Heat loss prevention in the delivery room in term and preterm infants

Maria Pia De Carolis[1], Serena Antonia Rubortone[1], Iliana Bersani[1], Serafina Lacerenza[1], Francesco Cota[1], Cristina Garufi[2], Costantino Romagnoli[1]

[1] Division of Neonatology, Catholic University of Sacred Heart, and [2] University of Rome "La Sapienza", Sant' Andrea Hospital, Rome, Italy. E-mail: mpia.decarolis@rm.unicatt.it

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This study was conducted to determine whether or not simultaneous use of additional measures to prevent heat loss and efficient training of caregivers influenced the incidence of hypothermia at birth.

Two cohorts of term/late-preterm and preterm infants were compared before (Group IA and IB) and after (Group IIA and IIB) the introduction of additional measures and a specific training of caregivers.

In term/late-preterm neonates of Group IIA, admission temperature was higher (36.3°C vs 36°C; p<0.001) and incidence of hypothermia lower (61.2% vs 81.0%; p<0.001) compared to Group IA, with reduction of moderate hypothermia (8.8% vs 27.3%; p<0.001).

Among preterm neonates, admission temperature was higher (36.0°C vs 35.5°C; p<0.001) and incidence of hypothermia lower (68.1% vs 92.3%; p<0.001) during the second period, when no cases of severe hypothermia and reduction of moderate forms were observed (42.5% vs 70.7%; p<0.001).

Additional interventions to prevent hypothermia and caregivers' training were effective in preventing hypothermia.

Key words: hypothermia, delivery room, resuscitation, neonate.

Hypothermia after delivery is a worldwide problem closely associated with neonatal morbidity and mortality, especially in preterm infants[1]. Efforts to limit heat loss either in the delivery room (DR) during resuscitation or during transport, particularly in preterm infants, have been recommended[2]. The conventional approach of pre-heating the radiant warmer and drying the body and head with a pre-warmed towel is recommended by the Neonatal Resuscitation Program (NRP) in order to prevent heat loss in term neonates. Additional interventions such as pre-warming the DR, placing a portable warming pad under the layer of towels, and using polyethylene bags, have been suggested for preterm infants[2].

The aim of the present paper was to determine whether or not an efficient caregivers' training, an educational process improving the utilization of preventive interventions, and the simultaneous use of additional measures influenced the admission temperature and incidence of hypothermia in both term/late-preterm and preterm neonates.

Material and Methods

The present study was prospectively carried out in the DR of the University Hospital "A. Gemelli" of Rome (Italy) in two different periods, before and after the introduction of evidence-based thermal care interventions (care bundles) in two cohorts of infants involving term/late-preterm and preterm neonates. During the second period, all the caregivers had attended a specific training in NRP, and a dedicated DR resuscitation team was steadily present during daytime hours.

Thermal care interventions

Term/late-preterm neonates

During the first period (1-31 January 2008; Group IA), all term/late-preterm neonates received routine thermal care at birth: placement under an overhead heat source, thorough drying, and removal of any wet blanket. During the second period (1-31 January 2009; Group II A), in addition to the routine care, transwarmer mattresses (CrystalGel BiliCrystal® Cremascoli & Iris) and stockinet caps were used. In neonates with birth weight (BW) <2500 g, water mattresses set between 36.5-37°C (Kanmed Baby Warmer® Cremascoli & Iris) were utilized during the transport from the DR to the nursery.

Preterm neonates

During the first study period (1 January 2007 to 31 December 2008; Group IB), all preterm neonates received routine thermal care measures such as placement under a radiant warmer, thorough drying, and transport to the Neonatal Intensive Care Unit (NICU) by means of pre-warmed incubators. During the second study period (1 January to 31 December 2009; Group IIB), additional interventions were adopted, including gel transwarmer mattresses and stockinet caps. Babies born at less than 28 weeks' gestation were wrapped in polyethylene wraps (Neowrap, Fisher & Paykel Healthcare) without any previous drying. A heated humidifier (MR850, Fisher and Paykel Healthcare, Auckland, New Zealand), set at 37°C, was used in neonates needing ventilation and, if volume expanders were required, pre-warmed intravenous fluids were administered.

Educational program

Caregivers present in the DR during the second period had previously joined a training program of NRP including simulations and debriefing activities with an experienced instructor in addition to the standard lectures and lessons. The program aimed at increasing the level of staff awareness in relation to neonatal hypothermia. The educational sessions involving the whole staff (neonatologists, nurses attending deliveries, and obstetrics) were carried out to improve the procedural skills in the use of preventive interventions designed to reduce heat loss. In addition, during the same period, considering the majority of cesarean sections usually planned during the morning, a dedicated team composed of a nurse, pediatric resident, and an experienced neonatologist was constantly present in the DR from 7:00 am to 1:00 pm. During the remaining hours of days and nights, the neonatologist was convened by the obstetric staff of the DR only "on call", in case of need.

During the whole study period, infants were stabilized in the DR under radiant warmer (GE Ohmeda; Ohio® Infant Warmer System 3300), and premature neonates were transferred to the NICU in a pre-warmed incubator (Baby Shuttle, Ginevri, Italy), with temperature set at 37°C. The time required to transfer neonates from the DR to the nursery or to the NICU was about 5-7 minutes and 12-15 minutes, respectively.

Neonates with major congenital malformations, open neural tube defects, and abdominal wall defects, as well as neonates born to hyperthermic mothers (temperature >38°C) were excluded from data collection.

Rectal temperature was measured at the admission using a digital thermometer (Kendall Filac 3000). According to the classification approved by the World Health Organization (WHO) [3], hypothermia was defined as mild (36-36.4°C), moderate (32-35.9°C) or severe (<32°C).

Results are presented as mean ± standard deviation (SD) for the continuous variables and as number (percentage) for the categorical variables. Unpaired Student's t-test and analysis of variance (ANOVA) for parametric data, Wilcoxon rank-sum test (Mann-Whitney U test) for nonparametric data, and Fisher's exact test for categorical variables were used to compare both term and preterm neonates of the groups. The Bonferroni correction was used for multiple comparisons. A $p<0.05$ was considered statistically significant. Statistical analysis was performed using the "Stata Statistical Software: Release 10" (StataCorp LP, College Station, TX).

Results

Term/late-preterm neonates

One hundred forty-three neonates of Group IA were compared with 170 neonates of Group IIA. There were no statistical differences in the baseline characteristics such as gestational age (GA), BW, sex, Apgar score, and mode

Table I. Baseline Characteristics of Term Neonates in the Two Groups

	Group IA (N=143)	Group IIA (N=170)	P
Gestational age, wks*	38.7 ± 1.5	38.7 ± 1.4	ns
Birth weight, g*	3266 ± 438	3205 ± 427	ns
Male, n (%)	71 (49.6%)	88 (51.7%)	ns
Apgar score			
at 1 min	8.6 ± 0.89	8.6 ± 0.83	ns
at 5 min	9.2 ± 0.65	9.3 ± 0.61	ns
Cesarean section, n (%)	54 (37.7%)	61 (35.8%)	ns
Hypothermic neonates, n (%)	116 (81%)	104 (61.2%)	<0.001
Hyperthermic neonates, n (%)	0	2 (1.2%)	ns

* Values expressed as mean ± Standard Deviation.

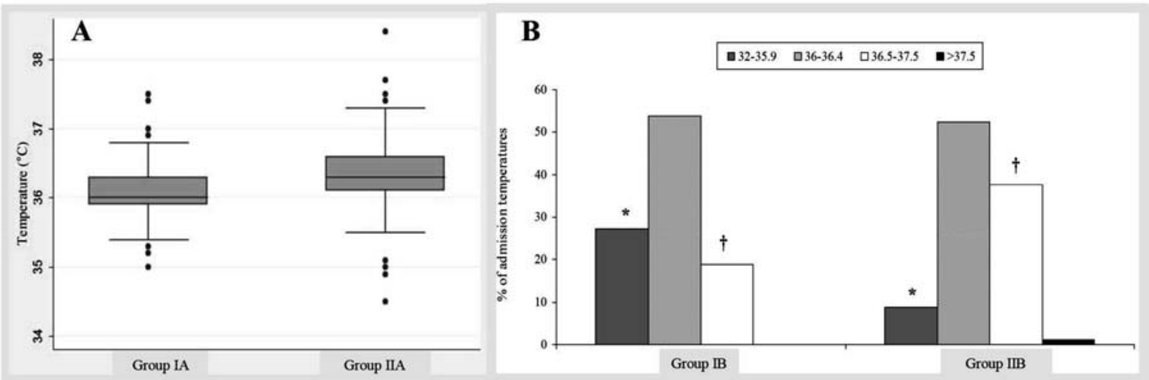

Fig. 1. Admission temperature values (A) and their distribution (B) in term/late-preterm neonates of the two groups. * p<0.001; † p<0.001

of delivery (Table I). One hundred sixteen of 143 neonates (81%) of Group IA and 104 of 170 neonates (61.2%) of Group IIA were hypothermic (p<0.001). The median temperature was 36.0°C in Group IA and 36.3°C in Group IIA (Fig. 1A).

Figure 1B shows that no neonates presented severe hypothermia. The rate of neonates with mild hypothermia was similar in the two groups (77/143, 53.8% vs 89/170, 52.4%), while the rate of moderate hypothermia was statistically lower in Group IIA (39/143, 27.3% vs 15/170, 8.8%, p<0.001). However, two neonates (1.2%) of Group IIA showed admission temperature >37.5°C.

Preterm neonates

Two hundred twenty-two neonates of Group IB were compared to 113 neonates of Group IIB. There were no statistical differences in the baseline characteristics such as GA, BW, sex, Apgar score, and mode of delivery (Table II). Two hundred and five of 222 neonates (92.3%) of Group IB and 77 of 113 neonates (68.1%) of Group IIB were hypothermic (p<0.001). The median temperature was 35.5°C in Group IB and 36.0°C in Group IIB (Fig. 2A).

As shown in Figure 2B, severe hypothermia was detected in only two neonates (0.9%). Moderate hypothermia was observed in 157 of 222 neonates (70.7%) of Group IB and in 48 of 113 neonates (42.5%) of Group IIB (p<0.001), while mild hypothermia was similar between the two groups (46/222, 20.7% vs 29/113, 25.7%).

In Group IIB, the lowest temperatures were significantly associated with lower GA (p<0.05) (Fig. 3). Figure 4 shows the median temperature values throughout the day: they were more stable from 7:00 am to 1:00 pm, when a dedicated team attended deliveries, while a greater variability was registered during the remaining hours.

Table II. Baseline Characteristics of Preterm Neonates in the Two Groups

	Group IB (N=222)	Group IIB (N=113)	p
Gestational age, wks*	28.7 ± 2.6	29.2 ± 2.5	ns
Birth weight, g*	1111 ± 390	1290 ± 431	ns
Male, n (%)	129 (58%)	66 (58%)	ns
Apgar score			
at 1 min	6.1 ± 2.1	6.3 ± 2.3	ns
at 5 min	7.3 ± 1.2	7.9 ± 1.5	ns
Cesarean section, n (%)	192 (86.4%)	103 (91.1%)	ns
Hypothermic neonates, n (%)	205 (92.3%)	77 (68.1%)	<0.001
Hyperthermic neonates, n (%)	0	1 (0.9%)	ns

* Values expressed as mean ± Standard Deviation.

Discussion

While throughout pregnancy, the fetus lives in a stable environment at a relatively constant temperature, at birth, the neonate is forced to face a cold stress. Cold stress is an essential part of the physiological transition from intrauterine to extrauterine life, but elevated and prolonged heat losses can increase the risk of hypothermia, especially in preterm babies[4]. After birth, deep body and skin temperature of term newborns can drop at a rate of approximately 0.1°C and 0.3°C per minute, respectively, unless prompt action is taken[5]. Current resuscitation guidelines underline the importance of preventing heat loss at birth both in term and preterm neonates, suggesting to keep a core body temperature within the normal range of 36.5 to 37.5°C (skin temperature of 0.5 to 1.0°C lower)[6].

In very preterm infants, maintaining an adequate body temperature during the first hour of life, considered the "golden hour"[7], is a crucial point during resuscitation in the DR and transport to the NICU. In fact, hypothermia has a potential negative effect on clinical outcome[1,8-12], with the mortality rate being dependent on both duration and severity of neonatal hypothermia[12]. It was demonstrated that the use of routine thermal care was ineffective in preventing hypothermia among very preterm neonates[2,8,11], while additional interventions, such as barriers to heat loss and external heat sources, were able to reduce the risk of its occurrence[13].

Because of a remarkable high prevalence of hypothermia observed in our hospital, we adopted a simultaneous use of several additional interventions to prevent hypothermia, since it is reported that a bundled approach promotes a rapid improvement in patient outcomes[14].

In our study, both additional measures and an adequate educational process for caregivers were effective in preventing hypothermia both in term/late-preterm and in preterm neonates.

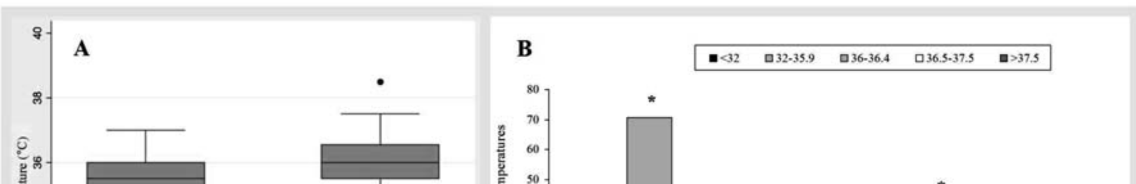

Fig. 2 Admission temperature values (A) and their distribution (B) in preterm neonates of the two groups. * p<0.001; † p<0.001

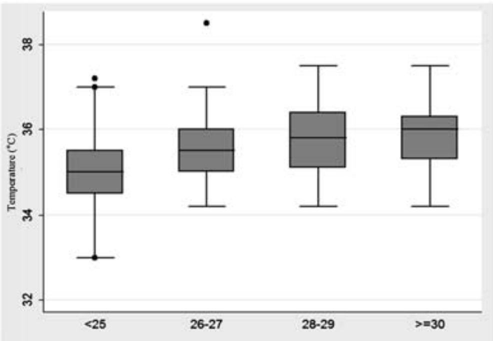

Fig. 3. Admission temperature values according to GA in preterm neonates of Group IIB (one way ANOVA, $p<0.05$).

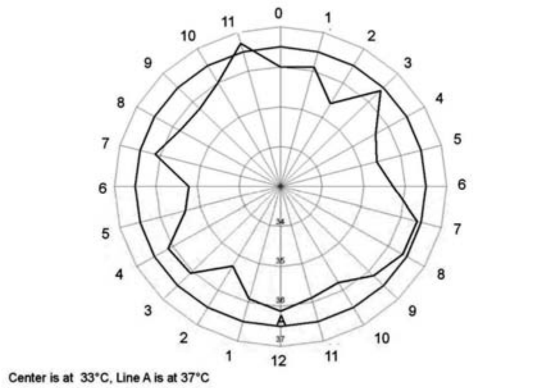

Fig. 4. Median temperature related to the hour of birth among preterm neonates of Group IIB.

Specific training of caregivers, including simulations and debriefing, improves both performance and motivation of the resuscitation teams[5,15].

Considering the increasing trend of body temperature in preterm neonates during the morning, when a dedicated team was steadily present in the DR, we think that this strategy should be implemented. Nevertheless, the prevalence of hypothermic neonates during the second period was still high. In agreement with Lee et al.[16], we believe that a quality improvement project periodically reviewing the ongoing process and verifying the acquired skills (feedback loop) could improve the outcome. A larger number of meetings or of feedback mechanisms could identify patients at higher risk and the measures needing to be improved.

The large number of hypothermic neonates detected at lower GA despite the preventive interventions demonstrates that hypothermia is still a challenge for neonatologists. Further efforts should be performed, especially in this group of infants, to maintain temperature within the normal range during resuscitation and transport to the NICU. A DR temperature >25°C, as recommended[17], and/or the use of more powerful radiant warmers[18] and of polyethylene caps[19], could be extremely helpful. Considering the distance between our DR and the NICU, and therefore the further potential drop in temperature, the use of heated and humidified air for the respiratory support during transport[20] could further contribute to improving outcomes in this extremely vulnerable population.

As we used several additional measures, we cannot clearly establish which intervention provided the most beneficial effect in reducing hypothermia. In agreement with McCall et al.[13], we can affirm that, compared with routine thermal care, any additional intervention designed to prevent hypothermia and applied early in the DR may be beneficial in clinical practice.

However, we must consider that both preterm and term/late-preterm babies may be rendered hyperthermic by an over-enthusiastic thermal care[21]. The presence of cases of hyperthermia during the second study period suggests that an accurate temperature monitoring aimed at avoiding overheating is essential.

In our experience, the additional measures we adopted were practical, easy to apply, and extremely cheap. This means that they may be widely utilized in clinical practice, without interfering with conventional resuscitation procedures at birth, either in preterm or in term neonates.

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