Sleeping Position, Infant Apnea, and Cyanosis: A Population-based Study

Anne-Louise Ponsonby, MBBS, PhD*; Terence Dwyer, MPH, MD*; and David Couper, PhD*

ABSTRACT. Objectives. To examine the relationship between usual infant sleeping position and the parental report of infant cyanosis, pallor, breath-holding, and breathing difficulties; and to document hospital admission rates for apnea/cyanosis over time and to describe how admission rates vary by usual sleeping position.

Methods. A prospective cohort study was conducted. It involved the one fifth of Tasmanian live births that were assessed, using a perinatal score, as being at higher risk for sudden infant death syndrome (SIDS). From May 1, 1988 to April 30, 1993, 6213 infants participated in the hospital (4 days postnatal age) and home interview (5 weeks postnatal age) (89% of eligible infants). Data on usual sleep position and infant history of cyanosis were collected at home interview. Hospital admission records for apnea/cyanosis in the first year of life were linked to data on cohort infants in southern Tasmania.

Results. Infants who slept supine were not more likely to have been reported to experience cyanosis, pallor, or breathing problems at 1 month of age, when compared with infants sleeping in other positions. In fact, the risk of cyanosis was higher in the prone, face-down sleeping position than in the supine sleeping position (adjusted odds ratio = 4.21, 95% confidence interval [1.33, 13.28]). Among cohort infants in southern Tasmania, hospital admission rates for apnea/cyanosis did not differ by usual sleeping position or year of birth.

Conclusions. Infants usually sleeping supine do not have increased rates of morbidity in relation to parental reports or hospital admissions for apnea/cyanosis. In a location where SIDS and total postneonatal mortality has fallen after intervention to reduce the prevalence of the prone position, rates of hospital admission for apnea/cyanosis have not changed. Pediatrics 1997;99(1). URL: http://www.pediatrics.org/cgi/content/full/99/1/e3; infant sleeping position, sudden infant death syndrome, infant cyanosis, infant apnea.

ABBREVIATIONS. SIDS, sudden infant death syndrome; OR, odds ratio; AOR, adjusted odds ratio; UOR, unadjusted odds ratio.

Intervention has now occurred in several countries to promote the side or back sleeping position for healthy babies after evidence from research that the prone sleeping position increased the risk of sudden infant death syndrome (SIDS). The interventions have been accompanied by a decline in SIDS with no reports of increases in other causes of postneonatal death. In 1994, a meeting held by the National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland, USA, evaluated trends in postneonatal mortality and SIDS rates from 1985 through 1992 for Australia, Britain, New Zealand, the Netherlands, Norway, Sweden, and the United States. All countries that had experienced a rapid decline in prone sleeping had reductions of approximately 50% in their SIDS rate with a concomitant reduction in postneonatal mortality. In Tasmania, Australia, we have previously reported that the usual prone sleep position at 1 month of age was associated with a 4.5-fold increase in SIDS risk among infants in a prospective cohort study. Intervention occurred during 1991 to reduce the prevalence of the prone sleeping position among healthy infants with a subsequent decline in SIDS mortality of 60%. A recent within-cohort analysis showed that the decreased prevalence of the prone sleeping position accounts for over two thirds of the reduction in the SIDS rate among infants born after intervention to promote side and back sleeping among healthy infants.

Concern has been expressed, nonetheless, that the negative consequences of abandoning the prone position have not been fully evaluated. For example, the supine position might require a greater potential need for upper airway patency and could, with neck flexion, increase the risk of life-threatening events and adverse effects secondary to the pooling of secretions in the posterior pharynx. Reservations have also been expressed that a public recommendation for supine positioning of infants would carry risks to many infants who may not be identifiable prospectively, such as infants with unidentified gastroesophageal reflux, infants with obstructive sleep apnea attributable to subtle craniofacial abnormalities, or infants with central sleep apnea. In support of these reservations was the finding from a small physiological study on 10 newborns that sleep apnea (≥6 seconds) was less common in the prone than the supine position. Also, in preterm infants the supine position has been found to be associated with lower oxygen saturation and a lower ventilatory response to hypercapnia compared with the prone position and increased central and mixed apnea.

The concerns relating to aspiration have been partially eased by reports from England, Norway, and Australia that there has been no reported increase in deaths attributable to aspiration as prone prevalence decreased. Physicians in Norway and Britain have reported that referrals and hospitalizations for apparent life-threatening events have decreased after

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http://www.pediatrics.org/cgi/content/full/99/1/e3
intervention to recommend that healthy infants should not be nursed prone. In addition, in the Netherlands, the registered deaths attributable to cot death or SIDS per 1000 live births declined from 1.0 in 1980–1987 to .6 in 1988–1990 and to .4 in 1991–1993, after intervention to avoid the prone position. There was a concurrent decrease in similar causes of death resulting in a reduction in the postperinatal mortality rate from 4.0/1000 live births in 1980–1987 to 2.6/1000 live births in 1993. However, the effect of sleeping position interventions on potential morbidity outcomes such as infant apnea has not yet been rigorously assessed.

The two objectives of this report were as follows. The first objective was to examine the relationship between usual infant sleeping position and the parental report of infant cyanosis, pallor, breath-holding and breathing difficulties in a large infant cohort study. The second objective was to document hospital admission rates for apnea/cyanosis over time and to describe how admission rates vary by the usual sleeping position of the infant.

**METHODS**

**Study Subjects**

A cohort study was conducted from 1988 to 1995 to investigate the etiology of SIDS in Tasmania. The six major obstetric hospitals in the state participated, representing approximately 93% of live births in the state. Infants born within these hospitals were assessed using a scoring system to identify those infants at higher risk for SIDS. The infants were given a composite score based on maternal age, birth weight, season of birth, infant sex, duration of the second stage of labor, and intended infant feeding. Infants with a score over a certain cut-off point were eligible to join the study. All multiple births were also included in the study. Infants with severe neonatal disease or a major congenital anomaly, infants who would not be residing in Tasmania at 1 month of age, and infants who were to be adopted were excluded from the study.

From May 1, 1988 to April 30, 1993, 6962 live birth infants were eligible for inclusion in the survey. This represents approximately one fifth of all live births in the state. Of these eligible infants and their mothers, 6707 (96%) participated in the hospital interview and 6213 (89%) participated in both the hospital and home interviews. The characteristics of the sample were as follows: 22% of infants were low birth weight (<2500 g), 21% were born to teenage mothers, 69% of the infants were male, and 12% were from multiple births. Thirty-three percent of study births were in March to April, 26% in May to July, and 41% between August and February. For the 5-year period commencing May 1, 1988 the study recruitment system had a sensitivity of 47% and specificity of 79% with regard to SIDS cases under 12 months of age. In Tasmania, public health activities to reduce the prevalence of the prone infant sleeping position occurred particularly during 1991. This included the recommendation by obstetric hospital staff that healthy babies sleep on their side or back. Infants born May 1, 1988 to April 30, 1991 and May 1, 1991 to April 30, 1993 were classified as preintervention and postintervention birth cohorts, respectively. This classification delineates a date (May 1, 1991) after which cohort participants were informed at home interview of the association between sleeping position and SIDS. This information was given after the data on usual sleep position had been collected. We have previously reported that the prevalence of the prone sleeping position was lower in the 2 years postintervention (4%) compared with the 3 years before intervention (30%) in this 5-year cohort.

**Measures in the Cohort Study**

Standard study measurements were collected by research assistants in three stages. First, a hospital interview was conducted when the infant was 4 days old. Sociodemographic, obstetric, and perinatal data, including information on maternal nutrition, alcohol consumption, and smoking practice during pregnancy were obtained, in addition to birth weight, height, head circumference, tricip and subscapular skinfold thickness measurements.

Second, a home visit was conducted after the infant was 4 weeks old—during the fifth postnatal week. Premature infants (≥36 weeks gestation) were seen at 40 weeks postconceptional age. The home visit was deferred if the infant had not been discharged from hospital at least 2 weeks previously. A comprehensive verbal questionnaire was administered by a trained interviewer. Data were obtained on usual sleep position (that is, the position the infant usually slept in), usual sleep pattern, body movement during sleep, infant illness history and health service attendance, pattern and type of infant feeding, parental smoking practice, infant overnight clothing and bedding, home heating and hydration, whether the baby usually vomited after feeds (passing) and other characteristics of the infant and parental care. Anthropometric, temperature, and clinical development measurements were made on the infant. The physical features of the house were noted, and readings were taken for humidity and 24-hour maximum-minimum infant bedroom temperature on the day of the home visit. Respondents were asked: “Has baby had any episodes of the following? Going pale, going blue in the face, breath-holding, not breathing, or trouble breathing?” For each of these questions a positive response was classified as a positive parental report. The reports were not restricted to sleep observation only. It is possible that an adverse effect of a sleeping position could manifest during the awake cycle as well as the sleep cycle of the infant. By asking about baby turning blue in the face, it was hoped that information pertaining to central cyanosis rather than the peripheral cyanosis (infant’s hands and feet only turning blue due to cold, etc) would be obtained. For the rest of this article, the term cyanosis refers to a positive history of baby turning blue in the face by home visit interview. The term breathing difficulties refers to a positive history of baby having an episode of not breathing or trouble breathing by home visit interview. Not all questions were answered by all parents. For example, 15 of the 6213 infants who participated in home interview had missing data on either sleeping position or history of infant cyanosis or breathing difficulties.

Third, a phone interview was conducted when the infant was 12 weeks old to review infant progress, illness history, feeding, and immunization history. In addition to the three interviews, data were obtained on hospital admission.

**Hospital Admission Data**

Hospital admission data could not be obtained for the full cohort as record linkage was not feasible for the northern area of the state. However, in southern Tasmania, all pediatric hospitalizations for apnea/cyanosis occurred at the Royal Hobart Hospital. Hospital admission records include an admission diagnosis for each child. For the years 1988 through 1994 inclusive, we reviewed these records and identified the group of infants admitted to hospital with an apneic or a cyanotic episode, including apparent life-threatening events. These admissions were distinct from the infant’s birth and initial hospital stay. The cohort files were record-linked to this hospital data. For cohort births from May 1, 1988 to April 30, 1993, 49 cohort infants were admitted during the first year of life with the diagnosis of apnea or a cyanotic episode. One of these hospitalized infants was born in southwestern Tasmania and the remainder were born in the two major obstetric hospitals in southern Tasmania. Each infant was counted only once, although four infants had repeat admissions. The admission rate was calculated as the number of cohort infants with a diagnosis of apnea or a cyanotic episode divided by the number of infants involved in the cohort study in southern Tasmania during the same study period. The southern-born cohort infants differed from the other cohort infants with regard to gestational age, with 22% of southern infants premature compared with 15% of other infants (P<.001). Home monitoring was uncommon in Tasmania during the study period, with less than 1% of infants estimated to receive home monitoring during the first 6 months of life.

**Analyses**

The associations between various factors were first examined using frequency tables and univariate odds ratios (ORs) with corresponding 95% confidence intervals. Logistic regression models were built to examine the relationship between the exposure...
and outcome of interest with adjustment for confounders. The basic set of confounders for multivariate analyses included the recruitment scoring system components, prematurity, birth order, and postconceptional age at home visit. Additional terms were added to the model if they were potentially important confounders of the particular exposure-outcome association. The outcome factor was a binary term taking the value 1 if the infant had experienced an episode of the corresponding type or hospital admission, and 0 if the infant had a negative history. The adjusted odds ratio (AOR) is the OR corresponding to the exposure of interest obtained from the multivariate logistic regression model that includes the appropriate confounders. Second, effect modification of the relationship between sleeping position and cyanosis was examined by using a logistic regression model with terms for the possible modifier, sleep position, confounders, and interaction term for the possible effect modifier and sleep position. The significance of the effect of the possible modifier was based on the P value associated with the Wald’s $X^2$ test for the interaction term in the model. The hierarchy principle was always observed. Results of statistical tests were regarded as statistically significant if the associated P values were less than 0.05. No adjustment has been made for multiple testing. All sleeping position findings, both positive and negative, are reported. This allows readers who are concerned by the multiple testing to judge the extent of the problem and make formal adjustments if they so desire. Data analysis was undertaken using the SAS/STAT Version 6.09 statistical package.

RESULTS

Prevalence and Hospital Admission Age Distribution

For cohort infants participating in the home interview, 12.5% were reported to have experienced an episode of cyanosis. The prevalences of at least one reported episode of pallor, breathing difficulties or trouble breathing, or breath-holding were 11.8%, 13.6%, and 20.4% respectively. The admission rate of hospitalization for apnea or cyanosis in the first 12 months of life was 1.37% (49 of 3572) for cohort infants participating in the hospital interview and 1.36% (45 of 3309) for cohort infants participating in the home interview. The postnatal age at admission ranged from 0 to 32 complete weeks. The median age was 7 weeks with a 25% centile of 3 weeks and a 75% centile of 14 weeks. A review of the inpatient records for each hospital admission for apnea/cyanosis was conducted. For hospitalized infants in the 5-year birth cohort, in eight (16%), a serious intercurrent infectious illness was present, in two a specific cause (congenital heart disease, central nervous system abnormality) for apnea/cyanosis was found, in three children the full inpatient file could not be accessed, and the remainder (73%) had apnea/cyanosis alone or in conjunction with reflux or a mild upper respiratory tract infection. The last group is referred to as apnea with no definite cause found in the remainder of this report.

The Relationship Between Reported Episodes at 1 Month and Hospital Admission

The relationship between reported episodes at 1 month and hospital admission is documented in Table 1. Infants who were reported to have had an episode of any of the four types described had an increased risk of hospital admission for apnea or cyanosis in the first 12 months with risk estimates varying from less than three for episodes of breath-holding to eight for episodes of breathing difficulties. A positive history of episodes of pallor, or breath-holding at home interview predicted a higher risk of subsequent hospital admission for apnea or cyanosis during the first year of life. Restricting the analysis only to infants hospitalized with apnea with no definite cause found, the associations between parental report of cyanosis, pallor or breathing difficulties and hospital admission status were increased. For example, the parental report of breathing problems or cyanosis at home interview was strongly related to hospitalization in the first year of life for these infants, with ORs of 13.52 (6.51, 28.08) and 8.32 (4.16, 16.63), respectively.

The Relationship Between Usual Sleep Position and Reported Episodes

Infant sleeping position was examined in relation to a history of cyanosis, pallor, breathing difficulties, and breath-holding (Figure). Most of the infants in the sleep position group called other were reported to have no usual sleeping position. The prone face-to-side, prone face down, side, or other sleeping positions did not differ from the supine position for episodes of pallor or breathing difficulties. The small group of infants who usually slept prone and face down had a significantly higher cyanosis rate than infants usually sleeping supine (Table 2). Infants who usually slept prone and face down were all born in the preintervention period and more tended to be premature (31.6% versus 18.8%, P = .15) and to sleep on ti-tree or another natural fibre mattress (52.9% versus 32%, P = .07) than other infants. The association between this sleep position and cyanosis persisted after adjustment for natural fibre mattress type or the factors listed in Table 2.

TABLE 1. Relationship Between Parental Report and Hospital Admission for Apnea/Cyanosis

<table>
<thead>
<tr>
<th>Parental Report of a Positive History at Home Interview</th>
<th>Hospital Admission for Apnea/Cyanosis Before Home Interview (n = 20)</th>
<th>Hospital Admission for Apnea/Cyanosis After Home Interview (n = 24)</th>
<th>Any Hospital Admission for Apnea/Cyanosis (n = 45)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio (95% Confidence Interval)</td>
<td>Odds Ratio (95% Confidence Interval)</td>
<td>Odds Ratio (95% Confidence Interval)</td>
</tr>
<tr>
<td>Episode of cyanosis</td>
<td>16.19 (6.19, 42.36)</td>
<td>2.31 (0.91, 5.86)</td>
<td>5.55 (3.06, 10.09)</td>
</tr>
<tr>
<td>Episode of pallor</td>
<td>7.70 (3.19, 18.63)</td>
<td>3.17 (1.31, 7.70)</td>
<td>4.69 (2.54, 8.65)</td>
</tr>
<tr>
<td>Episode of breathing difficulty</td>
<td>38.45 (11.22, 131.79)</td>
<td>2.79 (1.15, 6.78)</td>
<td>8.48 (4.67, 15.41)</td>
</tr>
<tr>
<td>Episode of breath-holding</td>
<td>2.17 (0.86, 5.45)</td>
<td>3.40 (1.52, 7.63)</td>
<td>2.68 (1.47, 4.89)</td>
</tr>
<tr>
<td>Episode of any of the above</td>
<td>27.24 (3.64, 203.67)</td>
<td>2.39 (1.04, 5.47)</td>
<td>5.03 (2.48, 10.20)</td>
</tr>
</tbody>
</table>

* One infant was interviewed partially in hospital therefore not classified in the “before” or “after” group.
side, and prone face-to-side sleeping positions, did not differ significantly with regard to reported cyanosis rates. The mothers whose infants were classified as other sleep position were more likely to report that their infant had experienced cyanosis (Table 2). The effect of sleeping position was then examined separately for the group of infants who usually vomited after feeds (ie, posseted). Among these infants, the proportion experiencing cyanosis by usual sleeping position was: prone face down 18.2%, prone face-to-side 11.5%, side 10.9%, supine face up 10.1%, supine face-to-side 11.1%, other 9.9% (X² test for association, \( P = .96 \)). Thus, infants who possetted and slept supine were not more likely to experience cyanosis than infants who possetted and slept in other sleep positions. The association between the prone face down sleep position and cyanosis did not appear to be potentiated by the concurrent use of a ti-tree or kapok mattress or the use of a sheepskin at interview or during cold winter weather. However, the small number \( n = 18 \) of infants usually sleeping prone and face down means that a true effect may be present but was undetected due to inadequate statistical power. For breath-holding, only the sleep po-

### TABLE 2. Cross-sectional Association Between Sleeping Position and Infant Cyanosis

<table>
<thead>
<tr>
<th>Sleep Position</th>
<th>Proportion of Infants With a Positive History of Cyanosis Among Those With Specified Sleeping Position</th>
<th>Univariate Analysis Odds Ratio (95% Confidence Interval)</th>
<th>Multivariate† Analysis Odds Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual prone face-down*</td>
<td>27.8% (5/18)</td>
<td>4.03 (1.34, 12.16)</td>
<td>4.21 (1.33, 13.28)</td>
</tr>
<tr>
<td>Usual prone face to side*</td>
<td>10.0% (117/1171)</td>
<td>1.16 (0.75, 1.80)</td>
<td>1.35 (0.85, 2.15)</td>
</tr>
<tr>
<td>Usual side*</td>
<td>10.0% (459/4593)</td>
<td>1.16 (0.78, 1.75)</td>
<td>1.19 (0.78, 1.81)</td>
</tr>
<tr>
<td>Other*</td>
<td>15.1% (16/106)</td>
<td>1.86 (0.96, 3.61)</td>
<td>1.98 (1.00, 3.95)</td>
</tr>
</tbody>
</table>

* Reference category = the supine (on back) sleeping position (8.7% of these infants) (27/310) had a history of cyanosis.
† Adjusted for teenage motherhood, low birth weight, prematurity, infant sex, duration of second stage of labor, season of birth, birth order, multiple birth, intention to bottle-feed after birth, marital status, maternal education, paternal employment, hospital of birth, interviewer, period of birth, and infant age at home visit.

**Figure.** Proportion of positive parental reports by usual sleep position.
sition called other differed significantly from the usual supine sleeping position, with infants who sleep in the position called other having increased rates of breath-holding.

The Relationship Between Usual Sleep Position and Hospital Admission for Apnea or Cyanosis

The usual prone sleeping position was not associated with hospital admission for apnea and cyanosis (unadjusted odds ratio [UOR] = 1.19 [0.58, 2.41]). Prematurity and low maternal education increased the likelihood of an infant’s admission. Adjustment for gestation (≥28 weeks, 29 to 36 weeks, or >36 weeks) or low maternal education resulted in AORs of 1.02 (0.50, 2.09) and .95 (0.42, 2.15), respectively for the prone position. Hospital admission subsequent to home interview was also not related to the prone sleeping position. (UOR = .83 [0.28, 2.44]). The rates of hospital admission by specific sleeping position were: other sleep position, 1.6%; prone face-to-side sleeping position, 1.6%; side sleeping position, 1.4%. There were no admissions among the infants who usually slept supine or prone and face down. A similar pattern was observed when the analysis was restricted to only those infants hospitalized for apnea/cyanosis in whom no definite cause was found.

Rate Changes Over Time

The rates of hospitalization for apnea or cyanosis did not differ significantly by year of birth (F = .17). The admission rates for apnea or cyanosis in the 5-year cohort period from May 1, 1988 were: year 1: 1.1%; year 2: 1.0%; year 3: 2.2%; year 4: .9%; year 5: 1.8%. Hospital admissions did not change in the postintervention period (UOR = .95 [0.53, 1.70]). Further adjustment for sleeping position did not alter this result (AOR = 1.11 [0.58, 2.11]). After adjustment for the scoring system components for recruitment into the cohort (maternal age, infant sex, birth weight, season of birth, intention to bottle-feed, multiple birth, and duration of second stage of labor), hospital of birth, and interviewer, the hospital rate was slightly higher postintervention but this was not statistically significant (AOR 1.25, [0.65, 2.43]). Infant cyanosis was more commonly reported for infants born after May 1, 1991 (UOR = 1.29 [1.09, 1.52]). This effect increased after adjustment for sleep position, maternal postnatal smoking and antihistamine use by period of birth (AOR = 1.38 [1.15, 1.65]). There was also an increase in reporting breath-holding (UOR = 1.20 [1.05, 1.37]) and episodes of pallor (UOR = 1.20 [1.00, 1.44]) and, to a lesser extent, breathing difficulties (UOR = 1.11 [0.95, 1.31]) in the latter birth period.

DISCUSSION

In this population-based study, infants who usually slept supine did not have increased rates of parental report of breathing problems and cyanosis or hospital admission for apnea or cyanosis compared with infants sleeping in other positions at 1 month of age. In fact, infants who usually slept prone and face down had a higher rate of reported cyanosis compared with supine infants.

The cohort was based on the one fifth of live births in a geographical area who were at higher risk for SIDS. It is not representative of the general infant population of Tasmania. Miettinenen22 and Rothman23 state that an analytical cohort study, to be generalizable to other populations, does not have to be representative of the community from which it was selected. Miettinenen states that key concerns with regard to study base are (a) definition of eligible participants, (b) distribution matrix, and (c) sample size. Here, the eligibility criteria are defined. The confounding effect of the components of the scoring system were taken into account in the multivariate analyses. One possible disadvantage is that some of the scoring components may also be acting as effect modifiers of the relationship between an exposure and apnea or cyanosis. If this is the case, then it is possible that the results for noncohort infants may differ slightly. If so, the difference would be one of degree—these infants should not differ in a material way from other infants. Selection bias attributable to nonresponse is unlikely to be a major problem as the overall response rate of eligible infants was high: 89%. Hospital admissions of infants in southern Tasmania for apnea/cyanosis occurred only at the one hospital during the study and thus all clinical apnea cases presenting to medical care that were assessed as severe enough to warrant hospitalization should have been detected. Hospital admission for apnea/cyanosis was a relatively uncommon event, even among this population, increasing the possibility of type II statistical error. For example, the study would have adequate power to detect increased hospitalization for prone infants at the 5% level only if the OR was 2.3 or higher.

Hospital admission data were examined as well as parental report outcomes because of the potential problems of overreporting of minor symptoms and other reporting biases. Parental symptom report did, however, relate well to hospital admissions for apnea/cyanosis in Table 1. The increased reports of infant cyanosis over time could not be explained by changes in infant sleeping position, antihistamine use, or maternal postnatal smoking rates by period of birth. An increase in parental anxiety or awareness of color change in their infant because of active health promotion activities after May 1, 1991 to reduce the risk of SIDS may have contributed to the increases in symptom report. However, reporting bias is unlikely to explain the finding that only the prone face down sleeping position was strongly associated with cyanosis when compared with the supine position. In fact, parents of infants who usually sleep face down, could be expected to have been less likely to report infant cyanosis (baby turning blue in the face) because of a reduced opportunity to view the infant’s face during sleep. Furthermore, all the infants reported to sleep in this position were born before intervention. The finding is consistent with a recent physiological study of 11 infants, which found that end-tidal carbon dioxide partial pressure rose in all subjects while they were in the face down position; inspired carbon dioxide was three times greater on soft than hard bedding.19 It was concluded that in-
phants sleeping face down may occasionally have significant asphyxia. Other mechanisms, such as airway obstruction, could also be involved. Here, the odds of cyanosis were not shown to be influenced by the type of bedding but this may reflect an inability to detect an effect due to the small number of prone face down infants (only a small proportion of infants, .3% of the cohort, usually slept prone and face down). Infants who were described by their mother as other (predominantly no usual sleep position) were more likely to have experienced cyanosis—possibly because a proportion of such infants were sleeping face down—a position parents are probably less willing to admit to. In addition, infants experiencing excessive mobility are more likely to become submerged under thick bedclothes or occupy other unfavorable positions in the cot. This second reason, however, is unlikely to be an explanation for these infants who were only 1 month old at the time of the home interview.

The data on maternal report of cyanotic or other episodes were collected at the same infant age as data on usual sleeping position. However, the usual sleeping position of an infant at 1 month of age may not reflect the infant’s usual sleeping position at the time of hospital admission for an apneic or cyanotic episode. Among controls in the Tasmanian case control study, there was only moderate agreement (Kappa = .68) between the usual prone sleeping position at the 1-month prospective home visit and the usual prone position at follow-up case control interview. However, the risk estimates for prone position and SIDS were found to be similar when prospective home interview data was compared with data pertaining to usual position at the time of death or control interview. In this study, the median age at hospital admission was 7 weeks, only a short interval after the home interview.

This study’s strengths include a large population-based sample, high participation rates, and study measurements collected at a relevant postnatal age for infant apnea. However, the sample size and study methodology meant that certain conditions, such as gastroesophageal reflux, could not be measured with the precision of laboratory studies. For this reason, the findings from this study can not be taken to definitively rule out an association between gastroesophageal reflux and apnea in some infants sleeping supine with the face up. Promotion of the supine and side sleeping position has been followed by a reduction in SIDS and total postneonatal mortality in several countries. In the United Kingdom, where SIDS mortality declined by two thirds after the Back to Sleep health education campaign, a recent case-control study found the supine sleeping position to be more protective against SIDS than the side position. The evidence from this cohort of no association between the supine sleeping position and parental report of cyanosis, breathing difficulties, or hospitalization for apnea/cyanosis provides further support for the current recommendation to promote the supine and side sleeping positions for healthy infants.

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