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Experience of the use of a thermal blanket in preterm infants in the delivery room and hypothermia at NICU admission

Mariana Butler Poletto[1], Gleise Aparecida Moraes Costa[1], Cristina Ortiz Sobrinho Valete[2], Cibele Wolf Lebrão[3], Cassia Mazzari Gonçalves[3], Selma Maria da Costa[3], Rodolfo Strufaldi[3]

[1]Centro Universitário FMABC – Santo André (SP), Brazil
[2]Departamento de Medicina, Universidade Federal de São Carlos (UFSCar) – São Carlos (SP), Brazil
[3]Hospital Municipal Universitário (HMU) – São Bernardo do Campo (SP), Brazil

ABSTRACT

Introduction: Thermoregulation is a challenge, especially for preterm infants, and hypothermia is associated with worse neonatal outcomes. **Objective:** To describe the effect of using a thermal blanket in the delivery room, combined with double cloth caps for the head and plastic caps covering the head and body, on the occurrence of hypothermia in preterm infants. **Methods:** A before-and-after study that included a convenience sample of 60 preterm infants <34 weeks gestational age and birth weight <1,500g (March 2021-March 2022), who were admitted to neonatal intensive care unit (NICU) immediately after birth, was conducted to report the experience after the implementation of a protocol of use of a thermal blanket in the delivery room combined with the use of double cloth caps for the head and plastic caps covering the head and the body. Groups were compared by Mann-Whitney and Fisher's exact tests for the outcome of hypothermia at admission. **Results:** Implementation of the protocol increased the median temperature at NICU admission (36.2°C vs 35.6°C; p=0.01), did not reduce the frequency of hypothermia at NICU admission (70.9% vs 89.6%; p=0.07), and did not result in hyperthermia. The time to normalize axillary temperature before the protocol was 218 minutes and after, 70 minutes (p=0.05). **Conclusion:** The use of the thermal blanket was safe, and the experience reported an increased axillary temperature with thermal blanket use, did not cause hyperthermia, did not reduce hypothermia, and had a mild impact on time to normalize axillary temperature.

Keywords: critical care; delivery rooms; hypothermia; infant, premature.

INTRODUCTION

Worldwide, it is estimated that 15 million preterm infants are born per year. This estimate is significant since prematurity is one of the main causes of death during the neonatal period[1-3]. Hypothermia, defined as axillary[4] temperature <36.5ºC, is frequent in preterm infants with extremely low birth weight at neonatal intensive care unit (NICU) admission. In China, a multicenter cohort study estimated an 88.2% frequency of hypothermia in exceptionally low birthweight neonates[5]. In Brazil, an average rate of 53.7% of hypothermia was reported by the Brazilian Network of Neonatal Research, and this frequency varied from 19.8% to 93.3%, revealing that there is great variability[6].

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Corresponding author: Cristina Ortiz Sobrinho Valete - Universidade Federal de São Carlos - Rodovia Washington Luís, km 235 – CEP: 13565-905 - São Carlos (SP), Brazil - E-mail: cristina.ortiz@ufscar.br

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Importantly, hypothermia at NICU admission has been associated with morbidity such as intraventricular hemorrhage, bronchopulmonary dysplasia, neonatal sepsis, retinopathy of prematurity, and neonatal death[7-9].

Some strategies have been advocated to prevent hypothermia in preterm infants, such as the use of plastic bags or plastic wraps covering parts of the body and head, and thermal mattresses[10]. A combination of interventions may be appropriate because they act through different mechanisms. Importantly, a meta-analysis observed an increased risk for hyperthermia when a plastic bag or wrap was combined with a thermal mattress, revealing that thermal control is a challenge for these infants[11]. The optimal combination of interventions is still under study, and there is a gap in the literature about this issue.

In moderate and late preterm infants, the use of thermal mattresses and increased delivery room temperature were associated with a decreased incidence of NICU admission hypothermia from 27% to 7.8%, with an increase in mild hyperthermia from 1.4% to 6.2%, associated with concomitant polyethylene wrap use[12]. Dunne et al.[13], in a review study, discussed hypothermia and the recommendations for thermoregulation in preterm infants. They debated external heat sources, interventions to prevent heat loss, and the frequency of hypothermia and hyperthermia, reinforcing that abnormal temperatures must be avoided. A recent systematic review and meta-analysis reinforced that quality improvement bundles reduce hypothermia in exceptionally low birth weight neonates but may increase hyperthermia. Studies that evaluated the use of forced-air warming applied to the neonate in the delivery room to prevent neonatal hypothermia are scarce. In the surgical scenario, this use has been associated with better temperature control in term neonates and older children, with reduction of hypothermia[14].

Considering this scenario, it is important to investigate hypothermia in these infants for a better understanding of this issue and how to prevent it. The hypothesis is that, after implementing a protocol, the occurrence of hypothermia changed.

The objective of this study was to describe the effect of the use of a thermal blanket in the delivery room, combined with the use of double cloth caps for the head and plastic caps covering the head and the body, for preterm infants, on the occurrence of hypothermia.

METHODS

This is a quasi-experimental before-and-after study conducted at a tertiary public university hospital in the state of São Paulo, Brazil. The effects of implementing the use of a thermal blanket in the delivery room, combined with previous recommendations for preterm infants (double cloth caps for the head and plastic caps covering the head and body), were evaluated. All health professionals received training over one month during their work shifts, and a Plan, Do, Check, Act (PDCA) cycle was followed.

In a convenience sample, we included all infants <34 weeks' gestational age and birth weight < 1,500 g born between March 2021 and June 2021 and admitted to the NICU immediately after birth. After the protocol, all preterm infants who were submitted to all the recommendations and admitted to the NICU immediately after birth were included. Two groups were considered: between March 2021 and June 2021 (before the protocol) and between July 2021 and March 2022 (after the protocol). After the protocol implementation, preterm infants who had not received all the recommended interventions were excluded. An equal number of preterm infants was included in each period. In both periods, infants were excluded if they had any congenital malformations, an absence of data regarding temperature in the medical record, if they were transferred to another hospital, or if they died immediately after birth (Figure 1).

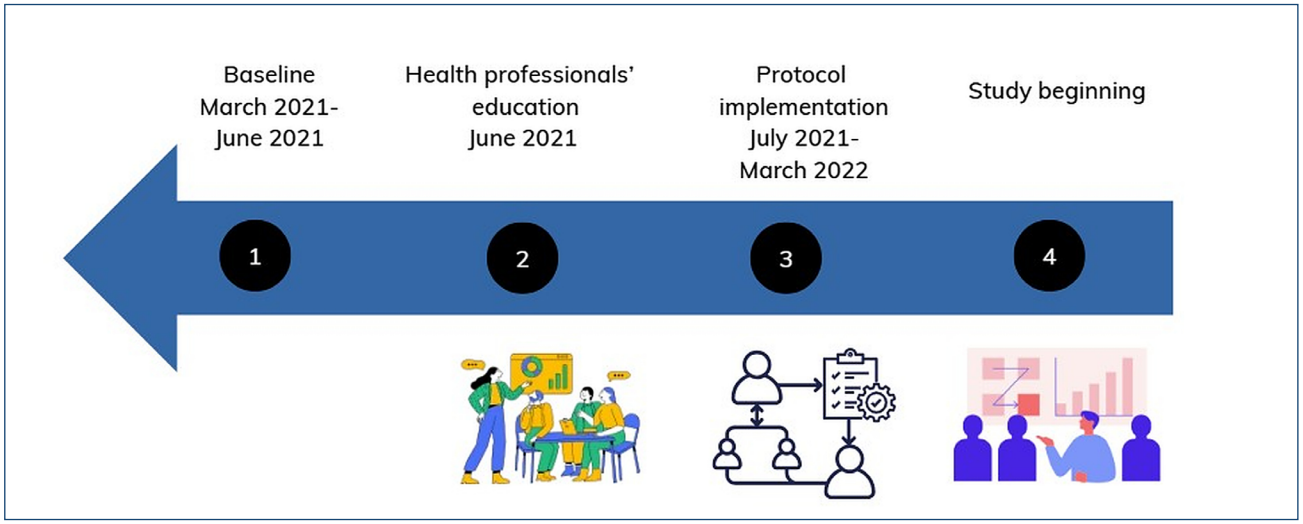


Figure 1: Study timeline.

All infants used a double cloth cap for the head and plastic caps covering the head and the body and were cared for under a radiant warmer, as recommended by the American Academy of Pediatrics. A thermal blanket was added to the previous routine care offered for preterm infants (double cloth caps for the head and plastic caps covering the head and the body) since July 2021. In the delivery room, preterm infants were placed on a pre-warmed thermal blanket (Forced-Air Warming) with a target temperature set at 38.0ºC. All infants were transferred to the NICU utilizing a pre-warmed transport incubator, using the thermal blanket, the double cloth caps for the head, and plastic caps covering the head and the body, and continued using them in the NICU for a minimum of six hours. The delivery room temperature was controlled between 23 and 26ºC.

Data were retrospectively collected from electronic charts. Demographic information was collected. Variables such as gestational age, birth weight, sex, mode of delivery, classification of birth weight to gestational age by the INTERGROWTH 21st, 5th minute Apgar score, Score for Neonatal Acute Physiology and Perinatal Extension (SNAPPE II), axillary temperature at NICU admission, time to normalize temperature, and in-hospital death were registered[15,16].

Delivery room and maternal axillary temperatures were registered. The neonate's axillary temperature was measured using a digital thermometer at NICU admission. When the infant had hypothermia, it was checked every 30 minutes until temperature normalization. The time to normalize axillary temperature in minutes was defined as the time to reach 36.5ºC for those who had hypothermia. Hypothermia was defined as an axillary temperature below 36.5ºC, mild hypothermia between 36ºC and 36.4ºC, moderate between 35.9 °C and 32 °C, severe <32ºC, and hyperthermia above 37.5ºC, according to the World Health Organization[4]. The primary outcome was hypothermia (yes or no) at NICU admission.

Data were analyzed using Stata 18.0 (Stata Corp, L.C.). Descriptive statistics were performed. The Kolmogorov-Smirnov test was used to evaluate normality ($p<0.001$). Continuous variables are presented as median and interquartile ranges (IQR). Categorical variables are presented as frequencies. Differences between medians were compared using the Mann-Whitney test, and between proportions by the chi-squared test. The Kruskal-Wallis test was used to compare more than two medians. We made comparisons in neonatal characteristics and outcomes between the two periods (before and after the protocol) and compared the delivery mode and median gestational age according to axillary temperature at NICU admission. The correlation between axillary temperature at NICU admission and gestational age was analyzed by the Spearman test. Differences between frequencies were compared using Fisher's exact test. A statistical significance of $p<0.05$ was considered.

This study was conducted in accordance with the Declaration of Helsinki and Resolution 466/2012 of the Brazilian National Health Council, and was approved by the local Research Ethics Committee (CAAE: 43394821.6.0000.0082). Exemption from the collection of the Informed Consent Form was obtained.

RESULTS

A total of 62 preterm infants were eligible for the study, and two were excluded because of a lack of registration of temperature at NICU admission. Data from 60 preterm infants were analyzed. Thirty (50.0%) were male, 42 (70.0%) were born by cesarean section, and 21 (35.0%) were small for gestational age. Median birth weight was 1,147g (IQR 810- 1,475 g), gestational age was 30.4 weeks (IQR 27.1-32.2 weeks), 5th minute Apgar was 8 (IQR 7-9), and SNAPPE-II was 20 (IQR 9-35). Considering birth weight < 1,000 g and gestational age <30 weeks, there were 21 (35.0%) and 28 (46.7%) preterm infants, respectively. Groups before and after the protocol implementation were comparable, except for cesarean section. Preterm infants' characteristics and outcomes before and after the protocol implementation are shown in Table 1. Gestational age and axillary temperature at NICU admission were positively correlated (Spearman 0.3899; $p=0.002$).

Hypothermia at NICU admission was observed in 48 (80.0%) neonates. Mild hypothermia was observed in 20 (33.3%) and moderate in 28 (46.6%), without differences in proportions before and after the protocol. Severe hypothermia was not observed. Overall median axillary temperature at NICU admission was 36.0ºC (IQR 35.3 - 36.3ºC). Maximum axillary temperature at NICU admission was 37.2ºC, and none of the 60 preterm infants presented hyperthermia. Time to normalize axillary temperature before the protocol was 218 minutes, and after, 70 minutes ($p=0.05$), as shown in Figure 2. Normothermia at NICU admission was observed for preterm infants with higher gestational ages ($p=0.008$), but without differences considering cesarean section ($p=0.815$), as shown in Table 2.

DISCUSSION

In this study, it was observed that the use of a thermal blanket in the delivery room, combined with a double cloth cap for the head and plastic caps covering the head and the body for preterm infants, increased axillary temperature at NICU admission, did not cause hyperthermia, but the frequency of hypothermia was not different. We observed that there was a mild decrease in the time to normalize axillary temperature after the protocol.

Median axillary temperature increased after the protocol. This result agrees with the literature. Caldas et al.[6] and Peleg et al.[17] observed an increase in temperatures after interventions. Many different thermoregulation practices exist worldwide, and plastic

Table 1: Preterm infants' characteristics, temperature at admission, and hypothermia, before and after the new protocol

	Before the new protocol (n=29)	After the new protocol (n=31)	p-value[a]
Characteristics			
Gestational age (weeks), median (IQR)	30.8 (28.0-32.4)	30.0 (27.0-32.0)	0.13
Birth weight (g), median (IQR)	1,255 (930-1,475)	1,130 (790-1,475)	0.51
Male sex, n (%)	15 (51.7)	15 (48.4)	0.79
Cesarean section, n (%)	16 (55.1)	26 (83.9)	**0.02**
Small for gestational age, n (%)	9 (31.0)	12 (38.7)	0.42
5th minute Apgar, median (IQR)	9 (7-9)	8 (7-9)	0.40
SNAPPE II, median (IQR)	21 (5-40)	21 (12-31)	0.89
Outcomes			
In-hospital death, n (%)	5 (17.2)	3 (9.6)	0.51
Lowest temperature of the delivery room in 0C, median (IQR)	24.0 (23.8-24.1)	23.9 (23.3-24.0)	0.19
Axillary maternal temperature in 0C, median (IQR)	36.3 (36.0-36.6)	36.2 (36.0-36.3)	0.44
Axillary infant temperature at NICU admission in 0C, median (IQR)	35.6 (35.0-36.2)	36.2 (35.6-36.5)	**0.01**
Hypothermia at NICU			
admission, n (%)	26 (89.6)	22 (70.9)	0.07
Mild	8	12	0.12
Moderate	18	10	
Severe	0	0	

[a]p-values for differences between medians were calculated using the Mann-Whitney test and between frequencies using the Fisher exact test.

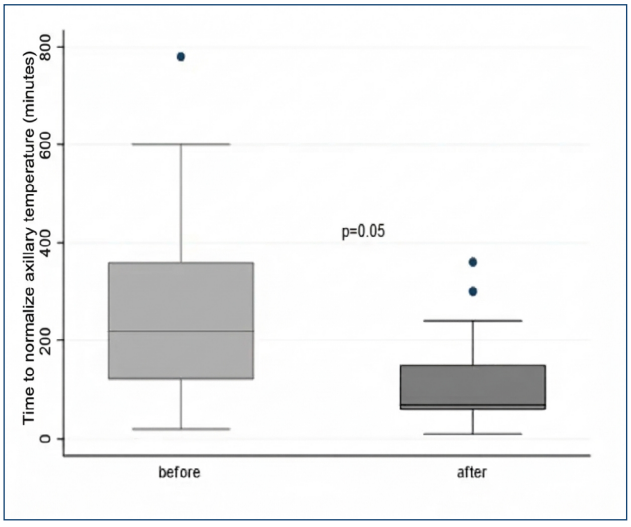


Figure 1: Study timeline.

Table 2: Preterm infants normothermia, mild and moderate hypothermia according to cesarean section and gestational age.

Axillary temperature at NICU admission	Cesarean section, n (%)	Gestational age, median (IQR)
Normothermia	9 (75.0)	32.2 (30.4-33.2)
Mild hypothermia	13 (65.0)	31.5 (28.5-32.2)
Moderate hypothermia	20 (71.4)	28.3 (26.0-31.0)

NICU: Neonatal intensive care unit.

wrap seems to be the most frequent practice[18]. Abiramalatha et al.[11] reviewed several interventions in the delivery room that aimed to reduce hypothermia in infants <36 weeks. Although the certainty of evidence was variable, they observed that most interventions resulted in a better core body temperature, and specifically, the use of a plastic bag or wrap with heated, humidified respiratory gas resulted in better prognosis. On the other hand, different from this study, the authors reported an increased risk of hyperthermia when plastic bags or wraps were combined with thermal mattresses. One of the studies included in that meta-analysis used an exothermic mattress, which contains a metal disc with sodium acetate gel. When this gel is activated, it rapidly produces heat that reaches temperatures[19] from 38.0 to 42.00C.

In this study, differently, a thermal blanket with temperature control at 38.00C was used, and hyperthermia was not observed. Although the mechanism of heat transfer is the same (conduction) between the exothermic mattress and the thermal blanket, it seems reasonable to suggest that temperature control of the device is essential to avoid hyperthermia. A controlled trial with the use of a thermal blanket at admission to the NICU for infants <1,500 g birth weight observed that fewer infants in the intervention group had hypothermia at 30 minutes[10]. The use of a portable thermal nest added to standard care may also reduce hypothermia in neonates[20].

We did not observe a reduction in hypothermia at NICU admission. Manani et al.[21] observed a reduction of hypothermia from 44% to 0% in exceptionally low birth weight infants with standardization of delivery room management, which included the use of chemical mattresses and servo-controlled radiant warmers. Differently, the authors defined hypothermia at a different cut-off, 36ºC. The authors did not report on the occurrence of hyperthermia. More recently, a meta-analysis revealed a decrease in hypothermia with quality improvement bundles in exceptionally low birth weight infants, with an increase in hyperthermia (odds ratio 2.79). In extremely low birth weight infants, a meta-analysis showed a decrease in hypothermia but no increase in hyperthermia, suggesting that the gestational age of included infants may influence the occurrence of hyperthermia[22].

In the present study, 35% of infants were extremely low birth weight, and we did not observe hyperthermia. Of note, cesarean section was more frequent after the protocol. Although cesarean section has been suggested by the literature as a risk factor for hypothermia[23], we did not observe differences in axillary temperatures at NICU admission according to cesarean section. Lower axillary temperatures were associated with lower gestational age.

The current study revealed an overall frequency of hypothermia at NICU admission of 80.0%, and this is a matter of concern. A prospective study that included 80 infants < 1,500 g birth weight observed a 60% frequency of hypothermia[10]. Another study that analyzed all infants < 1,500 g birth weight for 5 years observed that 79% of infants had hypothermia[23]. A population-based cohort revealed a frequency of hypothermia[24] at admission of 56.2%. A Brazilian study revealed that the frequency of admission hypothermia was as high as 93.3%[6]. In the present study, we believe that the observed reduction in the frequency of hypothermia was not statistically significant because of the small sample size. We must emphasize that the reduction of hypothermia is challenging and has been variable in the literature[11,25].

Although the time to normalize axillary temperature after NICU admission was three times lower with the use of the blanket, there was no statistical difference. We considered this difference of clinical significance, as temperature control constitutes quality of care. Another study, in a unique design, observed that 30 minutes after installing the thermal blanket in the NICU, fewer infants had hypothermia compared to usual care[10]. O'Brien et al. observed what they called the time to normothermia in 532 infants who were cared for under a radiant warmer and plastic bags after birth, and this varied up to 235 minutes[23].

When forced-air warming was applied to 111 patients submitted to cesarean section, there was a difference in the probability of recovering from hypothermia[26]. In our study, the time to normothermia was 218 minutes before the protocol, which means more than three hours. It must be reinforced that by reducing the severity of hypothermia, we could reduce the time to recover, as there is a speed for the increase in body temperature.

This study has some limitations, including the small sample size and the retrospective design. Also, the neonate's temperature in the delivery room was not registered, impairing the discussion about where hypothermia occurred, in the delivery room or during the transportation to the NICU. We needed to extend the period of data collection after the protocol because the team did not adhere 100% to it. There was a trend toward a shorter time to normalize axillary temperature with the use of a thermal blanket. However, we were underpowered by the small sample size. On the other hand, the use of the protocol did not result in hyperthermia. The strength of this study lies in its effort to implement a protocol that reduces hypothermia without inducing hyperthermia, suggesting it is safe.

Conclusion

In conclusion, our experience revealed that the use of a thermal blanket in preterm infants <34 weeks and <1,500g birth weight since the delivery room, in the unit analyzed, combined with the use of a double cloth cap for the head and plastic caps covering the head and the body, increased axillary temperature, did not cause hyperthermia, did not reduce hypothermia, and tended to decrease time to normalize axillary temperature. This way, the use of the thermal blanket was safe, and although thermoregulation was partially improved, its use brings benefits to preterm infants and should be adopted. Future and larger prospective studies examining these interventions' impact and safety are warranted to inform best practices for these preterm infants.

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