

Point of View

How to improve the neonatal intensive care unit environment

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Evaluation is a continuous process and nature shapes us as per our deeds. Destroying nature will come back to haunt us. The earth's biodiversity crisis threatens all of humanity in numerous unseen ways. The recent Corona pandemic is just an example. We have been modifying the environment around us through agriculture, urbanisation, science and technology. Because of these changing environmental and fast evolving high-technological factors, nature started pushing humans to be born prematurely. As an example, studies have shown prematurity to be attributable to air pollution¹. The most recent US data indicate that the rate of premature birth increased in 2018 for a fourth consecutive year to 10%². These preterm infants are forced to spend most of their initial time after birth in a man-made artificial environment.

Preterm neonates are prone to poor neuro-developmental outcomes like deficits in learning and memory, disrupted sensory-processing, tone abnormalities and poor self-regulation. If these abnormalities continue in future generations in the form of epigenetics, it could be disastrous. In fact, not only survival, intact survival is important. The brain is early to develop but late to mature as an organ. Neuronal proliferation occurs in the first trimester, whereas synapse formation, deepening of sulci and gyri and myelination occur in the second and third trimesters. Millions of synapses are formed per minute during 28-40 gestational weeks³. This shows us how vulnerable the brain is. Late-stage development is usually activity-dependent. If we sensitize the brain, only then do we develop that sense. Ambylopia is one such example.

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The concept of an enriched environment is not new. It has been in existence for a very long time but has been somewhat forgotten. Hoffman, a neuroscientist, stated that genes are like bricks and our environment is the architect that builds the brain. This is why Neonatal Intensive Care Units (NICUs) should be enriched with highly positive environments and should not be dull and mundane. Nightingale in 1860 stressed the need for a well-ventilated environment for neonates. The frontal lobes of the rats which were exposed to enriched environment were heavier by 7–10%. They had developed 20% more acetylcholine receptors and synapses⁴. Neonates not only require protection but also need stimulation.

Environments not only indicate physical phenomena, but also include the circumstances, objects, or conditions with which one is surrounded. In a more extended sense, it may signify the circumstances and conditions that make up everyday life. NICU environment is usually divided into the macro-environment (physical environment such as temperature, light, sound, culture, values and team behaviour) and the micro-environment (caregiving factors, containment, touch, handling, position and family-centred care).

Progression of touch, balance, taste, smell, hearing, and sight is the sequence of the order in which our senses develop⁵. Stimulation of early maturing senses (e.g., tactile, vestibular) have an influence on the development of later maturing senses. Untimely, precocious stimulation may disrupt the normal maturational process of another sensory system. But, in contrast to the *in utero* environment where light is negligible, our NICUs have high intensity lights. One sense can change the perception of another sense. 'Deprivation' or 'over-stimulation' can both cause harm. We need to be mindful of these concepts during the course of treatment. As the pupillary reflex is not well developed in babies below 32 gestational weeks, we need to protect them by covering the eyes.

As per synactive theory of development, 5 sub-systems viz. autonomic, motor, state, attention /interaction and self-regulatory, are in constant interaction with each other and guide the neonate's interaction with the environment⁶. If one system is

disturbed, all the other systems are disturbed as well. *In utero*, they self-regulate themselves by constant sucking and swallowing and head and hand coordination due to the lack of gravity. Therefore, once in the NICU, it is better to self-regulate the baby by non-nutritive sucking (NNS) and nesting. Duration of ventilation will be less if nesting is done in term neonates as well.

Neonatal behavioural assessment scale, developed by Brazelton *et al* in 1973⁷, in turning (28 weeks), coming out (34 weeks), active reciprocity stage (35 weeks or more) mentioned by Gorski, Davison, and Brazelton (1979)⁸ will depend on self-regulation and self and environmental interactions. In turning stage, autonomic instability will occur, in coming out stage, the baby will interact for a very short time with the environment. Understanding of both theories is important as our approach should be based on the stage and the behavioural situation of the baby. We should not disturb the baby's sleep merely for the sake of our convenience. Stress signs of the baby should be respected and responded to earlier.

Prone positioning in the NICU has been strongly supported in many studies⁹. Flexed position, midline orientation and hand-to-mouth co-ordination are necessary for the baby *in utero*. Self-regulating is by means of continuous amniotic fluid sucking and continuous mouth and hand coordination, which are lacking in *ex utero*. As mentioned earlier, this is possible because of the absence of gravity *in utero*. It would work better to protect self-image and congenital dislocation of hip by using appropriately sized diapers. Avoid deformities e.g., the shape of the hard palate, positional plagiocephaly by putting the baby in midline position.

Preterm babies are not in a state to express the pain that they feel. Hence, it is better to identify their subtle features and treat them accordingly. REM sleep is important for normal brain development. REM sleep deprivation during early development leads to permanent deviations in behaviour, alterations in neurotransmitter responses and reduced brain volumes. Sleep has important biologic and immunologic consequences. Hence, it is important to control noise levels in the NICU. The use of high technology for monitoring and regulating the acoustic environment is required. Simple earplugs are important during transporting the baby. Quality of sound also has great significance as fetuses surprisingly tolerate qualitative loud sounds very well. The three semi-circular canals reach morphologic maturity by 14 gestational weeks and is the early sensation. Gentle position change is required. The mother's breathing movements during kangaroo mother care (KMC) are the best vestibular stimuli.

As early as 18 weeks of gestation, more than 120 compounds are present in the amniotic fluid. Tastes of milk activate a centrally mediated endogenous opioid system¹⁰. Maternal rhythms of melatonin and cortisol are present in breast milk to maintain these rhythms. A period of familiarisation with the odour of breast milk will facilitate the early acquisition of oral feeding skills. Even though in this era, everyone is inclined to use organic food, some mothers don't hesitate to start top-up feeding immediately after birth. The mother's own milk is not comparable to any other milk in the world. The importance of breast feeding should be taught to mothers. Hence, we need to concentrate on mother's education, which is of utmost importance in low-income countries.

Maternal armpits harbour many commensal bacteria and an odour similar to amniotic fluid; that's why Kangaroo mother care will decrease the infections and improve bonding. As memory and olfaction are structurally and functionally nearer to adult olfaction sense, olfactory memory will persist longer; 65% of people do not forget bad odour up to 1 year¹¹. Sanitisers should be opened away from the baby and it is advisable to avoid perfumes as well.

Pupillary reflex will start developing at 28 gestational weeks and *in utero* the baby is usually not stimulated by light (less than 2% of external light)¹². The intensity of light should be adjustable in the NICU. Simulated day/night environment will promote diurnal rhythms. Exposure to high intensity light by a preterm infant in the NICU is a risk for structural and growth alterations of the eye such as amblyopia, myopia etc. and can cause alterations in visual function. Direct light into the eyes of the baby should always be avoided. Cycling light can be used starting at 32 gestational weeks (On: 100-200 lux; off: 10 lux). The incubators should be covered with a cloth. Procedure lights should be focused on the task only. Cycled lighting is better than near darkness which allows more time in sleep state, more weight gain, better motor activity levels and better heart function¹³.

Many animals reject their babies if they do not see them immediately after birth. In humans, too, it is important for the baby and mother to interact immediately after birth in the "early sensitive period"¹⁴. How many institutions are practising breast crawl in term babies! Tactile hypersensitivity or tactile defensive behaviour is reported in many case reports due to excessive or less tactile stimulation in the neonatal period¹⁵. After 34 gestational weeks only will infants develop habituation. Excessive handling may also have negative physiologic consequences, particularly below seven days, which leads to more chances of intraventricular haemorrhage due to the immature

germinal matrix. Hence, cluster-care is needed. Swaddling, facilitated tuck and non-nutritive sucking (NNS), an important oral-tactile intervention, support both feeding and behavioural development. NNS also aids in digestion by increased salivary lipase release. Massage therapy with moderate pressure (not feathery) stimulates increased vagal tone, increased insulin levels and increased growth hormone secretion¹⁶. Lastly, it is vital that, as a part of environmental protection, biodegradable products are adopted.

Whatever physical environment is required for a human being should also be created in the NICU as far as possible. "We shape our buildings, and afterwards our buildings will shape us". This saying of Winston Churchill is realistic. Design should provide the best technological and environmental support possible to all three constituencies — infants, families and caregivers. Availability of sufficient numbers of adequately trained personnel is needed to avoid burnouts. Parents and family members are an integral part of the NICU team and open communication with family members is valuable. They should work together with the NICU team and be involved in decision making. Parents should not be mere visitors. An organic approach and sensitive quality environment are of utmost importance in NICUs. NIDCAP and COPE, the NICU programmes based on holistic development of neonate, must be given priority.

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