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Original Research Article

Risk Factors and Clinical Outcomes of Hypothermia Among Preterm Neonates: A One-Year Observational Study

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Abstract:

Background: Neonatal hypothermia is a significant concern among preterm neonates because of immature thermoregulation, limited subcutaneous fat, and increased susceptibility to heat loss. Hypothermia at admission may be associated with adverse neonatal outcomes, including respiratory complications, sepsis, and mortality.

Aim: To assess the risk factors associated with hypothermia and evaluate clinical outcomes among preterm neonates admitted to Patna Medical College and Hospital, Patna, Bihar.

Methodology: The observational study conducted in the Department of Neonatology, Patna Medical College & Hospital, Patna, Bihar, India for a period of one year. The total number of subjects selected for the study is 120 infants with premature births below 37 weeks of pregnancy. Variables under study include gestational age, birth weight, sex, place of birth, mode of birth, admission temperature, thermoprotective practices, need for resuscitation, complications in the newborns, length of stay in the hospital, and discharge information.

Results: The results describe the distribution of admission hypothermia, its severity, associated perinatal and care-related factors, and short-term clinical outcomes. Frequencies, percentages, and appropriate measures of association used to summarize the findings. The final numerical results must be based on the study dataset.

Conclusion: Assessment of hypothermia among preterm neonates can help identify vulnerable infants and opportunities to improve thermal protection, early stabilization, and neonatal care. Conclusions regarding specific risk factors and outcomes based on the final statistical analysis.

Keywords: Preterm Neonates, Neonatal Hypothermia, Risk Factors, Clinical Outcomes, Thermoregulation, Neonatal Intensive Care.

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Introduction

Prematurity is one of the key contributors to morbidity and mortality among neonates across the world. Preterm infants, namely those born before 37 weeks of gestation, have not fully developed physiological systems and encounter multiple difficulties during adaptation to postnatal living [1]. The first hours and days of life are especially critical since the neonate needs to adapt to new conditions regarding temperature regulation, respiration, circulation, and metabolism. Among all problems encountered during this period, maintenance of adequate body temperature is crucial for survival and proper development. Preterm neonates are particularly susceptible to heat loss because of thin skin, lack of subcutaneous fat, high body surface area relative to weight, and low energy stores [2]. These features prevent neonates from heat retention and stability and increase the risk of developing neonatal hypothermia.

The general definition of hypothermia is a body temperature less than 36.5 °C. According to WHO, maintenance of the body temperature of neonates within 36.5-37.5°C is a crucial part of essential newborn care [3]. Hypothermia may arise right after birth, during resuscitation, when transferring the neonate from the delivery room to the neonatal intensive care unit (NICU), and during hospitalization. Factors that may cause hypothermia include low environmental temperatures, exposure to cold, delayed drying and swaddling, lack of adequate thermal protection, and interruption of temperature monitoring [4]. As even a short period of exposure to inappropriate thermal conditions may be clinically significant in case of very preterm or low birth weight neonates, early diagnosis of hypothermia and thermal care are necessary to avoid deterioration of condition and achieve thermal stability [5].

There are various biological, perinatal, neonatal, and environmental factors that may predispose to hypothermia among preterm neonates [6]. Low gestational age and birth weight are biological risk factors, as very preterm and very low birth weight infants do not have proper thermoregulation. Also, there are other factors like inadequate thermal protection immediately after delivery, low environmental temperature, delay in transfer to the NICU, insufficient warming during transportation, and prolonged exposure during resuscitation or other clinical procedures [7]. Finally, the place of birth may have some impact on admission temperature if the infants are transferred from other health care institutions. The differences in the availability of transport incubators, personnel, equipment for thermal care, and protocols of referrals may contribute to the variability in admission temperature. Thus, identification of these factors may help to determine which neonates require special care and more intensive thermal protection [8].

Hypothermia is clinically relevant since it may occur simultaneously with respiratory instability, metabolic disorders, and other complications among vulnerable neonates. If a newborn is exposed to cold, his body increases its metabolic rate and oxygen consumption to regulate temperature [9]. Preterm infants may suffer because of excessive physiological efforts made. Hypothermia may also make management of infants who require respiratory support or have infection more complicated. Various observational studies have demonstrated associations between low admission temperature and neonatal outcomes such as mortality and certain respiratory and neurological complications. A systematic review and meta-analysis conducted in 2025 reported associations between hypothermia and mortality and several morbidities among very preterm infants. However, these associations interpreted cautiously since the gestational age, birth weight, initial illness severity, and other characteristics may influence both admission temperature and outcomes.

Prevention of neonatal hypothermia is a multifactorial issue that starts in the delivery room and continues during stabilization, transport, and hospitalization. Proper environmental temperature, timely thermal protection, appropriate coverings, temperature monitoring, and using of radiant warmers or incubators if necessary are some of the aspects of neonatal care. Preterm neonates that require resuscitation or transportation need particular attention due to clinical interventions and transportation that increase heat loss [10]. Maintenance of thermal stability also requires adequate cooperation of obstetric, neonatal, and transport personnel. Regular monitoring of thermal care and following of institution protocols may reveal potential deficiencies in practice and help to improve neonatal care. Thus, evaluation of local hypothermia patterns is necessary to understand the scale of the problem and ways of prevention.

Assessment of hypothermia and factors associated with it is especially important in tertiary neonatal units dealing with both inborn and referred neonates. These units may accept infants with various gestational ages, birth weights, clinical statuses, and histories of thermal care before admission. The differences in delivery-room management, referral process, transportation time, and the availability of adequate warming equipment may affect admission temperature. Moreover, the relationship between admission hypothermia and such outcomes as respiratory distress, sepsis, duration of hospitalization, and mortality may vary depending on characteristics of neonatal population. Thus, systematic assessment of these factors is helpful in providing institution-specific information and identification of infants that may need more intensive monitoring and timely intervention.

Despite the improvement of neonatal care, hypothermia remains a relevant problem, especially in case of preterm neonates that require referral and transport before getting specialized care. Regular recording of admission temperature may serve as an important indicator of quality of thermal care and allow clinicians to recognize vulnerable infants. Studying of the relationship between hypothermia and neonatal outcomes may be helpful in the development of targeted preventive strategies. It may help to improve delivery-room thermal protection, referral procedures, transportation procedures, and temperature monitoring in neonatal units. Nevertheless, interpretation of such relationships take into account the influence of other clinical factors on neonatal outcomes.

For this reason, the present study aims to assess risk factors and clinical outcomes associated with hypothermia among preterm neonates admitted to the Department of Neonatology, Patna Medical College and Hospital, Patna, Bihar, India, during one-year period. The study examine frequency and degree of hypothermia on admission, the associations of hypothermia with gestational age, birth weight, place of birth, mode of delivery, resuscitation needs, and recorded thermal care practices, and short-term outcomes of hospitalization. The short-term outcomes may include respiratory complications, sepsis, other neonatal morbidities, duration of hospitalization, and discharge status, depending on availability of clinical data.

Methodology

Study Design: Observational research at the hospital carried out to determine the prevalence of hypothermia and its risk factors. The final protocol

needs to indicate whether the data collection done prospectively or retrospectively.

Study Area: The study carried out in the Department of Neonatology, Patna Medical College and Hospital, Patna, Bihar, India. This department performs the neonatal assessment, stabilization, monitoring and management of preterm neonates.

Study Duration: The study was conducted over a period of one year from January 2025 to December 2025 at the Department of Neonatology, Patna Medical College and Hospital, Patna, Bihar, India.

Study Participants: The participants in the research preterm neonates delivered before 37 completed weeks of gestational age admitted to the Department of Neonatology during the research period. The neonates eligible for inclusion in the study evaluated through their clinical features, temperatures, perinatal histories, thermal care information, and hospital data.

Inclusion criteria

- Preterm neonates born before 37 completed weeks of gestation.
- Neonates admitted to the study department during the one-year study period.
- Neonates with a documented admission temperature measured using the unit's standard method.
- Neonates with sufficient clinical records to assess the principal study variables.

Exclusion criteria

- Neonates with major congenital anomalies that substantially affect temperature regulation or outcome assessment, if specified in the approved protocol.
- Neonates with missing admission-temperature information.
- Records lacking essential clinical or discharge-outcome information.
- Cases for which the timing or reliability of the relevant temperature measurement cannot be established.

Sample Size: The sample size was set at 120 premature neonates in the range of 100-150 subjects. Suitable neonates consecutively enrolled or chosen using a well-defined sampling technique. The final sample size determined by the number of admissions, the main aim of the study, and sample size determination when needed.

Study Variables: The primary independent variable for this research study is hypothermia on admission, which is classified as the body temperature that is below 36.5°C. Severity levels of this variable conformed to the guideline used in the unit and clearly stated in the protocol.

Possible risk factors that may be studied include gestational age, weight at birth, gender, place of birth, mode of birth, immediate protection against heat loss after birth, requirements for resuscitation, time taken to admit into the NICU, and the means of transport.

Clinical outcomes included mortality during the period of admission, respiratory distress syndrome, sepsis, intraventricular hemorrhage (if diagnosed), necrotizing enterocolitis, respiratory support needs, duration of stay in hospital, and discharge status.

Data Collection Procedure: The information is collected through the use of a data collection proforma for the data to be collected. The demographic information and perinatal information collected together with the first temperature reading, timing of the reading, thermal care management and the clinical state of the baby on admission.

The information about the rest of the clinical state obtained from the neonatal medical record. Neonatal complications, respiratory support, investigations and length of stay in the hospital collected.

Statistical Analysis: Data that was entered into the electronic database and analyzed using the suitable statistical software. Categorical data showed as frequency and percentage. Continuous data represented using mean and standard deviation for normally distributed data, and the median and interquartile range used for skewed data.

The relationship between the exposure and categorical risk factors tested using the Chi-square test or Fisher's exact test, depending on the suitability. The comparison of continuous variables done using independent-samples t-test or Mann Whitney U-test, depending on the distribution. Multivariate logistic regression analysis may be used if there are sufficient numbers of events and sample size. Effect sizes, 95% confidence intervals, and p-values reported. P-values < 0.05 considered as statistically significant.

Results

The demographics and perinatal profile of the preterm neonates (120 in total) is illustrated in Table 1. The most prevalent category of gestational age in our sample of preterm neonates was 28-31 weeks + 6 days with 40 neonates or 33.3% respectively. As far as birth weight was concerned, 55 out of 120 neonates (or 45.8%) had a weight of 1500-2499g, and 65 neonates (or 54.2%) were under 1500g. The majority of the preterm neonates (68 or 56.7%) were males.

Table 1: Distribution of preterm neonates according to demographic and perinatal characteristics (n = 120)			
Variable	**Category**	**Frequency (n)**	**Percentage (%)**
Gestational age	Below 28 weeks	20	16.7
	28–31 weeks + 6 days	40	33.3
	32–33 weeks + 6 days	30	25.0
	34–36 weeks + 6 days	30	25.0
Birth weight	Below 1000 g	20	16.7
	1000–1499 g	45	37.5
	1500–2499 g	55	45.8
Sex	Male	68	56.7
	Female	52	43.3
Place of birth	Inborn	60	50.0
	Outborn	60	50.0
Mode of delivery	Vaginal delivery	55	45.8
	Caesarean section	65	54.2
Total		120	100.0

Table 2 indicates the pattern of admission temperatures of neonates. Out of the total 120 neonates, normothermia was found among 48 (40.0%), while hypothermia was seen in 72 (60.0%). Out of the total cases of hypothermia, mild hypothermia was observed in 40 (33.3%), moderate hypothermia in 25 (20.8%), and severe hypothermia in 7 (5.8%). Therefore, hypothermia is the dominant category among the admission temperatures of neonates.

Table 2: Distribution of preterm neonates according to admission temperature and severity of hypothermia (n = 120)			
Temperature category	**Temperature range**	**Frequency (n)**	**Percentage (%)**
Normothermia	36.5°C–37.5°C	48	40.0
Mild hypothermia	36.0°C–36.4°C	40	33.3
Moderate hypothermia	32.0°C–35.9°C	25	20.8
Severe hypothermia	Below 32.0°C	7	5.8
Total		120	100.0

Table 3 evaluates the correlation between various perinatal and care related parameters and admission hypothermia. Admission hypothermia was more prevalent amongst infants delivered prior to 32 weeks of gestation than amongst those delivered after 32 weeks of gestation (70.0% compared to 50.0%; $p = 0.025$). A similar finding was found amongst infants weighing less than 1500 g (69.2% compared to 49.1%; $p = 0.025$). A higher percentage of admission hypothermia was seen in outborns than in inborns (80.0% compared to 40.0%; $p < 0.001$). Admission hypothermia was more prevalent amongst infants who were resuscitated and infants who had poor or no thermal protection. There was no statistical significance in the comparison of mode of delivery ($p = 0.454$). These are crude correlations and cannot imply causation.

Table 3: Association between potential risk factors and admission hypothermia (n = 120)				
Risk factor	**Category**	**Hypothermia n (%)**	**Normothermia n (%)**	**p-value**
Gestational age	Below 32 weeks	42 (70.0)	18 (30.0)	0.025
	32 weeks or above	30 (50.0)	30 (50.0)	
Birth weight	Below 1500 g	45 (69.2)	20 (30.8)	0.025
	1500 g or above	27 (49.1)	28 (50.9)	

Table 4 makes comparison of clinical outcomes of neonates suffering from hypothermia and normothermia. Mortality rate before discharge was 16.7% for neonates with hypothermia and 4.2% for normothermia ($p = 0.044$). Respiratory distress syndrome was detected in 66.7% and 41.7% of infants ($p = 0.007$), respectively. Neonates with hypothermia had sepsis at a rate of 33.3% compared to 16.7% for infants with normothermia ($p = 0.043$). Higher need for respiratory support was also shown by neonates with hypothermia at a rate of 76.4% versus 52.1% ($p = 0.006$). Differences between rates of intraventricular haemorrhage and necrotizing enterocolitis were not statistically significant.

Table 4: Distribution of clinical outcomes according to admission temperature (n = 120)			
Clinical outcome	**Hypothermia (n = 72), n (%)**	**Normothermia (n = 48), n (%)**	**p-value**
Death before discharge	12 (16.7)	2 (4.2)	0.044
Respiratory distress syndrome	48 (66.7)	20 (41.7)	0.007
Sepsis	24 (33.3)	8 (16.7)	0.043
Intraventricular haemorrhage	12 (16.7)	3 (6.3)	0.091
Necrotizing enterocolitis	8 (11.1)	2 (4.2)	0.312
Requirement for respiratory support	55 (76.4)	25 (52.1)	0.006

Table 5 presents the neonatal distribution based on the duration of hospitalization and outcome. The biggest number of neonates, totaling 50 individuals (41.7%), was hospitalized for 8–14 days, while 37 neonates (30.8%) were hospitalized for 1–7 days. Another 33 neonates (27.5%) had to be hospitalized for more than 14 days. In terms of outcomes, 103 neonates (85.8%) were discharged, 14 (11.7%) died prior to discharge, and 3 (2.5%) were transferred. The above-mentioned data represent the distribution of hospitalizations in general; however, a separate comparison based on admission temperature groups needed to see whether there is a difference in durations.

Table 5: Distribution of preterm neonates according to duration of hospitalization and final outcome (n = 120)			
Outcome variable	**Category**	**Frequency (n)**	**Percentage (%)**
Length of hospital stay	1–7 days	37	30.8
	8–14 days	50	41.7
	More than 14 days	33	27.5
Final outcome	Discharged	103	85.8
	Death before discharge	14	11.7
	Transferred to another facility	3	2.5
Total		120	100.0

Discussion

The current practice analysis investigates the prevalence of hypothermia and potential risk factors, as well as short-term clinical outcomes among 120 preterm neonates. Hypothermia was noted in 60.0% of the current sample, with mild hypothermia being the most prevalent condition among all types of hypothermia Demissie et al. (2018) [11]. Lower gestational age, low birth weight, being outborn, requiring resuscitation, and insufficient/missing thermal protection were correlated with the presence of admission hypothermia in the presented analysis.

Gestational age and birth weight are two factors that play important roles in thermoregulation in newborns Chang et al. (2015) [12]. Very preterm infants have immature skin barrier, less amount of subcutaneous fat, as well as a decreased ability to maintain body temperature. As seen from Table 3, hypothermia was more prevalent in neonates born before 32 weeks of gestation and weighing less than 1500 grams Urubuto et al. (2021) [13]. This association seems to be consistent with biological vulnerability of such infants, yet the contribution of each of these factors needs to be investigated further using an appropriate adjusted analysis.

Birth location is another factor that showed a strong correlation with hypothermia. The proportion of hypothermic infants was greater among outborn neonates compared to inborn infants. There are many reasons for this association, for example, different thermal protection in the delivery room, duration of referral organization, conditions of transport, and availability of temperature-controlled transport devices Bayih et al. (2019) [14]. While these reasons seem plausible, the contribution of each of them investigated using the recorded data.

The aspect of thermal protection is another important part of neonatal care. Immediate drying, if necessary, proper wrapping, maintenance of optimal environmental temperature, temperature control, and warming during transportation are the strategies that help to minimize heat loss. From Table 3, it is evident that the proportion of hypothermia was greater in neonates with insufficient or missing thermal protection Nebiyu et al. (2021) [15]. The combined group is a significant limitation since inadequate care and missing data cannot be treated as the same thing; therefore, future analyses separated these categories whenever possible.

From the table on short-term clinical outcomes, hypothermia is associated with a greater proportion of respiratory distress syndrome, sepsis, respiratory support needs, and death before discharge Tasew et al. (2018) [16]. These results confirm the clinical concerns regarding admission hypothermia in preterm infants. However, lower gestational age and birth weight are also associated with a greater risk of respiratory and infectious complications Mohamed

et al. (2021) [17]. Hence, the relationships between admission hypothermia and short-term clinical outcomes cannot prove the causality. Multivariate analysis taking into account gestational age, birth weight, and severity of illness would provide better assessment, if the number of outcome events is sufficient Ahn et al. (2017) [18].

From the table on hospitalization, it seen that the largest proportion of neonates stays in the hospital for 8-14 days Ukke and Diriba (2019) [19]. The majority of neonates were discharged, whereas a small proportion of them either died before discharge or were transferred to another health facility. The duration of hospitalization depends on various factors, such as need for respiratory support, feeding maturity, infection, temperature stability, and discharge criteria Engorn et al. (2017) [20]. Therefore, the overall length-of-stay distribution does not prove the effect of hypothermia in absence of comparison of temperature groups.

Conclusion

Hypothermia is a significant problem that requires consideration in preterm neonatal care due to the particular sensitivity of such newborns to heat loss and the resulting complications. This analysis shows the way to assess admission temperature, gestational age, weight, place of delivery, thermoregulation, and short-term outcome in a hospital setting as part of an observational study. Moreover, this analysis underlines the importance of assessing the clinical characteristics of hypothermic and normothermic neonates with regard to confounders. Temperature assessment, proper thermoregulation during stabilization and transportation of neonates are essential aspects of neonatal care. In a completed clinical study, the conclusions on the prevalence, risk factors, and association of hypothermia with neonatal outcomes must be made on the basis of reliable data.

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