RESEARCH PAPER

Effect of Kangaroo Mother Care Transport in Preventing Moderate Hypothermia in Low Birth Weight Babies During Transportion to Home After Discharge: *A Randomized Controlled Trial*

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Background: Transport of neonates is often neglected, which results in high mortality of neonates during transport.

Objective: To determine the effectiveness of kangaroo mother care (KMC) in terms of hypothermia prevention during transport from hospital to home for low birth weight neonates.

Study design: Randomized controlled trial.

Participants: A total of 152 low birth weight neonates being discharged from the neonatal intensive care unit of our hospital between March, 2021 and August, 2022.

Intervention: Neonates in the study group (*n*=76) received KMC during transport from the hospital to home, while the control group (*n*=76) did not receive KMC during transport. Axillary temperature was recorded in both groups at the time of discharge, every 5 minutes during transport, and on reaching home.

Outcomes: Hypothermia episodes in neonates while receiving KMC compared to neonates not receiving KMC.

Results: Primary endpoint of the study was moderate hypothermia. During transport, 23 (30.3%) neonates in the control group experienced moderate hypothermia during transport, which was statistically significant [0% vs 30.3%; *P*<0.001]. From 10 minutes of transport till the neonates reached home, the mean (SD) temperature in the study group was significantly higher than in the control group [36.8 (0.23) °C vs 36.6 (0.3) °C; *P*<0.001] at time 15 minutes. Similar results were noted in preterm neonates [36.7 (0.25) °C vs 36.5 (0.29) °C; *P*<0.001] at time 15 minutes. The number of hypothermia episodes was more in the control group than in the study group during most of the transport time [7.6% vs 43.2%; *P*<0.001] at time 15 minutes.

Conclusions: Low birth weight neonates receiving KMC showed optimal thermoregulation, whereas a high incidence of moderate hypothermia was seen among neonates receiving conventional care during transport.

Keywords: *Ambulance, Outcome, Skin-to-skin, Temperature*.

Trial Registration: Clinical Trials Registry India: CTRI/2020/11/029050 **PII**:**S097475591600491**

In India, most deliveries occur at the secondary level of care or below. Those newborns requiring higher levels of care need transport [1]. The transport of neonates is not well managed, resulting in high mortality of neonates during transport [2,3]. Preventing hypothermia is a critical component of care during transport in resource-limited settings. Transportation of sick neonates has a direct relationship with morbidity and mortality [3]. Suboptimal thermoregulation and transfer conditions increase the chances of poor outcomes [4,5]. Thus, a specialized transport system that focuses on the neonate's basic needs during transport should be developed [6,7].

Back transport i.e., transport of neonates back to the home, is required to be strengthened in developing nations. Low birth weight (birth weight below 2500g, LBW) newborns are discharged early from the hospital in resource-poor settings as compared to a high-income countries, which may further increase the chances of hypothermia [8,9]. Kangaroo mother care (KMC) is an efficient technique that provides warmth to an infant through direct skin-to-skin contact. Many propose that kangaroo transport of preterm and term babies who are physiologically stable, across either a short or a long distance, is possible without affecting the neonate's capacity to remain physiologically stable [10-12]. However, even recent studies find no mention of KMC as a transport modality [13,14]. We studied the effect of kangaroo mother care in hypothermia prevention in low birth weight neonates (less than 2.5 kg) during transport from hospital to home.

METHODS

This randomized control trial of neonates was done from March, 2021 to August, 2022 at our tertiary care center in central Gujarat. During hospitalization, all the mothers and relatives of LBW newborns provide KMC after the standardized training. In addition, they are empowered and encouraged to provide KMC at home. LBW newborns are discharged when they reach around 1700 g weight, feed well on breast and/or spoon, maintain temperature without assistance, gain weight for three consecutive days, and parents are confident to take care at home.

All the LBW neonates (from 1 kg to less than 2.5 kg) who were physiologically stable were enrolled in the study. Informed consent of parents was taken before the study. Any neonate with identified congenital malformation or abnormality at birth was excluded from the study.

Balanced randomization was done using sequentially sealed opaque envelopes; neonates were randomly assigned to either the study group (KMC, 76 neonates) or the control group (No KMC, 76 neonates). Due to the nature of the study trial, blinding was not possible. However, statisticians were blinded to the group allocation.

Neonates in the study group received KMC while transported from the hospital to their homes. KMC was provided by keeping newborns prone and upright between the mother's breasts. They wore cap, diapers, socks, and gloves. Mother and newborn were both covered with one linen cloth for binding and then covered with a warm blanket. The thermometer probe was placed in the axilla by lifting the cloths, and KMC was not interrupted at the time of measurement. The neonates in the control group did not receive KMC while being transported from the hospital to their homes. Instead, they wore cotton cloth (*Jabla*), diapers, socks, cap, and gloves and were covered with a warm blanket during the transport.

Travel distance was considered within 30 km radius with the expectation of reaching home within 30 min. All the newborns were transported in a close vehicle (ambulance or car) arranged by relatives. The same study investigator accompanied all the mothers and newborns during the transport and recorded the temperature. During the transport, newborns were breastfed on demand in both groups. Mothers wore traditional clothes (gown or saree) during transport. No external heating (warming) device was used in either group.

We used World Health Organization (WHO) criteria for defining hypothermia. Mild hypothermia was considered when the temperature of the newborn was between 36-36.5°C, and moderate hypothermia was considered when the temperature of the newborn was between 32-36°C [15].

Right axillary temperature readings were recorded using Ez-life digital thermometer (Model No: DT-111) in both the groups. The thermometer was wiped clean before use and then kept in the axilla till the beep sound. The temperature was measured at the time of discharge from the hospital and every 5 minutes during transport (5, 10, 15, 20, 25, and 30 minutes) and at the time of arrival at their home. The temperature was measured in Celsius (°C).

The primary endpoint of the study was moderate hypothermia. Hence, those neonates in whom moderate hypothermia was noted, were removed from the analysis of thermoregulation. An intervention was done to warm these neonates by providing kangaroo mother care. Repeat temperatures were taken to ensure that the neonate had achieved optimum temperature.

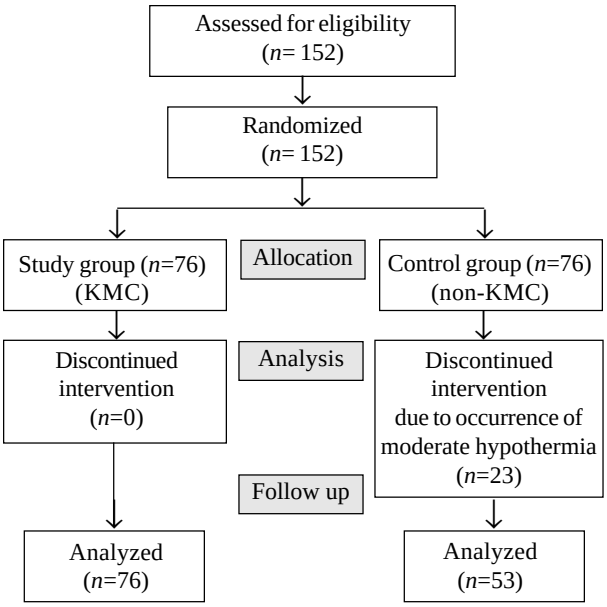
There is no regional data on the temperature of neonates during transport or after reaching home. A study in the same center found the prevalence of hypothermia at admission to be about 50%. We assumed the prevalence of hypothermia to be less than half of it, i.e., 20% when neonates reach home. Assuming a 20% prevalence of hypothermia during transportation from hospital to home without any intervention and a 15% reduction in hypothermia with KMC, a sample of size 76 per group is required to achieve 80% power allowing for 5% type I (alpha) error.

Statistical analysis: The analysis was carried out using STATA (14.2). The Shapiro-Wilk W test was used to determine whether the data were normally distributed or not. To compare mean (SD) values between the study and control groups, the independent sample *t* test was used. The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to compare the median (IQR) between the groups. A line chart was created to show the temperature trend between the two groups while in transport.

RESULTS

From March, 2021 to August, 2022, 152 neonates (76 in the study group and 76 in the control group) were randomized (**Fig. 1**). The baseline profile of the study participants is depicted in **Table I**. All the baseline characteristics were similar across the groups.

In the first ten minutes of travel, no neonates in the study group experienced moderate hypothermia, whereas 23 (30.26) neonates in the control group experienced moderate hypothermia during transportation (P<0.001). During the transport, from 10 minutes until the baby arrived home, the mean temperature in the study group was significantly higher than in the control group group [36.76 (0.23) °C vs 36.56 (0.3) °C; P<0.001 at time, 15 minutes] (**Table II**). The average temperature in the study group increased by 0.01°C (36.62-36.63 °C) within 5 minutes of



KMC: kangaroo mothers case.

Fig. 1 Study flow chart.

Table I Baseline Characteristics of Low Birth Weight Neonates Enrolled in the Study

Variable	*Study group (n=76)*	*Control group (n=76)*
Male sex	37 (48.7)	48 (63.2)
Cesarean delivery	42 (55.3)	45 (59.2)
Small for gestational age	34 (44.7)	37 (48.7)
Gestation age ≤37 wk	46 (60.5)	53 (69.7)
Very low birth weight (<1.5 kg)	3 (3.9)	8 (10.5)
Comorbidities		
None	37 (48.7)	31 (40.8)
Respiratory distress	24 (31.6)	28 (36.8)
Others[c]	15 (19.7)	17 (22.4)
Gestation age (wk)[a]	35.96 (2.21)	35.74 (2.22)
Postmenstrual age at discharge (wk)[a]	37.01 (1.94)	37.03 (1.89)
Birth weight (kg)[a]	2.09 (0.34)	1.98 (0.35)
Weight on discharge (kg)[a]	2.09 (0.25)	2.03 (0.3)
Temperature at discharge (ºC)[a]	36.62 (0.27)	36.63 (0.27)
Duration of hospital stay (d)[b]	4 (3,9.5)	6.5 (3,10.5)

Values in no. (%), [a]mean (SD) or [b]median (IQR). [c]jaundice/sepsis/ hypoglycemia.

discharge from the hospital, while it decreased by 0.07 °C (36.61-36.54°C) in the control group during the transport. Until the neonates arrived home, a similar trend of increased temperature in the study group and decreased temperature in the control group was observed (**Fig.2**). When neonates arrived at home, the average temperature in the study group increased by 0.22 °C (36.62-36.84 °C), while it decreased by 0.13 °C (36.63-36.50°C) in the control group. In the control group, it was observed that there was a fall in temperature up to 10 minutes, as most of the hypothermia episodes were noted around that time. In the control group, after 10 minutes, temperature recordings were steady and significantly lower compared to the study group showing better thermoregulation in the KMC group as compared to the non-KMC group. A similar pattern was observed in preterm neonates with a gestational age of less than 37 weeks. For most time intervals, the control group has significantly more mild hypothermia episodes than the study group [e.g., 43.2% vs 7.6%; *P*<0.001 at time 15 minutes] (**Table III**).

DISCUSSION

In the current study, KMC effectively prevented moderate hypothermia in low birth weight neonates during transport from hospital to home. Geographical differences, demography, and available expertise for neonate transportation techniques can influence outcomes. Hence, each region must develop its model for safe and efficient transport [16].

Table II AxillaryTemperature at Various Time Points in Low Birth Weight Neonates During Transport

Time point	*Study group*		*Control group*		*P value*
	No.	*Temperature*	*No.*	*Temperature*	
At discharge	76	36.62 (0.27)	76	36.63 (0.27)	0.083
At 5 min	76	36.63 (0.23)	76	36.56 (0.27)	0.09
At 10 min	75	36.71 (0.25)	76	36.56 (0.26)	<0.001
At 15 min	66	36.76 (0.23)	37	36.56 (0.3)	<0.001
At 20 min	47	36.85 (0.26)	21	36.64 (0.3)	0.006
At 25 min	23	36.88 (0.24)	12	36.58 (0.34)	0.005
At home	76	36.84 (0.3)	53	36.5 (0.29)	<0.001

All values in mean (SD).

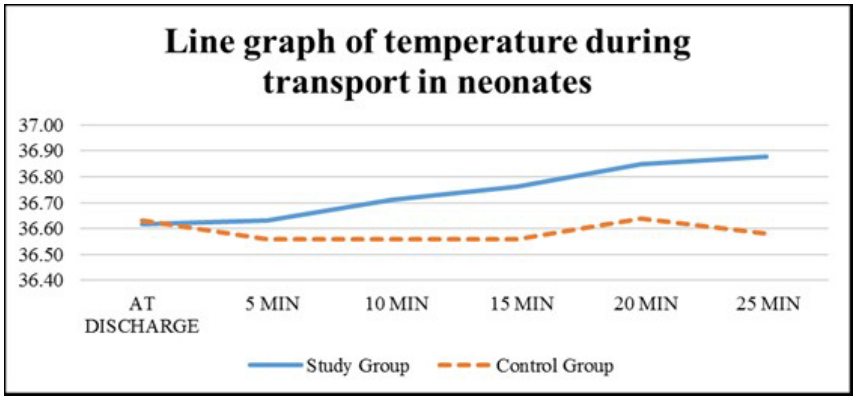


Fig. 2 Temperature during transport in low birth weight babies in the two groups.

Furthermore, every method and transport modality has advantages and disadvantages.

KMC transport in Germany was reported as a safe, effective, and inexpensive mode while enhancing parent-child bonding [17]. In a study of 24 neonates, where 16 were transported in KMC position and eight in an incubator, Swedish researchers reported comparable physiological stability during and even 48 hours after transport. The KMC-positioned infants were placed in the position using a safety harness connected at five places with the safety belt of the parent [17]. This study also did a basic cost-effectiveness evaluation, which showed that KMC transport was almost half as expensive as incubator transport (based on cleaning labor charges) [18]. In Brussels, 94 term and preterm neonates were back transferred in the KMC position [19]. The neonatal physiological parameters were stable, and mothers reported low stress and gave a high rating for this method of transport. Because of the constant care provided by the kangaroo caregiver, the cardiorespiratory risks are less in kangaroo transport. Swedish parents were reported to be satisfied with KMC transport done between hospitals, with the main reason being zero separation from the infant and the feeling of being involved in the infant's care by providing secure means of transport [20]. However, the current study did not take feedback from parents.

Some previous studies have addressed transport of neonates with polyethylene bags, showing promising results in preventing hypothermia in preterm neonates less than 34 weeks [21]. In a study done in Dar es Salaam, Tanzania, only seven out of 348 infants were transported in the KMC position [22]. This demonstrates a high scope for developing protocols for safe and effective transport using KMC. The next steps would be to develop protocols for KMC transport between hospitals in India, and show their superiority to current methods of transport. Further multicentric studies can be done based on discharge weight in different weight strata to get more information regarding the effectiveness of KMC during transport.

This study supports the idea of using KMC as an important tool in preventing hypothermia during transport

Table III Mild Hypothermia Episodes at Various Time Intervals in Low Birth Weight Neonates During Transport

Time point	*Study group*		*Control group*		*P value*
	No.	*Temperature*	*No.*	*Temperature*	
At discharge	76	21 (27.6)	76	17 (22.4)	0.45
At 5 min	76	17 (22.4)	76	26 (34.2)	0.10
At 10 min	75	8 (10.7)	76	26 (34.2)	0.001
At 15 min	66	5 (7.6)	37	16 (43.2)	<0.001
At 20 min	47	0	21	7 (33.3)	<0.001
At 25 min	23	0	12	5 (41.7)	0.002
At home	76	4 (5.3)	53	22 (41.5)	<0.001

All values in no. (%).

WHAT IS ALREADY KNOWN?

- Kangaroo mother care (KMC) has been used for neonatal transport in developed countries but not in India.

WHAT THIS STUDY ADDS?

- KMC transport reduces neonatal hypothermia when low birth weitht neonates are transported home from hospital.

of neonates, especially low birth weight neonates.

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Ethics clearance: Institutional Human Research Ethics Committee – 2, Pramukhswami Medical College; No. IEC/ HMPCMEE/123/Faculty/5/249/20, dated Sep 9, 2020.
Contributors: SMN: conceptualized and designed the study, coordinated and supervised data collection, and critically reviewed the manuscript for important intellectual content; PP, DP, RP: have coordinated the study and critically reviewed the manuscript for important intellectual content; VP; carried out the study, collected data, drafted the initial manuscript, and reviewed and revised the manuscript; MKS: carried out the initial analyses, helped draft the initial manuscript, and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.
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