sharing for the entire night has more than doubled in the past 10 years, and 45% of babies spend at least some time bed-sharing each night. Facilitation of breastfeeding and enhancement of parent-child bonding are important advantages of bed-sharing. However, case-control studies demonstrate that sharing the same sleep surface with an infant increases the infant's risk of sudden and unexpected death (eg, SIDS, suffocation, asphyxia, entrapment). The risk is particularly high when one or both parents smoke, there are multiple bed-sharers, one or both parents has consumed alcohol or arousal-altering medications, one or both parents is overtired, and the infant is younger than 11 weeks old.

Sleeping on a couch, sofa, armchair, or waterbed is extremely dangerous and always should be discouraged. Infants also should not bed-share with other children. Recent studies have demonstrated that the risk for SIDS is lowest when the infant is in the same room as the parent, but on a separate sleep surface, such as a crib or bassinet. Room-sharing without bed-sharing, therefore, is recommended. The crib or bassinet should be placed next to the parent's bed to allow for easy access for breastfeeding. The infant can be brought into the parent's bed for breastfeeding or comforting but should be returned to his or her own crib when the parent is ready to go to sleep.

Management and Support

The death of an infant is devastating for all concerned. However, in addition to the loss of their infant, families who have had an infant die of SIDS may face police investigation, a prolonged wait for determination of the cause of death, and a lack of emotional closure, all of which complicate the grieving process. The pediatrician should ensure that an autopsy is performed in all cases of sudden unexpected death, discuss the autopsy results with the family, and provide emotional support to the family, including age-appropriate support for surviving siblings. If appropriate, the family should be referred for genetic counseling or metabolic testing. In addition, the family should be directed to local counseling and support groups. Information about SIDS and local support groups can be obtained from First Candle/SIDS Alliance (www.firstcandle.org; 1-800-221-7437).

Summary

Based on strong research evidence, home monitors should not be used as an approach to prevent SIDS, (1) all infants should be placed in the supine position for every sleep, (2) pacifier use should be encouraged for SIDS risk reduction, (3) prenatal and postnatal exposure to tobacco should be avoided, (4) and room-sharing without bed-sharing is recommended. (5)(6)(7)

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PIR Quiz

Quiz also available online at www.pedsinreview.org.

6. Which of the following is *not* a risk factor for SIDS?
 - A. African-American race.
 - B. Bed-sharing.
 - C. Low birthweight.
 - D. Male sex.
 - E. Previous episode of apnea.
7. Which of the following is a *true* statement about SIDS?
 - A. Bundling infants with several blankets can reduce the risk.
 - B. Pacifier use has been shown to increase the risk.
 - C. Some infants may be genetically predisposed to SIDS.
 - D. The incidence is higher today than 10 years ago.
 - E. The side sleeping position is safer than the prone position.
8. A mother in your practice has lost two infants to SIDS. She is pregnant again and comes to your office for a prenatal visit. She admits to occasional tobacco use. Of the following, the *best* course of action to avoid a third episode of SIDS is to:
 - A. Allow the mother to continue to smoke occasionally while pregnant but stop as soon as the baby is born.
 - B. Have the baby sleep in a car seat for the first 6 months after birth.
 - C. Obtain a thorough history for social and genetic risk factors.
 - D. Purchase a sleeping wedge for the crib.
 - E. Use an apnea monitor for the first year after birth.
9. Of the following, the *most* appropriate sleeping situation for infants is:
 - A. Prone position, no blankets, one pillow under the head.
 - B. Side position, no blanket, no pillow under the head.
 - C. Side position, one thin blanket, no pillow under the head.
 - D. Supine position, no blanket, one pillow under the head.
 - E. Supine position, one thin blanket, no pillow under the head.

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