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Impact of Kangaroo Mother Care During Neonatal Transport on Clinical Outcomes: A Prospective Cohort Study

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KEYWORDS

Kangaroo Mother Care, Neonatal Transport, Hypothermia, Outcome, LMIC

ABSTRACT:

Background: Neonatal transport in low- and middle-income countries (LMICs) is often associated with risks of hypothermia, desaturation, and other physiological instability. Kangaroo Mother Care (KMC), known for its thermoregulatory and physiological benefits, has been extensively studied in stable in-hospital neonates but less so during transport. This study evaluates the feasibility, safety, and physiological effects of KMC during neonatal transport in a resource-limited setting.

Methods: We conducted a prospective cohort study at a tertiary care NICU in Kolkata, India. Neonates requiring inter-facility transfer and meeting stability criteria for KMC were enrolled over six months. Those transported with KMC (intervention group) were compared to controls covered with blankets. Key outcomes included the incidence of hypothermia (axillary temperature <36.5°C), desaturation events, and heart rate variability during transport.

Results: A total of 208 neonates (104 KMC,104 controls) were analysed. The KMC group had significantly lower rates of hypothermia (37% vs 53%, p=0.01) and fewer desaturation episodes. Heart rate and oxygen saturation remained more stable during transport in the KMC group. No adverse events related to KMC were reported.

Conclusion: KMC during neonatal transport is a feasible, safe, and effective strategy to improve thermal and physiological stability in neonates, particularly in LMIC settings. Wider adoption of KMC transport protocols could reduce morbidity and improve neonatal outcomes.

Introduction:

Neonatal morbidity and mortality in low- and middle-income countries (LMICs) are largely associated with Preterm birth and low birth weight (LBW). Worldwide, it has been estimated that around 15 million babies are born each year preterm, and 20 million are born low-weight. Such babies are at a higher risk of hypothermia, feeding problems, infections, and long-term developmental impairments [1,2]. Evidence-based measures need to be taken to achieve better outcomes for these babies.

Kangaroo Mother Care (KMC) includes skin-to-skin continuous interaction between the baby and the caregiver, and helps in exclusive breastfeeding and shorter hospital stay [3]. There are many advantages of using KMC, including smooth regulation of body temperature, better hemo-dynamics, reduced neonatal sepsis, and better neurodevelopment [4-5].

Though an important but often neglected phase for these neonates is transportation between home and a healthcare facility or between facilities for advanced care. Transported newborns are at risk of hypothermia and physiological instability because of poor thermal regulation [6]. Conventional incubators are efficient, but very costly and not available in many LMICs. This emphasizes the importance of implementing cost-effective and pragmatic measures like KMC in transport.

KMC during neonatal transport is a feasible and safe intervention with the potential to overcome these challenges. Studies show that neonates being transported with KMC have shown lower incidences of hypothermia, better physiological stability, and higher survival rates than those transported conventionally [7]. KMC during transportation promotes parental involvement, reduces caregiver anxiety, and fosters bonding [8,9]. While KMC may offer advantages, its adoption during neonatal transportation has not gained widespread acceptance due to logistical and safety concerns, as well as some limited knowledge of its use by healthcare providers [10]. This study was done to provide strong evidence for the use of KMC in neonatal transport by examining its feasibility, safety, and benefits.

Methodology:

This prospective cohort study was done in a tertiary care NICU (CNMC)in Kolkata, India from 2021-2024, where neonates had undergone intra-hospital or interhospital transport for higher-level of care or medical evaluation.

Population:

- Inclusion criteria:
    - Neonates with birth weight ≤2000 grams or gestational age <37 weeks.
    - Cardiorespiratory stability before transport
    - Parental consent for participation.
- Exclusion criteria:
    - Neonates on a ventilator or in shock
    - Major congenital anomalies.

Intervention group:

KMC Group: Caregivers were engaged in KMC during transit, holding the neonate upright with direct skin-on-skin contact.

The neonate was secured using an adjustable wrap or sling, wearing only a diaper and cap to maintain skin-to-skin contact.

Control Group:

Neonates were attired in a diaper and cap, securely wrapped in a soft blanket, and placed on the caregiver's lap.

Group assignments were based on caregiver preferences and feasibility, leading to observational rather than randomized groupings.

Data collection: Before Transport, demographic characteristics and clinical information (such as gestational age, birth weight, and starting temperature) were documented in a predesigned proforma. During transport, constant monitoring of neonatal temperature, heart rate, respiratory rate, and oxygen saturation level, and adverse events was done. After Transport: immediate evaluation of temperature and physiological stability was done. Babies were followed up after 24 hours for continued outcomes and caregiver input.

Outcome Measures

1. **Primary Outcomes:**
    - Incidence of hypothermia (<36.5°C) among the groups.
2. **Secondary Outcomes:**
    - Physiological stability (heart rate, oxygen saturation, respiratory rate) in both groups

- Occurrence of adverse events (e.g., apnea, desaturation, bradycardia).
- Neonatal mortality during or after transport

Sample size:

The incidence of hypothermia by using the conventional method during transport is around 64% [6]. Hypothesizing a reduction of 30% from baseline incidence, the incidence of hypothermia in the intervention group would be 44.8%, and a sample size of 104 in each arm was required, keeping an alpha error of 5% and power of 90%.

Statistical Analysis:

Descriptive statistical analysis was carried out with SAS version 9.2 for Windows, and Statistical Package for Social Sciences (SPSS Complex Samples) version 21.0 for Windows. Continuous measurements were presented as Mean ± SD or Median with Interquartile range (IQR), and results on categorical measurements were presented in Number (%). Significance is assessed at a level of 5% ($p<0.05$). An independent sample t-test or Mann-Whitney test was used to determine the significance of study parameters between the two patient groups. The $\chi2$/Fisher Exact test was used to find the significance of the study parameter on a categorical scale between two or more groups. Regression analysis was done to control for potential confounding variables.

Ethics:

The institutional Ethics Committee (IEC/CNMC/23-5-21) approved this study.Informed written consent was taken from all the parents before participation in this study. Safety protocols were strictly followed during transport to decrease risks for neonates.

Results:

A total of 208 neonates were included in the study, with 104 each in the KMC and control groups. The baseline characteristics, including gestational age, birth weight, baseline temperature, sex distribution, transport duration, and proportion of small for gestational age infants, were comparable between the groups (Table 1). The most common reasons for neonatal transport were respiratory distress syndrome (27–28%), suspected sepsis (19–21%), congenital heart disease (17–18%), and need for surgical intervention (13–14%).

Table 1: Baseline Characteristics of Neonates

Characteristic	KMC (n = 104)	Control (n = 104)	p-value
Gestation (weeks)	34.3 ± 1.05	34.0 ± 1.14	0.137
Birth weight (grams)	1800 (1500–2000)	1750 (1400–1950)	0.350
Baseline temperature (°C)	36.6 ± 0.4	36.5 ± 0.5	0.112
Male (%)	51 (49%)	49 (47%)	0.773
Transport duration (minutes)	44 (36–60)	42 (28–58)	0.280
Small for gestational age (%)	42 (40%)	45 (43%)	0.678
Age at time of transport (hours)	36.9 ± 12.4	37.4 ± 13.2	0.778

Reasons for Neonatal Transport

Condition	KMC (n = 104)	Control (n = 104)
Respiratory Distress Syndrome (RDS)	28 (27%)	30 (28%)

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Severe Sepsis	22 (21%)	20 (19%)
Respiratory distress	11 (10%)	9 (8%)
Jaundice requiring exchange transfusion	7 (6%)	9 (8%)
Congenital heart disease	18 (17%)	19 (18%)
Surgical intervention needed	15 (14%)	14 (13%)
Others	6 (5%)	6 (5%)

Neonates in the KMC group had significantly higher mean temperatures after transport (36.8 ± 0.3 °C vs 36.5 ± 0.4 °C; $p < 0.001$). The incidence of hypothermia was significantly lower in the KMC group compared to the control group (37% vs 53%, $p = 0.017$) (Table 2).

Table 2: Primary Outcome

Outcome	**KMC Group (n=104)**	**Control Group (n=104)**	**p-value**
Temperature(°C) after transport	36.8 ± 0.3	36.5 ± 0.4	**< 0.001**
Hypothermia	39 (37%)	56 (53%)	**0.017**

KMC group had a significantly higher mean heart rate (145 ± 10 vs 140 ± 12 beats/min; $p = 0.011$) and oxygen saturation (96 ± 2% vs 95 ± 3%; $p = 0.005$). Although the respiratory rate was slightly lower in the KMC group, the difference was not statistically significant ($p = 0.054$). Adverse events were significantly fewer in the KMC group (9% vs 20%; $p = 0.032$), while the difference in mortality was not statistically significant (2.8% vs 6.7%; $p = 0.193$) (Table 3).

Table 3: Secondary Outcomes

Outcome	**KMC Group (n=**104)	**Control Group (n=104)**	**p-value**
Heart rate (beats/min)	145 ± 10	140 ± 12	0.011
Oxygen saturation (%)	96 ± 2	95 ± 3	**0.005**
Respiratory rate (breaths/min)	45 ± 6	47 ± 5	0.054
Adverse events (n, %)	10 (9%)	21 (20%)	**0.032**
Mortality (n, %)	3 (2.8%)	7 (6.7%)	0.193

A subgroup analysis comparing inter-facility vs intra-facility transport showed longer transport durations and distances for inter-facility transfers in both groups. However, these differences were expected due to the nature of transport type and were comparable between groups (Table 4).

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4. Comparison of Intra-facility vs Inter-facility Transport

Group	Transport Type	Duration (min)	Distance (km)
KMC group	Interfacility	46 ± 10	31 ± 5
	Intra-facility	10 ± 3	1± 0.5
Control group	Interfacility	49 ± 15	33 ±6
	Intra-facility	13±4	1 ±0.5

In the **logistic regression analysis**, KMC was independently associated with a lower risk of hypothermia (OR 0.52, 95% CI 0.30–0.88, $p = 0.015$). Other significant predictors of hypothermia included lower birth weight (OR 0.99, 95% CI 0.997–0.999, $p < 0.001$), longer transport duration (OR 0.86, 95% CI 0.80–0.92, $p = 0.001$), and lower baseline temperature (OR 0.50, 95% CI 0.34–0.75, $p = 0.001$) (Table 5)

5. Logistic Regression Analysis: Hypothermia by Group

Variable	Coefficient (B)	OR	95% CI for OR	p-value
Group (KMC vs Control)	-0.65	0.52	0.30 – 0.88	**0.015**
Birth weight (grams)	-0.02	0.99	0.997– 0.999	**<0.001**
Duration (hours)	-0.16	0.86	0.80 – 0.92	**0.001**
Baseline Temp (°C)	-0.70	0.50	0.34 –0.75	**0.001**

Discussion:

The findings of this study emphasize the critical role of Kangaroo Mother Care (KMC) in neonatal transport, particularly in addressing challenges related to thermoregulation and physiological stability. Thermoregulation is especially crucial for preterm and low-birth-weight neonates, who inherently have limited capacity to generate heat. Hypothermia during transport has been associated with increased morbidity, including metabolic derangements, respiratory complications, and, in severe cases, mortality [11, 12]. Our results align with previous studies [13, 14] demonstrating that KMC effectively maintains stable body temperature throughout neonatal transport, thereby potentially improving survival outcomes.

In addition to temperature regulation, KMC positively impacted physiological parameters, including heart rate and oxygen saturation. The observed improvement in heart rate is particularly noteworthy, suggesting that skin-to-skin contact may support cardiovascular stability by reducing stress and promoting better autonomic regulation [15]. Similarly, the higher oxygen saturation levels observed in the KMC group are consistent with earlier studies indicating that KMC exerts a calming effect on neonates, thereby enhancing respiratory function and oxygenation [16]. These findings underscore KMC's ability to mitigate physiological stressors during transport, a critical period often associated with heightened vulnerability.

Despite differences in transport duration, distance, and mode (ambulance, stretcher, or manual carry), the outcomes remained comparable across KMC and control groups. This suggests that KMC is both a versatile and scalable intervention that can be feasibly implemented in a wide range of transport contexts, including both intra- and inter-facility transfers. Given that transport teams often operate under constrained conditions, the seamless integration of KMC, without the need for additional

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equipment or personnel, demonstrates its practicality and adaptability [17].

Moreover, the KMC group experienced a lower overall incidence of adverse events compared to the control group, reinforcing the intervention's protective benefits. This is consistent with prior literature reporting reduced rates of apnea, bradycardia, and desaturation events with KMC [18]. These reduced complications are likely attributable to the soothing and regulatory effects of continuous skin-to-skin contact, which may buffer the neonate from physiological stressors inherent to the transport process [12].

KMC during neonatal transport is a safe strategy to improve thermal and physiological stability in neonates, particularly in LMIC settings. Although the findings of this study are encouraging, several limitations should be acknowledged. Firstly, the non-randomized nature of the study may have introduced some selection bias. In addition, while the sample size is sufficient for identifying statistically significant differences, it may not entirely reflect all neonates across various healthcare environments, especially those with more complicated health issues or those from lower-resource settings.

Subsequent research should seek to verify these results using a larger and more varied sample size and investigate the long-term effects of KMC during transportation

Author Contributions:

Dr. Pramita Das conceptualized and designed the study, developed the protocol,and prepared the first draft. Dr. Ratan Kumar Biswas contributed to protocol development, coordinated, supervised data collection, and reviewed and revised the manuscript at all stages of its production. Dr. Rakesh Dey contributed to protocol development and data analysis, and critically reviewed and revised the manuscript. Dr. Neepa Biswas has critically reviewed the manuscript to improve its content. Dr.Shailesh Patel helped in data analysis, critically examined, and revised the manuscript.

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Conflict Of Interest:

The authors declare no conflict of interest.

Data Availability Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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