**Changing Infants’ Sleep Position Increases Risk of Sudden Infant Death Syndrome**

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**Objective:** To examine whether the prone sleeping position may increase the risk for sudden infant death syndrome (SIDS), particularly in infants unused to prone sleep.

**Design:** A 3-year (1987-1990) case-control study.

**Setting:** Nationwide study in New Zealand.

**Subjects:** Four hundred eighty-five infants who died of SIDS and 1800 controls.

**Main Outcome Measures:** Infants were classified as unaccustomed to prone if their usual sleep position was nonprone and they were placed prone for the last sleep. Secondary prone was used to describe infants placed non-prone but found prone.

**Results:** Infants usually and last placed nonprone were at the lowest risk for SIDS (odds ratio [OR], 1.0); those usually and last placed prone were at increased risk (adjusted OR, 4.6; 95% confidence interval, 3.4-6.3). Risk was greatly increased among infants unaccustomed to the prone position (adjusted OR, 19.3; 95% confidence interval, 8.2-44.8). These infants accounted for 8% (31/386) of all SIDS deaths. Ninety percent (28/31) of infants in this group were found prone, and 71% (20/28) of those found prone were found with their faces turned down into bedding—a position in which asphyxia has been implicated as a mechanism of death. In addition, 138 infants who died of SIDS were last placed non-prone. Forty-seven infants (34%) in this group were found prone (secondary prone), and 60% (28/47) of those found prone were found with their faces turned down into the bedding. This group accounted for 12% of all SIDS deaths. Most of these infants (91% [43/47]) were usually placed nonprone.

**Conclusions:** Infants placed supine to sleep were at the lowest risk of SIDS, which supports the recommendation that this is the preferred sleeping position for healthy infants. In New Zealand, 20% of SIDS deaths involved lack of experience with the prone sleeping position. Our findings suggest the possibility that an infant’s competence in escaping from potentially lethal situations during prone sleep (eg, the face-down position) may be impaired by inexperience in prone sleeping. Great caution should be exercised in placing infants unaccustomed to the prone sleeping position in the prone position.

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**Editor’s Note:** So how do we keep infants younger than 1 year in the supine position while sleeping? Crib belts, anyone?

_Catherine D. DeAngelis, MD_

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In the past 10 years public health initiatives to reduce use of the prone sleep position in infants have resulted in marked reductions in the incidence of the sudden infant death syndrome (SIDS) in several countries, including the United States. Identification of associated factors that might increase the risk of prone sleeping may lead to additional public health interventions and a further reduction in SIDS deaths and may provide further insights into the mechanism by which prone sleeping causes SIDS. Reports of SIDS deaths occurring on the first night of exposure to prone sleeping or upon first exposure of prone-sleeping infants to hazardous sleep environments have suggested the possibility that the prone position may increase SIDS risk, particularly in infants unused to prone sleep. The potential importance of experience is reinforced by the theory that infants at the age when risk for SIDS is highest are in the process of replacing airway protective reflexes with learned protective behaviors. In this article, we examine the relationship of sleep position experience to SIDS using the New Zealand Cot Death Study data. Additionally, numerous reports of SIDS deaths in infants who spontaneously turn to the prone position on the night of death prompted us to evaluate potential interactions between habitual sleeping position and spontaneous change on the night of death.
SUBJECTS AND METHODS

The study has been described in detail previously. In brief, it was a 3-year (November 1, 1987, through October 31, 1990) nationwide case-control study that covered 78% of all births in New Zealand. There were 485 deaths caused by SIDS in the postneonatal age group (3.5 of 1000 live births), which we compared with 1800 control infants. Autopsies were carried out in 474 (98%) of the 485 SIDS cases.

METHODS

Controls were randomly selected from all live births in the study regions, except home births (<1%). The controls were not matched with cases and were a representative sample of all live births. Parents or guardians of cases and controls were interviewed about a wide range of topics. For questions on infant care practices that related particularly to the period prior to death in cases, parents of controls were given a nominated date and time of day on which to base the interview, which was randomly allocated to ensure an age and time distribution similar to that expected for the cases. Seventy percent of interviews of control infants were carried out within 4 days of the nominated date and time. Interviews were completed for 81% of the case families and 88% of control families.

The parents were shown a number of drawings and asked the following questions concerning sleep position: (1) “Which drawing best describes the way you usually put your baby down to sleep in the last 2 days?” (This is subsequently referred to as how the infant is usually placed.) (2) “Which best describes the position you usually found your baby after sleep in the last 2 days?” (This is subsequently referred to as how the infant is usually found.) (3) “Which best describes the way you put your baby down for: the last time (cases)/the nominated sleep (controls)?” (This is subsequently referred to as how the infant was placed for his or her last sleep.) (4) “When you found your baby dead, in what position was he/she?” (This question was asked only of cases.)

Unaccustomed prone sleeping position was used to describe those infants who were usually placed nonprone to sleep but were placed prone for their last sleep. Secondary prone was used to describe those infants who were last placed to sleep nonprone but were found dead in the prone position.

Obstetric records were examined for 96% of the cases and 98% of the controls. Ethical approval for this study was obtained from the research ethics committee in each region.

DATA ANALYSIS

Relative risk ratios were estimated from Mantel-Haenszel odds ratios (ORs). Logistic regression was used to calculate ORs adjusted for possible confounders: selection effects (age of infant, region, season, and time), sociodemographic background (marital status, occupation, age mother left school, and age of mother), pregnancy variables (parity, age of mother at first pregnancy, attendance at antenatal clinics, and education classes), infant factors (sex, birth weight, and gestation), and postnatal factors (admission to neonatal unit, sheepskin bedding use, breastfeeding, maternal smoking, and infant sharing a bed with another person). These variables have been defined previously. Interactions were tested by calculating the change in deviance between models with and without the interaction term present.

RESULTS

Table 1 shows the prevalence and ORs for position placed to sleep for the last sleep and for the usual position. The risk for SIDS is increased predominantly for the prone sleeping position. The lateral sleeping position shows an increased risk intermediate between that for prone and supine sleep for both usual and last sleep, but neither increase is significant after adjustment for potential confounders.

The next analysis gives the risk of SIDS with the different combinations of the last and usual infant sleeping position (Table 2). As there were a small number of cases who were placed to sleep supine at the last sleep, sleep position is categorized as either prone or nonprone (includes both supine and lateral). The lowest risk group was for infants who were usually placed nonprone and were placed nonprone for the last sleep. Infants placed prone at both times were at a 4-fold increased risk of SIDS compared with infants placed nonprone at both times. The striking observation was the 18-fold increased risk of SIDS for infants unaccustomed to prone sleeping (normally placed nonprone and placed prone for last sleep). The interaction was statistically significant ($\chi^2 = 15.6; P = .001$). This group accounts for 8.0% of all SIDS cases.

Of the 31 SIDS infants who were in the category unaccustomed to prone sleeping, 28 (90%) were found prone; 20 (71%) were found with their faces turned down into the mattress. It should be noted that although by definition unaccustomed to prone designates infants who were normally placed nonprone; most of these 31 infants (90%) also had a history of usually being found nonprone, leaving only 10% with significant experience in the prone position as a result of having previously spontaneously turned to prone.
It is uncertain why the infants were placed prone. More of these infants who were unaccustomed to the prone sleeping position were irritable in the last 2 days compared with all other SIDS cases (32% [10/31] vs 18.1%; \( \chi^2 = 3.7; P = .06 \)). However, the prevalence of fever, vomiting, and severity of illness in infants unaccustomed to prone sleeping was not significantly different from that of other SIDS infants, and the age of the infant, maternal smoking, and caregiver did not differ between the 2 groups.

Table 3 shows the risk of SIDS for the various combinations of usual position placed to sleep and usual position found. The 2 groups of infants who were usually placed nonprone and were placed nonprone for the last sleep. In this group of infants, 43 (34.4%) were found prone (secondary prone). It is noteworthy that most of these 43 infants were not accustomed to the prone position not only because they were usually placed nonprone but also because a large majority (82.5% [33/40]; data were missing for 3 infants) had a history of usually being found nonprone. Twenty-seven (63%) of the 43 were found face down into the mattress.

There were 250 SIDS infants who were placed prone for the last sleep. Of these, 232 (93.5%) were found prone (data were missing for 2 infants). Of those found prone, 103 were found face down into the mattress. This proportion is less than that in the unaccustomed to prone sleeping group (50.7% vs 71% [20/28]; \( \chi^2 = 4.23; P = .05 \)).

In contrast to these groups, there were 125 SIDS infants who were usually placed nonprone and were placed nonprone for the last sleep. In this group of infants, 43 (34.4%) were found prone (secondary prone). It is noteworthy that most of these 43 infants were not accustomed to the prone position not only because they were usually placed nonprone but also because a large majority (82.5% [33/40]; data were missing for 3 infants) had a history of usually being found nonprone. Twenty-seven (63%) of the 43 were found face down into the mattress.

Table 4 shows the mean ages by position placed and position found. The most noticeable feature is that infants placed prone for the last sleep but found nonprone were older than the other groups, although the only comparison that reached statistical significance was with infants who were placed nonprone for the last sleep and found nonprone (\( P = .03 \)).
Proprone sleeping position became recognized as a risk factor for SIDS during the study. To explore if recall bias was a possible explanation for the findings, the proportion of infants found prone who had been placed to sleep in the nonprone position was examined for each of the 3 years. The proportion did not change significantly. Similarly, the interaction between usual sleeping position and last sleeping position for the risk of SIDS was similar for each of the 3 years.

Finally, we looked at the subgroup of infants who were usually placed to sleep supine. A small number usually changed their position and were found in the lateral or prone position. These infants were not at increased risk of SIDS (Table 5).

We have shown that infants unaccustomed to the prone sleep position are at much greater risk for SIDS when placed prone than if had they been used to prone sleeping. Although usual sleeping position was based on position in the 2 days prior to the last sleep, this usual position very likely reflects an established pattern of much longer duration in most cases, as suggested by prior studies of parental care practices in New Zealand and also by the fact that for 97% of control infants and 89% of the cases the usual and last sleep positions were the same. The recently published Nordic Epidemiological SIDS case-control study also found an increased risk in infants placed prone for the last sleep who were unaccustomed to that position; however, it is unclear if this increased risk was statistically significant compared with infants used to prone sleeping who were also last placed prone. Our data offer only limited explanations for why caregivers might have chosen to place these unaccustomed to prone sleeping infants prone on the night of death. In all but 2 cases, the infant’s usual caregiver seems to have made the decision. Unaccustomed to prone SIDS infants did not have more symptoms (e.g., fever, vomiting, severity of illness) than all other SIDS cases. We found a trend for unaccustomed to prone SIDS infants to be more often irritable than the other SIDS cases in the 2 days prior to death (P = .06). However, it seems unlikely that irritability prior to death could be a symptom of an underlying disorder that was the cause of death of these infants. Previously published data from the New Zealand Cot Death Study indicate that there was no difference in irritability in cases as compared with controls in the 2 days prior to death. Furthermore, 2 prior studies have indicated that SIDS infants are “more droopy” or “sleepier” than control infants shortly prior to death, indicating that irritability per se cannot be considered a major risk factor for SIDS.

Recall bias is unlikely to explain these results, as in the first half of the study, prone sleeping position was not widely recognized as a risk factor for SIDS. We also found similar results in each year of the study for both unaccustomed to prone sleeping and secondary prone sleeping.

Previously, we reported an increased SIDS risk for infants unused to cosleeping (infant sharing a bed with another person) who coslept for the last sleep. The present finding of increased risk in unaccustomed to prone sleep infants does not interact with cosleeping. Together, the present and the prior report suggest that lack of experience with a potentially dangerous sleep environment can result in increased risk when these environments are first encountered. In this context, it is worth noting that 90% (n = 28) of the 31 unaccustomed to prone SIDS infants were found prone at death and that 71% of these infants had their nose and mouth turned down into the bedding. Furthermore, the incidence of this face-down death position in the unaccustomed to prone infants was significantly increased compared with that of the usually and last placed prone SIDS cases.

A similar finding of an increased incidence of the face-down position in SIDS infants who lacked experience in prone sleeping has recently been reported by others. Other studies have suggested that the death of infants in this circumstance is likely to have been caused by asphyxia as a result of rebreathing of expired air and/or airway obstruction. If so, one can ask why these infants failed to lift and turn their heads to the side—the normal response of an infant whose breathing is compromised when sleeping prone in the face-down position. Two possibilities can be suggested. First, infants who normally sleep supine have later attainment of gross motor skills, including ability to lift their heads, compared with prone-sleeping infants, a situation that also seems to be true for side-sleeping infants. Additionally, although head lifting is a component of the innate startle reflex, to gain access to fresh air an infant whose face is turned down into the bedding must combine head lifting with head turning. Some normal infants fail to successfully perform this maneuver when placed face down or do so only after repeated unsuccessful attempts. Such difficulties with airway defense may be the result of the normal developmental disappearance of the startle reflex and other subcortically mediated protective reflexes during the first 6 months of life. Infants who sleep prone, unlike back or side sleepers, normally lift and turn their heads from one side to the other frequently. Lack of practice in employing such head lifting and turning movements could reduce the airway defensive capability in the infant who is inexperienced at prone sleeping who encounters respiratory difficulty when he or she first manages to get into a prone, face-down position.

Taking into account these several considerations, we view our findings as both supportive of and compatible with a neurodevelopmental theory for SIDS as formu-

Table 5. Position Usually Found for Infants Usually Placed to Sleep Supine*

<table>
<thead>
<tr>
<th>Position Usually Found</th>
<th>Cases, No. (%)</th>
<th>Controls, No. (%)</th>
<th>Univariate OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supine</td>
<td>16 (84.2)</td>
<td>156 (76)</td>
<td>1.0</td>
</tr>
<tr>
<td>Lateral or prone</td>
<td>3 (16)</td>
<td>48 (24)</td>
<td>0.6 (0.1-2.3)</td>
</tr>
</tbody>
</table>

*OR indicates odds ratio; CI, confidence interval.
In this regard, our findings are in agreement with the conclusions of other investigators. The high incidence of the face-down death posture in the secondary prone group is comparable with that of the unaccustomed prone infants and suggests a similar causal mechanism of death (ie, failure of the head lifting and turning airway protective response).

Finally, our data suggest that infants who have established a pattern of spontaneously changing sleep position, including those who turn to prone, are at lower risk than prone-sleeping infants who stay prone. This finding is similar to that of a recent study from Scotland reporting that infants who have a history of spontaneously changing sleep position are at reduced SIDS risk. In part, these findings may reflect older age and/or greater motor development in this group, as indicated by their ability to change sleep position.

These findings have important implications for the care of infants younger than 1 year, after which the risk of SIDS is very low. First, although no causal effect has been shown for the increased risk observed when infants used to nonprone sleep are placed prone, it would seem prudent to use extreme caution when placing such infants prone. This warning is particularly relevant in countries such as the United States where parents of non-prone-sleeping infants have been encouraged to expose infants to supervised prone positioning when awake (“tummy time”). Infants should not be left in the prone position if they fall asleep while playing in the prone position. It is possible that experience of the prone position when awake might ameliorate the risk of SIDS from unaccustomed or secondary prone sleeping. It is also relevant in countries such as the United States where many babysitters and day-care caregivers are unaware of safety issues regarding SIDS and sleep position. Second, our findings highlight the risk to infants when they roll spontaneously to prone during sleep for what may be the first time. Third, these findings offer some reassurance for parents of supine-sleeping infants who habitually spontaneously roll to other positions during sleep, because these infants do not seem to be at increased risk.

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