



ORIGINAL RESEARCH PAPER

Paediatrics

TRAINING MODULES FOR NICU STAFF IN EARLY DEVELOPMENTAL CARE OF NEWBORN

KEY WORDS: Training Module; Early Developmental Care; Newborn; Neuromotor; Neurobehaviour; Neurosensory; Multimodal.

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ABSTRACT

According to WHO update (2014) India leads globally with the highest number of preterm births annually (23.6% of 15 million global pre-term births) (1). Worldwide preterm babies are at a higher risk for developmental problems. Early developmental care (EDC) aimed at providing them support for optimal neurobehavioral development(10) can be both resource-consuming and labour-intensive(18). A simple and standard EDC training module has been devised; based on an understanding of preterm neurodevelopmental journey and encouraging cost-effective and traditional methods; and is being used for the training and sensitization of all NICU(neonatal intensive care unit) staff towards neuroprotective practice behaviour. The modules have 4 sub-sets – i.) neurobehaviour, ii.) neuromotor, iii.) neurosensory and iv.) multimodal strategies; and is currently being used either as a full-day nursing workshop or as an abridged version (of 60 minutes) for doctors. Nursing workshops include special awareness sessions on retinopathy of prematurity(ROP) and discharge planning.

Abbreviations - EDC (Early developmental care); NICU (Neonatal intensive care unit); KMC(Kangaroo Mother Care); ROP (Retinopathy of prematurity); NIDCAP (Neonatal Individualized Developmental Care Assessment Program); UDC (Universe of Developmental Care).

Introduction- According to the last WHO update (November 2014) India leads globally with the highest number of preterm births estimated at 3,519,100; accounting for 23.6% of the around 15 million global pre-term birth annually [1]. It is estimated that over 300,000 of these preterm babies die each year from associated complications [2]. Many of them could be saved with current, cost-effective interventions and many survivors face a lifetime of disability.

Worldwide preterm babies are at a higher risk for developmental problems including motor impairments, cognitive deficits and poor academic achievement [3]; as well as behavioral disorders like attention-deficit, attention-deficit-hyperactive, anxiety [4,5,6]; and autism [7]. The early stressful environmental influences on the brain during critically sensitive developmental periods maybe possible contributing factors [8]. Pain, sleep deprivation and other stressful events activate the hypothalamic– pituitary– adrenal (HPA) axis causing developmental trauma. It is crucial for the neonatal clinician to understand the age-specific needs and developmental requisites of the critically ill premature infant [9]. Early developmental care (EDC), an emerging new field in neonatology aims to create an intervention program designed to provide support for optimal neurobehavioral development during this highly vulnerable period of brain growth [10]. Developmentally supportive individualized care of newborn results in significantly improved outcomes including fewer days on the ventilator, earlier feeding success, shorter hospital stay, a marked reduction in the number of complications, and improved neurodevelopmental outcomes during the first 18 months of life [11].

EDC programs- Currently, the NIDCAP (Neonatal Individualized Developmental Care Assessment Program) model of EDC is a widely-used early intervention program based on the observation of the preterm infant's behaviour. Based on Heidi Als' "Synactive Theory" [11,12], which builds upon Brazelton's theory of *infant behavior*, [13] it interprets the developmental process to be based on neurodevelopmental subsystem interaction between the neonate, its environment, and caregivers; and that any imbalance within one subsystem affects all others. Another conceptual infant care- giving model was introduced by Coughlin et al in 2008 known as the Universe of Developmental Care (UDC) model which delineated five core measures for age-appropriate developmentally supportive care; namely (a) the healing environment, (b) protected sleep, (c) assessment and management of pain and stress, (d) activities of daily living, and (e) family-centered care [14,15]. The Neonatal Integrative Developmental Care Model has expanded the core measures to seven, with inclusion of position and handling, protection of skin, and optimization of nutrition [16]. A meta-

analysis of trials on developmental care interventions has expressed concern that their implementation is both resource-consuming and labor-intensive and have suggested further well-designed research with cost-benefit analyses [17,18]. In developing countries, cost factor needs to be carefully weighed against the economic impact of long-term neuro-developmental complications of the affected population.

Current status of EDC in India- As on September 2014, 548 Special Newborn Care Units (SNCUs) at district/sub-district hospitals or medical colleges providing care for sick neonates have been made operational across India [19]. There are also a growing number of NICU/SNCUs in the private healthcare sector in urban and semi-urban areas with facilities being used by the mid- to-high-income population. With improving neonatal care, survival rates are increasing; but so are the neurodevelopmental problems in the increasing number of survivors. However, early developmental care (EDC) is still at a somewhat nascent stage in the country.

In the background of this knowledge, it was imperative that we put forth some mechanism of guidelines for our NICU staff to help them achieve a developmentally supportive care attitude in their day-to-day NICU practice. Hence, an EDC training module was prepared for conducting workshops for the training of all NICU staff with an aim towards sensitizing them to age-appropriate developmental care. From the Indian perspective, our EDC training module needed to address the following requirements-

- a) Allow a simple understanding of the preterms' neurodevelopmental journey;
- b) Be flexible to fit an all-day training workshop for NICU nurses as well as a short hour-long orientation session for junior doctors;
- c) Be amenable for practice in the differently enabled and equipped neonatal units of the country with serious trained manpower and resource constraints;
- d) Encourage the use of cost-effective and traditional methods to make economic common-sense;
- e) Incorporate elements of both UDC and Synactive models that can be implemented locally.
- f) Based on the module guidelines each NICU/SNCU should be able to formulate their unit EDC protocols.

Using this EDC module 11 nursing workshops have been conducted in 2014-2016 in different parts of India, (Kolkata – 4, Shillong – 1, Mumbai – 2, Lucknow – 1, Ludhiana – 1, Pune -1, Kohlapur – 1). Nursing staff were asked to fill pre-workshop

questionnaires on their practice of 5 key EDC components- 1. Nesting; 2. KMC; 3. Pain management; 4. ROP and 5. hearing screening. Our inferences were as follows -

1. 90% nurses were aware but did not routinely practice nesting or pain management in their units.
2. Almost all practiced KMC, but there were no clear cut guidelines. Mostly KMC was started few days prior to discharge.
3. ROP referrals were done, but nurses were not emphasizing follow up.
4. Universal hearing screen was not practiced and high-risk screening depended on the discretion of the consultant in charge.
5. Ophthalmologists for ROP screening and audiologist for hearing screening were not available in most units and patients had to be referred elsewhere with resultant drop-outs and lost-to-follow-ups.

EDC training module- The workshops for nurses are conducted using the training modules with slide shows and demonstration tables with dummies for hands-on sessions. The module is currently being used as either a full-day nursing workshop or an abridged version for doctors (as a part of 'Cradle to crayon' workshops of GDBP chapter of Indian Academy of Paediatrics)[20].

Based on primary neurodevelopment, the modules have been divided into 4 sub-sets -

- I.) **Neurobehaviour** - the ultimate guide to all NICU care, the neurobehaviour module aims to train NICU staff to recognize newborn behavior through observation and assessment of individual babies.
- II.) **Neuromotor** - positioning, 'nesting' and handling techniques
- III.) **Neurosensory** - a.) Sensory neuroprotective measures -
 - i.) tactile (protection of the skin, 'positive touch')
 - ii.) auditory
 - iii.) visual
 - iv.) olfactory
 - v.) gustatory
- b.) Protection of sleep
- c.) Pain management
- d.) The healing environment
- IV.) **Multimodal** - a.) KMC (kangaroo mother care)
- b.) feeding strategies

Nursing workshops also include special sessions on-
 a.) Retinopathy of prematurity (ROP)
 b.) Discharge planning, follow-up and family participation.

I.) **Neuro-behaviour-** The aim is to train NICU staff to recognize individual newborn behavior patterns through observation and modify care according to the behavioral cues. The module teaches the staff to 'look, listen and watch' individual babies under their care for behavioral cues. The staff are taught to recognize 'positive' or 'coping' cues as well as 'negative' or 'stress' cues. This helps them to provide cue-based care and clustered cares for babies in NICU which promote minimal handling and protect deep sleep [21,22].

Als' Synactive theory provides the main theoretical underpinning. The 5 behavioral subsystems, [namely- a.) autonomic, b.) motor, c.) state organization, d.) attention/interaction and e.) self-regulation][23] help the NICU staff's understanding of newborn

behavior patterns. The staff is taught to recognize primitive autonomic behavior manifested as changes in colour, heart rate, patterns of breathing etc. as signs of stress behavior and which can be the only stress cues in a fragile and sick preterm. Self-regulation, on the other hand, is the ability to maintain and/or regain a balanced, relatively stable and relaxed state of subsystem-integration, and is therefore, a more nuanced behavior pattern seen in a term/near-term infant. A sick or preterm infant would find it difficult to achieve self-regulation and NICU nurses are taught to use strategies to assist in self-regulatory behavior. The goal of the module is to teach the NICU staff to use neonatal behavioral cues as reliable guides for modulating their caregiver practices.

II.) **Neuro-motor** -

The aim is to train NICU staff the importance of individualized positioning and optimal handling of preterm and sick neonates that will support their neurodevelopment and minimize complications.

Explanation of development of active muscle tone in a growing fetus is used to teach NICU staff the importance for neonatal positioning for neuromotor support. Active muscle tone develops at around 36 week's gestation, when babies in-utero assume physiological flexion by pushing up against the uterine walls. Premature babies who have not yet achieved physiological flexion miss out on some or all of the essential stages of muscle tone development. They have to work against gravity to move their limbs and often find it difficult to maintain the positions of sleep and self-comfort. Without support, gravity causes the limbs to flop into the so-called 'frog leg position' or 'W and M position'. This excessive abduction and rotation of the hip and shoulder joints can result in poor or delayed development and mobility problems in the future, including the ability to crawl, stand, walk and fine motor skills such as hand-mouth co-ordination. Near-term babies (34-37 weeks gestation) who have not yet achieved 'complete' physiological flexion, can also benefit from supportive positioning [24,25].

Nesting- The use of positional aids help the preterm infant maintain a beneficial position by providing a snug and secure 'nest' allowing them to feel more physiologically stable and secure, just as they were in an enclosed womb.

The module trains NICU nurses to provide nesting for babies with the use of towels, sheets and blanket rolls. Use of linens which can be washed, laundered and preferably, autoclaved before re-use, instead of expensive ready-made positional aids for individual babies reduces both infections and cost. For smaller preterm babies, soft gamgee rolls can also be used.

Key points for neonatal positioning are-A – Alignment; B – Boundary; C – Comfort; F –Flexion; and M- Midline; hands near Mouth.

III.) **Neuro-sensory-**Sensory development occurs in a precise order that optimally should not be altered. Sensory interference may occur when immature sensory systems are stimulated out-of-tune or with inappropriate stimuli, contributing to behavioral, cognitive, and functional deficits [16,26]. Preterm babies are at increased risk for auditory and visual impairment including sensorineural hearing loss and deficits in visual acuity and color vision [27,28]. In a NICU baby there may be up to 130 sensory disturbances per day with an average of 14 painful procedures per day [29]. Sensory neuro-protective measures (vide Table 1) are guided by the principle 'first do no harm' [30].

Table 1 -

a.) Sensory neuroprotection	
I.). Tactile sensory neuroprotection	1.Protection of skin – use of cling films; minimal use and careful removal of adhesive tapes. 2.Positive Touch - Level I- Grasp hold Level II-Containment holding Level III-Kangaroo Mother Care; Infant Massage (using plant-based, odour- free, additive-free edible oil like coconut oil in individual small containers). Levels of contact dependent on coping capabilities of infant and caregiver.

ii.) Auditory sensory neuroprotection	<p>Short-term behavioural measures-</p> <ol style="list-style-type: none"> 1. Staff sensitization on noise impact on the infant; 2. Designated quiet times during the day; 3. Conversation away from cot side during handovers; 4. Avoid sudden loud noise and prompt silencing of alarms; 5. Encourage visitors to talk quietly; 6. Discourage use of mobiles by visitors and staff; 7. Monitor periodically to identify times and causes of high levels. <p>Long-term structural measures-</p> <ol style="list-style-type: none"> 1. Sound proof rooms; 2. NICU should be situated away from the main road.
iii.) Olfactory sensory neuroprotection	<ol style="list-style-type: none"> 1. Avoid strong smells and perfumes in the nursery; 2. Use fragrance-free cleaning agents; 3. Alcohol wipes should not be left in baby's cot; 4. Early skin-to-skin contact is encouraged to provide mother's scent.
iv.) Gustatory sensory neuroprotection	<ol style="list-style-type: none"> 1. Positioning in flexed, midline alignment with hands near mouth helps to promote suck reflex; 2. Non-nutritive suck; 3. Expressed breast milk from mother is kept in baby's cot before feeds to provide simultaneous gustatory and olfactory stimulation.
v.) Visual sensory neuroprotection	Protect and cover eyes from direct light during procedures or phototherapy
b.) Protection of sleep	<ol style="list-style-type: none"> 1. Low ambient light 2. Protect eyes from bright light 3. Cycled lighting simulating day and night cycles 4. Clustered care for minimal handling 5. Designated 'quiet' times 6. Monitoring of noise levels in NICU
c.) Pain management– use of Non –pharmacological or Comfort measures	<ol style="list-style-type: none"> 1. Non-nutritive sucking (EBM/sucrose) 2. Containment hold during procedures 3. Swaddling and facilitated tuck 4. Grasp hold 5. Kangaroo Mother Care
d.) Healing environment	<ol style="list-style-type: none"> 1. Infection control, hand-washing 2. Continuity of care-giver practices, 3. Suitable physical and sensory macro-environment 4. Family participation

The module emphasizes on tactile sensation as skin is the preterm neonate's largest (approx. 2500 cm²) and earliest functioning sensory organ [31]. According to the *shared surface* theory of the UDC model, the infant skin is the main neurodevelopmental interface between the caregiver and infant. The epidermis, an ectodermal derivative sharing common embryological origin with the brain, is considered as the surface of the brain [14]. Skin also acts as a protective mantle and a surface for non-invasive monitoring. The most sensitive areas are the nose, mouth, hands and feet; areas most often involved in painful procedures.

Protection of this fragile preterm skin with the use of disposable cling films stretched across the open-care cot is recommended as a cheap option that allows easy visibility and ready access for caregivers while also reducing insensible fluid loss.

Touch is the foundation of infant experience. 'Positive touch', a term coined by Bond [31] was an inspiration from Leboyer's iconic illustration of infant massage by an Indian mother [32]. Neonatal massage has been a traditional child-rearing practice in the Indian subcontinent [33]. The module attempts to reacquaint NICU staff with traditional positive touch practices as NICU babies receive mostly painful or negative touch experiences. Positive touch is a non-clinical touch experience that responds to and not ignores the baby's behavior. It aims to a.) allow parents some sense of ownership of their infant in a difficult and uncertain atmosphere; and b.) enhance the immature infant's experience by promoting self-regulation and neurological stability. Positive touch can be graded in 3 levels depending on infant and care-giver capability; level I being suitable for the most fragile and sick preterm.

Pain management- NICU staff are taught non-pharmacological or comfort measures of pain relief [34] during and after painful procedures; enforcing timeouts if necessary. The key is to anticipate pain, assess and act accordingly.

Protection of sleep - Sleep deprivation (both REM and NREM) results in a loss of brain plasticity, later manifesting as smaller

brains and altered subsequent learning. Facilitation and protection of sleep and sleep cycles are essential to long-term learning and continuing brain development by preserving brain plasticity. Staffs are taught measures to promote sleep [35].

Healing environment- Infection control, continuity of care-giver practices, suitable physical and sensory macro-environment and family participation contribute towards a healing environment.

IV.) Multimodal strategies- Kangaroo Mother Care (KMC)

KMC is a key multimodal strategy. KMC reduced overall mortality, infections, hypothermia, severe illness, lower respiratory tract disease, and hospital stay; while improving gains in weight, length and head circumference [36]. It can safely and effectively manage procedural pain in neonates. Up to half a million newborns could be saved annually if KMC is promoted everywhere [37].

In actuality, practice of KMC is highly variable within NICUs as clinicians struggle to integrate KMC consistently and safely into an already busy workflow. The Sobreviver (Survive) Project notes that mere knowledge about evidence-based practice is not enough to ensure adoption — process is critical; and practice was significantly impacted when each unit developed a protocol for KMC with clear eligibility criteria [38].

Feeding –Feeding is a key multimodal strategy in NICU, involving neuromotor, neurosensory as well as neuro-behaviour systems.

At present, most Indian NICUs use a physical model of infant feeding dependent on factors like gestation, development of oromotor reflexes and level of support the baby requires in terms of ventilation, oxygen etc. However, "contingent caregiving," i.e., providing care when the infant indicates readiness to receive care, has been reported to have positive effects on immediate neurobehavioral responses and on long-term developmental outcomes [39]. Though bottle feeding is considered especially

amenable to contingent caregiving by recent research, it is recommended that most Indian nurseries practice the traditional paladi or spoon feeding. The advantage of paladi (or jhinuk)

feeding is that it can be started at a relatively lower developmental level and is culturally acceptable (vide Table 2; Fig).

Table 2 - Types of feeding

Types of feeding	Gavage feeding	Paladi/Jhinuk feeding	Cup feeding	Breast/nipple feeding
Development level	Non-nutritive sucking (NNS) < 32 weeks	Swallow- breathing needed, suck/ lap not needed >32 weeks	Swallow- breathing needed, needs to lap up milk >32 weeks	Needs Suck – Swallow – Breathe ~ 35 weeks
When to start?	Baby tolerating enteral feeds Volume and frequency decided as per weight and tolerance of baby	Stable vital signs Good color Good muscle tone, when alone in bed or during simple handling Begins to show signs of hunger Infant can maintain stability with NNS	Stable vital signs Good color Good muscle tone when alone in bed or during simple handling Begins to show signs of hunger Infant can maintain stability with NNS	Baby active participant Mother is supportive
Advantages	Earliest form of enteral support	Can be started at lower oromotor developmental level Culturally acceptable		Final phase of establishing feeds



Figure 1 & 2- Paladi-feeding and a paladi/jhinuk

Objectives of developmentally supportive feeding:

1. Reduce stress of feeding.
2. Provide positive oral experiences –
 - a) midline flexion positioning (sucking is a flexion activity) with hands to mouth,
 - b) promote non-nutritive sucking ,
 - c) promote skin-to-skin contact,
 - d) appropriate light and sound levels.
3. Prevent negative feeding experiences.
4. Allow cue-based feeding to maximize feeding potential of the preterm infant with a positive interaction between the infant and the caregiver.

Goals: A confident and competent parent with a medically stable infant, and a safe feeding plan that supports growth and nutrition. Premature babies benefit from breast milk nutritionally, immunologically and developmentally. The many short-term and long-term benefits compared with formula feeding include an improved neurodevelopmental outcome [40]. Most premature babies require extra support for feeding with a paladi, cup, spoon or gavage feeding. In addition, the mother requires support for expressing milk. Where this is not possible, donor milk is recommended.

In conclusion, the emphasis should be on quality rather than quantity of feeds, reducing stress during feeding, promoting cue based feeding and parental input.

Retinopathy of prematurity (ROP)-

A short session on ROP is included in the nurses' workshop. One of the commonest causes of preventable blindness in preterm neonates, ROP is emerging as a 'third epidemic' in middle income countries [41] due to

- Increasing survival of preterm neonates
- Insufficient monitoring of oxygen saturation

- Failure to adhere to ROP screening guidelines and failure to follow-up

The goal is to increase awareness of NICU nurses about -

- a. Optimum use of oxygen
- b. ROP screening. A simplified guideline for ensuring follow-up and preventing drop-outs - ROP screening at 4 weeks of birth for all babies delivered before 34 weeks or birth weight ≤ 1750 grams [42,43].

Discharge-planning: A small session on discharge-planning is included in the nurses' workshop. A meticulously planned neonatal discharge ensures follow-up, prevents drop-outs and allows early intervention, if necessary.

Conclusion- The challenge of implementing neuroprotective strategies for the vulnerable neonates as we strive to improve morbidity and mortality rates is formidable but not impossible. The perception that EDC is not entirely "necessary" in an increasingly hi-tech NICU needs to change. Underestimating its importance, given the growing body of evidence and the vast number of preterm births in our country may be counter-productive. Training and sensitization of all NICU staff including doctors towards neuroprotective practice behavior using standard training modules and promoting indigenous and cost-effective measures is necessary and as neonatal clinicians, also, our moral imperative.

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