

# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **Changing Concepts of Sudden Infant Death Syndrome: Implications for Infant Sleeping Environment and Sleep Position**

Task Force on Infant Sleep Position and Sudden Infant Death Syndrome

*Pediatrics* 2000;105;650-656

DOI: 10.1542/peds.105.3.650

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://www.pediatrics.org/cgi/content/full/105/3/650>

PEDIATRICS is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. PEDIATRICS is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2000 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 0031-4005. Online ISSN: 1098-4275.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# AMERICAN ACADEMY OF PEDIATRICS

Task Force on Infant Sleep Position and Sudden Infant Death Syndrome

## Changing Concepts of Sudden Infant Death Syndrome: Implications for Infant Sleeping Environment and Sleep Position

**ABSTRACT.** The American Academy of Pediatrics has recommended since 1992 that infants be placed to sleep on their backs to reduce the risk of sudden infant death syndrome (SIDS). Since that time, the frequency of prone sleeping has decreased from >70% to ~20% of US infants, and the SIDS rate has decreased by >40%. However, SIDS remains the highest cause of infant death beyond the neonatal period, and there are still several potentially modifiable risk factors. Although some of these factors have been known for many years (eg, maternal smoking), the importance of other hazards, such as soft bedding and covered airways, has been demonstrated only recently. The present statement is intended to review the evidence about prone sleeping and other risk factors and to make recommendations about strategies that may be effective for further reducing the risk of SIDS. This statement is intended to consolidate and supplant previous statements made by this Task Force.

---

ABBREVIATION. SIDS, sudden infant death syndrome.

---

Sudden infant death syndrome (SIDS) is a disease of unknown cause. Despite recent decreases in the incidence of SIDS, SIDS is still responsible for more infant deaths in the United States than any other cause of death during infancy beyond the neonatal period.<sup>1</sup>

SIDS is defined as:

"The sudden death of an infant under 1 year of age, which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history."<sup>2</sup>

The occurrence of SIDS is rare during the first month of life, increases to a peak between 2 and 4 months old, and then declines. The following have been consistently identified across studies as independent risk factors for SIDS: prone sleep position, sleeping on a soft surface, maternal smoking during pregnancy, overheating, late or no prenatal care, young maternal age, prematurity and/or low birth weight, and male sex.<sup>3-11</sup> Blacks and American Indians have consistently higher rates, 2 to 3 times the national average. The risk factors with the greatest potential for modification include prone sleep position, sleeping on a soft surface, maternal smoking, and overheating. National campaigns aimed at re-

ducing prone sleeping have resulted in a dramatic decrease in the incidence of SIDS in the United States (Fig 1) and numerous other countries.<sup>12-17</sup> A Back to Sleep campaign was initiated in the United States in 1994, as a joint effort of the US Public Health Service, the American Academy of Pediatrics, the SIDS Alliance, and the Association of SIDS and Infant Mortality Programs (800-505-CRIB). Despite the success of the current campaign, several modifiable risk factors remain that require increased attention. The purposes of this statement are to reemphasize the importance of infant positioning for sleep as an effective modifiable risk factor for SIDS, to focus increased attention on other modifiable environmental factors, to describe complications that may have arisen from modifying risk factors, and to make recommendations about other strategies that may be effective for further reducing the risk of SIDS.

### MODIFIABLE RISK FACTORS

#### Prone Sleeping

Prone sleeping has been recognized as a major risk factor for SIDS, with odds ratios ranging from 1.7 to 12.9 in various well designed epidemiologic studies.<sup>6,14,18-21</sup> The plausibility of a causal association between prone sleep positioning and SIDS is made most compelling by the observation that in countries, including the United States, in which campaigns to reduce the prevalence of prone sleeping have been successful, dramatic decreases in the SIDS rates have occurred. The association is further strengthened by observations that in cultures in which prone sleeping is rare, SIDS rates historically have been very low.<sup>22,23</sup> In addition, several studies have documented that the statistical relationship between prone positioning and SIDS often strengthens when corrections are made for confounding variables.<sup>6,24,25</sup>

The original 1992 sleeping position recommendation from the American Academy of Pediatrics identified any nonprone position (ie, side or supine) as being optimum for reducing SIDS risk.<sup>26</sup> Subsequent studies from England<sup>11</sup> and New Zealand<sup>27</sup> have shown that side sleeping has a slightly higher risk than the supine position, although the side-sleeping position still seems to be considerably safer than prone. The higher risk for SIDS among infants placed on their sides may relate to the relative instability of this position. Although infants placed on their sides usually roll to their backs, the risk of rolling to the prone position from the side is significantly greater than rolling to the prone position from the back.<sup>11,12,28</sup>

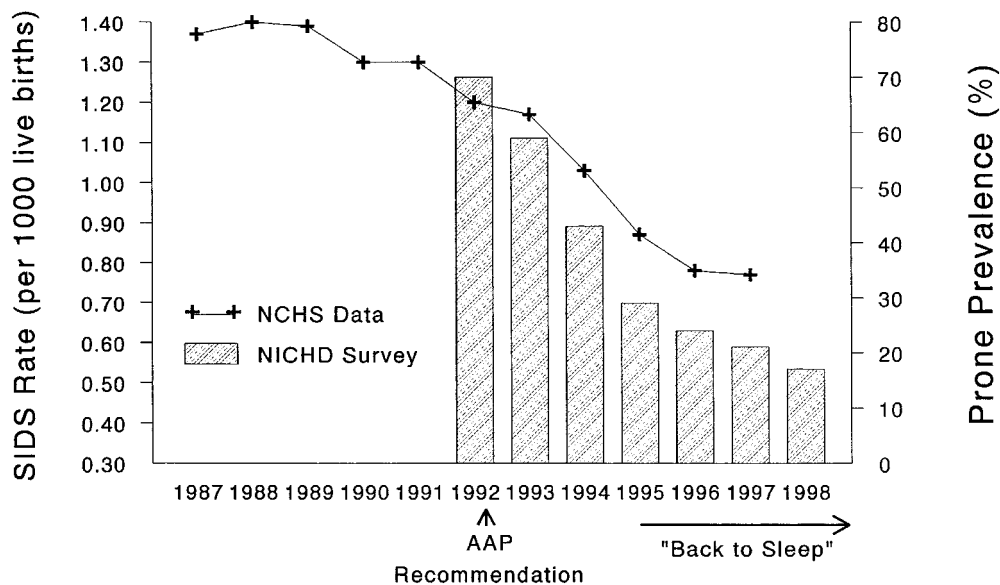
Strategies to decrease prone sleeping in the United

---

The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

PEDIATRICS (ISSN 0031 4005). Copyright © 2000 by the American Academy of Pediatrics.

## U.S. SIDS Rate vs Prone Prevalence



**Fig 1.** SIDS rate in the United States (line) from National Center for Health Statistics (NCHS) data and prone-positioning rate from National Institute for Child Health and Human Development (NICHD) surveys (bars). The American Academy of Pediatrics (AAP) recommendation was made at the April 1992 Spring Meeting and was published in June 1992.<sup>26</sup> The Back to Sleep campaign was begun in mid-1994.

States have included the following: 1) disseminating information to hospital nurseries and physicians, 2) targeting child care education programs, and 3) initiating public media campaigns. Although some countries have almost abolished prone sleeping,<sup>15,29,30</sup> ~20% of US infants continue to sleep prone at the highest risk age range for SIDS.<sup>12</sup> Of concern is that black infants are twice as likely to be placed prone as white infants. In addition, nearly 20% of caregivers apparently switch from placing infants in the non-prone to prone sleep position between 1 and 3 months old, the peak age range for SIDS.<sup>31,32</sup> Also, although parents may know of the recommendation, many other child caregivers, such as child care center workers, do not.<sup>33</sup> There is also some evidence that infants who are accustomed to sleeping supine are at particularly high risk for SIDS when they subsequently are placed in a prone position for sleep.<sup>34–36</sup>

### Soft Sleep Surfaces and Loose Bedding

Polystyrene bead-filled pillows were among the first soft sleep surfaces identified as contributing to the deaths of young infants<sup>37</sup> and subsequently were removed from the market following action by the US Consumer Product Safety Commission. Additional epidemiologic studies identified other soft surfaces, such as pillows, quilts, comforters, sheepskins, and porous mattresses, as a significant risk factor, particularly when placed under the sleeping infant.<sup>6,25,38–42</sup> Several reports described that in a significant number of SIDS cases, the heads of the infants, including some infants who slept supine, were covered by loose bedding. Many of these studies found loose bedding to be an epidemiologic risk factor for SIDS.<sup>11,30,36,38,40,43,44</sup>

### Overheating

There is some evidence that the risk of SIDS is associated with the amount of clothing or blankets on an infant, the room temperature, and the season of the year.<sup>6,45–48</sup> The increased risk associated with overheating is particularly evident when infants sleep prone<sup>6</sup> but is less clear when they sleep supine. It is unclear whether the relationship to clothing and climate is an independent factor or merely a reflection of the use of more clothing, quilts, and other potentially asphyxiating objects in the sleeping environment during cold weather. The SIDS statistics always have shown a distinct seasonality, with higher rates recorded during winter months. It may be that the seasonality reflects increased infections, which also are known to be more frequent during cold weather. A significant decrease has been observed in the seasonal association of SIDS as prone sleeping has decreased and SIDS rates have decreased, thus suggesting an interaction among environmental factors.

### Smoking

Maternal smoking during pregnancy has emerged as a major risk factor in almost every epidemiologic study of SIDS.<sup>9,10,49,50</sup> No intervention studies have documented a decrease in SIDS associated with a decrease in maternal smoking, although changing such behavior has been far more difficult to accomplish than changing infant sleep position. Smoke in the infant's environment after birth has emerged as a separate risk factor in a few studies,<sup>10,51</sup> although separating this variable from maternal smoking before birth is problematic.

## Bed Sharing

There are some reports of infants being suffocated by overlying by an adult, particularly when the adult is in an unnaturally depressed state of consciousness, such as from alcohol or mind-altering drugs. Co-sleeping on sofas has emerged as a major risk factor in 1 study (Peter J. Fleming, Department for Child Health, Bristol, UK, unpublished data presented at a meeting convened by US Consumer Product Safety Commission, Bethesda, MD, December 9, 1998). Others<sup>52</sup> have shown bed sharing with multiple family members in an adult bed to be particularly hazardous for the infant. Although overlying may be the mechanism in some of these cases, soft sleep surfaces, entrapment, and the likelihood of rolling to the prone position in such circumstances also may have a role. The risk of SIDS associated with co-sleeping is significantly greater among smokers.<sup>11,53-55</sup> Some behavioral studies have demonstrated that infants have more arousals and less slow-wave sleep during bed sharing,<sup>56,57</sup> but no epidemiologic evidence exists that bed sharing is protective against SIDS.

## Preterm Birth and Low Birth Weight

Infants born before term or who are low birth weight are at increased risk for SIDS, and risk increases with decreasing gestational age or birth weight.<sup>4,5</sup> The increased risk cannot be explained by a greater likelihood of apnea of prematurity among preterm SIDS victims while they are in the hospital after birth.<sup>4</sup> It is unclear whether other complications of prematurity, such as bronchopulmonary dysplasia that has been associated with SIDS, can explain a significant amount of the increased risk associated with prematurity.<sup>58</sup> There are no data suggesting that strategies designed to reduce risk in full-term infants should not also be applied to premature infants. The relationship to prone sleeping, for example, has been shown to hold for infants of low birth weight as well as for those born with a normal birth weight at term.<sup>24</sup>

## Factors Thought to Protect Against SIDS

Although several retrospective studies have demonstrated a protective effect of breastfeeding on SIDS,<sup>3,59</sup> other analyses and prospective cohort studies failed to find such an effect after adjustment for confounding variables.<sup>60-64</sup> Although breastfeeding is beneficial and should be promoted for many reasons, the Task Force believes that evidence is insufficient to recommend breastfeeding as a strategy to reduce SIDS.

Four recent studies have reported a substantially lower SIDS incidence among infants who used pacifiers than among infants who do not.<sup>11,36,65,66</sup> Although this association has been strong and consistent, it does not prove that pacifier use prevents SIDS. Mechanisms by which pacifiers might protect against SIDS have been proposed, such as stenting of the upper airway, but data are lacking to demonstrate that any of them are relevant to SIDS. Conversely, other studies have demonstrated that pacifier use can be linked to a shortened duration of

breastfeeding, increased susceptibility to otitis media, and increased dental malocclusion. The Task Force believes that additional outcome studies are required before a specific recommendation about pacifiers can be made.

## OTHER CAUSES OF INFANT DEATH SOMETIMES MISTAKEN FOR SIDS

### SIDS Among Siblings

Several studies that have evaluated SIDS among siblings have found that having a sibling who died of SIDS is a significant risk factor.<sup>4</sup> However, others have failed to find such a relationship<sup>67</sup> or have shown that siblings of infants who have died of SIDS are at risk for all causes of infant death, not just SIDS.<sup>68,69</sup> In addition, most of the studies reporting familial SIDS have the limitation of having been conducted during a period when case and scene investigations were not routine and assignment of the SIDS diagnosis may have been flawed. Thus, the true risk is unknown.

### Infanticide

The large majority of SIDS cases have no evidence of parental psychiatric disease or neglect of the infant. However, recent publications have documented that a few mothers of infants with a history of acute life-threatening events have been observed trying to harm their infants,<sup>70,71</sup> and several cases previously thought to be multiple cases of SIDS within a family<sup>72</sup> actually were cases of multiple homicide.<sup>73</sup> As the number of cases of true SIDS has decreased in recent years, the proportion of cases attributable to infanticide may be increasing.<sup>74</sup> Estimates of the incidence of infanticide among cases designated as SIDS have ranged from <1% to as much as 10%.<sup>71,75-78</sup> A thorough investigation of the case and scene is critical in every case because it improves the chances for an accurate diagnosis.<sup>79</sup> When 2 infants in the same family reportedly have died of SIDS, immediate concern should be raised about the cause of the deaths.

### Cardiac Arrhythmias

A recent publication reported that a significant number of SIDS cases in Italy had prolongation of the QT interval on a screening electrocardiogram, which may have led to a fatal cardiac arrhythmia.<sup>80</sup> However, questions about the study methods have been raised,<sup>81-88</sup> and it is unlikely that this abnormality will explain more than a small minority of SIDS cases. Despite a call to the contrary,<sup>89</sup> there seems to be little justification for a widespread program of electrocardiographic screening to identify potential SIDS victims.

## COMPLICATIONS OF NONPRONE SLEEPING

When the Academy first suggested that infants be placed for sleep in a nonprone position,<sup>25</sup> concerns were expressed that undesirable complications would ensue. Aspiration pneumonia, gastroesophageal reflux, plagiocephaly, and developmental delay were some of the feared complications.<sup>90</sup> Conversely, there is some direct and indirect evidence that in-

infants who vomit are at greater risk of choking if they are sleeping face down.<sup>91,92</sup> There is no evidence of an increase in aspiration or increased complaints of vomiting since the incidence of supine sleeping has increased dramatically.<sup>91</sup> Although gastroesophageal reflux has been reported to occur less frequently in the prone position,<sup>93-95</sup> there has been no increase in infant deaths attributable to aspiration in the United Kingdom with the change from prone to supine sleeping for infants.<sup>96</sup> Several reports have suggested an increase of occipital plagiocephaly since prone sleeping has become more frequent,<sup>97,98</sup> and there has been concern that this increase has led to an increase in unnecessary operations for craniosynostosis, perhaps secondary to a misdiagnosis of plagiocephaly as craniosynostosis (American Academy of Pediatrics, Committee on Practice and Ambulatory Medicine, Section on Plastic Surgery, and Provisional Section on Neurosurgery, Positional skull deformities, Statement in preparation). Several studies have evaluated the relationship of developmental milestones and sleep position. Attainment of gross motor milestones seems to occur slightly later in infants who sleep supine than in infants who sleep prone; however, a difference is no longer detectable by 18 months old.<sup>99,100</sup> There is some concern that caregivers may not be allowing infants to lie prone even while awake. Prone positioning when awake and observed (tummy time) is recommended for development of upper shoulder girdle strength and avoidance of occipital plagiocephaly. These reminders should become a part of routine office anticipatory guidance.

#### PROPOSED MECHANISMS OF SIDS

It is generally accepted that SIDS may be a reflection of a variety of causes of death. A leading hypothesis for a large proportion of SIDS cases is that SIDS may reflect a delayed development of arousal or cardiorespiratory control. Examinations of the brainstems of infants who died with a diagnosis of SIDS have revealed hypoplasia or decreased neurotransmitter binding of the arcuate nucleus, a region thought to be involved with the hypercapnic ventilatory response, chemosensitivity, and blood pressure responses.<sup>101,102</sup> The hypothesis is that certain infants, for reasons yet to be determined, may have a maldevelopment or delay in maturation of this region, which would affect its function and connectivity to regions regulating arousal. When the physiologic stability of such infants becomes compromised during sleep, they may not arouse sufficiently to avoid the fatal noxious insult or condition. One theory proposes that rebreathing and associated hypoxia and hypercarbia provide the noxious stimulus, while another proposes hyperthermia, perhaps in combination with asphyxia, as the stimulus. The argument has been made that prone sleep position on soft sleeping surfaces and covering of the head increase the likelihood of rebreathing, hyperthermia, or both.<sup>6,15,30,37,42,45,103-105</sup> Numerous animal and some human models have been developed to test these hypotheses.<sup>8,6,27,102,106-110</sup> In addition, protective responses to other life-threatening stimuli have been

compared in the prone and supine position. The rate of swallowing to clear the airway of stimuli to the laryngeal chemoreflex (a reflex that leads to apnea and bradycardia) is diminished in the prone position.<sup>111</sup> Arousal responses to the laryngeal chemoreflex and the baroreceptor reflex are also diminished in active sleep in the prone position.<sup>111,112</sup>

#### RECOMMENDATIONS

During the past decade, a variety of strategies have been developed that reduce the risk of SIDS. The following list includes a modification and expansion of the recommendations made by this Task Force since 1992. It should be emphasized that the recommendations are intended for sleeping infants and primarily for well infants. Individual medical conditions may warrant a physician to recommend otherwise, after weighing the relative risks and benefits.

1. Infants should be placed for sleep in a nonprone position. Supine (wholly on the back) confers the lowest risk and is preferred. However, while side sleeping is not as safe as supine, it also has a significantly lower risk than prone. If the side position is used, caretakers should be advised to bring the dependent arm forward to lessen the likelihood of the infant rolling to the prone position.
2. A crib that conforms to the safety standards of the Consumer Product Safety Commission and the ASTM (formerly the American Society for Testing and Materials) is a desirable sleeping environment for infants. (Although many cradles and bassinets also may provide safe sleeping enclosures, safety standards have not been established for these items.) Sleep surfaces designed for adults often are not free of the aforementioned hazards and may have the additional risk of entrapment between the mattress and the structure of the bed (eg, the headboard, footboard, side rails, and frame), the wall, or adjacent furniture, as well as between railings in the headboard or footboard.<sup>113</sup>
3. Infants should not be put to sleep on waterbeds, sofas, soft mattresses, or other soft surfaces.
4. Avoid soft materials in the infant's sleeping environment.
  - Soft materials or objects, such as pillows, quilts, comforters, or sheepskins, should not be placed under a sleeping infant.
  - Soft objects, such as pillows, quilts, comforters, sheepskins, stuffed toys, and other gas-trapping objects should be kept out of an infant's sleeping environment. Also, loose bedding, such as blankets and sheets, may be hazardous. If blankets are to be used, they should be tucked in around the crib mattress so the infant's face is less likely to become covered by bedding. One strategy is to make up the bedding so that the infant's feet are able to reach the foot of the crib (feet to foot), with the blankets tucked in around the crib mattress and reaching only the level of the infant's chest. Another strategy is to use sleep clothing with no other covering over the infant.

5. Bed sharing or cosleeping may be hazardous under certain conditions.<sup>54,113–115</sup>
  - As an alternative to bed sharing, parents might consider placing the infant's crib near their bed to allow for more convenient breastfeeding and parent contact.
  - If a mother chooses to have her infant sleep in her bed to breastfeed, care should be taken to observe the aforementioned recommendations (nonprone sleep position, avoidance of soft surfaces or loose covers, and avoidance of entrapment by moving the bed away from the wall and other furniture and avoiding beds that present entrapment possibilities).
  - Adults (other than the parents), children, or other siblings should avoid bed sharing with an infant.\*
  - Parents who choose to bed share with their infant\* should not smoke or use substances, such as alcohol or drugs, that may impair arousal.
6. Overheating should be avoided. The infant should be lightly clothed for sleep, and the bedroom temperature should be kept comfortable for a lightly clothed adult.<sup>11</sup> Overbundling should be avoided, and the infant should not feel hot to the touch.
7. A certain amount of tummy time while the infant is awake and observed is recommended for developmental reasons and to help prevent flat spots on the occiput. Positional plagiocephaly also can be avoided by altering the supine head position during sleep. Techniques for accomplishing this include placing the infant to sleep with the head to 1 side for a week or so and then changing to the other and periodically changing the orientation of the infant to outside activity (eg, the door of the room).
8. Although various devices have been developed to maintain sleep position or to reduce the risk of rebreathing, such devices are not recommended, because none have been tested sufficiently to show efficacy or safety.<sup>117</sup>
9. Electronic respiratory and cardiac monitors are available to detect cardiorespiratory arrest and may be of value for home monitoring of selected infants who are deemed to have extreme cardiorespiratory instability. However, there is no evidence that home monitoring with such monitors decreases the incidence of SIDS. Furthermore, there is no evidence that infants at increased risk of SIDS can be identified by in-hospital respiratory or cardiac monitoring.<sup>118</sup> There are no new data that would lead to a change in the recommendations made in the 1985 statement of the

- American Academy of Pediatrics on prolonged infantile apnea or the 1986 National Institutes of Health consensus statement on the value of home monitors.<sup>119,120</sup>
10. There is concern that the annual rate of SIDS, which has been decreasing steadily since 1992, now appears to be leveling off, as has the percentage of infants sleeping prone (Fig 1). The national campaign for reducing prone sleeping (Back to Sleep) should continue and be expanded to emphasize the safe characteristics of the sleeping environment, including safe bedding practices, and focus on the portion of the population that continues to place their infants prone. Other potentially modifiable risk factors, such as avoidance of maternal smoking, overheating, and certain forms of bed sharing, should be included as important secondary messages.

TASK FORCE ON INFANT POSITIONING AND SIDS,  
1998–1999

John Kattwinkel, MD, Chairperson  
John G. Brooks, MD  
Maurice E. Keenan, MD  
Michael Malloy, MD

CONSULTANTS

Marian Willinger, PhD  
National Institute of Child Health and Human  
Development  
N. J. Scheers, PhD  
US Consumer Product Safety Commission

REFERENCES

1. Guyer B, MacDorman MF, Martin JA, Peters KD, Strobino DM. Annual summary of vital statistics 1997. *Pediatrics*. 1998;102:1333–1349
2. Willinger M, James LS, Catz C. Defining the sudden infant death syndrome (SIDS): deliberations of an expert panel convened by the National Institute of Child Health and Human Development. *Pediatr Pathol*. 1991;11:677–684
3. Hoffman HJ, Damus K, Hillman L, Krongrad E. Risk factors for SIDS: results of the National Institute of Child Health and Human Development SIDS Cooperative Epidemiological Study. *Ann N Y Acad Sci*. 1988;533:13–30
4. Hoffman HJ, Hillman LS. Epidemiology of the sudden infant death syndrome: maternal, neonatal, and postneonatal risk factors. *Clin Perinatol*. 1992;19:717–737
5. Malloy MH, Hoffman HJ. Prematurity, sudden infant death syndrome, and age of death. *Pediatrics*. 1995;96:464–471
6. Ponsonby AL, Dwyer T, Gibbons LE, Cochrane JA, Wang Y-G. Factors potentiating the risk of sudden infant death syndrome associated with prone position. *N Engl J Med*. 1993;329:377–382
7. Kemp JS, Nelson VE, Thach BT. Physical properties of bedding that may increase risk of sudden infant death syndrome in prone-sleeping infants. *Pediatr Res*. 1994;36:7–11
8. Chiodini BA, Thach BT. Impaired ventilation in infants sleeping face down: potential significance for sudden infant death syndrome. *J Pediatr*. 1993;123:686–692
9. MacDorman MF, Cnattingius S, Hoffman HJ, Kramer MS, Haglund B. Sudden infant death syndrome and smoking in the United States and Sweden. *Am J Epidemiol*. 1997;146:249–257
10. Schoendorf KC, Kiely JL. Relationship of sudden infant death syndrome to maternal smoking during and after pregnancy. *Pediatrics*. 1992;90:905–908
11. Fleming PJ, Blair PS, Bacon C, et al. Environment of infants during sleep and risk of the sudden infant death syndrome: results of 1993–5 case-control study for confidential inquiry into stillbirths and deaths in infancy. *Br Med J*. 1996;313:191–195
12. Willinger M, Hoffman HJ, Wu K-T, et al. Factors associated with the transition to nonprone sleep positions of infants in the United States: the National Infant Sleep Position Study. *JAMA*. 1998;280:329–335
13. Mitchell EA, Grunt JM, Evard C. Reduction in mortality from sudden

\*It should be noted that the US Consumer Product Safety Commission is on record as opposing bed sharing by an infant and an adult, particularly if there is more than 1 adult in the bed. Many cases of infant suffocation have been reported during bed sharing.<sup>116</sup> However, it is recognized that a significant portion of the population practices bed sharing between mother and infant as a strategy to facilitate breastfeeding and that the presence of the father in the bed will be common. It is the consensus of the Task Force that there are insufficient data to conclude that bed sharing under carefully controlled conditions is clearly hazardous or clearly safe.

- infant death syndrome in New Zealand. *Arch Dis Child*. 1994;70:291-294
14. Platt MJ, Pharoah POD. Child health statistical review, 1996. *Arch Dis Child*. 1996;75:527-533
  15. Dwyer T, Ponsonby A-L, Blizzard L, Newman NM, Cochane JA. The contribution of changes in prevalence of prone sleeping position to the decline in sudden infant death syndrome in Tasmania. *JAMA*. 1995;273:783-789
  16. Wennergren G, Alm B, Oyen N, et al. Irgens LM, on behalf of the Nordic Epidemiological SIDS Study: the decline in the incidence of SIDS in Scandinavia and its relation to risk-intervention campaigns. *Acta Paediatr*. 1997;86:963-968
  17. Hoyert DL, Kochanek KD, Murphy SL. *Deaths: Final Data for 1997. National Vital Statistics Report, XLVII*. No 10. Hyattsville, MD: National Center for Health Statistics; 1999
  18. Dwyer T, Ponsonby A-L, Newman NM, Gibbons LE. Prospective cohort study of prone sleeping position and sudden infant death syndrome. *Lancet*. 1991;337:1244-1247
  19. Mitchell EA, Scragg RK, Stewart AW, et al. Results from the first year of the New Zealand cot death study. *N Z Med J*. 1991;104:71-76
  20. Irgens LM, Markestad T, Baste V, Schreuder P, Skjaerven R, Oyen N. Sleeping position and sudden infant death syndrome in Norway 1967-91. *Arch Dis Child*. 1995;72:478-482
  21. Taylor JA, Drieger JW, Reay DT, et al. Prone sleep position and the sudden infant death syndrome in King County Washington: a case-control study. *J Pediatr*. 1996;128:626-630
  22. Davies DP. Cot death in Hong Kong: a rare problem? *Lancet*. 1985;2:1346-1348
  23. Lee NN, Chan YF, Davies DP, Lau E, Yip DC. Sudden infant death syndrome in Hong Kong: confirmation of low incidence. *Br Med J*. 1989;298:721
  24. Oyen N, Markestad T, Skjaerven R, et al. Combined effects of sleeping position and prenatal risk factors in sudden infant death syndrome: the Nordic epidemiological SIDS study. *Pediatrics*. 1997;100:613-621
  25. Mitchell EA, Thompson JMD, Ford RPK, et al. Sheepskin bedding and the sudden infant death syndrome. *J Pediatr*. 1998;133:701-704
  26. Kattwinkel J, Brooks J, Myerberg D. Positioning and SIDS. AAP Task Force on Infant Positioning and SIDS. *Pediatrics*. 1992;89:1120-1126
  27. Mitchell EA, Scragg RK. Observations on ethnic differences in SIDS mortality in New Zealand. *Early Hum Dev*. 1994;38:151-157
  28. Waters KA, Gonzalez A, Jean C, Morielli A, Brouillette RT. Face-straight-down and face-near-straight-down positions in healthy, prone-sleeping infants. *J Pediatr*. 1996;128:616-625
  29. Her Majesty's Stationery Office. *Report of the Chief Medical Officer's Expert Group on the Sleeping Position Cot Death*. London, UK: Her Majesty's Stationery Office; 1993
  30. Markestad T, Skadberg B, Hordvik E, Morild I, Irgens L. Sleeping position and sudden infant death syndrome (SIDS): effect of an intervention programme to avoid prone sleeping. *Acta Paediatr*. 1995;84:375-378
  31. Lesko SM, Corwin MJ, Vezina RM, et al. Changes in sleep position during infancy: a prospective longitudinal assessment. *JAMA*. 1998;280:336-340
  32. Brenner RA, Simons-Morton BG, Bhaskar B, et al. Prevalence and predictors of the prone sleep position among inner-city infants. *JAMA*. 1998;280:341-346
  33. Gershon NB, Moon RY. Infant sleep position in licensed child care centers. *Pediatrics*. 1997;100:75-78
  34. Mitchell EA, Thach BT, Thompson JMD, Williams S. Changing infant's sleep position increases risk of sudden infant death syndrome. *Arch Pediatr Adolesc Med*. 1999;153:1136-1141
  35. Skadberg BT, Morild I, Markestad T. Abandoning prone sleeping: effect on the risk of sudden infant death syndrome. *J Pediatr*. 1998;132:197-198
  36. L'Hoir MP, Englebarts AC, van Well GTJ, et al. Risk and preventive factors for cot death in the Netherlands, a low incidence country. *Eur J Pediatr*. 1998;157:681-688
  37. Kemp JS, Thach BT. Sudden death in infants sleeping on polystyrene-filled cushions. *N Engl J Med*. 1991;324:1858-1864
  38. Ponsonby A-L, Dwyer T, Couper D, Cochrane J. Association between use of a quilt and sudden infant death syndrome: case-control study. *Br Med J*. 1998;316:195-196
  39. Scheers NJ, Dayton CM, Kemp JS. Sudden infant death with external airways covered. *Arch Pediatr Adolesc Med*. 1998;152:540-547
  40. Brooke H, Gibson A, Tappin D, Brown H. Case-control study of sudden infant death syndrome in Scotland, 1992-5. *Br Med J*. 1997;314:1516-1520
  41. Mitchell EA, Scragg L, Clements M. Soft cot mattresses and the sudden infant death syndrome. *N Z Med J*. 1996;109:206-207
  42. Kemp JS, Kowlaski RM, Burch PM, Graham MA, Thach BT. Unintentional suffocation by rebreathing: a death scene and physiological investigation of a possible cause of sudden infant death. *J Pediatr*. 1993;122:874-880
  43. Wilson CA, Taylor BJ, Laing RM, Williams SM, Mitchell EA, New Zealand Cot Death Study Group. Clothing and bedding and its relevance to sudden infant death syndrome: further results from the New Zealand Cot Death Study. *J Paediatr Child Health*. 1994;30:506-512
  44. Beal SM, Byard RW. Accidental death or sudden infant death syndrome? *J Paediatr Child Health*. 1995;31:269-271
  45. Fleming PJ, Gilbert R, Azaz Y, et al. Interaction between bedding and sleeping position in the sudden infant death syndrome: a population based case-control study. *Br Med J*. 1990;301:85-89
  46. Gilbert R, Rudd P, Berry PJ, et al. Combined effect of infection and heavy wrapping on the risk of sudden unexpected infant death. *Arch Dis Child*. 1992;67:171-177
  47. Ponsonby A-L, Dwyer T, Gibbons L, Cochrane JA, Jones ME, McCall MJ. Thermal environment and SIDS: case-control study. *Br Med J*. 1992;304:277-282
  48. Williams SM, Taylor BJ, Mitchell EA. Sudden infant death syndrome: insulation from bedding and clothing and its effect modifiers. *Int J Epidemiol*. 1996;25:366-375
  49. Malloy MH, Kleinman JC, Land GH, Schramm WF. The association of maternal smoking with age and cause of infant death. *Am J Epidemiol*. 1988;128:45-55
  50. Haglund B, Cnattingius S. Cigarette smoking as a risk factor for sudden infant death syndrome: a population-based study. *Am J Public Health*. 1990;80:29-32
  51. Mitchell EA, Ford RPK, Stewart AW, et al. Smoking and the sudden infant death syndrome. *Pediatrics*. 1993;91:893-896
  52. Hauck FR, Kemp JS. Bedsharing promotes breastfeeding and AAP Task Force on Infant Positioning and SIDS. *Pediatrics*. 1998;102:662-663. Letter
  53. Kloneff-Cohen H, Edelstein S. Bed sharing and the sudden infant death syndrome. *Br Med J*. 1995;311:1269-1272
  54. Scragg RK, Mitchell EA, Taylor BJ, et al. Bed sharing, smoking, and alcohol in the sudden infant death syndrome. *Br Med J*. 1993;307:1312-1318
  55. Scragg RK, Mitchell EA. Side sleeping position and bed sharing in the sudden infant death syndrome. *Ann Med*. 1998;30:345-349
  56. Mosko S, McKenna J, Dickel M, Hunt L. Parent-infant co-sleeping: the appropriate context for the study of infant sleep and implications for the sudden infant death syndrome (SIDS) research. *J Behav Med*. 1993;16:589-610
  57. Mosko S, Richard C, McKenna J, Drummond S. Infant sleep architecture during bedsharing and possible implications for SIDS. *Sleep*. 1996;19:677-684
  58. Gray PH, Rogers Y. Are infants with bronchopulmonary dysplasia at risk for SIDS? *Pediatrics*. 1994;93:774-777
  59. Ford RP, Taylor BJ, Mitchell EA, et al. Breastfeeding and the risk of sudden infant death syndrome. *Int J Epidemiol*. 1993;22:366-375
  60. Kraus JF, Greenland S, Bulterys M. Risk factors for sudden infant death syndrome in the US collaborative perinatal project. *Int J Epidemiol*. 1989;18:113-120
  61. Ponsonby A-L, Dwyer T, Kasi SV, Cochrane JA. The Tasmanian SIDS case-control study: univariable and multivariable risk factor analysis. *Paediatr Perinat Epidemiol*. 1995;9:256-272
  62. Gilbert RE, Wigfield RE, Fleming PJ, Berry PG, Rudd PT. Bottle feeding and the sudden infant death syndrome. *Br Med J*. 1995;310:88-90
  63. Henderson-Smart DJ, Ponsonby A-L, Murphy E. Reducing the risk of sudden infant death syndrome: a review of the scientific literature. *J Paediatr Child Health*. 1998;34:213-219
  64. Mitchell EA, Tuohy PG, Brun JM, et al. Risk factors for sudden infant death syndrome following the prevention campaign in New Zealand: a prospective study. *Pediatrics*. 1997;100:835-840
  65. Arnestad M, Andersen M, Rognum TO. Is the use of a dummy or carry-cot of importance for sudden infant death? *Eur J Pediatr*. 1997;156:968-970
  66. Mitchell EA, Taylor BJ, Ford RPK, et al. Dummies and the sudden infant death syndrome. *Arch Dis Child*. 1993;68:501-504
  67. Irgens LM, Skjaerven R, Peterson DR. Prospective assessment of recurrence risk in sudden infant death syndrome siblings. *J Pediatr*. 1984;104:349-351
  68. Peterson DR, Sabotta EE, Daling JR. Infant mortality among subsequent siblings of infants who died of sudden infant death syndrome. *J Pediatr*. 1986;108:911-914
  69. Guntheroth WG, Lohmann R, Spiers PS. Risk of sudden infant death

- syndrome in subsequent siblings. *J Pediatr*. 1990;116:520–524
70. Rosen CL, Frost JD, Bricker T, et al. Two siblings with recurrent cardiorespiratory arrest: Munchausen syndrome by proxy or child abuse? *Pediatrics*. 1983;71:715–720
  71. Southall DP, Plunkett MCB, Banks MW, Falkov A, Samuels MP. Covert video recordings of life-threatening child abuse: lessons for child protection. *Pediatrics*. 1997;100:735–760
  72. Steinschneider A. Prolonged apnea and the sudden infant death syndrome: clinical and laboratory observations. *Pediatrics*. 1972;50:646–654
  73. Firstman R, Talan J. *The Death of Innocents: A True Story of Murder, Medicine, and High-stakes Science*. New York, NY: Bantam; 1997
  74. Meadow R. Unnatural sudden infant death. *Arch Dis Child*. 1999;80:7–14
  75. Reece RM. Fatal child abuse and sudden infant death syndrome: a critical diagnostic decision. *Pediatrics*. 1993;91:423–429
  76. Bass M, Kravath RE, Glass L. Death-scene investigation in sudden infant death. *N Engl J Med*. 1986;315:100–105
  77. American Academy of Pediatrics, Committee on Child Abuse and Neglect. Distinguishing sudden infant death syndrome from child abuse fatalities. *Pediatrics*. 1994;94:124–126
  78. Kukull WA, Peterson DR. Sudden infant death and infanticide. *Am J Epidemiol*. 1977;106:485–486
  79. Centers for Disease Control and Prevention. Guidelines for death scene investigation of sudden, unexplained infant deaths: recommendations of the Interagency Panel on Sudden Infant Death Syndrome. *Morb Mortal Wkly Rep CDC Surveill Summ*. 1996;45:1–22
  80. Schwartz PJ, Stramba-Badiale M, Segantini A, et al. Prolongation of the QT interval and the sudden infant death syndrome. *N Engl J Med*. 1998;338:1709–1714
  81. Lucey JF. Comments on a sudden infant death article in another journal. *Pediatrics*. 1999;103:812
  82. Martin RJ, Miller MJ, Redline S. Screen for SIDS: a neonatal perspective. *Pediatrics*. 1999;103:812
  83. Guntheroth WC, Spiers PS. Prolongation of the QT interval and the sudden infant death syndrome. *Pediatrics*. 1999;103:813
  84. Hodgman J, Siassi B. Prolonged QTc as a risk factor for SIDS. *Pediatrics*. 1999;103:814
  85. Hoffman JIE, Lister G. The potential relationship between prolonged QT interval and sudden infant death syndrome. *Pediatrics*. 1999;103:815
  86. Tonkin SL, Clarkson PM. A view from New Zealand: comments on the prolonged QT theory of SIDS causation. *Pediatrics*. 1999;103:818
  87. Shannon DC. Method of analyzing QT interval can't support conclusions. *Pediatrics*. 1999;103:819
  88. Southall DP. Examine data in Schwartz article with extreme care. *Pediatrics*. 1999;103:819
  89. Towbin JA, Friedman RA. Prolongation of the QT interval and the sudden infant death syndrome. *N Engl J Med*. 1998;338:1760–1761
  90. Orenstein SR, Mitchell AA, Ward SD. Concerning the American Academy of Pediatrics recommendation on sleep position for infants. *Pediatrics*. 1993;91:497–499. Commentary
  91. Hunt L, Fleming P, Golding J, the ALSPAC Study Team. Does the supine sleeping position have any adverse effects on the child? I. Health in the first 6 months. *Pediatrics*. 1997;100(1). URL: <http://www.pediatrics.org/cgi/content/full/100/1/e11>
  92. Pickens DL, Schefft GL, Thach BT. Pharyngeal fluid clearance and aspiration preventative mechanisms in sleeping infants. *J Appl Physiol*. 1989;66:1164–1171
  93. Orenstein SR, Whittington PF. Positioning for prevention of gastroesophageal reflux. *J Pediatr*. 1983;103:534–537
  94. Meyers WF, Herbst JJ. Effectiveness of positioning therapy for gastroesophageal reflux. *Pediatrics*. 1982;69:768–772
  95. Vandenplas Y, Sacre-Smits L. Seventeen-hour continuous esophageal pH monitoring in the newborn: evaluation of the influence of position in asymptomatic and symptomatic babies. *J Pediatr Gastroenterol Nutr*. 1985;4:356–361
  96. Fleming PJ. Understanding and preventing sudden infant death syndrome. *Curr Opin Pediatr*. 1994;6:158–162
  97. Turk AE, McCarthy JG, Thorne CH, et al. The "Back to Sleep Campaign" and deformational plagiocephaly: is there cause for concern? *J Craniofac Surg*. 1996;7:12–18
  98. Argenta LC, David LR, Wilson JA. An increase in infant cranial deformity with supine sleeping position. *J Craniofac Surg*. 1996;7:5–11
  99. Dewey C, Fleming P, Golding J, the ALSPAC Study Team. Does the supine sleeping position have any adverse effects on the child? II. Development in the first 18 months. *Pediatrics*. 1998;101(1). URL: <http://www.pediatrics.org/cgi/content/full/101/1/e5>
  100. Davis BE, Moon RY, Sachs HC, Ottolini MC. Effects of sleep position on infant motor development. *Pediatrics*. 1998;102:1135–1140
  101. Kinney HC, Filiano JJ, Sleeper LA, Mandell F, Valdes-Dapena M, White WF. Decreased muscarinic receptor binding in the arcuate nucleus in sudden infant death syndrome. *Science*. 1995;269:1446–1450
  102. Panigrahy A, Filiano JJ, Sleeper LA, et al. Decreased kainate binding in the arcuate nucleus of the sudden infant death syndrome. *J Neuropathol Exp Neurol*. 1997;56:1253–1261
  103. Skadberg BT, Markestad T. Consequences of getting the head covered during sleep in infancy. *Pediatrics*. 1997;100(2). URL: <http://www.pediatrics.org/cgi/content/full/100/2/e6>
  104. Skadberg BT, Oterhals X, Finborud K, Markestad T. CO<sub>2</sub> rebreathing: a possible contributory factor to some cases of sudden infant death? *Acta Paediatr*. 1995;84:988–995
  105. Nelson EAS, Taylor BJ, Weatherall IL. Sleeping position and infant bedding may predispose to hyperthermia and the sudden infant death syndrome. *Lancet*. 1989;1:199–201
  106. Campbell AJ, Taylor BJ, Bolton DPG. Comparison of 2 methods of determining asphyxial potential of infant bedding. *J Pediatr*. 1997;130:245–249
  107. Lijowska AS, Reed NW, Chiodini BAM, Thach BT. Sequential arousal and airway-defensive behavior of infants in asphyxial sleep environments. *Am J Respir Crit Care Med*. 1995;151:A151. Abstract
  108. Kemp JS, Thach BT. Quantifying the potential of infant bedding to limit CO<sub>2</sub> dispersal and factors affecting rebreathing in bedding. *J Appl Physiol*. 1995;78:740–745
  109. Galland BC. The micro-environment of the sleeping newborn piglet covered by bed clothes: gas exchange and temperature. *J Paediatr Child Health*. 1994;30:144–150
  110. Kemp JS, Thach BT. A sleep position-dependent mechanism for infant death on sheepskins. *Am J Dis Child*. 1993;147:642–646
  111. Jeffrey HE, Megevand A, Page M. Why the prone position is a risk factor for sudden infant death syndrome. *Pediatrics*. 1999;104:263–269
  112. Galland BC, Reeves G, Taylor BJ, Bolton DP. Sleep position, autonomic function, and arousal. *Arch Dis Child Fetal Neonatal Ed*. 1998;78:F189–F194
  113. Nakamura S, Wind M, Danello MA. Review of hazards associated with children placed in adult beds. *Arch Pediatr Adolesc Med*. 1999;153:1019–1023
  114. American Academy of Pediatrics, Task Force on Infant Positioning and SIDS. Does bed sharing affect the risk of SIDS? *Pediatrics*. 1997;100:272
  115. Byard RW. Is breast feeding in bed always a safe practice? *J Paediatr Child Health*. 1998;34:418–419
  116. Drago DA, Dannenberg AL. Infant mechanical suffocation deaths in the United States. *Pediatrics*. 1999;103(5). URL: <http://www.pediatrics.org/cgi/content/full/103/5/e59>
  117. Carolan PL, Kemp JS, Wheeler WB. Effect of CO<sub>2</sub> dispersal rate of commercial products marketed to reduce sudden infant death syndrome risk. *Pediatr Res*. In press
  118. Malloy MH, Hoffman H. Home apnea monitoring and sudden infant death syndrome. *Prev Med*. 1996;25:645–649
  119. American Academy of Pediatrics, Task Force on Prolonged Infantile Apnea. *Pediatrics*. 1985;76:129–131
  120. National Institutes of Health Consensus Development, Conference on Infantile Apnea and Home Monitoring. Consensus statement. *Pediatrics*. 1987;79:292–299

# Changing Concepts of Sudden Infant Death Syndrome: Implications for Infant Sleeping Environment and Sleep Position

Task Force on Infant Sleep Position and Sudden Infant Death Syndrome

*Pediatrics* 2000;105;650-656

DOI: 10.1542/peds.105.3.650

<b>Updated Information &amp; Services</b>	including high-resolution figures, can be found at: <a href="http://www.pediatrics.org/cgi/content/full/105/3/650">http://www.pediatrics.org/cgi/content/full/105/3/650</a>
<b>References</b>	This article cites 104 articles, 60 of which you can access for free at: <a href="http://www.pediatrics.org/cgi/content/full/105/3/650#BIBL">http://www.pediatrics.org/cgi/content/full/105/3/650#BIBL</a>
<b>Citations</b>	This article has been cited by 73 HighWire-hosted articles: <a href="http://www.pediatrics.org/cgi/content/full/105/3/650#otherarticles">http://www.pediatrics.org/cgi/content/full/105/3/650#otherarticles</a>
<b>Subspecialty Collections</b>	This article, along with others on similar topics, appears in the following collection(s): <b>Office Practice</b> <a href="http://www.pediatrics.org/cgi/collection/office_practice">http://www.pediatrics.org/cgi/collection/office_practice</a>
<b>Permissions &amp; Licensing</b>	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://www.pediatrics.org/misc/Permissions.shtml">http://www.pediatrics.org/misc/Permissions.shtml</a>
<b>Reprints</b>	Information about ordering reprints can be found online: <a href="http://www.pediatrics.org/misc/reprints.shtml">http://www.pediatrics.org/misc/reprints.shtml</a>

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

