

## SHORT REPORT

# Admission temperatures following radiant warmer or incubator transport for preterm infants <28 weeks: a randomised study

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Sixty two infants <28 weeks were occlusively wrapped and randomised to radiant warmer or incubator transport to the neonatal unit. Median axillary temperature on arrival was 36.8°C in both groups. Target temperatures (36.5–37.5°C) were achieved in 60% of the incubator group compared to 75% in the warmer group (not statistically significant). While powered to detect a 35% difference between warming devices, a more modest difference is not excluded.

Low admission temperature in preterm infants is an important predictor of mortality and morbidity. Strategies to avoid hypothermia immediately after birth include methods of reducing heat loss (for example, plastic wrap), and using an external heat source.<sup>1</sup>

In this study we wished to minimize heat loss after birth using plastic wrap and compare two heat sources (radiant warmer and incubator) with regard to core temperature on admission. According to the null hypothesis, use of a radiant warmer and occlusive wrap would be no more likely to achieve desired admission temperatures than an incubator and occlusive wrap.

## METHODS

Infants 23–27 weeks gestation admitted to the neonatal unit were eligible provided there was no suspected congenital infection, major congenital abnormality or open skin defect. Following delivery the infant was placed on a radiant warmer and wrapped with occlusive polyethylene (NeoWrap, Fisher & Paykel Healthcare, Auckland, New Zealand). The infant (undried) was placed on the radiant warmer (heater output 100%) in the middle of the sheet and the sides closed over the limbs and trunk. The head was not wrapped or covered. Resuscitation was consistent with current American Heart Association guidelines. Ambient temperatures in delivery suite, theatre and the neonatal unit were maintained at 25°C.

Once stable, infants were moved from delivery or theatre to the neonatal unit, a 5–7 min trip. Infants were transported (wrapped) on either a radiant warmer (Fisher & Paykel CosyCot) with power source or in an incubator (Caleo, Drager, Biolab, Auckland, New Zealand) with power supply; all received mask CPAP. Heater output of the warmer was 100% throughout and incubator air temperature was set at 39°C and was 39°C at the start of the transfer. Portholes were open to provide CPAP. Skin servocontrol was not used before arrival to the nursery.

In the nursery infants were weighed (wrapped) and placed on a warmer. Axillary temperatures were measured immediately with digital electronic thermometers (Becton Dickinson, Auckland, New Zealand) and skin servocontrol commenced.

Primary outcome was the proportion with axillary temperature in the target range of 36.5–37.5°C.<sup>2,3</sup> Secondary outcomes

were interference with resuscitation, skin infection or 5 day course of antibiotics in the first week, respiratory support requirements, length of stay, chronic lung disease, necrotising enterocolitis, severe intraventricular haemorrhage, retinopathy of prematurity and death.

Sample size was determined from a separate pilot study; 43% of 21 infants <1000 g transported either by warmer or incubator were admitted with temperatures outside the desired range of 36.5–37.5°C. To detect a 35% difference (suggested by the pilot study and one deemed clinically significant), 29 infants were required for each group ( $\alpha$  0.05,  $\beta$  0.8).

Randomisation was stratified into 23–25 weeks and a group 26–27 weeks (block size 10; random numbers computer generated). Allocation to transport device was with sequentially numbered opaque sealed envelopes. For multiple births, each baby was allocated a separate envelope.

Statistics were Chi square or Fisher's exact test for proportions, Mann Whitney U test for nonparametric measures and linear regression for factors associated with admission temperature.

## RESULTS

There were 67 infants eligible; recruitment was from September 2002– October 2005. Four infants were not randomised and consent not obtained in one case; therefore 62 were analysed. Thirty underwent incubator transport (16 were 23–25 weeks and 14 were 26–27 weeks) and 32 warmer transport (17 of whom were 23–25 weeks and 15 were 26–27 weeks). One infant was randomised to the incubator group but transported by warmer. Data was analysed on an intention to treat basis. However, repeat analysis according to group of allocation did not significantly affect results. Another infant was randomised to the 23–25 week group but later assessed as 27–28 weeks; analysis was by intention to treat. Table 1 shows the baseline patient characteristics; there were no significant differences. More infants transported in incubators required intubation at delivery, but this was not statistically significant. Median CRIB-II scores were the same in both groups.

Temperature outcomes are shown in table 2. Overall, 40/62 (68%) infants had initial temperatures within the target range (36.5–37.5°C). 75% of the infants in the radiant warmer group compared to 60% in the incubator group were in the desired range—this was not statistically significant. To detect a 15% difference (observed) a study of over 200 would be required. The number needed to treat to avoid one infant with admission temperature outside the desired range was seven.

The lowest recorded admission temperature was 35.4°C (incubator transport). Eight infants had admission temperatures between 35.5–35.9°C and eight were between 36–36.4°C. Of 14 infants with gestation 23–24 weeks, three had admission temperatures below 36°C. Median axillary temperature on admission was 36.8°C in both groups. The interquartile range

**Table 1** Infant characteristics on study entry (group medians are shown with percentages or interquartile ranges in brackets)

	Incubator	Radiant warmer	P Value
Number	30	32	
Birth weight (g)	870 (751–1031)	902 (746–991)	0.98
Gestation (weeks)	26 (24.9–27)	26 (25–27)	0.78
SGA (<10th centile)	1 (3.3)	5 (15.6)	0.2
Male (%)	17 (57)	19 (59)	1.0
1 min Apgar <4 (%)	10 (33)	10 (31)	1.0
5 min Apgar <6 (%)	8 (27)	6 (19)	0.55
Complete antenatal steroids (%)	16 (53)	22 (69)	0.3
Cesarean delivery (%)	14 (53)	15 (53)	1.0
Intubation at birth (%)	16 (53)	10 (31)	0.12
CRIB II score	12 (10–14)	12 (10–14)	0.84

was wider and the coefficient of variation of admission temperature higher in the incubator group. Admission temperature was associated with birth weight on conditional linear regression—no other variables (including, antenatal steroid use, delivery method, maternal temperature, gestation, gender, SGA, Apgar scores, intubation at delivery, transport device or time to arrival) displayed a significant association. None of the variables listed above (including birth weight) had a significant association with temperature outside the 36.5–37.5°C range.

Admission temperature was above the set limit (37.5°C) in three (5%) of the infants. There was evidence of infection in the mothers of all three infants affected. Two of the mothers were febrile and the third had bacterial vaginosis. Overall five mothers had temperatures above 37.5°C during delivery and two of the infants were febrile (see above).

There were no significant relationships between any of the secondary outcomes and warming device or admission temperature.

Minimal interference with resuscitation was reported in one infant where there was difficulty in counting the heart rate until the wrap was partially removed. No cases of skin maceration were noted. There was one case of localised abdominal cellulitis in the first week of life, possibly associated with skin lead usage.

**What is already known on this topic**

- Importance of admission temperature.
- Plastic wrap results in higher admission temperature.
- Radiant warmer use produces more rapid re-warming.

**What this study adds**

- Radiant warmer or incubator achieved target admission temperature in most <1000 g infants.
- No significant difference between warming devices in occlusively wrapped infants.
- Under 5% had elevated admission temperature (>37.5°C).

**DISCUSSION**

The study did not find significant differences in admission temperature for infants <28 weeks gestation who were occlusively wrapped and transported via either radiant warmer or incubator. However, 15% more of the infants transported on the warmer reached the target temperature. A total of nine of the 62 infants (14.5%) had admission temperature below 36°C – the difference between the incubator and radiant warmer groups being about 10% (not statistically significant). This is similar to that reported in other studies that have used wrap.<sup>4 5</sup> In our study we did not cover the head, but as this represents a significant proportion of body surface area, it should be the subject of further study. There were no differences observed in the clinical outcomes between the two groups, although the study was not sufficiently powered to exclude such differences. Overall, in the setting of the present study, if the warmer has any clinical benefit, it is probably small.

Temperature above 37.5°C was less common (approximately 5%). From our study, care needs to be taken with transport of infants whose mothers are febrile or have signs of infection. The association between brain injury and elevated body temperature in asphyxiated term infants<sup>6</sup> suggests raised temperatures should be avoided.

While challenging, maintaining the temperature of tiny preterm infants prior to admission is extremely important. To assist in achieving this, some refinements of our technique (eg covering the head and use of skin servocontrol) are possible. However, this study, powered to detect a 35% difference, has shown no clear clinical benefit of either incubator or warmer transport from delivery to neonatal unit. A more modest difference between devices cannot be excluded and the general accessibility of infants nursed on radiant warmers and lower price may offer some advantage.

**Table 2** Temperature outcomes for preterm infants (23–27 weeks) transported via incubator or radiant warmer (median values with interquartile ranges are shown where appropriate)

	Incubator	Radiant Warmer	p value
Number	30	32	
Below 36.5°C (%)	10 (33)	7 (22)	0.4
Above 37.5°C (%)	2 (6.7)	1 (3.1)	0.60
Outside range (36.5–37.5) °C (%)	12 (40)	8 (25)	0.28
Below 36.0°C (%)	6 (20)	3 (9.4)	0.29
Outside range (36.0–37.5) °C (%)	8 (26.7)	4 (12.5)	0.20
Admission temperature (IQ range) °C	36.8 (36.2–37.3)	36.8 (36.5–37.1)	0.81
Time to admission (min)	17 (14–18.3)	14.5 (11–19.8)	0.21
Coefficient of variation	0.46	0.28	0.51
Maternal temperature (°C)	36.7 (36.2–37.2)	36.9 (36.4–37.2)	

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