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Efficacy of Polyethylene Wrap in Prevention of Hypothermia in Very Preterm and Very Low Birth Weight Neonates at Birth

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ABSTRACT

Background: Hypothermia is a significant risk factor for morbidity and mortality in very preterm and very low birth-weight neonates. Effective interventions to prevent hypothermia are critical in improving neonatal outcomes.

Objective: To determine the efficacy of polyethylene wraps in preventing hypothermia compared to standard care in very preterm and very low birth-weight neonates.

Methods: This quasi-experimental study was conducted from July 2023 to June 2024 at the Department of Paediatrics, Combined Military Hospital, Peshawar. A total of 198 neonates were randomly assigned to two groups: Group A (polyethylene wrap) and Group B (standard care). Axillary temperatures were recorded at specified intervals from birth to 24 hours. Hypothermia was defined as an axillary temperature <36.5°C, and its severity was classified as mild, moderate, or severe.

Results: Hypothermia occurred in 85.9% of neonates in Group A and 88.9% in Group B (p=0.521). Polyethylene wraps maintained significantly higher temperatures from 45 minutes post-birth onward (p<0.05) and reduced the need for additional interventions (p=0.001).

Conclusion: Polyethylene wraps effectively reduce the frequency of hypothermia-related interventions in very preterm and very low birth-weight neonates but do not significantly impact the overall incidence or severity of hypothermia.

INTRODUCTION

Premature delivery is a significant concern in neonatal care, occurring in approximately 15.7% of all births in Pakistan, with low birth weight affecting an estimated quarter of all births in the country (1, 2). These conditions place neonates at heightened risk for several complications, including respiratory distress syndrome, intraventricular hemorrhage, necrotizing enterocolitis, and hypothermia (1-3). The underlying causes of inadequate thermoregulation in these neonates are multifaceted and include factors such as immature skin development, low subcutaneous fat reserves, poor vasomotor control—particularly of cutaneous blood vessels—decreased heat production, a high surface area-to-weight ratio, and a high total body water content (4). Hypothermia in neonates can lead to severe and potentially life-threatening complications, including bradycardia, hypotension, cardiac arrhythmias, impaired surfactant production, poor distal tissue oxygenation, electrolyte imbalances, metabolic acidosis, coagulopathy, poor tolerance to enteral feeds, hypoglycemia, seizures, coma, and death (5, 6).

Given the severe consequences of hypothermia, it is critical to initiate warming measures for affected neonates as early as possible to prevent these complications (7). The decision to employ specific warming strategies typically depends on the severity of hypothermia. Mild hypothermia (36.0–36.4°C) is generally managed with skin-to-skin contact care or by placing the neonate in a room with a high ambient temperature (7, 8). Moderate hypothermia (32.0–35.9°C) may require additional interventions such as incubators or radiant heaters, while severe hypothermia (<32.0°C) may necessitate the use of temperature-controlled mattresses or convection incubators (7, 8). Among the various methods to manage neonatal hypothermia, polyethylene wraps offer a simple, cost-effective, and readily available option. These wraps work by reducing heat loss through convection, forming an insulating layer, and preventing water loss, although their efficacy is contingent upon the neonate's ability to generate some heat (9, 10).

This study aimed to evaluate the effectiveness of polyethylene wraps in reducing the incidence of hypothermia among very preterm neonates with very low birth weight, compared to standard care. While polyethylene wraps have been studied in neonates with normal or near-normal gestation and birth weights, there is a lack of research on their efficacy in very small and premature infants. This gap in knowledge is crucial because the diminished capacity of these neonates to produce their own heat could potentially undermine the primary mechanism by which polyethylene wraps function. Therefore, our study sought to address this gap by specifically focusing on a population of very preterm, very low birth-weight neonates to determine whether polyethylene wraps could provide a significant benefit in this vulnerable group.

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MATERIAL AND METHODS

This quasi-experimental study was conducted from July 2023 to June 2024 in the Department of Paediatrics at Combined Military Hospital, Peshawar. The study involved a total of 198 preterm neonates whose parents or guardians provided informed consent for participation. The sample was selected through consecutive non-probability sampling, and participants were randomly assigned to specific treatment arms using the block randomization method. The study was approved by the institutional ethical review board, and all procedures were conducted in accordance with the Declaration of Helsinki to ensure the ethical treatment of human subjects.

Eligible participants were neonates born before the completion of the 32nd week of gestation, with a birth weight of less than 1500 grams. Neonates born after 32 weeks of gestation, those with congenital anomalies, or those with an APGAR score of 7 or less at five minutes post-delivery were excluded. Additionally, neonates who died during the study period were excluded from the final analysis.

Upon delivery, the temperature of the delivery room or operating theater was maintained at 28°C, and each neonate was initially placed in a linen wrap pre-warmed to 38°C and transferred to a servo-controlled warmer. Neonates were thoroughly dried from head to toe using pre-warmed towels. In the intervention group, neonates were wrapped in a zip-lock polyethylene bag with the head exposed, while those in the control group were placed in a dry linen wrap with the head uncovered. If venous or sensor access was required, holes were made in the polyethylene bags or through the cloth in the control arm. Following initial stabilization, all neonates were transferred to the neonatal intensive care unit (NICU), where their heads were covered with caps for further management.

Temperature monitoring was conducted using a calibrated and control-tested digital thermometer placed in the axilla immediately after birth, then at 5, 10, 20, 30, 45, and 60 minutes post-birth, and subsequently at 2, 4, 6, 12, and 24 hours post-delivery. Hypothermia was defined as an axillary temperature of less than 36.5°C (11). Hypothermia severity was categorized as mild (36.0–36.4°C), moderate (32.0–35.9°C), and severe (<32.0°C) (11). Management of hypothermia varied according to its severity; mild cases were managed with skin-to-skin contact with the mother until temperature normalization, moderate cases were placed in an incubator, and severe cases were managed with a temperature-controlled mattress in addition to the interventions applicable to mild and moderate cases.

Data collected included gender, mode of delivery, and birth weight at the time of enrollment. The primary outcome was the development and severity of hypothermia within the first 24 hours post-delivery. The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to calculate means and standard deviations for quantitative variables, such as gestational age at delivery, birth weight, and axillary temperatures at various time intervals. Frequencies and percentages were used for qualitative variables, such as gender, mode of delivery, and the occurrence and severity of hypothermia. The Chi-square test was applied to compare qualitative variables between groups, while the independent samples t-test was used for quantitative variables. A p-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 198 neonates were enrolled in the study, with 99 neonates in each group. The demographic and clinical characteristics of the neonates are summarized in Table 1. The majority of the neonates were male, accounting for 58.6% (n=116) of the total sample. The mean gestational age at birth was 29.98 ± 1.23 weeks, and the mean birth weight was 1188.58 ± 193.19 grams. Vaginal delivery was the mode of delivery for 73.7% (n=146) of the neonates, while 26.3% (n=52) were delivered via caesarean section. There were no statistically significant differences between the groups in terms of gender distribution, gestational age, birth weight, or mode of delivery (p > 0.05).

Table 1. Patient Characteristics

Variable	Group A (n=99)	Group B (n=99)	p-value
Gender			
Males	60 (60.6%)	56 (56.6%)	0.564
Females	39 (39.4%)	43 (43.4%)	
Gestational Age (weeks)	30.01 ± 1.21	29.96 ± 1.25	0.773
Birth Weight (g)	1189.53 ± 195.57	1187.63 ± 191.76	0.945
Mode of Delivery			
Vaginal Delivery	75 (75.8%)	71 (71.7%)	0.518
Caesarean Section	24 (24.2%)	28 (28.3%)	

The primary outcome of the study was the occurrence and severity of hypothermia, as well as the axillary temperatures measured at specified time intervals. Table 2 provides a detailed comparison of the axillary temperatures between Group A (polyethylene wrap) and Group B (control) at different time points. At birth, the mean axillary temperature was comparable between the two groups (p=0.324). However, from 45 minutes post-birth onwards, the axillary temperature was significantly higher in Group A compared to Group B, with the difference remaining significant up to 24 hours post-delivery (p < 0.05). Hypothermia occurred in 85.9% (n=85) of neonates in Group A and 88.9% (n=88) in Group B, with no statistically significant difference between the groups in terms of the incidence of hypothermia

(p=0.521). However, the severity of hypothermia was not significantly different between the groups (p=0.773). Notably, neonates in Group A required fewer interventions to manage hypothermia compared to those in Group B (p=0.001), indicating that the polyethylene wrap was effective in reducing the number of hypothermic episodes that required additional interventions.

Table 2. Axillary Temperatures and Hypothermia Outcomes

Variable	Group A (n=99)	Group B (n=99)	p-value
Axillary Temperature at Birth (°C)	36.90 ± 0.26	36.94 ± 0.28	0.324
Axillary Temperature at 5 Minutes (°C)	36.84 ± 0.33	36.84 ± 0.33	0.983
Axillary Temperature at 10 Minutes (°C)	36.52 ± 0.55	36.47 ± 0.57	0.520
Axillary Temperature at 20 Minutes (°C)	36.44 ± 0.58	36.30 ± 0.61	0.082
Axillary Temperature at 30 Minutes (°C)	36.60 ± 0.60	36.45 ± 0.62	0.091
Axillary Temperature at 45 Minutes (°C)	36.88 ± 0.48	36.61 ± 0.61	0.001
Axillary Temperature at 60 Minutes (°C)	37.02 ± 0.49	36.76 ± 0.63	0.001
Axillary Temperature at 2 Hours (°C)	36.81 ± 0.50	36.56 ± 0.65	0.002
Axillary Temperature at 4 Hours (°C)	36.73 ± 0.49	36.48 ± 0.66	0.003
Axillary Temperature at 6 Hours (°C)	36.51 ± 0.49	36.27 ± 0.67	0.005
Axillary Temperature at 12 Hours (°C)	36.23 ± 0.53	36.00 ± 0.67	0.006
Axillary Temperature at 24 Hours (°C)	35.98 ± 0.55	35.75 ± 0.71	0.012
Development of Hypothermia	85 (85.9%)	88 (88.9%)	0.521
Severity of Hypothermia			0.773
None	14 (14.1%)	11 (11.1%)	
Mild	28 (28.3%)	27 (27.3%)	
Moderate	57 (57.6%)	61 (61.6%)	
Number of Interventions Needed	3.96 ± 3.31	5.67 ± 4.09	0.001

Overall, while the polyethylene wrap demonstrated a statistically significant effect in maintaining higher axillary temperatures after 45 minutes post-birth, it did not significantly reduce the incidence or severity of hypothermia compared to standard care. However, it did reduce the number of interventions needed to manage hypothermic episodes in very preterm, very low birth-weight neonates.

DISCUSSION

The present study evaluated the effectiveness of polyethylene wraps in preventing hypothermia among very preterm and very low birth-weight neonates. The results demonstrated that while the polyethylene wrap significantly maintained higher axillary temperatures compared to standard care, particularly after the first 45 minutes post-birth, it did not significantly reduce the overall incidence or severity of hypothermia. However, it was effective in reducing the number of interventions required to manage hypothermic episodes, which suggests a potential benefit in clinical practice.

The finding that polyethylene wraps maintained higher axillary temperatures aligns with previous studies that have shown the efficacy of such wraps in thermoregulation among preterm infants. For instance, Cardona-Torres et al. reported that polyethylene wraps were more effective than traditional care in maintaining body temperature, particularly 30 minutes after birth, which supports the temperature trend observed in the current study (15). Similarly, Nimbalkar et al. found that polyethylene wraps provided a significant thermoregulatory advantage as early as five minutes post-birth in a broader population of preterm neonates, though their study included a smaller proportion of very preterm infants compared to the present study (11). The delay in the significant temperature difference observed in our study could be attributed to the greater thermoregulatory challenges faced by very preterm neonates, who have immature thermoregulatory mechanisms and take longer to respond to interventions aimed at raising body temperature (16).

Despite the higher temperatures maintained by the polyethylene wraps, the lack of a significant reduction in the incidence or severity of hypothermia raises questions about the overall effectiveness of this intervention in very preterm neonates. While polyethylene wraps provide a barrier to heat loss through convection and evaporation, the underlying thermoregulatory challenges in very preterm neonates may limit the ability of this intervention to completely prevent hypothermia, especially in the absence of additional heat-generating mechanisms. This observation is consistent with findings from previous studies that emphasize the need for a multimodal approach to hypothermia management in this vulnerable population (19). The reduced number of interventions required in the polyethylene group, however, suggests that the wrap may play a role in stabilizing temperatures more effectively, thereby reducing the frequency of hypothermic episodes requiring further intervention. This could be particularly beneficial in resource-limited settings where advanced thermoregulatory equipment may not be readily available.

The study's strengths include its focus on a highly vulnerable population—very preterm and very low birth-weight neonates—who are at the greatest risk for hypothermia and its associated complications. Additionally, the use of a randomized, controlled design enhances the validity of the findings. However, the study also has several limitations. The quasi-experimental design, while robust, does not eliminate all potential confounders, and the requirement for additional interventions in hypothermic neonates may have

introduced some degree of bias into the results. The study also did not account for the potential impact of varying levels of exposure to ambient temperatures during frequent temperature monitoring, which could have influenced the outcomes. Moreover, the study was conducted in a single center, which may limit the generalizability of the findings to other settings with different environmental conditions and practices.

In light of these findings, further research is warranted to explore the effectiveness of polyethylene wraps in combination with other thermoregulatory interventions, such as the use of incubators or temperature-controlled mattresses, in preventing hypothermia in very preterm neonates. Future studies should also consider larger, multicenter trials to enhance the generalizability of the results and should include more detailed assessments of potential confounders, such as the frequency of temperature monitoring and ambient temperature variations. Additionally, investigating the long-term outcomes of neonates managed with polyethylene wraps could provide valuable insights into the sustained impact of this intervention on neonatal health.

CONCLUSION

In conclusion, while polyethylene wraps were effective in maintaining higher axillary temperatures and reducing the need for additional interventions in very preterm, very low birth-weight neonates, they did not significantly reduce the incidence or severity of hypothermia compared to standard care. These findings suggest that while polyethylene wraps are a useful component of hypothermia management, they should be used in conjunction with other supportive measures, particularly in neonates with severely impaired thermoregulatory capacity.

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