Sleeping position and rectal temperature

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Abstract

The effects of sleeping position upon body temperature were assessed by continuous monitoring of rectal temperature in 137 babies sleeping at home under conditions chosen by their parents. There were three groups of subjects: (1) normal babies aged 12-22 weeks whose temperature rhythms were developed, (2) normal babies aged 6-12 weeks who were developing their night time temperature rhythms, and (3) babies the night after diphtheria, pertussis, and tetanus immunisation, whose temperature rhythms were disturbed. Sleeping in the prone position was not associated with higher rectal temperatures at any time of night in young babies, nor did it exaggerate the disturbance of rectal temperature rhythm after immunisation. In older normal babies the prone position did not disturb rectal temperature in the first part of the night, though prone sleepers warmed a little faster prior to waking, especially in warm conditions. Prone sleepers were, however, born earlier in gestation and tended to be of lower birth weight. Normal babies can therefore thermoregulate effectively whatever their sleeping posture, even in warm conditions, though the prone position may make it slightly more difficult to lose heat. It is difficult to see how the prone position, even interacting with warm conditions, could induce lethal hyperthermia in otherwise normal babies. Perhaps the prone position is associated with other risk factors for sudden infant death syndrome.

A number of reports have suggested that sleeping in the prone position may be associated with an increased risk of cot death.¹⁻³ It has been suggested that the prone position increases the risk of overheating in the cot, particularly if babies are covered with a large amount of thermal insulation and sleeping in warm rooms.³

By 3 months of age babies have developed a consistent night time rhythm of deep body temperature, which seems to be maintained irrespective of environmental conditions.⁴ There have been no reports of the effects of sleeping position on this rhythm. It may be that babies sleeping prone show alterations of their temperature patterns, particularly in warm conditions, supporting the suggestion that it is difficult for them to lose heat.

Even if normal babies do not show altered temperature rhythms when prone, it might be that other factors tending to raise body temperature, such as a developing minor infection, might be more potent when sleeping in that

position. We have yet to find a way of monitoring sufficient numbers of babies in the very early stages of minor infection to test this hypothesis directly but we do have a model which may resemble the changes, namely the disturbance of temperature rhythm which follows diphtheria, pertussis, and tetanus (DPT) immunisation.⁵ The night after this immunisation rectal temperature does not fall in the usual way and remains about that expected during the day in most babies, though the extent of the elevation over the normal night time value varies considerably from individual to individual. We have seen a similar pattern in a few babies, who developed an observable minor infection a day or two after temperature recording, even though they were not apparently ill at the time of recording.

In this study, therefore, we compared the night time rectal temperature patterns of normal babies of different ages sleeping in different positions in their cots at home. As parents choose a wide variety of clothing, wrapping, and room temperatures we were able to examine the effects of warm and cool conditions. We have also examined the effects of sleeping position upon the changes in rectal temperature after immunisation.

Methods

In the course of our studies on the development of temperature rhythms,⁶ and the effects of immunisation,⁵ we have routinely recorded the sleeping position of babies. This was determined by direct observation by a trained health visitor. We have collated data from these studies in this paper, incorporating recordings from a total of 137 babies.

In all cases subjects were recruited by liaison with local general practitioners and health visitors. Basic perinatal data were collected before making arrangements to monitor body temperature at home over one or more nights at various ages.

On each recording night the baby was visited at home in the early evening, weighed naked, and temperature probes were attached. One soft probe, inserted 5 cm from the anal margin, measured rectal temperature, and other probes measured skin surface temperature on the head and either the abdomen or shin. Only rectal temperature data will be discussed here. A fourth probe measured the ambient temperature at the cot side. All probes were connected to a Grant Squirrel data logger set to sample at one minute intervals throughout the night. These techniques have been demonstrated to be

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both effective and safe,⁴ and full ethical committee approval was obtained for all the studies from which data have been abstracted for this paper.

At bedtime, sleeping position was noted by the health visitor. 'Prone' was defined as having the ventral surface of the trunk in symmetrical contact with the mattress cover, irrespective of the head position. 'Lateral' was having either the left or right side of the trunk in contact with the mattress covering and the humerus of both arms flexed at the shoulder joint. 'Supine' was having the dorsal surface of the trunk in symmetrical contact with the mattress cover. In a number of cases sleeping position was monitored for the first six hours of the night by infrared thermographic imaging. Some babies moved from the lateral to supine position and we have merged data from these two positions and compared it with that for prone babies; these babies have not been observed to move to the lateral or supine position (at least, not babies of the age range considered here).

Parents were asked to keep a diary of events such as feeds, nappy changes, periods of waking, etc, throughout the period of recording. Note was also made of the items of clothing and wrapping used by parents, so that a thermal insulation or 'tog value' could be calculated from data provided by the Shirley Institute, Manchester.

After each recording data were downloaded from the loggers to a computer and scrutinised for technical problems such as loss of probes. Only unblemished data were analysed further. Mean rectal temperatures, together with their standard errors, were calculated at half hour intervals, from one hour before bedtime until eight hours after bedtime, for various groups of babies sleeping either prone or supine/lateral. Statistical comparisons were made by Student's *t* test.

Results

SUBJECTS

Data were collated from body temperature recordings of three groups of babies sleeping at home: (1) 79 normal babies aged 12–22 weeks, (2) 26 normal babies aged 6–12 weeks, and (3) 33 normal babies sleeping at home the night after first DPT immunisation. The unimmunised babies were separated into two age groups because temperature rhythms are not completely developed until 12 weeks of age.⁴ Of the 136 babies studied, 126 were born at 36 weeks of gestation or later. The social class distribu-

tion of the families resembled that of the Leicester population as a whole.

(1) Normal babies aged 12–22 weeks

Within this group 50 (63%) of the babies were in the prone position at bedtime and 29 (37%) either lateral or supine. The prone babies had a mean (SEM) age of 16.00 (0.36) weeks, were covered with 12.34 (0.53) tog units of insulation (range 3.4–22.5), and slept in rooms where the minimum temperature was 16.62 (0.42)°C and the maximum temperature 20.23 (0.45)°C. Babies sleeping in the lateral or supine position were 16.00 (0.51) weeks of age, were covered with 13.23 (0.90) tog units of thermal insulation (range 6.2–20.65), and slept in rooms where the minimum temperature was 16.89 (0.44)°C and the maximum temperature 21.34 (0.42)°C (table).

There were no significant differences in age, tog value, or room temperature between babies sleeping prone and those sleeping supine or lateral. Babies sleeping prone were, however, born significantly earlier in gestation (mean gestation for prone sleepers was 38.47 (0.45) weeks, for lateral/supine sleepers 39.51 (0.31), *p* < 0.05 unpaired *t* test).

Figure 1 shows the night time rectal temperatures of babies sleeping in different positions. There were no significant differences at any time between babies sleeping prone and those sleeping supine or lateral. The body temperature of babies sleeping prone was not signifi-

Figure 1 The rectal temperature of babies aged 12–22 weeks sleeping in the prone or supine/lateral position at night. Points show mean (SEM) of observations from 50 babies sleeping prone and 29 sleeping supine/lateral. Times are normalised to bedtime.

Details of the babies in the three groups. Results are mean (SEM)

	(1) Normal babies aged 12–22 weeks		(2) Normal babies aged 6–12 weeks		(3) Normal babies after first DPT immunisation	
	Prone (n=50)	Not prone (n=29)	Prone (n=11)	Not prone (n=15)	Prone (n=13)	Not prone (n=19)
Age (weeks)	16.00 (0.36)	16.00 (0.51)	9.54 (0.62)	9.66 (0.31)	14.3 (0.40)	14.26 (0.20)
Tog value	12.34 (0.53)	13.23 (0.90)	8.65 (0.38)*	13.52 (0.32)	10.58 (0.92)	11.03 (0.95)
Range	3.40–22.50	6.20–20.65	5.70–13.90	6.20–18.60	4.90–14.70	5.10–15.70
Minimum room temperature (°C)	16.62 (0.42)	16.89 (0.44)	18.59 (0.33)*	16.88 (0.58)	18.24 (0.64)	18.25 (0.75)
Maximum room temperature (°C)	20.23 (0.45)	21.34 (0.42)	22.56 (0.57)	21.83 (0.42)	21.68 (0.95)	21.5 (0.85)
Gestational age (weeks)	38.47 (0.45)	39.51 (0.31)*	37.25 (0.80)	39.42 (0.53)*	39.30 (0.62)	39.50 (0.38)

*Significant differences (*p* < 0.05) between prone and not prone.

cantly different at bedtime, nor did it fall significantly less, or rise significantly more later in the night. There was, however, a trend for prone babies to warm a little faster towards the end of the night. This is more obvious if data are collated only for the more heavily wrapped babies in warmer rooms. The rectal temperature of babies sleeping prone, and covered with more than 15 tog units in rooms above 18°C, is significantly ($p < 0.05$) higher than that of babies sleeping supine/lateral from six hours after bedtime (fig 2).

The difference in rectal temperature late in the night was not associated with earlier waking in infants sleeping prone. There was no significant difference in the interval from bedtime to first disturbing the parents between prone and lateral/supine sleepers.

(2) Normal babies aged 6–12 weeks

In this group 11 (42%) were in the prone position at bedtime and 15 (58%) either lateral or supine, with lateral predominating. The prone babies had a mean (SEM) age of 9.54 (0.62) weeks, were covered with 8.65 (0.88) tog units of insulation, and slept in rooms where the minimum temperature was 18.59 (0.33)°C and the maximum temperature 22.56 (0.57)°C. Babies sleeping lateral or supine were 9.66 (0.31) weeks old, were covered with 13.52 (0.32) tog units of insulation, and slept in rooms where the minimum temperature was 16.88 (0.58)°C and the maximum temperature 21.83 (0.42)°C (table).

The prone sleepers were covered with significantly less insulation ($p < 0.01$, t test with 24 df) but were in significantly warmer rooms ($p < 0.01$, t test with 24 df on minimum temperatures). As with the older group the prone babies were born significantly earlier in gestation (gestation 37.25 (0.80) weeks for prone babies; 39.42 (0.53) for supine/lateral, $p < 0.01$ t test with 24 df).

Figure 3 shows the rectal temperatures over

Figure 2 The rectal temperature of babies aged 12–22 weeks sleeping in the prone position covered with more than 15 tog units in rooms where the average temperature exceeded 18°C, compared with that of babies sleeping supine. Points show mean (SEM) of observations from 11 babies sleeping prone and 29 sleeping supine or lateral. Times are normalised to bedtime.

Figure 3 The rectal temperatures of babies aged 6–12 weeks sleeping in the prone or supine/lateral position at night. Points show mean (SEM) of observations from 11 babies sleeping prone and 15 sleeping either supine or lateral. Times are normalised to bedtime.

the night for young babies sleeping in the prone or supine/lateral positions. There were no significant differences between the groups at any time. The body temperature of babies sleeping prone was not significantly different at bedtime, nor did it fall significantly less, or rise significantly more later in the night.

(3) Normal babies the night after first DPT immunisation

Of the 32 babies in this group 13 (41%) were prone and 19 (59%) supine/lateral at bedtime. The prone babies had a mean (SEM) age of 14.3 (0.4) weeks and those supine or lateral averaged 14.26 (0.2) weeks old. Prone babies were covered with 10.58 (0.92) tog units of insulation in rooms where the minimum temperature was 18.24 (0.64)°C and the maximum temperature 21.68 (0.95)°C. Babies sleeping in the supine/lateral position were covered with 11.03 (0.95) tog units of insulation in rooms where the minimum temperature was 18.25 (0.75)°C and the maximum temperature 21.5 (0.85)°C (table).

Figure 4 The rectal temperature of babies sleeping in the prone or supine/lateral position the night after their first DPT immunisation. Points show mean (SEM) from 13 babies sleeping prone and 19 sleeping supine or lateral. Times are normalised to bedtime.

There were no significant differences in age, thermal insulation, maximum or minimum temperatures between babies sleeping in different positions. The prone babies tended to be born earlier in gestation, though this trend was not significant.

Figure 4 shows the rectal temperature of babies sleeping prone or supine/lateral the night after the first DPT immunisation. There were no significant differences at any time of the night. The body temperature of babies sleeping prone was not significantly different at bedtime, nor did it fall significantly less, or rise significantly more later in the night.

Discussion

Combining the groups studied here we find that 54% of babies were prone at bedtime. This is a figure that compares with that in an earlier report,³ though in that part of our sample recorded after mid 1989 there is a smaller proportion of prone sleepers, suggesting that parental behaviour may be changing. Although prone babies did not sleep in different thermal conditions, they were born significantly earlier in gestation.

By 12 weeks of age babies have developed a predictable rhythm of night time temperature change.⁶ Rectal temperature falls after bedtime, stabilises around 36.4°C for a few hours, then rises gradually before waking. During the falling phase, and while the temperature is stable, there are no observable effects of thermal environment on rectal temperature.⁴ It is clear that the babies are thermoregulating effectively, though most are sleeping in environments where we would expect it to be difficult to lose heat.⁷

There is no effect of sleeping position upon the the first two phases of night time rectal temperature change. Early in the night the prone position is not associated with raised rectal temperature, though of course it may be that maintenance of a stable temperature requires greater changes in vasomotor activity or sweating in that position. Later in the night, however, prone babies do warm a little faster, a trend that is exaggerated in the babies who are well wrapped in warm rooms. These observations support

the speculation that prone babies may lose heat less rapidly,³ though it is clear from the early part of the night that, so long as thermoregulation is active, it can easily compensate for this.

Young babies, 6–12 weeks of age, have less well developed temperature rhythms.⁶ In this group we see no significant effect of sleeping posture on rectal temperature at any time of night.

The night after first DPT immunisation babies show a mild, transient disturbance of their normal temperature rhythm. Rectal temperature does not fall but may even rise above the normal value for an active, awake baby, though the infant is asleep.⁵ Presumably these changes are due to some mild pyrogen in the vaccine. Our final observations show that even under these conditions, where body temperature is being driven up in a way analogous to the effects of infection, the prone sleeping position is not associated with greater temperature rises.

Although we can offer some limited evidence to support the suggestion that prone babies may lose heat slightly less easily in their cots, it is clear that the normal processes of thermoregulation can cope with this challenge even when babies are very well wrapped, in warm rooms, and under the influence of a mild pyrogen.

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- 1 Lee NNY, Chan YT, Davies DP, Lau E, Yip DCP. Sudden infant death syndrome in Hong Kong: confirmation of low incidence. *BMJ* 1989;298:721.
- 2 Nelson EAS, Taylor BJ, Weatherall IL. Sleeping position and infant bedding may pre-dispose to hyperthermia and the sudden infant death syndrome. *Lancet* 1989;i:199–201.
- 3 Fleming PJ, Gilbert R, Azaz Y, *et al.* Interaction between bedding and sleeping position in the sudden infant death syndrome: a population based control study. *BMJ* 1990;301:85–9.
- 4 Wailoo MP, Petersen SA, Whittaker H, Goodenough P. Sleeping body temperatures in 3–4 month old infants. *Arch Dis Child* 1989;64:596–9.
- 5 Rawson D, Petersen SA, Wailoo MP. Rectal temperature of normal babies the night after first diphtheria, pertussis, and tetanus immunisation. *Arch Dis Child* 1990;65:1305–7.
- 6 Lodmore M, Petersen SA, Wailoo MP. The development of night time temperature rhythms over the first six months of life. *Arch Dis Child* 1991;66:521–4.
- 7 Wailoo MP, Petersen SA, Whittaker H, Goodenough P. The thermal environment in which 3–4 month old infants sleep at home. *Arch Dis Child* 1989;64:600–4.