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REDUCTION IN NEONATAL HYPOTHERMIA DURING TRANSPORT: A QUALITY IMPROVEMENT STUDY AT A TERTIARY CARE HOSPITAL IN NORTH INDIA

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ABSTRACT

Background: Neonatal hypothermia is a common but preventable cause of morbidity and mortality, particularly during inter-hospital transport of sick and preterm neonates. In our setting, nearly 38% of transported newborns were hypothermic on admission, prompting the need for a structured quality improvement initiative.
Aim: To reduce the incidence of admission hypothermia among transported extramural neonates by 50% over a 5-month period using targeted, low-cost interventions.
Methods: A prospective QI study was conducted at a level III NICU of a tertiary care hospital in North India from January to May 2025. The study included all outborn sick neonates transported to the NICU. The project used three sequential Plan-Do-Study-Act (PDSA) cycles, each addressing root causes identified through fish-bone analysis. Interventions included staff training on the "warm chain," transport with cap and socks, servicing and pre-warming of transport incubator, and introduction of EMBRACE™ conductive thermal mattress. Data were analyzed using descriptive statistics (percentages).
Results: A total of 105 transported neonates were included. The mean axillary temperature increased from 35.2°C at baseline to 37.0°C during the sustenance phase. The incidence of hypothermia declined progressively from 38% (baseline) to 30.4%, 25%, and 13.6% across PDSA cycles 1–3, and was sustained at 10.5% thereafter. Preterm and low-birth-weight infants remained at higher risk, but severe hypothermia was eliminated. No infant developed hyperthermia during the study.
Conclusion: Sequential QI interventions using the WHO POCQI model effectively reduced hypothermia among transported neonates. Emphasis on training, equipment maintenance, and affordable thermal aids can ensure safe and warm transport of neonates in resource-constrained settings.

Keywords*: Neonatal hypothermia, Quality improvement, Transport, PDSA cycles, Conductive thermal mattress, Warm chain.*

INTRODUCTION

Neonatal hypothermia, defined as an axillary temperature below 36.5°C [1], is a common but often under-recognized problem that significantly contributes to neonatal morbidity and mortality[1,2].The newborn with a temperature of 36.0-

36.4°C is under cold stress(mild hypothermia) which should give rise to concern. A baby with a temperature of 32.0—35.9°C has moderate hypothermia, while a temperature below 32°C is considered to be severe hypothermia.[2] The preterm and low birth weight infants are at highest risk of hypothermia. For every 5 minutes of exposure to an environment below 36.5°C, the surface body temperature decreases by approximately 0.3°C.[3]Studies have shown that for each 1°C drop in admission temperature below 36°C, there is increase in mortality by 28% and in late-onset sepsis by 11%.[4]

Extended periods of cold stress impose challenges on the newborn which can lead to harmful side effects, which include hypoglycaemia, respiratory distress, hypoxia, metabolic acidosis, coagulation defects, delayed readjustment from fetal to newborn circulation, acute renal failure, necrotizing enterocolitis, failure to increase weight, or weight loss and in extreme cases death.[3] Factors that increase the risk of developing hypothermia include prematurity, small for gestational age , asphyxia, certain congenital anomalies such as gastroschisis and damage to the central nervous system.[3]

Various factors predispose the newborn especially the preterm and LBW newborn to hypothermia. The physical factors include a large surface area -to -volume ratio, immature skin, a thin layer of insulating fat, poor vasomotor control, and lack of non-shivering thermogenesis.In addition, preterm and LBW newborns are unable to shiver, hindering effective thermogenesis.[5]The environmental factors consist of the "warm chain"- a set of ten interlinked procedures to minimize heat loss during the critical early hours of life,as highlighted by the WHO.[1] These include a warm delivery room, immediate drying, skin-to-skin contact, delayed bathing and weighing, appropriate clothing and bedding, and warm transportation, among others.[2] Despite these clear guidelines, lapses in thermal care during the immediate postnatal period continue to be reported in various clinical settings.

Neonatal transport is the need of the hour.Many neonates need transport from one centre to the other for better care and treatment services,especially the preterm, LBW and sick neonates.[6] Most of these babies are born in facilities not equipped to handle these babies.[7] The period when a newborn is transported is a potential weak link in the "warm chain". In unavoidable circumstances, babies are delivered at primary health care and then either transported in a high risk environment or requested to transport these babies to a level 2 or 3 care. The transport team has no choice but to perform 'scoop and run transport' due to a lack of stabilization services at parent health care.[7] Maintenance of target temperature during neonatal transport and at admission in these conditions is an enormous challenge.Hypothermia, hypoglycemia, cardiac arrest, tube displacement,apneic episodes are common complications encountered during transport at admission.[8]

A systematic review of 14 studies on neonatal transport in developing countries found that 11 studies had reported hypothermia as an important risk factor for morbidity and mortality.[9] A study by Manikyamba et al 2017 found that hypothermia was noted in 48.5% newborns at admission. Incidence of hypothermia was higher in non-SNCU referral babies(52.9%) and inthose with transport time > 3hours (87%) and in babies with non-ambulance transport (87.8%).[10]
A Quality Improvement study (QI) by Diggikar et al 2021 reported the incidence of admission hypothermia among transported newborns as 64%.[7]

The present QI study reported an incidence of 38% hypothermia among transported newborns at admission to the level 3 NICU at our institution-a tertiary care hospital in North India.It was carried out with the objective of identifying and rectifying the causes of neonatal hypothermia during transport ,based upon the WHO " Point-of-care Quality Improvement" model, where the gaps in quality could be identified and addressed through root-cause analysis and the implementation of evidence-based practices using Plan-Do-Study-Act (PDSA)cycles. PDSA cycles test changes by planning, carrying out, and studying the results of a change before acting on them in the next cycle.[11]

AIM

The aim of this Quality improvement study ,spanned over a period of 5months(Jan 1st -May 31st 2025) , was to decrease the percentage of incidence of hypothermia among transported extramural newborns at admission from 38% during the baseline phase, by 50% through targeted QI interventions.To our knowledge, this is the first QI initiative focusing on neonatal hypothermia amongst transported newborns in our hospital.

MATERIALS AND METHODS

SETTING:This study was undertaken at a tertiary care mother and child hospital in Chandigarh, North India. The hospital has a 16-bedded level III NICU with 1 inborn and 1 outborn unit. The hospital serves as a tertiary care referral centre for the surrounding peripheral centres like nursing homes and hospitals having level 1 neonatal care and public sector hospitals, and receives approx. 200 sick extramural babies annually.

DESIGN:A prospective, QI study undertaken over a period of 5months (Jan 2025 – May 2025). The study consisted of Baseline , Implementation and Sustenance phases.

Baseline phase (Jan 1-Jan 31) consisted of prospective data collection and identification of the key causes of hypothermia amongst transported newborns. This was followed by implementation phase (Feb 1-April30) which included three Plan-Do-Study-Act cycles of 1 month each. Sustenance phase was observed fromMay 1-May 31 to study the sustainability of the interventions.

SAMPLE:All outborn sick neonates retrieved from peripheral centres and transported to the tertiary care referral hospital during the 5months study period for level 3 NICU care were included in the study , for example- babies with birth asphyxia, shock,sepsis, respiratory distress/respiratory failure, preterm- Low birth weight babies etc.Inborn babies, and babies with major congenital malformations were excluded.

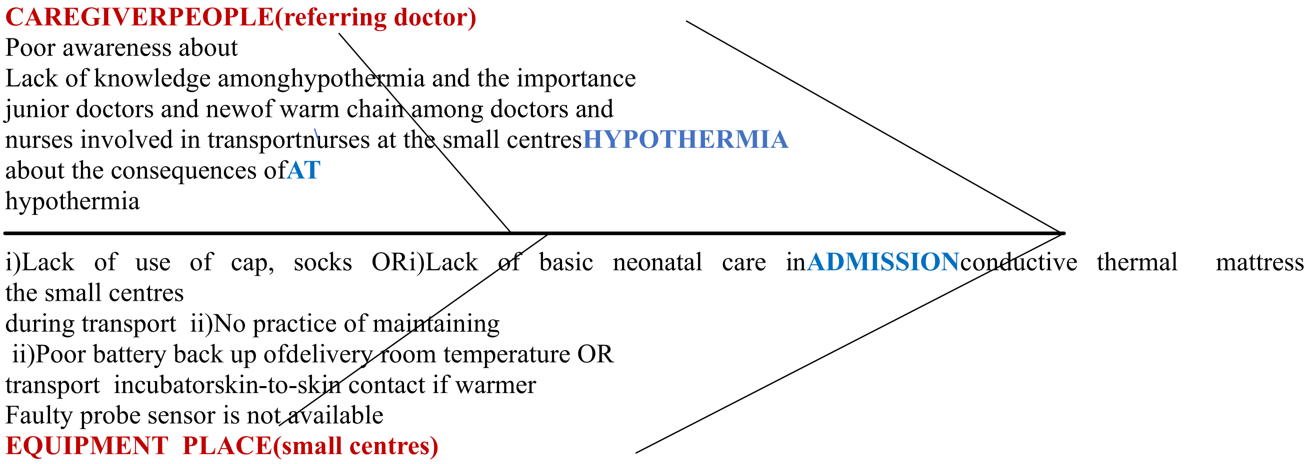
DEFINITIONS:Axillary temperature was measured with digital thermometer(Dr.Morependigital thermometer model MT-110) at the beginning of transport and upon admission to the NICU. Hypothermia was classified using WHO guidelines as mild (36°C to 36.4°C), moderate(32°C to 35.9°C) and severe at <32°C[1]. The balancing measure was the incidence of hyperthermia with axillary temperature> 37.5°C upon arrival, to monitor any unintended consequences of the study interventions.

TEAM: For every transport, a doctor who is trained in neonatal care, and one nurse accompanied the baby. A transport incubator , emergency transport kit (airway, breathing, circulation equipment), thermal care equipment, Masimo monitor,back up oxygen cylinder was carried.The transport nurse measured the axillary temperature of the neonate at the beginning of transport and recorded it in a demarcated register.

A QI team was formed comprising a senior neonatologist, a pediatric consultant and 3 neonatal staff nurses.The senior neonatologist worked as a team leader who took up administrative responsibilities and supervised and coordinated various activities , took decisions about the PDSA cycles , planned interventions and conducted meetings to achieve the targeted goals. The pediatrician collected and analysed the data ,and the neonatal staff nurses measured the axillary temperature of the baby upon admission to NICU and recorded it in the demarcated register.

MEASURES (PROCESS AND OUTCOME INDICATORS)
Process is described asbelow.The primary outcome indicators were the mean axillary temperature(MAT)upon admission to the NICU, and the percentage of hypothermia at admission.

BASELINE PHASE –(Jan 1st -Jan 31st 2025): Baseline phase consisted of prospective data collection and identification of the key causes of hypothermia amongst transported newborns. The incidence of hypothermia among the transported newborns at admission was found to be 38% .The root-cause analysis of hypothermia during transport was done using a fish bone diagram,and based upon the issues,we formulated our PDSA cycles



FISH BONE ANALYSIS
PDSA CYCLE 1 (Feb 1st -Feb 28th 2025): The QI team conducted its first meeting in Feb 1st week and identified that due to influx of junior doctors and new staff who were responsible for most of the transports, training them about normothermia was a priority. Thus, the first PDSA cycle focussed on imparting training to the junior doctors and the new staff about the importance of “warm chain” in maintaining normothermia and the deleterious consequences of hypothermia amongst the newborns, especially the fragile preterm and the low birth weight babies.The training was held once a week for 4 weeks ,and was led by the Consultant Pediatrician. Transporting the babies with cap and socks on was implemented as a part of maintaining normothermia. Data was reviewedat the end of the cycle.

PDSA CYCLE 2(Mar 1st-31st 2025): The core committee conducted a second meeting in March 1st week. It was found that the the battery back up of the transport incubator was only 30mins, which was highly inadequate for long distance transports.So the team leader arranged for servicing of the same, after which the battery back up time increased to 3 hours.The probe sensor was faulty, and that was replaced with a new one. The incubator was switched on as soon as call for transport was received , which gave at least 15mins for the incubator to get pre warmed.

The committee found that in spite of the training imparted on the importance of maintaining normothermia, the trainee doctors were opening the side ports of the incubator unnecessarily to observe the condition of the baby during the transport.So weekly trainings were continued for the junior doctors about the warm care of infants and avoiding unnecessary opening of the side ports.

Data was reviewed at the end of the 2nd PDSA cycle.

PDSA CYCLE 3(April 1st -30th 2025): After the third meeting, the QI team went through the fish-bone analysis again and it was found that we had still not achieved our target of reducing hypothermia among transported newborns by 50%. Training of the newly joined staff as well as the junior doctors involved in transport was continued.In addition, we introduced the use of EMBRACE TM, conductive thermal mattress to keep the newborn warm during transport. Mattress was preheated prior to the transport . Data was reviewed at the end of the cycle.

SUSTENANCE PHASE (May 1st-31st 2025): Sustenance of above interventions was studied during thisperiod.Data was reviewed at the end of the phase.

DATA ANALYSIS

Data obtained was entered on an Excel sheet and analysed using percentages in each phase.

RESULTS

A total of 105 outborn neonates transported to our NICU during the 5 month study period were included in the study. Of these, 21 were included in the baseline phase, and 84 babies in the study phase (23 in PDSA Cycle 1, 20 in PDSA Cycle 2, 22 in PDSA Cycle 3, and 19 in the sustenance phase).The gestational age of babies varied from 28 weeks to 39 +2weeks across both the phases..The birth weight of newborns varied from 890 grams to 3850 grams in the baseline phase, and 850grams to 3926grams in the study phase.The total number of preterm babies (<37weeks) were 59 and term babies(>37weeks) were 46.Thus,more number of preterm babies were transported as compared to the term babies.

The mean axillary temperature at admissionwas 35.2°C during the baseline phase, which increased progressively across the study phases to 37.0°C during the sustenance phase.

Incidence of hypothermia among the transported babies was calculated by dividing the number of hypothermic babies by the total number of transported babies. Phase-wise mean axillary temperature, total number of transported babies , number of hypothermic babies and incidence of hypothermia is depicted in table 1.

Baseline phase (Jan 2025)recorded 38% incidence of hypothermia among the transported babies with mean axillary temperature (MAT) being 35.2°C. Interventions in the form of educating and training the junior doctors and new staff involved in transport , as well as transporting babies with cap and socks on, brought about a slight reduction in the incidence of hypothermia to 30.4% and improvement in MAT to 35.9°C by the end of PDSA cycle 1(Feb 2025).

Building on this,further interventions were planned and implemented through sequential PDSA cycles 2 and 3.During PDSA cycle 2 (Mar 2025), servicing of the transport incubator was accomplished, thus increasing the battery back-up from 30mins to 3 hours, and prewarming of the transport incubator was initiated.This led to a further increase in MAT to 36.2°C and a further decrease in incidence of hypothermic babies to 25%, but still the goal of reducing the incidence of hypothermia by 50% was not achieved.

So during the PDSA cycle 3 (Apr 2025), we introduced the use of EMBRACE[TM] conductive thermal mattress for transporting the babies, which helped us to achieve normothermia with a MAT of 36.8°C and decreasing incidence of hypothermia further to 13.6%, thus achieving more than the targeted 50%reduction. The previous interventions were continued in each phase.

The sustenance of the above interventions was observed during the Sustenance Phase(May 2025) and it was found that the MAT stabilized at 37°C and the incidence of hypothermia was maintained at 10.5%.

The incidence of hypothermia was more among the preterm and low birth weight babies as compared to the term babies, in each phase , as shown in table 2 and 3.Incidence was highest amongst babies <1500grams. The proportion of neonates with moderate hypothermia decreased from 23.8% at baseline to 5.2% during the sustenance phase, while severe hypothermia was observed in only one ,preterm neonate during the baseline phase and was eliminated thereafter.

No neonate developed hyperthermia (>37.5°C) during the study period, indicating that interventions were safe and effective.

Table 1: Mean Axillary temperature, and incidence of Hypothermia during transport in each month.

	BASELINE PHASE	PDSA CYCLE 1	PDSA CYCLE 2	PDSA CYCLE 3	SUSTENANCE PHASE
MEAN AXILLARY TEMPERATURE UPON ADMISSION TO NICU	35.2°C	35.9°C	36.2°C	36.8°C	37°C
TOTAL NO.OF TRANSPORTED BABIES	21	23	20	22	19
%OF HYPOTHERMIC BABIES	38%(8)	30.4%(7)	25%(5)	13.6%(3)	10.5%(2)
%OF BABIES WITH MODERATE HYPOTHERMIA	23.8%(5)	17.4%(4)	15%(3)	9%(2)	5.2%(1)
%OF BABIES WITH SEVERE HYPOTHERMIA	4.7%(1)	NIL	NIL	NIL	NIL

Table 2:Incidence of hypothermia during transport w.r.t gestation (babies<37 weeks vs. babies>37 weeks)

	BASELINE PHASE	PDSA CYCLE 1	PDSA CYCLE 2	PDSA CYCLE 3	SUSTENANCE PHASE
TOTAL NO.OF TRANSPORTED BABIES No.OF HYPOTHERMIC BABIES	21 8	23 7	20 5	22 3	19 2
HYPOTHERMIC BABIES < 37 WEEKS	5 (23.8%)	4 (17.4%)	4(20%)	2(9.1%)	2(10.5%)
%Cold stress % Moderate Hypothermia	0(0%) 4 (80%)	1(25%) 3 (75%)	1(25%) 3 (75%)	1(50%) 1(50%)	1(50%) 1(50%)
% Severe Hypothermia	1 (20%)	0 (0%)	0(0%)	0(0%)	0 (0%)
HYPOTHERMIC BABIES > 37 WEEKS	3 (14.2%)	3 (13.0%)	1(5%)	1(4.5%)	0 (0%)
%Cold stress % Moderate Hypothermia	2 (66.7%) 1 (33.3%)	2 (66.7%) 1 (33.3%)	1(100%) 0 (0%)	0 (0%) 1 (100%)	0 (0%) 0 (0%)
% Severe Hypothermia	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)

Table 3:Incidence of hypothermia during transport w.r.t. birth weight

	BASELINE PHASE	PDSA CYCLE 1	PDSA CYCLE 2	PDSA CYCLE 3	SUSTENANCE PHASE
TOTAL NO.OF TRANSPORTED BABIES TOTAL NO.OF HYPOTHERMIC BABIES	21 8	23 7	20 5	22 3	19 2
HYPOTHERMIIC BABIES<1500 GMS	4(19.0%)	4(17.4%)	3(15%)	2(9.1%)	1(5.2%)
HYPOTHERMIC BABIES 1500-2499 GMS	3(14.3%)	2(8.7%)	1(5%)	1(4.5%)	1(5.2%)
HYPOTHERMIC BABIES >2500 GMS	1(4.7%)	1(4.3%)	1(5%)	0(0%)	0(0%)

DISCUSSION

Hypothermia is a significant risk for neonates during transport, especially the preterm and the low birth weight babies, due to their under developed thermoregulation, thinner skin, and higher surface area to mass ratio.[5] Neonatal transport is a potential weak link in the "warm chain".

In the peripheries, in-utero transfer is still not the norm and high risk pregnancies are delivered in centres not well equipped to handle the sick babies.[7] Most deliveries occur at the secondary level of care or below.Those newborns requiring higher levels of care need transport.[12]Deliveries occur in nursing homes, small private settings, and primary health care with varied facilities and once a baby is born, they are transferred to the nearest public teaching hospital or private hospital for advanced neonatal care. Transportation is a stressful event and maintaining normothermia during transport is a big challenge especially in the Indian context where dedicated ambulance for neonatal transport are very few.[7] In the public sector, most of the transportation is done by '108 Emergency service' – a free service by GVK Emergency Management and Research Institute with state of art emergency call response centers. This service is available in most states and on average their ambulance reaches the client at 18-26 minutes but dedicated neonatal ambulances are not available.[13] The incidence of complications can be high in these settings ranging from mildhypothermia to life-threatening episodes however there are no published data on this.[7]

Transportation of sickneonates has a direct relationship with morbidity andmortality, more so in the preterm low birth weight babies.[14]As our unit receives a large proportion of sick preterm and low birth weight babies from the peripheral centres and hypothermia was found to be a significant problem amongst the transported neonates, so we planned this Quality Improvement study to develop identify the root causes of hypothermia in our setting, and eliminate the same through 3 sequential Plan-Do-Study-Act cycles.

In our setting , various factors like lack of stabilization facilities at the parent hospital, equipment related factors like poor battery back up ,lack of use of conductive thermal mattress,lack of knowledge among the junior doctors and new staff involved in transport, were the main causes leading to hypothermia.The incidence of hypothermia in the baseline phase was 38%,which was reduced to 13.6%through three sequential Plan-Do-Study-Act cycles, and maintained at 10.5% in the sustenance phase,thus achieving our goal.The baseline prevalence of hypothermia in our study (38% prospectively at baseline) was consistent with previous reports from India and other developing countries, where hypothermia on arrival ranges between 48.5% to 87.8% of transported neonates.[10]

After the first PDSA cycle , it was found that there was not much reduction in hypothermia as compared to the baseline phase as explained by the knowledge practice gap.So weekly trainings of the junior doctors and new staff involved in transport were continued.During the second PDSA cycle,we addressed to prewarming and servicing of the transport incubator. This led to a great reduction in the incidence of hypothermia to 25%, but still the goal of reducing the incidence by 50% was not achieved.During the third PDSA cycle, we introduced the use of EMBRACE™, conductive thermal mattress to maintain normothermia during transport. The EMBRACE™ warmer, consists of Phase Changing Material (PCM) that once charged, maintains infant temperature of around 37 °C for at least 4 hours. The PCM consists of paraffin-based material (melting point 37 °C, latent heat capacity ~200 J/g) encased within a flattened medical-grade polyurethane pouch which serves as an external heat source. Individual PCM pouches are cleansed with soap and water or alcohol-based disinfectants between babies.[15] Introduction of the thermal mattress was particularly effective and helped in improvement in both mean axillary temperature, and further reduction in the incidence of admission hypothermia to 13.6%, thus helping us to achieve our goal , which was maintained at 10.5% during the sustenance phase. %). This highlights the feasibility of incorporating simple adjuncts to conventional incubator-based transport, especially where equipment limitations exist.

Importantly, the study ensured that the interventions did not result in hyperthermia as a balancing measure,underscoring the safety of the measures adopted.

Thus the interventions were associated with progressive improvements in both mean axillary temperature and reduction in hypothermia rates.These findings are in line with prior QI studies, such as Diggikar et al. (2021), who achieved a reduction in admission hypothermia from 62% to 24% by strengthening warm chain practices during transport.[7]

Similar to prior literature, we also observed that low-birth-weight and preterm infants were most vulnerable to thermal instability, reinforcing the need for vigilant thermal care in this group[16]

Our study adds to the growing body of evidence that targeted, context-specific QI initiatives can bridge major gaps in neonatal care. The success achieved with simple interventions highlights the importance of staff sensitization, equipment maintenance, and use of affordable technologies in reducing preventable morbidity.

This quality improvement (QI) study demonstrates that systematic, low-cost interventions implemented through sequential PDSA cycles can substantially reduce hypothermia among transported neonates.

Strengths of the studyinclude its prospective design, use of the WHO POCQI model, and systematic application of sequential PDSA cycles. Limitations include the relatively short study duration, single-centre setting, and lack of long-term outcome tracking (e.g., mortality, sepsis, neurodevelopmental outcomes). Future studies should assess the scalability and cost-effectiveness of these interventions across multiple centres.

CONCLUSION

Hypothermia during transport remains a major challenge in neonatal care, particularly among preterm and low-birth-weight infants. This Quality Improvement (QI) initiative, implemented using the WHO Point-of-Care Quality Improvement (POCQI) model, demonstrated that systematic, low-cost, and sustainable interventions can substantially reduce the incidence of hypothermia in transported neonates. The study highlights the effectiveness of simple, context-specific strategies in improving neonatal thermal care, even in resource-limited settings. Wider implementation of such QI initiatives can bridge existing gaps in neonatal transport practices, leading to better outcomes and reduced preventable neonatal morbidity and mortality.

REFERENCES

1. World Health Organization. Maternal Health and Safe Motherhood Programme & Meeting of Technical Working Group on Thermal Control of the Newborn(1992:Geneva, Switzerland).(1993)Thermal control of the newborn: a practical guide.World Health Organization https://apps.who.int/iris/handle/10665/60042
2. World Health Organization.Maternal and Newborn Health/ Safe Motherhood.(1997).Thermal protection of the newborn:a practical guide.World Health Organization https://apps.who.int/iris/handle/10665/63986
3. McCall EM, Alderdice F, Halliday HL, Jenkins JG, Vohra S . Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. Cochrane Database Syst Rev. 2018;2(2):CD004210. doi: 10.1002/14651858.CD004210.pub5 [DOI] [PMC free article] [PubMed] [Google Scholar]
4. Laptook AR, Salhab W, Bhaskar B. Neonatal Research Network Admission temperature of low birth weight infants:predictors and associated morbidities. Pediatrics.2007 Mar;119(3):e643-9.doi:10.1542/peds.2006-0943DOI:http://dx.doi.org/10.1542/peds.2006-0943

5. Baumgart S. Fetal and neonatal thermal regulation. In: Cloherty JP, Eichenwald EC, Stark AR, editors. Manual of neonatal care. 2nd ed. St. Louis (MO): Mosby; 2005.
6. Diehl B. Neonatal Transport. Critical Care Nursing Clinics of North America. 2018;30(4):597-606.
7. DiggikarS,Shalet N,S P,Venkatagiri P. Hypothermia reduction during neonatal transport in a tertiary carecenter in South India: a quality improvement initiative. Int J Contemp Pediatr. 2021 Apr;8(4):659-665.DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20211073
8. Kumar PP, Kumar CD, Venkatlakshmi A. Long distance neonatal transport-theneed of the hour.IndianPediatr. 2008;45:920-922.
9. Niermeyer S., Domek G. Neonatal transport in developing country settings: A systematic review. Pan American Health Organisation, Montevido. [(accessed on 24 February 2020)];2016 Available online: http://iris.paho.org/xmlui/handle/123456789/31317.
10. Manikyamba D, Madhavi N, Reddy MS, Satyavani A.Status of Neonatal Transport and Impact of Facilitated Referral on the Outcome of Transported Sick Newborns: At Tertiary Care Hospital. Sch. J. App. Med. Sci., 2017; 5(10B):3929-3934 DOI:10.36347/sjams.2017.v05i10.026
11. Deorari A, Mehta R, Livesley N. Improving the quality of care for mothers and newborns in health facilities:point of care quality improvement facilitator's manual.[Aug;2019].2017
12. Singh J, Dalal P, Gathwala G, Rohilla R. Transport characteristics and predictors of mortality among neonates referred to a tertiary care centre in North India: A prospective observational study. BMJ Open. 2021;11: e044625.
13. Kumutha J, Rao G, Sridhar B, Vidyasagar D. The GVK EMRI maternal and neonatal transport system in India: a mega plan for a mammoth problem. Seminars in Fetal and Neonatal Medicine. 2015;20(5):326-334.
14. Rathod D, Adhisivam B, Bhat BV. Transport of sick neonates to a tertiary care hospital, South India: condition at arrival and outcome. Trop Doct. 2015;45:96-9.3)
15. Gopalakrishnan S, Karmani S, Ramar P, Pandey A, Sodhi K. Conductive thermal mattress versus routine care to reduce neonatal hypothermia during transport among low-birthweight neonates: An experimental study with historical controls. Med J Armed Forces India. 2022 Sep;78(Suppl 1):S49-S54. doi: 10.1016/j.mjafi.2020.10.022. Epub 2021 Jan 6. PMID: 36147431; PMCID: PMC9485767.
16. Sanni, U.A., Usman, F., Ogunkunle, T.O. et al. Hypothermia in preterm infants admitted to low-resource neonatal units in northern Nigeria: an observational study of occurrence and risk factors. BMC Pediatr 24, 471 (2024). https://doi.org/10.1186/s12887-024-04960-3