

Developmental Supportive Care for Preterm Infants in Neonatal Intensive Care Units

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ABSTRACT

Survival of preterm infants (PTIs) is increasing with the availability of neonatal intensive care, advanced technologies and equipment. Nonetheless, they are vulnerable to developmental impairment. They require special care in neonatal intensive care units (NICU) involving their parents for survival with development. Therefore, this article was prepared to enhance awareness about the need and components of those care among nurses working in neonatal care units (NCUs). A review of the relevant literature showed that interventions for supporting the development of the infant include minimizing the environmental stressors in NICU. Some effective Developmental Supportive Care (DSC) interventions are skin-to-skin contact (SSC) or kangaroo mother care (KMC), breast milk feeding, sleep protection, positioning and handling, supportive sensory environment, protecting skin, stress and pain management, and minimizing infant-parent separation.

INTRODUCTION

Improved neonatal intensive care and expanded access to life-saving commodities, equipment, and technologies like Continue Positive Airway Pressure (CPAP), mechanical ventilation, and exogenous surfactant have resulted in increased survival rates even for very preterm and extremely preterm infants.¹ However, the immature brain, lungs, gastrointestinal tract, and skin of PTIs are still susceptible to injury and abnormal development often leading to long-term neurological and health problems. Preterm birth is an important contributing factor with an inverse relationship between birth weight or gestational age and risk for developmental impairment.^{2,3} However, literature indicated enhancement of developmental outcomes with special nursing care in NICU.^{4,5} Therefore, this article was prepared to create awareness about the developmental supportive interventions for preterm and sick newborns among nurses working in neonatal care units.

METHODS

The literature search was done to explore the different components of DSCs. The search focused on guidelines and protocols, review articles, original articles, systematic review/meta-analysis,

and reports. The electronic databases used for the literature search were Pub med, Google Scholar, Hinari, Science Direct, Cochrane Library, academia search, and research gate. The keywords and phrases like preterm infants/newborns/babies, inpatient/facility-based neonatal care, developmental supportive care, and neuroprotective care. Articles published within ten years were included with more emphasis on within five years. A total of thirty relevant literature was reviewed, summarized and to prepare this article.

Preterm Infants and Developmental Vulnerability

The third trimester of gestation is the period of intense growth and evolution for the fetal central nervous system. PTIs born before the third-trimester experience disruption in the delicate process of fetal maturation and neurologic growth.⁶ Although the resources of the NICU may save lives, the typical NICU environment is stressful for infants and their families. Abruptly separated from mothers, they are handled by many, exposed to uncontrolled light and noise, sleep disruptions, fluctuation of temperature and oxygen levels and pain and discomfort. Most touch are procedural, uncomfortable, and painful.^{6,7}

Mismatch of the normal intrauterine environment and exposure of inappropriate sensory input of the NICU at a critical stage of fetal neurologic development produces maladaptive physiological processes and predisposes the infant to improper developmental outcomes. In such environment, the pre-birth risk factors may be potentiated, further adversely affecting neurocognitive development.^{6,8} Later, PTIs show features of developmental impairment like mental retardation, cerebral palsy, autism, attention deficit disorders, visual and hearing problems, speech and language disorders, learning disabilities and many more.⁸ The cerebral palsy (CP) is the most commonly reported disabilities for which risk increases with decreasing gestational age.³ Previous studies reported higher prevalence of developmental impairment among preterm and LBW infants. The screening of 427 NICU admitted children in rural India reported developmental delay among 134 (31.6%) infants. Among the affected children, (45.5%) were preterm, (59.7%) had low birth weight (LBW).⁸ The systematic review to estimate long-term neurodevelopmental impairment risk among PTIs survivors revealed that among estimated 13 million preterm survivors, 345,000 (2.7%) were had moderate or severe, and 567,000 (4.4%) had mild neurodevelopmental impairment. Many more had specific learning or behavioral impairments or reduced physical or mental health.⁹

Developmental Supportive Care

Despite the impact of prematurity has long been recognized, the early days of neonatal care focused upon the survival care. The focus of care gradually shifted from mere survival to survival without disability.⁷ DSC is based on the principles of nursing science as outlined by Florence Nightingale which signifies the nurses' responsibility in creating and maintaining a healing environment.¹⁰ Considering its significance, WHO has also suggested for transforming care incorporating the DSC components partnering with the parents with maximum information sharing with them.¹¹ In the context of Nepal, NENAP provides guidance on some elements of DSC like KMC, and early exclusive breast feeding.¹²

Various models of developmentally supportive care are suggested to support the presumed neurodevelopmental needs of PTIs.^{11,13,14} The overall goal of such care is to create a more stress-free caring environment for the PTIs and family to promote both physiological stability and neurological development.⁷ Some of the common interventions mentioned in different model are SSC or KMC, breast milk feeding, protected sleep, supportive sensory environment, positioning and handling, protecting skin, stress and pain management, and minimizing infant-parent separation.^{6,11,14} SSC or KMC is a fundamental, essential component of neuro-protective care for PTIs admitted in NCUs. KMC with breast milk feeding can fulfill all the developmental care need of PTIs.⁶ The health personnel education and training should be the part of the DSC program.¹⁴

Kangaroo Mother Care

The KMC is the kangaroo position in which the infant is placed and held in an upright position with direct skin to skin contact on the mother/father's chest. Although early initiation and continuous KMC (over 18 hours/day) with exclusive breast feeding is the best practice, practice depends on the stability of the PTIs and the care context.¹⁵ Even intermittent KMC for more than one hour is important intervention for the PTIs and their mothers. Continuous or prolonged KMC provided by mother can provide the optimum environment for the infant. It facilitates supportive positioning and handling, fosters optimal autonomic and physiologic stability and promotes sleep, minimizes stress and pain, protects skin by providing humidity and supporting thermoregulation. It promotes breast milk supply among mothers, infant-parent attachment and accelerate brain development. It also empowers parenting role.^{6,16}

Nutrition and Feeding

Breast milk is the best nutrition for the PTIs. Preterm breast milk has more protein, less fluid, and higher levels of various bioactive molecules necessary for the PTIs.^{10,17} PTIs unable to breastfeed are fed expressed breast milk (EBM) through oro-gastric (OG) tube or oral feeding. Parental fluid with adjunct to enteral feeding is necessary in some critical cases. Enteral feeding is safe and preferred with trophic

feeds or minimal volumes of EBM feeds (10–15 mL/kg/day) through OG tubes (to prevent intestinal atrophy) preferably within 24 hours of life or by 24–48 hours according to the hemodynamic condition of the PTIs. The nutritional feeding is started gradually increasing amount of feeding and progressed in route from OG tube to oral and breastfeeding.^{12,17–19}

Early, fast enteral feeding has better outcomes compared to late, slow, or intermittent feeding. PTIs can be fed while on a ventilator or continuous positive airway pressure.^{17–19} Trophic feeding is more effective when combined with EBM oral stimulation.²⁰ The Non-nutritive Sucking is the evidence based intervention to support the physiological maturation for feeding progress from tube to oral and breastfeeding. The effective technique for NNS is to instruct mothers to empty her breast milk and make her PTI suck her empty breast for short period (2-3 minutes).^{19,20}

Proper Positioning

The spontaneous resting posture of PTI is often flat, extended, asymmetrical with head to one side, with the extremities abducted and externally rotated. This type of posture can be baseline for the significant developmental delays and sometimes permanent disabilities.⁶ The recommended positioning for PTIs is similar to the usual fetal position in the utero: neck slightly flexed, head and neck in straight aligned with the body, extremities flexed towards the midline and spine slightly flexed position. To maintain proper positioning therapeutic positioning aid, nesting (blanket/linen rolls around the PTI) and swaddling (wrapping the infants in a sheet or blanket for recommended position) are used. Prone or side-lying positions with support are preferable to supine positioning.^{6,11,21} Proper positioning enhances optimal musculoskeletal development, physiological stability, thermal regulation, neurobehavioral organization, comfort, sleep facilitation and skin integrity^{14,21}

Furthermore, moving suddenly and quickly can be stressful and has detrimental effects on brain development. Frequent handling of PTIs for activities like diaper change, position change, therapeutic procedure can be stressful with physiological responses like brady/tachycardia, apnea, hypoxia

difficulty sleeping. Therefore, they should be handled gently and slowly with the extremities flexed and body well supported. Caring and other diagnostic/therapeutic procedures should be clustered considering minimal handling.^{6,10,22}

Protected Sleep

Individual sleep patterns begin to emerge at approximately 28 weeks of gestation. Preservation of sleep and sleep cycles in the critical period of brain development is important for enhancement of brain plasticity and for neurodevelopment. It is also essential for the energy restoration, maintenance of bodily homeostasis, adequate growth and healing process of PTIs.^{6,10} The recommended interventions to promote PTI's sleep in the NICU are environmental modification like promoting quiet environment, minimizing light and noise, minimum handling with clustered routine care based on infant sleep wake status. The nursing care strategies include nesting, swaddling, facilitated tucking (wrapping to maintain a flexed in utero posture), nonnutritive sucking, gentle touch and massage, KMC, calm auditory stimulation.^{6,10,11,14} Care should be clustering to coincide with the feeding time, avoiding unnecessary sleep interruptions and postponing interventions that are not essential until the PTI wakes up. If care cannot be postponed, it is important to awaken gently for less abrupt transition from sleep to wake state.^{6,14,22}

Supportive Sensory Environment (SSE)

Early extra-uterine environmental exposure to the bright lights, noise, high activity levels, painful interventions, unpredictable care patterns, and parental separation in NICU acutely stress the fragile PTIs' physiological capabilities. Such stress if intense or prolonged, becomes toxic causing chronic hyperstimulation of the autonomic nervous system. Even necessary caregiving practices like diaper changes, bathing, or weighing are stressful to PTIs. Parental separation alone can disrupt infant's physiologic stability. Therefore, the SSE aims to minimize associated stress though complete elimination is unlikely. It involves promoting positive tactile, auditory and visual sensory system of PTIs. Physical environment includes facility to support the parental presence for breast feeding, KMC and other care.^{6,22}

Temperature

PTIs should be provided a thermo-neutral environment in which neither gaining nor losing heat.^{6,23} The environmental temperature of the NICU should be 22-26°C, humidity 30-60%, with adequate air exchange. The SSC by parents is the best environment in which temperature of mother's chest increases by 2°C to warm a cool infant and decrease by 1°C to cool an overheated infant (thermosynchrony). When SSC is not possible, temperature (36.5°C – 37.5°C) need to be maintained using incubator or radiant warmer, preferably incubator.²³

Sound Precaution

PTIs are especially sensitive to noise because they are exposed to excessive auditory stimulation before complete development of auditory system. The noisy situations are stressful responded with apnea, hypoxia tachy/bradycardia, and increased intracranial pressure, sleep interruption in PTIs. The excess noise exposure disrupts their growth and development and put them at risk for hearing, language, and cognitive disabilities.^{10,24} Nevertheless, systematic review revealed noise levels consistently above the recommendations in most of the NICUs.²⁴

Recommended acceptable sound level in NICU by American Academy of Pediatrics is 45 dB.²⁴ In NICU, high sound levels are related to therapeutic equipment (like ventilator), alarms, communication devices (phone, pager, mobile), sound of door and windows as well as talking and loud laughter. Sound levels are often related to activities such as shift change and medical round. Measures to minimize noise in NCU are to stopping alarm soon, minimizing sound of alarm and other equipment, telephone; eliminating radio; staff conversation in low volume or conversation away from infant bedside, keeping the porthole of incubator closed, not keeping equipment on the top of the incubator and application of quiet period especially during night.^{6,14,24}

Light Precaution

The visual system is not developmentally ready for external visual stimuli. Sleep deprivation and intense light exposure affect visual development. In most of the NICUs, continuous intense light such as examination lights, phototherapy lamps and

ambient space light affects neonatal sleep.²¹ Some interventions to control excess light are cycled lighting (low light at night), covering incubators with opaque covers, control excess light from the outside, using dimmer lights, restricting bright lights only for procedures and do not turn light bulbs directly onto the newborn's face. Eye patches need to be applied when exposed to bright light. Only indirect ambient lighting should be used.^{6,10,22}

Protecting Skin (Skin Care)

PTIs have an underdeveloped skin barrier, which increases the risk for high water and electrolyte loss, thermal instability, additional skin damage, and infection. In NICU, they have further risk of skin compromise related to the presence of dressings, adhesives tapes, and medical devices, such as intravenous cannula, and nasal prongs for their care.²⁵ Effective measures to protect skin of PTIs are maintaining humidity of more than 70% inside the incubator to decrease trans-epidermal water loss, less frequent (every 4 days) bath with plain water, limiting adhesive tape use and removing it gently, and topical emollient and coconut oil application. Skin to skin contact also provides good skin care. It is important to assess the skin condition using validated skin assessment tools.^{6,22,25}

Pain Management

The environment of NICU can be stressful for PTIs related to many procedures that cause pain, stress, and discomfort. PTIs experience stressful and painful events such as intubation, eye examination, lumbar puncture, heel pricks, and nasogastric tube insertion. Exposure to greater numbers of painful and invasive procedures during neonatal period are associated with delayed postnatal growth, and neurodevelopmental consequence in infants and children.^{26,27} Therefore, accurate monitoring of pain as the fifth vital sign is necessary utilizing standardized pain assessment tool (such as the Premature Infant Pain Profile-Revised) and consistent management of pain in neonates are important.⁶ The evidence-based, non-pharmacological management of neonatal acute pain includes maternal touch, holding and massage by mother, breastfeeding or human milk (has potent pain relief effect when used with breastfeeding or via oral-gastric tube); non-nutritive sucking (sucking

behaviors have an analgesic effect; a pacifier can be used); facilitated-tucking; swaddling; skin-to-skin contact. Sweet solutions, such as sucrose and glucose, are used to prevent acute-procedural pain in the NICU.^{28,29}

Parents Involvement in Care

Separation with inconsistent caregivers is one of the harmful stressor for PTIs' immature brain in NICU. Even in early days, PTIs know their parents voice, smell and touch and soothed by their loving presence. Minimization of infant-parent separation, early bonding and attachment and infant-parent makes significant difference in structural and functional development of their brain.^{6,30} Therefore, it is essential to support infant-parent attachment and involve them in infant minimizing their separation. Parents, especially mothers should be involved for providing positive sensory experience, comfort and security to their PTIs through infant touch, interaction, handling, supportive positioning, skin-to skin contact, feeding, and other general care. For parental involvement in care, providing information about PTI care and supportive environment in NICU are important (^{6,10,14}). Family centered care is the hallmark of care in global neonatal practice.

CONCLUSION

With the increased survival rate among PTIs, related developmental squeala is the concern in perinatology. Available literature suggested that nurses and other health professionals in NICU need to consider implementation of DSC components to maximize the chances of healthier developmental outcomes in very and extremely PTIs. PTIs need to be protected from discomfort, distress, and pain experiences in NCU by minimizing sound and light; minimum handling and clustering the care; facilitating the sound sleep; promoting skin-to-skin contact, exclusive breast milk feeding, and minimizing infant-parent separation. It will help to achieve more organized physiological, emotional and behavioral regulation in their developmental processes.

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