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A Combination of Plastic and Swaddle in Controlling Hypothermia in Infant Transfer at Hospital

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ABSTRACT

Premature and low birth weight babies are at risk of hypothermia admission, which is estimated at 39.8% of babies who arrive at the hospital shortly after referral. The handling of referral transfers of premature and low-birth-weight infants applies the principles of thermal care and comfort to maintain normothermia. This study aimed to evaluate the management of hypothermia in premature and low birth weight infants using a combination of plastic bags and swaddles. Controlling hypothermia admissions in infant transfer cases. The study used a nonequivalent control group design. The population in this study is premature and low birth weight infants. A total of 20 respondents were selected using the consecutive sampling technique. The research instrument was a hypothermia management observation sheet. The analysis used the T-test. The results showed a significant difference in body temperature between groups (p=0.000); there was a significant difference in body temperature between before and after (intervention p=0.002; control p=0.568). The combination of a plastic bag and a swaddle is safe to use in maintaining normal baby temperature during referral. This intervention is cost-effective, simple, and highly relevant, especially in facilities with limited resources.

INTRODUCTION

Hypothermia in newborns increases morbidity, such as hypoglycemia, hypoxia, metabolic acidosis, peri-intravascular bleeding, necrotic enterocolitis, sepsis, and bronchopulmonary dysplasia. It can even lead to a risk of death of around 1.64 times in babies in the neonatal intensive care unit (NICU). Hypothermia occurs when heat production and heat loss are imbalanced in infants. The WHO defines a normal body temperature for a newborn as 36.5–37.5°C. Babies born with low birth weight (LBW) are at high risk of hypothermia after birth (Cordeiro et al., 2021). Immediate postnatal wrapping with polyethylene plastic wrap consistently reduces the incidence of hypothermia and increases neonatal body temperature compared to conventional thermoregulatory care. The combined use of plastic wrap and swaddling minimizes heat loss through evaporation, convection, radiation, and conduction, thereby stabilizing neonatal core body temperature.

Premature and low birth weight babies do not have a complete thermoregulatory system, and they tend to have difficulty adjusting to changes in their environment. The baby's efforts in maintaining a normal body temperature can even pose a risk of lipolysis and glucogenesis. Infants require a significant amount of energy to maintain body heat, and they often experience energy deficiencies during this process, potentially disrupting brain growth and development and lung maturity. Nursing care aims to lower illness and death rates in premature and low birth weight babies by preventing hypothermia. This is done by managing the environment to help maintain the baby's body temperature (Sunandar & Aisah, 2024).

The mortality rate due to hypothermia in neonates weighing less than 2,000gr is 98% if the temperature is 32°C; 90% if the temperature is between 32°C and 35°C; and drops to 23% if the temperature can be maintained above 35°C (Roychoudhury & Yusuf, 2017). In several studies and reports from hospitals in Indonesia, it was found that a large number of babies who were referred arrived with low body temperature, and this happened differently in various places and among different groups. One study at Dr. Moewardi Regional Hospital in Surakarta examined 56 newborn babies who were referred and found that 60.7% had low body temperature upon arrival at the hospital (Rachmawaty et al., 2024). Infants undergoing procedures outside the NICU are at risk of hypothermia in up to 17% of 291 infants related to prolonged neonatal transport and the resulting variable environmental temperatures (Kenner, & Boykova, 2021).

WHO has identified support for controlling infant body temperature. Initial steps include maintaining adequate room temperature, providing infrared rays, plastic bags, hats, and respiratory support with heaters and humidified gas to prevent the baby from suffocating and experiencing hypothermia (Cordeiro et al., 2021). A hypothermic blanket is a product designed and manufactured as clothing for premature and low-birth-weight babies. This garment's inner layer is made of 1.2 mm thick polyethylene plastic and an outer layer of velvet fabric. The plastic layer protects the baby's body from heat. Direct contact with the cold surrounding environment, while velvet retains the baby's body heat to maintain warmth and prevent hypothermia due to evaporation from the environment. One intervention that can be given to babies with hypothermia is to wrap the baby in polyethylene plastic.

Plastic bags or wraps are effective and safe for preventing hypothermia in premature infants. Infants with gestational age <28 weeks had significantly higher initial and post-stabilization temperatures than unwrapped infants. This temperature increase resolved within an hour or two after removing the plastic wrap. Temperature increases were also found in babies aged between 28 to 34 weeks. The use of plastic reduces the incidence of hypothermia but does not reduce mortality, thus having a long-term impact on mortality (Asmarini & Rustina, 2021).

Plastic covers are inexpensive, effective, and simple to use without causing allergic reactions or skin irritation. Supporting research shows an increase in the average body temperature in the intervention group given the polyethylene cover method in neonates (pre-34.8°C to post-36.4°C) compared to the control group (pre-33.3°C to post-34.9°C). Thus, both can be alternative interventions to prevent hypothermia in LBW. The explanation of the advantages of the research describes the research findings as a plastic made of polyethylene that effectively and quickly controls body temperature, helping prevent hypothermia in premature infants. The difference in results was known after 24 hours of research (Morgaonkar et al., 2020).

Plastic bags or wraps are also effective in reducing the occurrence of hypothermia and increasing the intake temperature, especially for very premature newborns immediately after birth (Morgaonkar et al., 2020), and reducing the risk of moderate hypothermia during the transport process by 24.1%, which affects mortality and morbidity in premature neonates (Hu et al., 2017). To overcome all these challenges, researchers will provide an innovative application that combines the principles of thermal care and comfort using neo transfer swaddle made from a combination of plastic bag and swaddle is a baby sleeping bag with an ergonomic shape that can be adjusted to fit the baby's body shape, soft, warm covering the baby from head to toe, and equipped with adhesive to minimize the risk of over bundling. The neo transfer swaddle is safe for babies, making it a practical solution in areas with limited facilities and infrastructure. It does not require specialized skills so that it can be practiced quickly by health workers or the baby's mother.

The main challenge in managing referrals of infants with hypothermia, especially in primary healthcare facilities and regional hospitals, is that many perinatal care units have a limited number of incubators, often out of proportion to the number of infants requiring intensive thermal care. Furthermore, incubator distribution is also uneven. This leads to delays in temperature stabilization during referrals, an increased risk of continued hypothermia, and a reliance on alternative methods, such as occlusive dressings and swaddling.

The plastic layer protects the baby's body from direct contact with the cold environment and prevents heat loss, keeping the baby warm and preventing hypothermia from evaporation during the transfer process. This study aims to determine the effect of implementing research to maintain the baby's body temperature between 36°C - 38°C. The newborn's vital signs, including pulse rate, oxygen saturation, respiratory rate, and blood sugar levels, were recorded before and upon arrival. The newborn's temperature was monitored every 30 minutes while the newborn was in the neo transfer swaddle for at least 120 minutes outside the incubator, during the transfer process, and during emergency transport.

METHOD

The study used quantitative research and a quasi-experimental design with a nonequivalent control group. The population in this study is premature and low birth weight infants. Twenty respondents were selected using nonprobability sampling with consecutive sampling. Inclusion criteria were based on referral cases: premature and low-birth-weight infants. Inclusion criteria: Newborns with a gestational age of 24-36 weeks; Newborns with a birth weight of 500-2500gr; Newborns with an Apgar score >7; mothers and family members were informed about the study details, and the hospital ethics committee approved the study. The consent form was signed voluntarily. Exclusion criteria: Newborns requiring mechanical ventilation for life support; newborns with severe skin damage; patients who had to discontinue the trial for various reasons. Respondents were divided into two groups: the control group received treatment with standard plastic bags, while the intervention group received neo transfer swaddles.

The research instrument was a hypothermia management observation sheet to assess body temperature, random blood sugar, and oxygen saturation. The neo transfer swaddle tool is an innovative intervention model combining a plastic bag and a polyethylene swaddle, specifically for hypothermic baby blankets that are safe for babies. The respondent's family will first be explained the procedure. Implementation is carried out in accordance with established standard operating procedures. The procedure is quoted from several previous studies. Some aspects of monitoring infant safety during the intervention include checking body temperature before the procedure, observing vital signs, circulation, and signs of hypothermia, and monitoring body temperature and vital signs every 30 minutes. Analysis using a T-Test to determine the effect of a combination of plastic bag and swaddle blanket design on controlling normothermia during infant transfer in a case. This research has been reviewed by the RSUDAM and received ethical approval under number 567/KEPK-RSUDAM/VII/2025.

RESULTS

The study found that the intervention group had an average birth weight of 1579gr, with half of the births weighing 1500gr. The average GDS value is 126g/dL, ranging from 74 g/dL to 177g/dL. The mean peripheral pulse was 149 beats per minute. The mean oxygen saturation was 95%: the average body temperature before was 36.4°C, and the body temperature after was 37.1°C.

The control group had an average birth weight of 1888gr, and half of the group had a birth weight of 2088gr. The average GDS value was 101g/dL, ranging from 39 to 223g/dL. The average peripheral pulse was 172 beats per minute. The average oxygen saturation was 86%. The average body temperature before and after 36.5°C was 36.5°C, as shown in Table 1.

Table 1 shows that the average value of the baby's birth weight and peripheral pulse frequency was lower than that of the control group; the GDS reference value of the intervention group was above the reference value (reference value 50-110 gr/dl); oxygen saturation and body temperature were normal. The study found that the average body temperature increased in the intervention group before and after, while it did not change in the control group.

Table 1. Distribution of respondents based on birth weight, GDS, peripheral pulse, SpO2, body temperature before and after

Variable	Group	n	Mean	Med	SD	Min	Max
Birth Weight	I	10	1579	1500	461.458	870	2280
	K	10	1888	2088	576.954	850	2500
Blood Sugar	I	10	126	126	31.550	74	177
	K	10	101	87	51.524	39	223
Peripheral Pulse	I	10	149	150	16.308	126	184
	K	10	172	172	14.547	151	198
SpO2	I	10	95	96	3.742	87	99
	K	10	86	92	13.930	60	97
Pre body temperature	I	10	36.4	36.5	0.637	35.4	37.2
	K	10	36.5	36.5	0.543	36	38
Post body temperature	I	10	37.1	37.2	0.364	36.5	37.5
	K	10	36.5	36.5	0.346	36	37

Table 2. Distribution of body temperature differences before and after in the intervention and control groups

Body Temperature	Mean	SD	p-value	n
Intervention groups				
Pre	36.4	0.637	0.003	10
Post	37.1	0.364		
Control groups				
Pre	36.5	0.543	0.796	10
Post	36.5	0.346		

Table 2 shows the difference in average body temperature before and after the intervention in the intervention group was 0.7 °C. The results of the paired t-test showed p=0.003<0.005, indicating a significant difference between the before and after conditions. Meanwhile, in the control group, the average body temperature did not change before and after; the results of the Wilcoxon test showed a p-value of 0.796 (>0.005), indicating no significant difference between before and after.

Table 3. Temperature difference distribution body after between groups

Body Temperature	Mean	SD	p-value	n
Intervention groups	37.1	0.364	0.004	10
Control groups	36.5	0.346		10

Table 3 shows a significant difference in body temperature between the control and intervention groups (p=0.004).

DISCUSSION

Distribution of body temperature differences before and after in the intervention groups

The study results showed that babies who received the combined plastic wrap and swaddle intervention showed a 0.7°C increase in body temperature. The use of plastic wrap and swaddles helps maintain the baby's body temperature. This combination of interventions can prevent heat loss through evaporation, conduction, and convection. Research shows that wrapping babies right can make their temperature higher and lower the chance of getting too cold compared to usual care. However, it is important to check their temperature often because there is a small risk of overheating (Ramaswamy et al., 2023; Pratiwi et al., 2024).

Newborns are highly susceptible to hypothermia because of their limited ability to regulate body temperature, primarily due to their underdeveloped thermoregulatory system. Newborns have a larger surface area-to-weight ratio, which increases the body's rate of heat loss through various mechanisms such as conduction, convection, and evaporation. Additionally, newborns have a thin layer of subcutaneous fat, often with limited brown adipose tissue, which is the primary source of heat production. Newborns cannot yet shiver, the primary thermoregulatory tool used by adults. Newborns are at risk of developing hypothermia due to their inability to maintain body temperature. A baby's body loses heat quickly through evaporation because the entire body is still covered in amniotic fluid. If the baby is not dried, wrapped, or placed in skin-to-skin contact right away, their body temperature can drop very fast. Other factors, like a cold room, touching cold surfaces such as a resuscitation table or scale, waiting too long to dress or cover the baby, and not keeping the baby's temperature steady during resuscitation and stabilization, can also make hypothermia more likely. Premature babies are especially at risk because they have thinner skin, lose more moisture through it, have less brown fat for warmth, and cannot respond properly to temperature changes through their metabolism. These factors together make babies very sensitive to changes in their surroundings, so it is important to provide consistent and proper warmth from the moment they are born until they are stable (Darmstadt et al., 2023; Thairu et al., 2022).

The study results showed that body temperature after intervention is 37.1°C in a low birth weight (LBW) infant at referral, within the normal body temperature range according to the WHO (36.5–37.5°C). In LBW infants, a temperature of 37.1°C indicates stable thermoregulation, meaning the infant's body can still maintain heat despite a very high risk of heat loss. LBW infants have a larger body surface area compared to their body mass, a skinny subcutaneous fat layer, and a suboptimal brown fat mechanism, making them susceptible to hypothermia during transfer or referral. Therefore, a temperature of 37.1°C indicates that interventions to prevent heat loss—such as occlusive plastic, swaddling, hats, or skin-to-skin contact—are successfully maintaining the temperature within safe limits. However, this temperature must still be closely monitored during the referral process, as exposure to cold air, long transportation, or poor room ventilation can quickly lower it, potentially causing the infant to enter a phase of cold stress or hypothermia.

Distribution of body temperature differences before and after in the control groups

The study found that the average body temperature did not change or increase. However, a minimum body temperature of 36°C and a maximum of 37°C were observed. These results indicate that the body temperature of infants in the control group was essentially normal. Cloth swaddling alone during referral did not increase body temperature. Therefore, cloth swaddling alone should only be considered if the infant does not require strict hypothermia management. The lack of a difference in body temperature before and after in the control group indicates that cloth swaddling helps maintain body temperature only by preventing heat loss through convection.

A body temperature of 36.5°C in a low birth weight (LBW) infant at the time of referral is at the lower end of the normothermic range recommended by the World Health Organization, indicating a condition highly vulnerable to a temperature drop and at risk of hypothermia. LBW infants have a relatively larger body surface area, less brown fat, and thin skin that facilitates heat loss, severely limiting their ability to regulate body temperature, particularly during medical transportation (Darmstadt et al., 2023).

Babies who are swaddled in just cloth usually do not get warmer because cloth swaddling does not block heat loss very well. It allows heat to escape through evaporation, convection, and radiation. Newborns, especially those with low birth weight, have a large body surface area and not much brown fat, which makes it hard for them to generate body heat without shivering. Swaddling in cloth only helps keep the baby warm by trapping heat, but it does not produce more heat. So, if a baby is already too cold, swaddling in cloth alone will not help raise their body temperature. According to Pujiani et al (2023), swaddles help reduce heat loss through conduction and radiation, but are not as effective as plastic in preventing evaporative heat loss. Additionally, non-occlusive fabrics do not block conduction or convection well, allowing cold air

from the environment to remove heat from the baby. Therefore, using only non-occlusive swaddling is not effective at raising body temperature, particularly in low-birth-weight infants, who have a minimal ability to regulate their body temperature.

Temperature difference distribution body after between groups

Hypothermia in admitted infants is a serious problem that can increase the risk of death in newborns. Preventive measures such as keeping the infant warm before being admitted, maintaining warmth during transport, and quickly detecting and managing the complications upon admission are situations that can reduce neonatal mortality and morbidity. The application that combines the principles of thermal care and comfort using the neo transfer swaddle is made from a combination of plastic bag and swaddle is a baby sleeping bag with an ergonomic shape that can be adjusted to fit the baby's body shape, soft, warm covering the baby from head to toe, and equipped with adhesive to minimize the risk of over bundling.

The neo transfer swaddle is safe for use by infants, providing a practical solution in areas with limited facilities and infrastructure. It does not require specialized skills, allowing it to be quickly implemented by healthcare workers or mothers. The implementation of this innovative design intervention is a test of the neo transfer swaddle's effectiveness, based on a review of previous research, including "Plastic blankets as temperature stabilizer for premature low birth weight (LBW) baby" (Sunandar & Aisah, 2024); "Quality improvement approach to reducing admission hypothermia among preterm and term infants" (Sprecher et al., 2021); "Implementation of a temperature bundle improves admission hypothermia in very-low-birth-weight infants in China: a multicenter study"(Wang et al., 2022); "Evaluation of two polyethylene bags in preventing admission hypothermia in preterm infants: a quasi randomized clinical trial" (Possidente et al., 2023); "Effect of Using Polyethylene Plastic Bags against Increased and Stable Body Temperature in Low Birth Weight Babies (LBW) in the NICU Room of SLG Kediri Hospital" (Yalestyarini et al., 2024).

Several studies have found that the use of plastic wrap is the cheapest innovation to prevent hypothermia in LBW babies. This plastic wrap is widely used despite limited resources due to its affordability and accessibility. The American Heart Association recommends placing LBW babies born before 30 weeks of gestation in a plastic bag or wrapped immediately after birth. These materials should cover the baby's neck. Next, the baby's head should be covered with a cap. All subsequent resuscitation measures should be performed through a plastic bag. The critical drop of body temperature in neonates is termed "hypothermia" and increases the risk of morbidity and mortality. To minimize hypothermia during delivery room-to-nursery transportation, we trialed appropriate alternatives: aluminum-coated fabric (ACF), cotton swaddle, and their combination (Chanvorachote et al., 2022).

The World Health Organization defines neonatal hypothermia as a core temperature below 36.5 °C, categorizing it as mild (36–36.4 °C), moderate (32–35.9 °C), or severe (<32 °C). It is widely demonstrated that neonatal hypothermia at the time of admission has significant prognostic implications, and several multicenter observational studies showed an inverse relationship between admission temperatures and in-hospital mortality (Baracetti et al., 2025).

This approach reduces heat loss and maintains adequate humidity. Plastic wrap should be considered to increase the body temperature of low birth weight infants with hypothermia. Plastic is flexible, waterproof, and airtight. In addition, plastic is usually transparent, making it easier to monitor the baby (Roychoudhury & Yusuf, 2017). The results of the study "The effectiveness of using plastic wrap and cloth swaddle methods to increase the body temperature of low-birth-weight infants with hypothermia" showed no significant difference in the increase in the baby's body temperature between using plastic wrap and cloth swaddling (Pujiani et al., 2023). Swaddling involves wrapping a baby, especially a newborn, in a blanket or swaddling cloth. This technique is said to make the baby feel comfortable, warm, and protected, as if they were in the womb or being held tightly. This helps the baby feel calmer and sleep more soundly. However, swaddling has a side effect, namely, sudden infant death syndrome. Research shows that swaddling effectively increases body temperature. However, the resulting increase in body temperature is less than that produced by the skin wrap intervention.

Babies born prematurely and babies with low birth weight are often at high risk of hypothermia. This is due to the immature development of the body's temperature-regulating system, a thin subcutaneous fat layer, and a large body size relative to their weight. Hypothermia can be detrimental to a baby's health and can even be fatal, so it is important to have adequate care. A good way to maintain the baby's body temperature immediately after birth. Conventional methods such as incubators or radiant heaters are not always available, especially in hospitals with limited resources. Therefore, simple, inexpensive, and practical solutions, such as using sterile plastic bags and baby-wrapping techniques, can be a good choice.

A plastic bag is used by placing the baby's body (except the head) inside. The plastic bag helps reduce heat loss due to evaporating fluids. A baby in a plastic bag creates a space similar to a small incubator with controlled humidity. The use of plastic bags is considered practical, inexpensive, and readily available. Meanwhile, swaddling is a method of wrapping a baby in cloth to reduce moisture loss. Heat is transferred through the air and contact with cool surfaces. Swaddling makes babies feel secure, maintains their body position, and helps maintain a stable body temperature. Swaddling should be done with a clean, dry, and warm cloth, ensuring the baby can breathe comfortably. Combining these two methods is considered more effective because it addresses various ways of heat loss.

Research shows that using a combination of a plastic bag and a swaddle for premature and low-birth-weight babies can better maintain their body temperature and prevent hypothermia than using the bag alone. This combination is a simple, effective, and inexpensive way to maintain the body temperature of premature and low-birth-weight babies, especially in settings with limited facilities. This method reduces the risk of hypothermia by protecting against heat loss due to evaporation, conduction, and convection.

CONCLUSION

The combination of a plastic bag and a swaddle is safe to use in maintaining normal baby temperature during referral. This intervention is cost-effective, simple, and highly relevant, especially in facilities with limited resources. Practitioners can use this combination to help healthcare services with limited facilities and infrastructure, and it does not require special skills.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

ISP: Writing original draft, visualization, conceptualization; **YL:** writing original draft (supporting); **DY:** visualization (equal); **GA:** Supervision (lead), validation (equal).

Availability of data and materials

All data are available from the authors.

Competing interests

The authors declare no competing interests.

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