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Effect of post-delivery care on neonatal body temperature

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A prospective observational study of post-delivery care and neonatal body temperature, carried out at Kathmandu Maternity Hospital, was followed by a randomized controlled intervention study using three simple methods for maintaining body temperature. There were 500 infants in the initial observation study and 300 in the intervention study. In the observation study, 85% (420/495) of infants had temperatures <36°C at 2 h and nearly 50% (198/405) had temperatures <36°C at 24 h (14% were <35°C). Most of the infants who were cold at 24 h had initially become cold at the time of delivery (only seven infants had been both well dried and wrapped). In the intervention study, all infants were dried and wrapped before random assignment to one of the three methods: the "kangaroo" method, the traditional "oil massage" or a "plastic swaddler". All three were found to be equally effective. Overall, 38% (114/298) of the infants had temperatures <36°C at 2 h and 18% (41/231) at 24 h (when none was <35°C). □ *Developing world, hypothermia, neonate, post-delivery care*

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The adverse effects of hypothermia, particularly in preterm infants have been well documented (1–3). Infants nursed in a cool environment and hypothermic infants have a significantly increased risk of death. Neonatal hypothermia is also associated with an increase in morbidity from infection (4), abnormal coagulation (5, 6), post-delivery acidosis (7), delayed readjustment from the foetal to newborn circulation (8) and hyaline membrane disease (9).

Neonatal hypothermia may contribute to the very high perinatal mortality seen in the developing world. Tafari (10), in Addis Ababa, found that 53% (1291/2415) of neonatal unit admissions had temperatures <36 °C. There was linear increase in mortality with decreasing temperature at admission. Fifty-nine percent of those with temperatures <36 °C died compared to 15% with temperatures ≥36 °C. Few studies have been performed to determine the incidence of hypothermia in the developing world or to determine the factors that are important in its development. The purpose of the present study was to ascertain the incidence of post-delivery hypothermia in a hospital setting in Nepal, to establish the most important risk factors and to determine which of three simple methods of thermal balance would be most effective and acceptable.

Patients and methods

Initial observations

Before carrying out the temperature measurement studies, the current post-delivery practices were observed on the labour ward of the Maternity Hospital in Kathmandu. Infants were not well dried, were washed frequently and were often left uncovered. There were no towels and the cloths which were used to dry the baby sometimes had to serve as blankets also. No particular attention was paid to covering the head when the baby was wrapped up. The baby's temperature was not checked routinely and there were no low-reading thermometers available.

Study design

All live births in the hospital were eligible for admission to both of the studies. In the initial observational study, a cohort of 500 cases were entered. Subsequently, 300 infants (delivered in the same labour ward) were entered into a randomized controlled study of three different interventions. Randomization was by sealed envelope, opened at the time of delivery. All measurements and observations were carried out by a research team of two doctors and four midwives following a specific protocol agreed upon during a training period prior to the study.

Measurement of rectal temperatures

Low-reading mercury-in-glass thermometers, which had been checked for accuracy against a reference thermometer, were used. First, the mercury was shaken down to a point below 25 °C, the thermometer was inserted gently 3 cm into the rectum, the column was observed to increase before removing the thermometer after 3 min. (The thermometer was introduced to this depth to ensure that it did not reflect peripheral

temperature.) Rectal temperatures were obtained routinely at birth, at 30 min and at 2 h, and again at 24 h in all infants who were still in the hospital. Room temperatures were taken from alcohol wall thermometers. Diunal variation was marked but the mean results remained similar over both studies (see Table 6).

Methods used in the intervention study

As it is well known that drying and wrapping infants improves thermal balance it was felt both unnecessary and inappropriate to have a "no treatment" group to demonstrate this. After delivery each baby was first dried and then assigned to one of three interventions: (1) immediate breast contact, in which the baby was placed under the mother's clothes, on her chest. If the clothing alone was considered insufficient, the baby was swaddled in one of the labour room blankets and then kept immediately against the mother. (2) traditional mustard oil massage 90 cm below a 1 kw radiant heater where warm oil was rubbed onto the whole surface of the skin and head of the baby. The procedure was usually completed within 10 min of delivery. Thereafter the baby was swaddled in the usual manner, ensuring that the head was covered. The baby remained under the heater during the massage and afterwards, until transferred from the labour ward. (3) plastic swaddler, in which the baby was swaddled with an inner layer of plastic. Cheap plastic bags obtained at the local market were used. Before being used the bag was split, so that the two sides could be folded around each other and under the baby. Thereafter the baby was swaddled in a blanket also. None of these infants was placed under the heater.

Statistical analysis

The randomization codes were generated from tables (11) in balanced batches of 25 or 50. Data for the two studies were analysed separately. Subsequently, comparisons between the two groups were made. Results are expressed in terms of 95% confidence intervals (12). Where frequency data are quoted, the comparison between groups is made as odds ratios (95% confidence intervals).

Consent was not explicitly obtained in the observation study, where the temperature measurements were considered routine. In the intervention study, the mother's consent and cooperation were obtained with an explanation for the various procedures undertaken. The studies were approved by the Medical Research Committee of the hospital.

Results

Observation study

Five hundred infants were studied over a three-week period beginning in mid-December. This represented 87% of all live births in the Maternity Hospital. Infants not included were mostly born outside the delivery area. Of the 500 infants included in the study, temperature measurements were recorded in 475 babies at birth, 491 at 30 min, 496 at 2 h and 404 at 24 h. The infants missed at 24 h had mostly been discharged early. Two infants included in the study died soon after birth, one with severe birth asphyxia and the other with anencephaly.

Only seven infants were both well dried and well wrapped (whole body and hair dried in dry cloth and swaddled in at least two layers of dry cloth and head covered). During the first 2 h of life, it was unusual for the mother to hold the baby: this occurred in less than 10% of cases. The average time to completion of post-delivery care was more than 20 min.

Table 1. Proportions of hypothermic babies in the observation study.

	2 h ($n=495$)	24 h ($n=405$)
<36 °C	420 (85%)	197 (49%)
<35 °C	169 (34%)	58 (14%)
<34 °C	35 (7%)	13 (3%)

Table 2. Neonatal temperatures in the observation study.

	No.	Mean (SE)	(95% confidence intervals)
Birth[a] (°C)	475	36.75 (0.03)	(36.7–36.8)
30 min (°C)	491	35.4 (0.04)	(35.3–35.5)
2 h (°C)	495	34.95 (0.04)	(34.9–35.0)
24 h (°C)	405	35.7 (0.05)	(35.6–35.8)

[a] 95% within 10 min of birth.

Incidence of hypothermia. The proportions of infants with temperatures less than 36 °C, 35 °C and 34 °C at 2 h and 24 h after delivery are shown in Table 1. The actual temperatures of the infants are shown in Table 2. There were three infants whose temperatures decreased to less than 30 °C; the temperatures of these babies were 27.2 °C, 28 °C and 29 °C. Infants who were cold at 2 h were significantly more likely to be cold at 24 h (Table 3).

Risk factors. The principle risk factors for hypothermia were found to be low birth weight, preterm gestation and cold air temperature. More than 22% of the infants in the study were of low birth weight (<2500 g). These infants were significantly more likely to have temperatures less than 36 °C at both 2 and 24 h. The effect was seen even more clearly in the marked increase in the proportion of low-birth-weight infants with temperatures <34 °C at 2 h (21% (23/111) compared with 3% (12/382) (odds ratio 8.1 (4.2–15)).

Table 3. Relationship between hypothermia at 2 h and at 24 h.

	24 h: Observed (expected)				
	<34 °C	<35 °C	<36 °C	≥36 °C	Total
2 h					
<34 °C	6 (1)	9 (4)	10 (11)	7 (17)	32
<35 °C	3 (4)	13 (12)	40 (38)	55 (57)	111
<36 °C	4 (6)	17 (22)	75 (70)	108 (105)	204
≥36 °C	0 (2)	5 (6)	13 (19)	37 (28)	55
Total	13	44	138	207	402

Chi-square=47.5, d.f.=9, $p=1.3\times10^{-07}$.

Table 4. Proportions of hypothermic babies in the intervention study.

	Breast	Oil	Plastic	Total
2 h	$n=98$	$n=100$	$n=99$	$n=297$
<36 °C	42 (42%)	37 (37%)	35 (35%)	114 (38%)
<35 °C	7 (7%)	7 (7%)	2 (2%)	16 (5%)
24 h	$n=76$	$n=72$	$n=81$	$n=229$
<36 °C	10 (13%)	17 (23%)	14 (14%)	41 (18%)
<35 °C	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 5. Neonatal temperatures in the intervention study.

	No.	Mean (SE)	(95% confidence intervals)
Birth[a] (°C)	300	37.7 (0.03)	(37.6–37.8)
30 min (°C)	300	36.4 (0.04)	(36.3–36.5)
2 h (°C)	297	36.1 (0.04)	(36.0–36.2)
24 h (°C)	229	36.4 (0.04)	(36.3–36.5)
48 h (°C)	135	36.5 (0.06)	(36.4–36.6)

[a] All taken immediately after birth.

Eleven percent of the infants in the study were preterm. The effect of gestation on hypothermia was very clear at 24 h where 73% (35/48) of preterm infants were hypothermic compared with 46% (162/353) of term infants (odds ratio: 3.2 (1.6–6)).

On analysing the effect of air temperature, "cold air" was defined as air temperatures less than the mean. The mean temperature at 2 h was 20 °C and at 24 h 18 °C. The effect of air temperature was significant at both 2 and 24 h. The effect was more marked at 24 h where 59% (136/232) of infants in cold air were hypothermic compared with 35% (58/167) of those in "warm air" (odds ratio: 2.7 (1.8–4)).

Intervention study

Three hundred consecutive deliveries were assigned to different interventions during a three-week period beginning in mid-February. This represented 66% of the deliveries occurring at this time (the proportion included is smaller than that seen in the observation study, the reason being the greater time required to attend to each delivery). There was one death in the study due to birth asphyxia. The randomization procedure resulted in groups of infants which were very similar with respect to mother's age, gestation and birth weight.

Incidence of hypothermia. There were no significant differences in mean temperatures for the different interventions in each study. The proportions of hypothermic infants are shown in Table 4. All three methods were effective in preventing hypothermia. The overall temperatures of the infants in the intervention study for each measurement time are shown in Table 5. A significant association was again seen between early and late hypothermia. Seventy-one percent (29/41) of infants hypothermic at 24 h had been hypothermic at 2 h compared with 32% (60/187) of those who were normothermic at 24 h (odds ratio: 5.2 (2.5–10)).

Individual risk factors. The most important risk factors for hypothermia were cold air temperature and not being well wrapped. The mean air temperature in the study was 20 °C at 2 h and 18 °C at 24 h.

Fifty-two percent (66/127) of infants in a cold air environment (<20 °C) at 2 h were hypothermic compared with 28% (48/170) nursed in warm air (odds ratio: 2.75 (1.69–4.45)). Although a similar trend was found at 24 h, the difference was not significant.

Being poorly wrapped rather than well wrapped was significantly associated with hypothermia at 2 h (88% (22/25) cf. 34% (92/271) (odds ratio: 14.3 (4.2–48)) and at 24 h (43% (6/14) cf. 16% (35/214)) (odds ratio: 3.8 (1.2–11)). (The finding of poorly wrapped babies in the intervention study reflects inevitable mishaps in a busy delivery unit.)

Comparison of intervention study infants with those of the initial observation study

The overall proportions of hypothermic infants in the initial observation study and subsequent intervention study at 2 and 24 h are shown in Tables 1 and 4. There were much larger proportions of hypothermic infants in the observation study. At no time did any of the intervention study infants have a temperature <34 °C which compares with 7% (35/495) at 2 h and 3% (13/404) at 24 h in the observation study.

Comparison of the key variables in the two studies are shown in Table 6. In this context, it is important to note the similar birth weights, gestations and air tempera-

Table 6. Comparison of key variables in the two studies (mean (SD)).

	Observation	Intervention
Birth weight (g)	2780 (439)	2793 (396)
Gestation (weeks)	39.0 (2.1)	39.1 (2.3)
Air temp. 2 h (°C)	20.0 (1.6)	20.0 (1.5)
Air temp. 24 h (°C)	17.6 (2.7)	17.8 (1)

tures at 2 and 24 h in the two studies: 88% of deliveries in the observation study were normal compared with 90% in the intervention study.

Discussion

In the initial observation study, a high incidence of hypothermia (rectal temperature <36 °C) was found both after delivery and at 24 h; this included a large number of normal-sized, term babies. The finding of 49% of infants with a temperature <36°C at 24 h is very similar to the 50% reported from Zambia (13).

It is likely that lack of post-delivery care plays a significant role in the aetiology of neonatal hypothermia. Tafari & Olsson (14) thought that many of the hypothermic infants admitted to their neonatal unit in Ethiopia had originally become cold after birth. In the UK, a number of authors had noted that delivery at home, particularly in a cold room, was an important risk factor for the development of neonatal cold injury (15–17). This link is strongly supported by the significant association found between hypothermia at 2 h and at 24 h in both of the present studies.

The high incidence of early hypothermia in the Maternity Hospital was primarily due to poor post-delivery care, particularly in terms of absence of adequate measures to prevent heat loss. Less than 2% of the infants in the Maternity Hospital were both well wrapped and well dried and this was probably the main reason for the infants becoming cold in the first place.

In the immediate post-delivery period, because of the amniotic fluid covering the body, the most important mechanism of heat loss is evaporation (18). Dahm & James (19) found that simply drying a baby after delivery significantly reduced heat loss and that combining this procedure with wrapping the baby reduced post-delivery heat loss by more than 60%.

The subsequent methods used for maintaining warmth in the intervention study were all methods that had been studied previously. Färdig (20) found immediate breast contact to be more effective than use of a radiant heater in terms of prevention of heat loss immediately after delivery. In a study of 196 home deliveries in Holland (21), it was concluded that early breast contact was the "most physiological" post-delivery management. In a study in Malawi early breast feeding was shown to be effective in reducing the incidence of temperatures <36 °C at 24 h (22).

The silver swaddler has been shown to be effective both clinically (23) and experimentally (24) and it continues to have widespread use. Besch and co-workers (25) reported on the effective use of special air-bubble plastic bags immediately after birth. Similar results were obtained using a transparent single-layer polyethylene gown after delivery (26).

We also studied the traditional mustard oil massage. In the Indian subcontinent, it is a very common practice to rub the baby's skin with mustard oil after delivery (27, 28). In preterm infants this has been shown to be not only a source of warmth but also a source of nutrition (29).

We showed that the implementation of each of these simple methods on the labour ward improved greatly the temperatures of infants immediately after birth and indeed later. Without introducing new technology or heating sources to the labour ward, we were able to reduce the incidence of hypothermia by nearly 50% in the first 2 h after birth, from 85% in the initial observation study to 38%. The early intervention to prevent heat loss had the additional effect of reducing the numbers of infants who were cold at 24 h. Less than 20% had temperatures <36 °C at this time compared with nearly 50% in the observation study. Indeed, at 24 h, no infants had temperatures less than 35°C in the intervention study compared with 14.5% in the observation study. This suggests that prevention of early hypothermia can reduce significantly the incidence of late hypothermia. From the evidence presented previously, it is reasonable to assume that a reduction in late hypothermia will have a beneficial effect in terms of a simultaneous reduction in morbidity and mortality.

Although a considerable improvement was achieved by the interventions used, there remained an unacceptably high level of hypothermia. This was due mainly to cold air temperatures and to poor wrapping. Further improvements should be aimed for: in a comparative study carried out in the UK, only 1 of 500 infants studied at 24 h had a temperature <36 °C (Johanson, unpublished data).

In Nepal it would appear that as long as immediate drying is emphasized, the traditional practice of warm oil massage might be continued. However, in the absence of a suitable external heat source, early maternal contact should be encouraged. Plastic inner layer swaddling may be of benefit in those situations where neither mother nor external heat source is available (for example, during transfer between hospitals).

In conclusion, infants are at risk of hypothermia in Nepal primarily due to the continuation of practices which are known to increase the risk of becoming cold. The findings of these studies are important for a number of reasons: first, they highlight a problem that was not known to exist in the hospital situation in Nepal; second, they confirm the link between poor post-

delivery care and hypothermia; third, they suggest areas where improvements in care can be made easily. Further research is needed to assess the frequency of hypothermia in other developing countries. Efforts will need to be made to incorporate the problems of neonatal thermal control into the teaching programmes of all those who are entrusted with the post-delivery care of the newborn.

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