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Sudden infant death syndrome and advice for safe sleeping

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Sudden infant death syndrome (SIDS) is currently defined as “the sudden and unexpected death of an infant under 1 year of age, with the onset of the lethal episode apparently occurring during sleep, that remains unexplained after a thorough investigation including performance of a complete autopsy and review of the circumstances of death.”¹ Before this 2004 definition a diagnosis of SIDS did not require a death scene investigation or to have occurred during sleep, and therefore the definition for SIDS varies in the studies cited in this review.

The aim of this clinical review is to provide healthcare professionals with the most up to date information for parents and caregivers about SIDS and infant safety while sleeping.

How common is SIDS?

The incidence of SIDS was more than halved after public health campaigns publicised the known major risk factors of prone sleeping, maternal smoking, and overheating.² However, SIDS remains the leading cause of unexpected death in infants in Western countries, contributing to almost 50% of all postneonatal deaths. According to most recent statistics, 2671 infants died from SIDS in the United States in 2010,³ 221 in England and Wales in 2012,⁴ and 50 in Australia in 2012.⁵

What are the mechanisms for SIDS?

As SIDS is a diagnosis of exclusion, much research has been done into the underlying mechanisms that may underpin known risk factors. For a long time SIDS has been thought

SOURCES AND SELECTION CRITERIA

We searched PubMed for articles in English published between 1980 and January 2015 using the search terms “sudden infant death syndrome”, “SIDS”, and “cot death”. To date most studies have used a case-control design and there are no randomised controlled trials. The information in this review results primarily from the literature arising from these case-control studies and from the policy statements and technical reports of the American Academy of Pediatrics' Task Force on Sudden Infant Death Syndrome and consensus statements from the International Society for the Study and Prevention of Perinatal and Infant Death.

to be multifactorial in origin. The triple risk hypothesis (figure)⁶ proposes that SIDS may occur when a vulnerable infant, such as one born preterm or exposed to maternal smoking, is at a critical but unstable developmental period in homeostatic control and is exposed to an exogenous stressor, such as being placed prone to sleep. The model proposes that infants will die of SIDS only if all three factors are present, and that vulnerability lies dormant until they enter the critical developmental period and are exposed to an exogenous stressor. SIDS usually occurs during sleep, with a peak in incidence between 2 and 4 months of age, when sleep patterns are rapidly maturing.² The final pathway to SIDS is widely believed to involve immature cardiorespiratory control in conjunction with a failure of arousal from sleep.^{2,7} Support for this hypothesis comes from numerous physiological studies showing that the major risk factors for SIDS (prone sleeping, maternal smoking, prematurity, head covering) have sizeable effects on blood pressure and heart rate and their control⁸ and impair arousal from sleep.⁹ Deficits in areas of the brainstem involved in cardiorespiratory control and arousal, particularly in the serotonergic system, have been identified in infants who died from SIDS.¹⁰

What are the major risk factors for SIDS?

Sleeping position

In the 1980s, large case-control studies in several countries identified prone sleeping as the major risk factor for SIDS,¹¹⁻¹⁸ with a relative risk or odds ratio between 3.5 and 9.3.¹⁹ Subsequent studies also identified side sleeping as a risk factor, possibly because many infants are found prone after being placed on their side. A meta-analysis of 24 studies comparing the risks of side versus back sleeping showed an odds ratio of 1.4.²⁰ Infants who were unaccustomed to sleeping prone were particularly at risk in the prone position, with adjusted odds ratios ranging from 8.7 to 45.4.^{21,22}

Some parents and healthcare professionals are concerned about the risk of infants choking when supine.

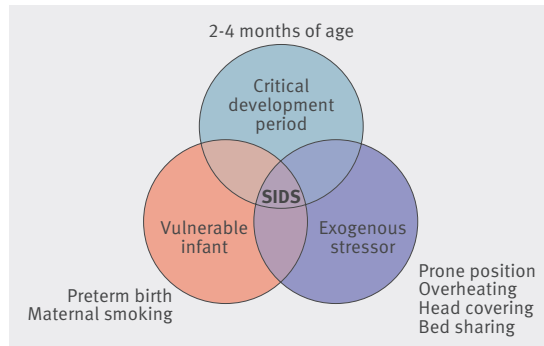
THE BOTTOM LINE

- Sudden infant death syndrome (SIDS) remains the leading cause of death between 1 month and 1 year of age
- Placing infants in the prone position (on their stomach) to sleep and exposure to maternal smoking are major risk factors for SIDS
- Infants born preterm are at four times the risk compared with infants born at term
- The safest place for infants to sleep is in the parental bedroom in their own cot and in close proximity to parents to allow for feeding and comforting; sleeping on a sofa or couch with an infant is extremely dangerous
- Bed sharing with infants is a risk factor for SIDS—infants are at highest risk if younger than 3 months or if the parents smoke, use illicit drugs, or consume alcohol
- Breast feeding decreases the risk of SIDS and therefore mothers should be encouraged to breast feed for this reason and other health benefits

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- ▶ The management of acute testicular pain in children and adolescents (*BMJ* 2015;350:h1563)
- ▶ Management of severe acute dental infections (*BMJ* 2015;350:h1300)
- ▶ Sudden cardiac death in athletes (*BMJ* 2015;350:h1218)
- ▶ Temporomandibular disorders (*BMJ* 2015;350:h1154)



Triple risk model for sudden infant death syndrome (SIDS), illustrating three overlapping factors: vulnerable infant, critical developmental period, and exogenous stressors. Adapted from Filiano and Kinney 1994⁶

However, careful study of the infant's airway has shown that healthy infants placed supine for sleep are less likely to choke on vomit than prone sleeping infants.²³ In the supine position the upper airway is above the oesophagus, allowing any regurgitated milk to be readily swallowed and as such avoiding aspiration into the respiratory tract. In the prone position the oesophagus sits above the upper airway, which makes it easier for regurgitated milk to be inhaled into the airway and lungs, leading to aspiration or choking. Several studies have found that the risk of aspiration is not increased by sleeping in the supine position.²⁴⁻²⁶ This is also true for infants with gastro-oesophageal reflux.

Smoking during and after pregnancy

Over 60 studies have identified that maternal smoking during pregnancy increases the risk of SIDS up to fivefold.²⁷⁻³¹ An estimated third of SIDS deaths could be prevented if exposure to smoke in utero was eliminated,³²⁻³³ and there is a positive dose-response relation between maternal smoking and the risk of SIDS.²⁷⁻³⁰⁻³¹⁻³⁴⁻³⁵ Moreover, paternal smoking and exposure to passive smoke during infancy have also been associated with an increased risk of SIDS, with some data showing a dose dependent relation.³⁴⁻³⁶ As a result, parents, especially mothers, should be encouraged to reduce smoking as much as possible during pregnancy and after birth and to discourage smoking around the baby after birth.

Preterm infants

Preterm infants are at a fourfold increased risk of SIDS compared with their full term counterparts, and despite the decrease in cases of SIDS since the introduction of messages about sleeping in the supine position the rates among preterm infants remain high.³⁷⁻³⁹ The association between prone sleeping and SIDS among infants of low birth weight is equal to or stronger than that in infants of normal birth weight.²² Preterm infants are commonly placed in the prone position while in the neonatal unit on the understanding that this improves respiratory function.⁴⁰ As preterm infants are at increased risk of SIDS it is important that they are placed supine as soon as clinically stable. The American Academy of Pediatrics recommends that infants should be placed supine from

32 weeks of postmenstrual age⁴¹ so that they and their parents can become used to this position well before discharge from hospital.

Head covering and bedding

During the last sleep, the heads of infants affected by SIDS were covered by bedding in 24.6% of cases compared with 3.2% among controls.⁴² Doonas, duvets, and quilts should be avoided in cots (cribs) as they may cover the infant's head or face and obstruct breathing.⁴²⁻⁴³ Furthermore, such soft bedding should never be placed under infants, nor should pillows or sheepskin rugs be used in cots, because of an increased risk of suffocation and rebreathing.⁴⁴⁻⁴⁶ Soft bedding in a cot increases the risk of SIDS fivefold, regardless of sleep position,⁴⁷⁻⁴⁸ and more than 20-fold if infants are also placed prone.⁴⁷ Infants should be placed to sleep in a cot with a firm, well fitting mattress that is clean and flat (not tilted or elevated), with no pillows or loose bedding. Cot bumper pads and similar products that attach to the sides of the cot are not recommended because of the danger of entrapment between the mattress or cot and firm bumper pads, the risk of suffocation against soft bumper pads, or strangulation with bumper pad ties.⁴⁹

Although it is safest if infants sleep without blankets, if blankets are to be used they should be thin and infants should be placed with their feet at the foot of the cot ("feet to foot"), with the blanket tucked in on three sides so as not to come above the infant's armpits. Although this practice makes sense to avoid covering an infant's head, and there was an increase in this practice seen in case-control studies during 1993-96 and 2003-06 particularly in non-SIDS infants,⁵⁰ there have been no studies to support that this is protective.⁵¹ Recently, use of an infant sleeping bag has been recommended. A safe infant sleeping bag is one in which the infant cannot slip inside the bag and therefore the head cannot be covered. The sleeping bag should be the correct size for the infant, with a fitted neck and armholes or sleeves to keep the baby warm and no hood to avoid any chance of the head becoming covered. Although this advice seems logical there is currently little evidence that sleeping bags are protective.⁵²

What factors are protective against SIDS?

Breast feeding

Breast feeding is associated with a decreased risk of SIDS.⁵³⁻⁵⁴ A recent meta-analysis of 18 case-control studies showed that breast feeding of any extent or duration was protective, with the reduction in risk ranging from 45% to 73% and the protective effect being strongest for exclusive breast feeding.⁵⁵

Room sharing

Sleeping in the parental bedroom reduces the risk of SIDS by as much as 50%.⁵⁶⁻⁶⁰ Compared with infants who slept in the parental bedroom, those who died from SIDS when sleeping in a separate room were more likely to be found with their heads covered by bedding and to have rolled prone if they had been placed on their side to sleep.⁶¹ It has been speculated that sleeping in the parental bedroom is also more likely to prevent suffocation, strangulation,

or entrapment and it allows close proximity for feeding, comforting, and monitoring of infants.⁶² The advice to room share with parents for the first 6-12 months is supported by studies from several countries.^{63 64}

Dummies (pacifiers)

Strong and consistent evidence shows that infants who die from SIDS are less likely to have used a dummy (pacifier) during their last sleep than age matched controls.⁶⁶ In some countries such as the United States, dummy use is promoted, after breast feeding has been established, as a risk reduction strategy for SIDS,⁶⁵ whereas in other countries, such as the United Kingdom, Australia, and New Zealand expert opinion is more ambivalent and dummy use is not actively encouraged. This is mainly because of uncertainty about how these devices confer protection, particularly as they fall out of the mouth soon after infants fall asleep.⁶⁶

What is bed sharing?

Parents have largely accepted the advice to place infants in a supine position to sleep, avoid exposure to smoke before and after birth, and avoid situations that would increase the risk of the face or head being covered or airway obstruction. One problem that has become increasingly important is parents sharing a sleeping surface with their infant. In recent years it has been reported that more than half of all sudden and unexpected deaths in infants occurred in a bed sharing situation.^{50 67-73} Bed sharing describes the situation where an adult (typically one or both parents) brings the infant on to the same surface (usually, but not limited to, a mattress) for sleep. “Co-sleeping” is sometimes used to depict the same scenario; however, this is more commonly understood to mean sleeping in close proximity to, but not necessarily on the same surface as, the infant.

How common is bed sharing?

Parent-infant bed sharing is common. In one US survey, 45% of parents reported that they had shared a bed with their infant aged less than 8 months in the past two weeks.⁷⁴ In England it was reported that almost half of all infants shared a bed at some time with their parents, and on any one night in the first month of life more than a quarter of parents slept with their infant.⁷⁵ In a Canadian study although 89% of 293 participants agreed that bed sharing had associated risks, 72% reported bed sharing routinely or occasionally.⁷⁶ Almost half of respondents discussed bed sharing with their doctor, and where the family doctor advised against this practice, parents were less likely to continue to bed share.⁷⁷

Why do parents choose to bed share?

Given that bed sharing is common, suggesting that it is inadvisable because of the increased risks of SIDS is controversial.⁷⁸ Bed sharing has been reported to be normal practice for 90% of the world’s population, with mothers in two thirds of all cultures sharing a sleeping surface with their infant.⁷⁹ However, in cultures where bed sharing is normal practice, the sleeping environment is typically different from that in western society. For example,

QUESTIONS FOR FUTURE RESEARCH

- What are the biological and physiological causes of SIDS?
- Which mechanisms increase the risk of SIDS in bed sharing situations and are there any safe bed sharing circumstances?
- What is the mechanism for the protective effect of dummies?

ADDITIONAL EDUCATIONAL RESOURCES

Resources for healthcare professionals

- American Academy of Pediatrics Task Force on Sudden Infant Death Syndrome (<http://pediatrics.aapublications.org/content/128/5/1030.full>)
 - guidelines providing information and recommendations for safe sleeping
- National SIDS organisations: Lullaby Trust, UK (www.lullabytrust.org.uk), and SIDS and Kids, Australia (www.sidsandkids.org)
 - advice on safe sleeping for both professionals and parents

in Asian countries where bed sharing is common and the risk of SIDS is low, beds are often firm mats on the floor with separate mats for infants, and soft bedding or pillows are rarely used. Furthermore, infants are generally breast fed and mothers usually do not smoke, consume alcohol, or take drugs that could impair their arousal.⁸⁰

Studies from England, the United States, and New Zealand have all reported a longer duration of breast feeding in infants who shared a bed.⁸¹⁻⁸⁵ In one US study, the reasons why African-American women chose to share a bed with their infants were no room for, or no money to buy, a cot, convenience of feeding (formula or breast milk), and ease of monitoring.⁸⁶

What is the evidence for bed sharing and risk of SIDS?

Although initial studies identified a greater risk of SIDS with bed sharing for infants whose mothers smoked,^{56 58 64 87-90} more recently it has become apparent that the risk is also increased in infants aged less than 3 months even if neither parent is a smoker.^{56 58} Importantly, in all 11 case-control studies reporting an association between bed sharing and SIDS, the risk of SIDS was increased in infants who bed shared; no study found a protective effect.⁹⁰ The largest analysis to date was published in May 2013,⁹¹ with 19 studies from nine datasets across the UK, Europe, and Australasia and totalling 1472 cases of SIDS and 4679 controls. The individual level analysis showed that even for infants at low risk (that is, breast fed and with parents who neither smoked nor used illicit drugs or alcohol), bed sharing was associated with a fivefold increased risk of SIDS in the first three months of life (adjusted odds ratio 5.1, 95% confidence interval 2.3 to 11.4), compared with infants placed for sleep in a supine position in a cot in the parents’ bedroom. In the first two weeks of life the risk of SIDS for those bed sharing was more than eightfold higher (adjusted odds ratio 8.3, 3.7 to 18.6). The risk was not increased for low risk bed sharing infants aged more than 3 months (1.0, 0.3 to 3.0). Furthermore, the model predicted that, overall,

CURRENT ADVICE FOR PARENTS

Infants should be placed in the supine position for all sleep periods
 Infants should be kept in a smoke-free environment before and after birth
 Infants aged less than 6 months should sleep in their own cot in the parental or adult caregiver's bedroom and not share a sleeping surface with a parent, caregiver, or other child
 Parents should be advised of the risks of sharing a bed with infants, even if they do not smoke, drink alcohol, or use illicit drugs, and the infant is breast fed, if the infant is less than 3 months of age
 Bed sharing with parents who smoke, drink alcohol, or use illicit drugs is particularly dangerous and parents should be warned of the significantly increased risk of SIDS
 Sleeping on a sofa with an infant should always be avoided because of the significantly increased risk for SIDS
 Parents should avoid using any loose or soft bedding that could cover an infant's face, doonas, heavy blankets, pillows, or cot bumpers, and should not place toys in the cot
 If blankets are used, infants should be placed with their feet at the foot of the cot and the blanket tucked in on three sides to reduce the risk of the head becoming covered
 A good alternative to blankets is an infant sleeping bag
 Mothers who want to breast feed should be encouraged and assisted to do so—infants may be brought into bed to feed but should be placed back in their cot to sleep
 Routine use of a dummy is protective against SIDS; however, among this group of infants it is important to establish breast feeding first for 3-4 weeks before the introduction of a dummy
 Immunisations consistent with the standard immunisation schedule are recommended
 These recommendations are based on the advice of the American Academy of Pediatrics Task Force on Sudden Infant Death Syndrome 2011 (<http://pediatrics.aappublications.org/content/128/5/1030.full>)^{62 65}

nearly nine out of 10 infant deaths while bed sharing would probably have been prevented had the infants been placed supine in a cot in the parents' bedroom. Even in low risk healthy infants aged less than 3 months it was predicted that more than 80% of deaths would have been prevented had bed sharing been avoided. The analysis also showed an interaction between parental smoking, maternal alcohol consumption in the previous 24 hours, and maternal illicit drug use and bed sharing. For bed sharing infants, the adjusted odds ratio was 17.6 if the mother's partner smoked, 47.5 if the mother smoked, and 64.9 if both parents smoked. If the mother consumed more than two units of alcohol the adjusted odds ratio was 89.7, and if she used illicit drugs the risk was inestimably high. Criticisms of this study include the large amount of imputed missing data on parental alcohol and drug consumption and oldness of studies (1987-2003).⁵⁰ The imputation methods used were, however, correctly performed and there is no reason why the age of the studies would materially alter the validity of the risk estimates and conclusions. A recent reanalysis of data collected in two English studies during 1993-96 and 2003-06 included 400 cases of SIDS and 1386 controls.⁹² Thirty six per cent of the infants affected by SIDS were co-sleeping with an adult (defined in this study as sleeping on the same surface, including a sofa, chair, or bed) at the time of death compared with 15% of control infants.⁹² Similar to the 2013 study,⁹¹ sharing a bed with a parent who had consumed more than two units of alcohol before sleep was a risk for all infants (odds ratio 18.3). For infants aged less than 98 days, co-sleeping with a smoker also significantly increased the risk for SIDS (odds ratio 8.9). However, the study found that in the absence of alcohol

or smoking, bed sharing just failed to reach significance in infants aged less than 98 days (odds ratio 1.6, 95% confidence interval 0.96 to 2.7, P=0.07).

What are the current recommendations about bed sharing?

Advice to parents about bed sharing currently differs internationally. In the Netherlands, and based on Dutch research, parents are advised not to bed share with infants aged less than 3 months.⁹³ In the United States, the American Academy of Pediatrics and the national Safe to Sleep campaign advise against any bed sharing in infants up to 1 year of age, but instead recommend that infants sleep in close proximity to their parents but on a separate sleep surface. Some expert bodies in other countries, including Australia and the UK, advise against bed sharing, in particular if parents smoke, drink alcohol, or use illicit drugs. They also provide recommendations to bed share more "safely," should parents choose to share a bed with their infant.

What are the risks of falling asleep with an infant on a sofa?

Sleeping on a sofa or couch with an infant is extremely dangerous. The risk of SIDS in infants who co-slept on a sofa was 67 times that in infants who slept in their own cot.^{43 47 58 59 92 94} A recent US study reported that 13% of infant sleep related deaths in 2004-12 occurred while sleeping on a sofa.⁹⁵ Parents should be alerted to this risk and counselled that it is riskier to feed infants on a sofa than on a bed.

What is the advice for expectant parents after a SIDS related death?

The risk of SIDS recurring in subsequent siblings is not clear. The next born siblings of firstborn infants dying of any non-infectious natural cause are at significantly increased risk for infant death from the same cause, including SIDS.⁹⁶ The relative risk is 9.1 for the same cause of death compared with 1.6 for a different cause. The relative risk for recurrent SIDS (range 5.4-5.8) is similar to that for non-SIDS causes of recurrent death (range 4.6-12.5).⁹⁶ The risk for recurrent infant mortality from the same cause as in the index sibling thus seems to be increased to a similar degree in subsequent siblings both for explained causes and for SIDS. This increased risk in families who have experienced SIDS is consistent with genetic risk factors interacting with environmental risk factors. Understandably, parents will be extremely anxious for subsequent pregnancies and will need to be reassured. Given that there is no evidence for the presence or extent of central apnoea being predictive of subsequent death from SIDS, the use of home apnoea monitors is problematic. Over the counter apnoea monitors are in widespread use worldwide, and clinician experience suggests that these devices are used largely without medical advice or supervision. Evidence of the efficacy of such devices in preventing SIDS is, however, lacking.^{97 98} Both medical practitioners and parents should bear this in mind when deciding on use of a monitor, and the potential advantages and disadvantages of monitoring considered for each individual family. If a monitor is to be used, it should be accompanied by ongoing medical and technical support, plus psychological support where indicated.⁹⁹