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Why or how does the prone sleep position increase the risk of unexpected and unexplained infant death?

Peter Fleming, Peter Blair and Anna Pease.

For more than 25 years we have known that infants placed prone for sleep are at increased risk of dying unexpectedly, and avoiding the prone sleep position for infants leads to a much lower incidence of such deaths\textsuperscript{1,2}. What is less clear, despite many published investigations into the physiology and possible pathophysiology of sleep position in infants, is why this is the case.

Multiple hypotheses of varying credibility have been proposed to account for the association between infants sleeping prone and increased risk of unexpected deaths\textsuperscript{3,4}, but no single clear pathophysiological mechanism has yet been identified to fully explain the link between observed physiology and the pathway leading to death. Physiological studies to date suggest the possibility of multiple, probably interacting mechanisms making infants more vulnerable in the prone sleep position.

Several physiological features of the prone sleeping position in infants have been identified:

- The arousal threshold is higher and the ratio of sub-cortical to cortical arousals is lower when prone than when supine\textsuperscript{5}
- Heat loss is reduced when prone compared to when supine\textsuperscript{6}
- In growing preterm infants, the ventilatory response to inhaled carbon dioxide is lower when prone than when supine\textsuperscript{7}
- Baroreflex sensitivity as assessed by the response to an imposed 15° head-up tilt is lower when prone than supine\textsuperscript{8}
- Blood pressure is lower and heart rate higher when prone than when supine \textsuperscript{9}
- Brain tissue oxygenation index (a measure of mean oxygen tension in brain tissue) is lower when prone than when supine between the ages of 2 weeks and 6 months\textsuperscript{10}
- Whilst the prone sleeping position has been reported to be associated with higher parasympathetic and the supine with higher sympathetic activity\textsuperscript{11}, non-parametric frequency domain analysis (which can usually identify characteristic differences between sympathetic and parasympathetic activity) showed no differences between prone and supine position in newborn infants though such differences were present by one month of age\textsuperscript{12}.

To these may now be added the observations of Wu et al (\textit{add reference}) showing that, in the first few days after birth, in healthy term infants when prone compared to supine, cardiac output fell, mainly because of reduced stroke volume, but there was no significant change in cerebral oxygenation at this age. This implies that cerebral blood flow has been maintained despite a fall in cardiac output in the prone position, a finding consistent with the previous observation by the same authors of a fall in skin blood flow when prone\textsuperscript{13}. The infant’s head position may also be important in this context, as turning the head 90° to one side (as is commonly observed in the prone position) leads to reduced jugular venous return and thus may contribute to reduced cardiac stroke volume\textsuperscript{14}.
It is not clear whether the apparent differences in cardiovascular responses at different ages reported by different authors are real or may be explained by differences in duration of studies and/or differences in sleep state at different ages.

It is however clear that, in the prone position compared to the supine there are numerous differences in the control of cardiovascular, respiratory and thermoregulatory systems in normal infants, and a variety of potential external stressors may thus produce different physiological responses depending on the infant’s position.

For example, the higher nasal airway temperature in the prone position may promote growth of vasoactive toxin-producing staphylococci, leading to a profound fall in blood pressure and thus cerebral perfusion. Several studies have shown that such bacteria are present in a higher proportion of infants who die unexpectedly than in control infants. Physiological recordings obtained from infants at the time of unobserved and unexplained sudden deaths are compatible with the effects of the primary event being profound hypoxia possibly due to a fall in blood pressure.

As our understanding of normal infant developmental physiology improves it may become possible to identify specific pathophysiological pathways and thus directly intervene to minimise the potential for harm, but for the present it is important to emphasise the importance of avoiding the prone sleeping position and encouraging the supine position for all infants for every sleep.

In recent years, we have become aware of devices marketed to “improve” infant sleep, or reduce the perceived risk of head asymmetry. Some of these devices involve placing the baby prone when awake and unsettled in order to facilitate settling the infant to sleep. The risk posed to infants from the use of such devices if they fall asleep in this position is likely to be significant, a message that health professionals should convey to parents.

We have become aware from recent discussions with numerous families, including some recently bereaved families whose infants have died suddenly and unexpectedly that there is a widespread belief that, if they use a “breathing” monitor (more accurately a baby movement sensor) their baby will be protected from the risk of unexpected death, and thus placing their baby to sleep in the prone position is acceptable.

Despite multiple studies investigating the potential benefits from baby breathing monitors there is no evidence that the use of apnoea monitors (or other types of monitor) has any effect in reducing the risk of unexpected infant death.

Certainly, the use of a monitor does not reduce the risk of placing infants in side or front sleeping positions. The provision or sale of such monitors for “parental reassurance” is thus potentially misleading.

The observations reported of babies who have died unexpectedly whilst on physiological monitors have shown that in most such events cessation of breathing was not the primary event but occurred at the end of period of cardiovascular compromise. Thus a breathing monitor would almost certainly be of no value in such an episode.

Understanding why ‘back is best’ provides parents with the knowledge and the confidence they need to make decisions about their baby’s sleeping position. As healthcare professionals, it is thus important that we seek to ensure that parents receive accurate, up to date information on the
background to safe infant care practices, and to continue to emphasise the importance of the supine sleep position for every sleep for every baby.

References.


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