



HYPOTHERMIA IN PRETERM INFANTS < 34 WEEKS : DISTRIBUTION, RISK FACTORS AND OUTCOMES

Paediatrics

Dr Sahana Giliyaru

Professor, Department Of Pediatrics, Raja Rajeswari Medical College And Hospital Bangalore.

Dr Koduru Bhanu Hruday Reddy

Junior Resident, Department Of Pediatrics Raja Rajeswari Medical College And Hospital Bangalore.

Dr Adarsh. E*

Hod And Professor, Department Of Pediatrics Raja Rajeswari Medical College And Hospital Bangalore. *Corresponding Author

ABSTRACT

Background: Neonatal hypothermia is a progressive reduction in the axillary temperature of the newborn (temperature < 36.5°C). It is categorized as mild hypothermia (36°C–36.4°C), moderate hypothermia (32°C–35.9°C), and severe hypothermia (<32°C). Neonates are prone to rapid heat loss and consequent hypothermia because of the large surface area-to-body mass ratio, decreased subcutaneous fat, immature skin, high body water content, poorly developed metabolic mechanism, and altered skin blood flow. Hypothermic neonates had a higher risk of developing hypoglycemia, respiratory distress syndrome, jaundice, and metabolic acidosis. **Aims And Objectives:** The aim of the study was to study the occurrence of neonatal hypothermia among preterm infants (<34 weeks) its distribution, risk factors and outcomes. **Inclusion Criteria:** All preterm neonates (<34 weeks) admitted to NICU in RRMCH, Bengaluru. **Exclusion Criteria:** Preterm > 34 weeks and term neonates. Preterm neonates with major congenital malformations. **Methods:** Temperature of preterm newborn babies was recorded with digital thermometer in axillary region and measured in degree Celsius at admission. Clinical characteristics, neonatal outcome and risk factors of hypothermia was identified. **Results:** The prospective observation study included 40 infants. The association between Neonatal hyperbilirubinemia and hypothermia was statistically significant ($p < 0.05$). The birth weight is significantly ($p < 0.05$) associated with the admission temperature. Positive correlation was found between birthweight and the temperature at admission implying that as the birthweight increases, temperature at admission increases and this association was found to be statistically significant. **Conclusion:** Gestational age at birth and hypothermia at admission were independent risk factors for the occurrence of hypothermia in the first hours during admission. A variety of interventions, such as polyethylene bags, heating mattresses or increasing the delivery room temperature, have been shown to reduce hypothermia in premature infants. Hypothermic neonates had a higher risk of developing neonatal hyperbilirubinemia followed by respiratory distress syndrome

KEYWORDS

INTRODUCTION:

In both developed and developing countries, hypothermia is an important risk factor for morbidity and mortality in newborns. The World Health Organization (WHO) established criteria for assessing hypothermia and published a guidebook on the thermal protection of newborns in 1997, indicating that this issue is a worldwide problem even for term infants, particularly in developing nations.⁶ WHO classifications of hypothermia are (1) cold stress or mild hypothermia: 36.0 to 36.4°C (96.8 to 97.5°F); (2) moderate hypothermia: 32.0 to 35.9°C (89.6 to 96.6°F); and (3) severe hypothermia: below 32°C (<89.6°F).

Prevention of hypothermia in preterm infants is essential as studies have shown that neonatal hypothermia is associated with increased morbidity and mortality rates [2–8]. Although hypothermia is rarely a direct cause of death, it contributes to a substantial proportion of neonatal mortality globally, mostly as a comorbidity⁷. Consequences of neonatal hypothermia include increased risk of pulmonary vasoconstriction, reduction of peripheral perfusion, metabolic acidosis, jaundice, respiratory distress, growth retardation, hypoglycemia, pulmonary hemorrhage, necrotizing enterocolitis, impaired cardiac function, disseminated intravascular coagulopathy, respiratory distress syndrome, cardiac arrhythmia and eventually death.

The aim of this study is to determine the occurrence and duration of hypothermia in infants <32 WEEKS gestational age at birth during the first three hours after arrival at our neonatal intensive care unit (NICU) and to identify risk factor.

METHODS:

The study was conducted in the Neonatal Intensive Care Unit (NICU) of Rajarajeswari Medical College and Hospital (RRMCH), Bengaluru. Cases were selected based on inclusion and exclusion criteria.

Study Design And Subjects:

The present study was prospective observational study in less than 34 weeks of gestation preterm infants admitted to NICU to Rajarajeswari medical college and hospital- a tertiary care hospital All preterm

neonates (<34 weeks) admitted to NICU in RRMCH, Bengaluru were included in the study. Preterm > 34 weeks and term neonates. Preterm neonates with major congenital malformations were excluded from the study.

Methodology And Statistical Analysis:

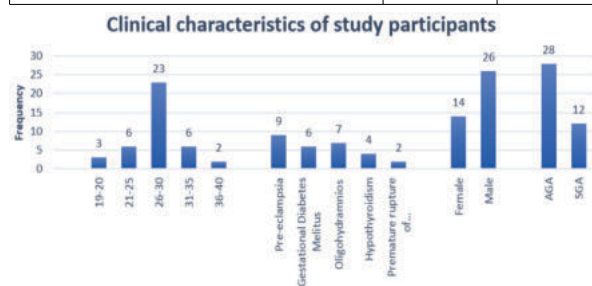
Methods of collection of data cases was selected based on inclusion criteria and exclusion criteria. Detailed clinical examination and physical findings will be recorded on pre designed proformas after taking informed consent.

After obtaining parental consent, all preterm neonates born before 34 weeks of gestation and admitted to NICU were included in the study. Preterm babies were stabilised in labour room and those babies requiring NICU admission were brought to NICU through a transport incubator. Temperature of preterm newborn babies was recorded with digital thermometer in axillary region and measured in degree Celsius at admission. For all preterm neonates (<34 weeks of gestation), gestational age was assessed by early scan or last menstrual period and examined by Modified Ballard Scoring system. Regarding maternal characteristics, the following variables were collected: maternal age, maternal health conditions like preeclampsia, gestational diabetes mellitus, chorioamnionitis, use of antenatal corticosteroids, mode of delivery, length of time of labor. For preterm infants following variables were included: time of birth, weight at birth, gestational age, sex, singleton or twin delivery; temperature of the radiant warmer, temperature of the delivery room, need for resuscitation in delivery room, axillary temperature at the time of admission to NICU; APGAR score in the 1st and 5th minutes of life, use of cling wrap, caps, bag and mask ventilation, intubation. Presence of morbidities in preterm infants like hypoglycemia, respiratory distress syndrome, hyperbilirubinemia, NEC, sepsis, apnea of prematurity were recorded. The collected data was entered into Microsoft Excel Worksheet-2010 and data was taken into IBM SPSS Statistic for windows, version 24 (IBM Corp., Armonk, N.Y., USA) software for calculation of frequency, percentage, mean, standard deviation and Probability value.

RESULTS:

Table 1: Clinical characteristics of study participants

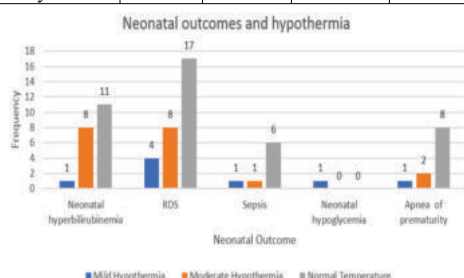
Variable	Frequency	Percentage
Maternal Age		
19-20	3	7.5
21-25	6	15
26-30	23	57.5
31-35	6	15
36-40	2	5
Maternal risk factors		
Pre-eclampsia	9	22.5
Gestational Diabetes Melitus	6	15
Oligohydramnios	7	17.5
Hypothyroidism	4	10
Premature rupture of membranes(PROM)	2	5
Gender		
Female	14	35
Male	26	65
AGA/SGA		
AGA	28	70
SGA	12	30

**Figure : Clinical characteristics of study participants**

An observational study was done among 40 preterm newborns in NICU. The mean maternal age is 26.56 ± 3.929 years. Table 1 shows the clinical characteristics of the study participants. Majority (57.5%) of the mothers were in age group of 26-30 years. Among the maternal risk factors pre-eclampsia, 9 (22.5%) was the most reported one followed by oligohydramnios seen among 7 (17.5%). Among the neonates 28 (70%) were AGA and 12 (30%) were SGA. Gender wise distribution of the new borns shows males, 26 (65%) in predominance.

Table 2: Neonatal outcomes and hypothermia

Variable	Mild Hypothermia	Moderate Hypothermia	Normal Temperature	Total	p-value
Neonatal hyperbilirubinemia	1(5)	8(40)	11(55)	20(100)	0.025
RDS	4(13.8)	8(27.6)	17(58.6)	29(100)	0.138
Sepsis	1(12.5)	1(12.5)	6(75)	8(100)	0.74
Neonatal hypoglycemia	1(100)	0	0	1(100)	0.01
Apnea of prematurity	1(9.1)	2(18.2)	8(72.7)	11(100)	0.90



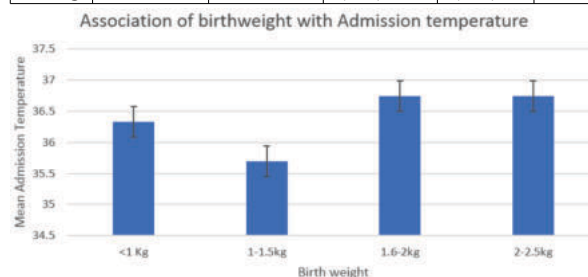
Association of neonatal outcomes with hypothermia is shown in table 2. Among the 29 neonates with RDS moderate hypothermia was seen in 8 (27.6%), Mild hypothermia was recorded in 1 (5%) of neonates with Neonatal hyperbilirubinemia. The association between Neonatal hyperbilirubinemia and hypothermia was statistically significant ($p < 0.05$). Among the 8 neonates with sepsis moderate hypothermia was seen in 1 (12.5%) of them.

Table 3: Association of birthweight with Admission temperature

Birthweight	N	Admission temperature		p-value
		Mean	Standard Deviation	
<1 Kg	11	36.327	0.793	0.029
1-1.5kg	17	35.70	1.159	
1.6-2kg	5	36.740	0.134	
2-2.5kg	7	36.743	0.257	
Total	40	36.185	0.963	

Table: Admission temperature and birthweigh

Birth Weight	Mild hypothermia	Moderate hypothermia	Normal Temperature	Normal Temperature	p-value
<1 Kg	2(18.2)	2(18.2)	7(63.6)	11(100)	0.162
1-1.5kg	2(12.5)	7(43.8)	7(43.8)	16(100)	
1.6-2kg	0	0	5(100)	5(100)	
2-2.5kg	0	0	7(100)	7(100)	

**Figure: Association of birthweight with Admission temperature**

The neonates with birth weight <1kg the recorded mean temperature at time of admission was 36.32 ± 0.793 and in neonates who weighed 2-2.5kg the mean temperature recorded was 36.743 ± 0.257 . The birth weight is significantly ($p < 0.05$) associated with the admission temperature (Table 3).

Table 4: Gestational age with Admission temperature

Birth Weight	Mild hypothermia	Moderate hypothermia	Normal Temperature	Normal Temperature	p-value
<1 Kg	2(18.2)	2(18.2)	7(63.6)	11(100)	0.162
1-1.5kg	2(12.5)	7(43.8)	7(43.8)	16(100)	
1.6-2kg	0	0	5(100)	5(100)	
2-2.5kg	0	0	7(100)	7(100)	

Table : Admission temperature and Gestational age

Gestational age (in wks)	Mild hypothermia	Moderate hypothermia	Normal Temperature	Normal Temperature	p-value
28-30	0	1(25)	3(75)	4(100)	0.814
30-32	0	0	2(100)	2(100)	
32-34	4(11.8)	8(23.5)	22(64.7)	34(100)	
				7(100)	

The mean temperature at time of admission was 36.156 ± 1.025 for gestational age of 32-34 weeks (Table 4). There was no statistically significant association between Gestational age with admission temperature ($p < 0.05$).

Prevalence's of severity Hypothermia in Caps, Cling Wraps and prewar-med towels

Hypothermia	Caps	Cling Wraps	Prewar-med towels
Mild	4 (9.33%)	4 (9.33%)	4 (9.33%)
Moderate	9 (16%)	9 (16%)	9 (16%)
Normal	27 (72%)	27 (72%)	27 (72%)

The Prevalence of Hypothermia in Caps, Cling Wraps and prewar-med towels used subjects is 13 (28.00%) and among subjects who had mild hypothermia on admission: 4 subjects (9.33%) with mild hypothermia; 9 subjects (16%) with moderate hypothermia.

Figure 1 shows the correlation between temperature at admission and gestational age where it shows positive correlation which indicates that as the gestational age increases, temperature at admission increases and this association was not found to be statistically significant ($p > 0.05$).

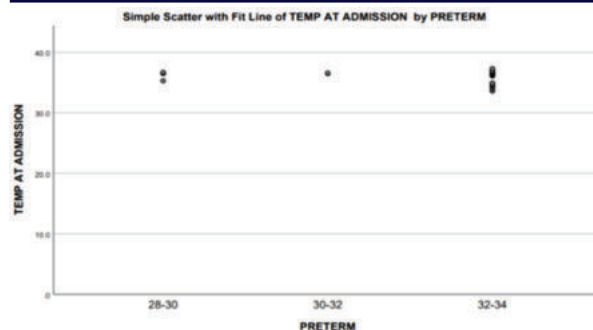
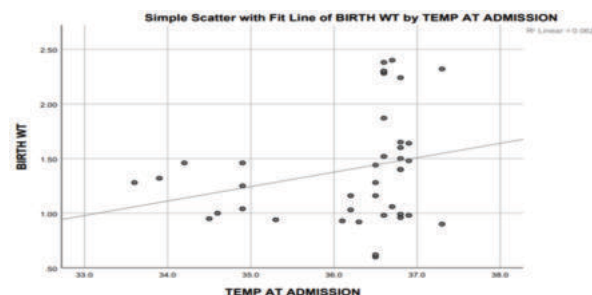


Figure 1: Correlation between admission temperature and gestational age

Correlation between admission temperature and Birth weight



Positive correlation was found between birthweight and the temperature at admission implying that as the birthweight increases, temperature at admission increases and this association was found to be statistically significant (Fig 2)

DISCUSSION

A observation study was conducted with an aim to study the occurrence of neonatal hypothermia among preterm infants (<34 weeks) admitted in neonatal intensive care unit.

Hypothermia is physiologically damaging in neonates, especially for those with very low weight and extremely low weight at birth, and whose GA is extremely low.¹

In the study by wagh et al² study 46(61.3%) neonates were appropriate for gestational age and 29(38.7%) were SGA these results were similar to our present study where 70% were AGA and 30% were SGA.

Another study by Norman et al³ showed that major proportion of the Indicated preterm infants were SGA suggesting the influence of intrauterine compromise resulting in growth restriction.

In the present study The mean temperature at time of admission was 36.156 ± 1.025 for gestational age of 32-34 weeks. Study by Wilson et al¹ reported a temperature of 36.4°C (35.9°C - 36.8°C) at admission in the NICU shows cases of hypothermia in premature infants. In a cohort study that evaluated the distribution of temperature in the admission to the NICU of infants who were moderately premature (29-33 weeks) and extremely premature (<29 weeks), the thermal lability at admission increased as the GA decreased⁴

With regard to neonatal outcomes, study by Chang et al⁵ found a correlation between the extent of reduced temperature on admission and RDS. In the present study among the 29 neonates with RDS moderate hypothermia was seen in 8(27.6%). Hypothermia may result in an increase in oxygen consumption, leading to hypoxemia. Hypoxemia, in turn, can cause pulmonary vasoconstriction and increased respiratory distress by impairing surfactant release and decreasing respiratory muscle efficiency.

A study on Korean neonates found that out of 3464 neonates who were having some degree of hypothermia, 798 neonates suffered from sepsis which accounted for 22.83% of hypothermic neonates⁶. A different study by Chang HY et al., reported sepsis in 10 (10%) of neonates with mild hypothermia and 27 (16.7%) neonates with moderate hypothermia⁵. In our study Among the 8 neonates with sepsis moderate hypothermia was seen in 1 (12.5%) of them.

Present findings revealed that there was no significant association between birth weight and hypothermia, similar to Ethiopian⁷ and Indian⁸ study.

Study by Shresta et al also reported similar results where there was no significant association between low birth weight and hypothermia But, studies from Uganda⁹ and Pakistan¹⁰ have reported association between low BW and newborn hypothermia. In present study less number of LBW babies may have influenced the statistical significance.

This study found a relation between temperature at admission with GA, and weight at birth. Positive correlation was found between birthweight and the temperature at admission implying that as the birthweight increases, temperature at admission increases and this association was found to be statistically significant. Similar data was found in a retrospective research that analysed the occurrence of hypothermia ($<36.5^\circ\text{C}$) in premature children with a GA<32 in the first three hours of admission¹¹. The authors found that, the lower the weight at birth and the GA, the more frequent and longer-lasting the hypothermia ($p<0.01$), considering that premature infants take more time to reach normothermia when they are admitted with hypothermia¹¹. In addition, moderate hypothermia was found in the admission of very low weight premature infants, being associated to short and long-term consequences⁷. Hypothermia in the admission at the NICU was associated to an increase in the Respiratory Discomfort Syndrome and in mortality rates. It may also play an important role among the multi-factorial causes that compromise the neurological development of premature infants⁷.

CONCLUSION

Neonates require a neutral thermal surrounding for their optimal growth and development. Among the Neonatal outcomes, RDS constituted the biggest percentage of neonatal morbidity followed by Neonatal hyperbilirubinemia.

Birth weight of neonate carried a significant relationship with temperature at admission where increase in birthweight increases, temperature at admission.

These results add weight to the urgency of initiating interventions to maintain normothermia as soon as the VLBW preterm neonate is born. Additional and more aggressive interventions other than standard thermal management are needed in these most vulnerable populations. This study recommends the elaboration of an intervention bundle to better manage the thermal control of premature infants and the use of body temperature as an indicative of the quality of the attention offered.

REFERENCES

- Wilson E, Maier RF, Norman M, Misselwitz B, Howell EA, Zeitlin J, et al. Admission hypothermia in very preterm infants and neonatal mortality and morbidity. *J Pediatr*. 2016;175:61-7.e4. doi: <https://doi.org/10.1016/j.jpeds.2016.04.016>.
- Wagh AS, Jain N. Comparison of neonatal morbidities of late preterm with term born babies. *Journal of Pharmaceutical and Biomedical Sciences (JPBMS)* 2012;15(9):1-6
- Norman JE, Morris C, Chalmers J. The Effect of Changing Patterns of Obstetric Care in Scotland (1980–2004) on Rates of Preterm Birth and Its Neonatal Consequences: Perinatal Database Study. *PLoS Med*. 2009; 6(9): e1000153
- Laptook AR, Bell EF, Shankaran S, Boghossian NS, Wyckoff MH, Kandefer S, et al. Admission temperature and associated mortality and morbidity among moderately and extremely preterm infants. *J Pediatr*. 2018;192:53- 9.e2. doi: <https://doi.org/10.1016/j.jpeds.2017.09.021>
- Chang HY, Sung YH, Wang SM, Lung HL, Chang JH, Hsu CH, et al. Short- and long-term outcomes in very low-birth weight infants with admission hypothermia. *PLoS One*. 2015;10(7):e0131976.
- Lee NH, Nam SK, Lee J, Jun YH. Clinical impact of admission hypothermia in very low-birth weight infants: Results from Korean Neonatal Network. *Korean J Pediatr*. 2019;62(10):386-94.
- Seyum T, Ebrahim E. Proportion of neonatal hypothermia and associated factors among new-borns at Gondar University teaching and referral hospital, Northwest Ethiopia: a hospital based cross sectional study. *Gen Med*. 2015;3(4):1-7
- Kalengada PK, Mangalgi S, Pradeep GC. To assess the thermoregulation of neonates in the postnatal wards of the hospital: a prospective study. *Indian J Child Health*. 2016; 3(2):143-6.
- Byaruhanga R, Bergstrom A, Okong P. Neonatal hypothermia in Uganda: prevalence and risk factors. *J Tropical Pediatr*. 2005;51(4):212-5
- Ali SR, Mirza R, Qadir M, Ahmed S, Bhatti Z, Demas S. Neonatal hypothermia among hospitalized high risk newborns in a developing country. *Pak J Med Sci*. 2012; 28(1):4953.
- Mank A, van Zanten HA, Meyer MP, Pauws S, Lopriore E, te Pas AB. Hypothermia in preterm infants in the first hours after birth: occurrence, course and risk factors. *PLoS ONE*. 2016;11(11):e0164817. doi: <https://doi.org/10.1371/journal.pone.0164817>