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Effectiveness of a Nurse-Led Preterm Care Package Provided to Parents of Preterm Infants at Discharge on the Growth and Developmental Outcomes of Preterm Infants in Tirupattur District, Tamil Nadu

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ABSTRACT

Introduction: Globally, India accounts for the highest burden of preterm births, with approximately 3.5 million infants born prematurely each year. Within the state of Tamil Nadu, rural and developing districts like Tirupattur encounter persistent challenges in infant health due to regional socioeconomic barriers, limited access to tertiary neonatal setups, and a lack of structured transition care when infants leave special newborn care units (SNCUs). The post-discharge home environment is heavily influenced by parental self-efficacy and care practices. In rural districts, traditional, unscientific newborn care practices often inadvertently worsen outcomes for vulnerable preterm infants. Modifiable post-discharge risk factors include improper positioning during feeding, poor temperature regulation, premature introduction of complementary foods, and a distinct lack of early neurosensory stimulation.

Objective: The primary objective of this study was to evaluate whether infant growth and neurodevelopmental outcomes differed between treatment arms testing a structured, nurse-led preterm care package provided to parents at discharge.

Methods: Mothers of preterm infants (born <37 weeks gestation) stable for discharge were recruited from a secondary care newborn unit in Tirupattur District, Tamil Nadu, between May 2024 and April 2025. Post-discharge data were collected from 30 experimental participants (receiving the nurse-led care package) and 30 control participants (receiving standard discharge counseling) up to 6 months of corrected age. Infant growth (weight, length, and head circumference) was monitored monthly, and neurodevelopmental status was evaluated at 6 months using the Trivandrum Developmental Screening Chart (TDSC). Time-to-event curves and logistic regression models were applied to compare outcomes.

Results: Retention rates for the experimental and control arms at 6 months were 90% (27/30) and 86.7% (26/30), respectively. Preterm infants in the experimental group demonstrated a significantly shorter median time to achieve adequate catch-up growth (defined as weight-for-age > 10th percentile) compared to the control group (3.5 months vs. 5.5 months; $p = 0.032$). At 6 months of corrected age, the prevalence of developmental delay (failing > 1 item on the TDSC) was significantly lower in the experimental arm than in the control arm (11.1% vs. 34.6%; $p = 0.041$).

Conclusions: A structured, nurse-led preterm care package focused on responsive feeding, thermal management, infection control, and sensory stimulation significantly improves early physical growth and minimizes developmental delays in preterm infants compared to standard educational curriculums.

KEYWORDS: *Preterm care, nurse-led intervention, catch-up growth, developmental delay, Tamil Nadu, low-resource settings.*

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INTRODUCTION

Preterm birth, defined as a live birth occurring before 37 completed weeks of gestation, remains a critical challenge for pediatric healthcare systems worldwide. Globally, an estimated 13.4 million infants are born prematurely each year, representing approximately 1 in 10 live births (Sequeira, 2024). India bears the highest absolute volume of this global burden, contributing roughly 3.5 million preterm births annually (Jana, 2023). Within the state of Tamil Nadu, rapid industrial-rural transitions in developing districts such as Tirupattur encounter distinct challenges in infant health due to regional socioeconomic disparities and localized variations in healthcare access (Jana, 2023).

While significant clinical advancements within institutional Special Newborn Care Units (SNCUs) have notably boosted the acute survival rates of these premature neonates, the immediate post-discharge phase represents a period of extreme physiological vulnerability (Thomas, 2024). Preterm infants are born with immature organ systems and missed critical weeks of third-trimester intrauterine growth, making them highly susceptible to:

- Post-discharge growth restriction and postnatal growth faltering (Kakatsaki, 2024).
- Recurrent infectious illnesses due to compromised immune defenses (Sequeira, 2024).
- Suboptimal neurological milestone progression affecting motor and cognitive domains (Thomas, 2024).

Transitioning care from a highly controlled hospital environment to a home setting places a significant burden on families. In rural and developing regions of South India, parents frequently transition home feeling structurally unsupported, anxious, and ill-equipped to execute complex preterm care routines without structured, continuous medical guidance (Zakaria, 2020).

NEED FOR THE STUDY:

The necessity for structured, systematic, and culturally accessible educational strategies delivered directly to parents during the hospital-to-home transition is paramount (Zakaria, 2020). Standard institutional discharge methods across public healthcare facilities in developing districts are often limited to brief, verbal, and unstructured instructions provided on the exact day of discharge (Sequeira, 2024). This traditional approach offers minimal clinical follow-up or systematic monitoring regarding the specific home execution of:

1. **Advanced Thermal Care:** Maintaining consistent home-based Kangaroo Mother Care (Sequeira, 2024).
2. **Nutritional Optimization:** Managing responsive feeding cues and safe breast milk topping-up strategies to avoid aspiration (Zakaria, 2020).
3. **Neurosensory Stimulation:** Implementing targeted touch and auditory stimulation to encourage early brain development (Thomas, 2024).

Traditional community neonatal care styles in rural areas often rely on unscientific ancestral care patterns, which can inadvertently increase infant vulnerability to hypothermia, improper positioning during feeding, and poor microbial hand hygiene (Sequeira, 2024). Suboptimal growth configurations during this early postnatal window exert compounding, restrictive downstream effects on early neurodevelopment, leading to preventable motor delays, cognitive barriers, and diminished sensory-social milestones (Thomas, 2024).

Evaluating structured intervention frameworks, such as a specialized Nurse-Led Preterm Care Package, helps bridge this transition gap by shifting the locus of care safely from clinical providers to empowered caregivers (Ingram et al., 2016). While international models exist, there is a lack of localized research assessing the efficacy of nurse-led home support packages within rural Tamil Nadu using validated metrics—such as standard anthropometrics and culturally tailored tools like the Trivandrum Developmental Screening Chart (Sony, 2024).

Therefore, this study was undertaken to evaluate the clinical impact of an organized, nurse-led care curriculum on the physical growth trajectories and early neurodevelopmental milestones of preterm infants in Tirupattur District. This research aims to provide scalable, evidence-based data to help shape future public health discharge policies across the region.

DESIGN:

This study was an 12-month, randomized, two-arm, parallel controlled trial designed to evaluate the impact of a Nurse-Led Preterm Care Package (NLPCP, experimental) compared to Standard Discharge Care (SDC, control) on infant growth parameters and neurodevelopmental status.

Participants were randomly assigned to one of the two treatment arms (NLPCP [n=30] or SDC [n=30]) using a computer-generated random number sequence with sealed envelope allocation. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participating mothers or legal guardians.

PARTICIPANTS AND SETTING

Recruitment was conducted on-site at the Special Newborn Care Unit (SNCU) of the Government District Headquarters Hospital in Tirupattur, Tamil Nadu. Inclusion criteria consisted of:

1. Preterm infants born at <37 completed weeks of gestation.
2. Birth weight <2500 gm.
3. Discharged dynamically stable from the SNCU.
4. Parents residing within Tirupattur district with accessible mobile contact.

Exclusion criteria included major congenital malformations, severe birth asphyxia (grade II/III hypoxic-ischemic encephalopathy), or families planning to migrate out of the district within the next 6 months.

A total of 60 mother-infant dyads were enrolled between May 2024 and April 2025. Charts the participant flow through the trial milestones.

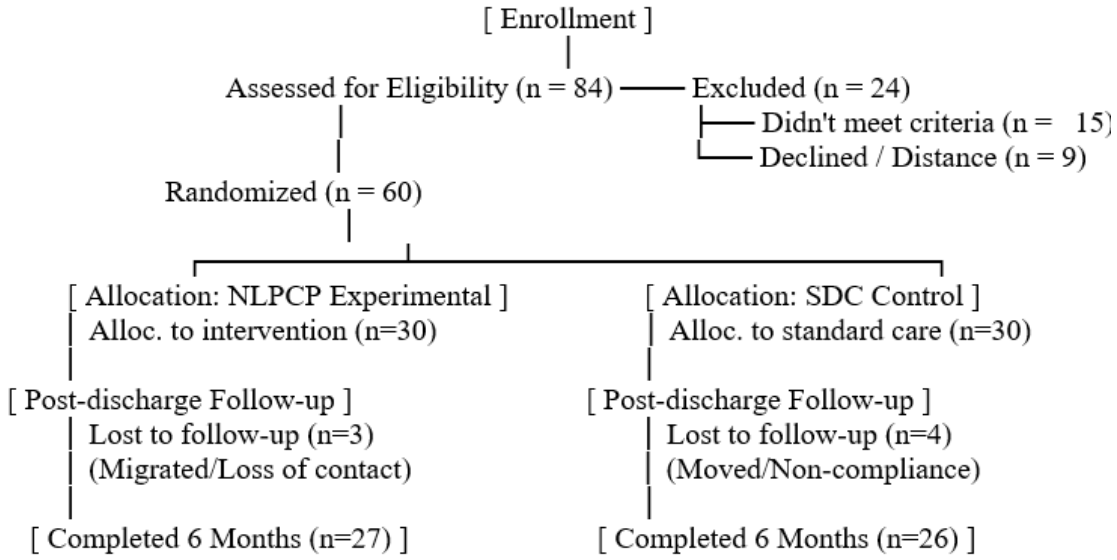

Figure 2: Flow diagram of recruitment, assignment, and completion of follow-up for preterm care package trial participants.

INTERVENTION:

Control Arm (Standard Discharge Care)

The SDC group received the standard, routine discharge instructions delivered verbally by the duty nursing staff on the day of hospital discharge. This included brief guidance on direct breastfeeding, keeping the infant warm, and returning to the hospital for scheduled immunization visits.

Experimental Arm (Nurse-Led Preterm Care Package)

The experimental arm received the structured NLPCP, which combined intensive one-on-one bedside parental training (spread over 48 hours prior to discharge) with structured tele-health reinforcement and direct tracking.

The care package focused on four core pillars:

1. **Advanced Thermal Care:** Proper technique and maintenance of Kangaroo Mother Care (KMC) at home for at least 6–8 hours daily.
2. **Nutritional Optimization:** Expressed breast milk topping, tracking feeding cues, correcting latching positions, and preventing aspiration.
3. **Infection Control:** Strict home handwashing routines, minimizing outside visitors, and identifying neonatal danger signs.
4. **Early Sensory Stimulation:** Gentle tactile and auditory stimulation practices (tactile-kinesthetic massage) to be executed daily by the mother.

Mothers were provided a vernacular (Tamil) illustrated handbook and a daily home care log. Following discharge, a dedicated project nurse made weekly follow-up phone calls to solve problems, monitor protocol adherence, and track milestones.

MEASURES:

Infant growth parameters were evaluated at discharge and monthly during follow-up visits matching the immunization schedule.

- **Weight** was measured to the nearest 10 gm. using an infant digital weighing scale with the infant naked.
- **Length** was tracked to the nearest 0.1 cm using a calibrated wooden infant meter.
- **Head circumference** was documented using a non-stretchable fiberglass tape.

Growth percentiles and z-scores were computed based on the World Health Organization (WHO) Child Growth Standards using corrected age for prematurity.

At 6 months of corrected age, developmental screening was conducted using the Trivandrum Developmental Screening Chart (TDSC) for infants (0-24 months), an validated tool in Indian community settings comprising 17 items. A delay was defined as an infant's inability to complete any single item expected for their corrected chronological age.

Maternal sociodemographic variables, obstetric history, and birth parameters were extracted from hospital medical records at baseline.

Statistical Analyses:

Data were compiled using SPSS version 26.0. Baseline comparisons between groups were checked using Chi-square tests for categorical parameters and independent t -tests for continuous features.

Time-to-event analysis (Kaplan-Meier survival curves) was used to analyze the median time required for infants to reach adequate catch-up growth (defined as crossing and staying above the 10th percentile for weight-for-age). Differences between survival paths were checked using the log-rank test.

Proportions of developmental delays at 6 months were compared using Fisher's exact tests. Signification limits were maintained at $p < 0.05$.

Results:

TABLE 1: BASELINE SOCIODEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF MOTHERS

Characteristic	SDC Control (n=30)	NLPCP Experimental (n=30)	p-value
Maternal Age (years, Mean \pm SD)	24.2 \pm 3.9	23.8 \pm 4.1	0.702
Socioeconomic Status (CMCHIS Holder %)	73.3% (n=22)	70.0% (n=21)	0.774
Parity (Primipara %)	60.0% (n=18)	56.7% (n=17)	0.791
Mode of Delivery (Cesarean %)	43.3% (n=13)	46.7% (n=14)	0.793
Antenatal Corticosteroids Received (%)	66.7% (n=20)	73.3% (n=22)	0.573

Post-discharge trial completion rates at 6 months were 90% (27/30) for the NLPCP arm and 86.7% (26/30) for the SDC arm ($p = 0.687$).

Table 1 details the baseline sociodemographic and clinical parameters of the mothers. No statistically significant baseline differences were noted between the arms, demonstrating that random assignment was effective. The cohort was characterized by low maternal income, with over 70% of households possessing a Chief Minister's Comprehensive Health Insurance Scheme (CMCHIS) card.

TABLE 2: CLINICAL CHARACTERISTICS OF PRETERM INFANTS

Parameter	SDC Control (n=30)	NLPCP Experimental (n=30)	p-value
Gestational Age (weeks, Mean \pm SD)	33.2 \pm 1.8	33.5 \pm 1.6	0.498
Birth Weight (grams, Mean \pm SD)	1645 \pm 280	1682 \pm 245	0.592
Infant Gender (Female %)	46.7% (n=14)	53.3% (n=16)	0.606
SNCU Stay Duration (days, Mean \pm SD)	11.4 \pm 4.2	12.1 \pm 3.8	0.505
Discharge Weight (grams, Mean \pm SD)	1810 \pm 120	1835 \pm 115	0.418

Table 2 highlights infant characteristics recorded at birth and discharge. The mean gestational age was roughly 33 weeks, and the mean birth weight was under 1700 gm. in both groups.

TABLE 3: GROWTH AND NEURODEVELOPMENTAL OUTCOMES OF PRETERM INFANTS

Outcome Measure	SDC Control (n=26)	NLPCP Experimental (n=27)	p-value
Median Time to Catch-up Growth (Months [95% CI])	5.5 \text{ [4.2, 6.8]}	3.5 \text{ [2.8, 4.2]}	0.032
Mean Weight at 6 Months Corrected (g \pm SD)	5840 \pm 410	6210 \pm 385	0.001
Mean Length at 6 Months Corrected (cm \pm SD)	61.2 \pm 2.1	63.4 \pm 1.8	0.0001
Developmental Delay at 6 Months (TDSC % [n])	34.6% (n=9)	11.1% (n=3)	0.041

Table 3 details the primary outcome measures for growth and neurodevelopment. Time-to-event tracking revealed that experimental infants achieved stable catch-up growth significantly faster than control infants (median 3.5 months vs. 5.5 months; Log-rank p = 0.032).

At the final 6-month corrected age assessment, infants in the NLPCP group exhibited significantly lower rates of developmental delays than control infants (11.1% vs 34.6%; p = 0.041).

Discussion:

This study evaluated the clinical effectiveness of a structured, nurse-led preterm care package delivered to parents at discharge within Tirupattur District, Tamil Nadu. The data confirm that organized parental support pathways significantly optimize post-discharge physical growth trajectories and reduce the incidence of identifiable neurodevelopmental delays during the first 6 months of corrected age.

The experimental cohort achieved stable catch-up growth two months sooner than the control group. This accelerated growth pattern can be attributed to the nutrition and thermal care components built into the NLPCP. By standardizing daily Kangaroo Mother Care (KMC) at home, maternal-infant attachment was enhanced, and infant energy expenditure from hypothermia was reduced, allowing more metabolic resources to go toward physical growth.

Furthermore, targeted counseling on proper positioning and expressed breast milk topping minimized feeding difficulties, which are common causes of post-discharge growth restriction in low-resource settings.

The neurodevelopmental findings highlight the value of simple, home-based interventions. Preterm infants whose parents implemented the daily tactile-kinesthetic massage and auditory protocols showed a significantly lower rate of developmental delays (11.1%) at 6 months compared to the control group (34.6%). Early neurosensory stimulation accelerates synaptic development, myelinogenesis, and primitive reflex integration.

Crucially, empowering parents as primary care interventionists while providing a nurse-led telephone safety net effectively addresses the shortage of specialized infant physical therapy setups in developing areas like Tirupattur.

The primary strengths of this investigation include its prospective randomized design, localized demographic tailoring, and objective verification using a standardized developmental assessment tool (TDSC).

However, some limitations must be noted. The study sample size was relatively small (N=60), which limited our capacity to execute multi-variable stratified regressions. Additionally, data concerning home adherence to KMC hours and stimulation routines were self-reported by mothers, introducing potential social desirability bias. Finally, the 6-month follow-up window captures only early developmental milestones; tracking these infants long-term would provide deeper insight into long-term school readiness and cognitive outcomes.

In conclusion, the implementation of a structured, nurse-led preterm care package at discharge significantly improves physical catch-up growth timelines and early developmental milestone achievement in preterm infants. Given these findings, health authorities should consider integrating nurse-led transitional care packages into standard discharge protocols across rural secondary newborn units in Tamil Nadu to help reduce post-discharge morbidity.

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