Effects of Early Life Experiences on Brain Development of Premature Babies Admitted in Neonatal Intensive Care Unit

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Abstract: Infancy is the most crucial time period in children's life during which babies require sensitive and responsive care-giving from their primary caregivers for their overall growth and development. Sick preterm babies, who require admission at Neonatal Intensive Care Unit (NICU) and experience physical separation from their parents during early days of their lives, are at high risk to encounter toxic stress that can be detrimental for their developing brains, overall development and stress regulatory mechanism in later life.

This paper presents case study of a preterm baby who encountered toxic stress due to the effects of disease process, physical separation from primary caregivers, painful procedures at NICU, as well as bright and noisy environment of NICU. In the light of the presented case study and reviewed literature, modifications in the NICU environment are suggested to reduce the sources of toxic stress on the developing brains of premature babies. Role of lactation support for mothers of preterm babies, kangaroo mother care, and neurodevelopmental care in the NICU environment is highlighted to assure growth promotion, brain development, infant-mother bonding, and better cognitive functions among premature babies.

Keywords: Neurodevelopment, NICU, Premature babies, Toxic stress.

Postnatal period is the most crucial time period in children's life. During this period young babies not only physiologically adjust to their extra-uterine life but also learn to develop basis trust in the world. The transmitted stimuli to children's brain during this sensitive and critical period affect the structure and functions of their developing brain cells and associated pathways in many ways [1]. Therefore, starting from this crucial period, role of sensitive and responsive care-giving, developmental stimulation and supportive environment, breastfeeding, and close interaction with the primary caregiver is essential for young children's physical, motor, language, emotional and social development [1].

Children who are born premature often require admission at neonatal intensive care unit (NICU) and experience separation from their primary caregiver soon after their birth. If the environment does not support sensitive and responsive care-giving, then these babies experience toxic stress during early days of their lives which pose detrimental effects on their developing brains. To ascertain the early life experiences of premature babies admitted in NICU, this paper presents case study of a sick preterm children, and in the light of the presented case and reviewed literature, it discusses the possible stressors and their effects on the developing brain of young children who require hospital admission soon after their birth and recommends strategies to support brain development of sick premature babies admitted in NICU.

CASE STUDY

A five day old male child was born premature at 32 week of gestation with a birth weight of 2000 grams (2 Kg). The child belongs to a middle class Muslim family that is residing in Karachi, Pakistan (an urban setup). His family is comprised of grandparents and parents (an extended family). Child's parents are first cousins and he is the first child of this couple. At the time of birth, the child developed respiratory difficulties and hypothermia so since then he is away from his mother and admitted at the Neonatal Intensive Care Unit (NICU) of a tertiary care hospital in Karachi, Pakistan. He has been placed in an incubator to assure thermoregulation and close monitoring of his condition. The bright lights and loud noises of the monitoring devices at NICU make him uncomfortable and inconsolable throughout the day.

At NICU, the child is mostly handled by the nurses and doctors. Nurses check child's hemodynamic stability (pulse, temperature, blood pressure, and oxygen saturation) every two hourly, provide daily sponge bath to him, and offer him the pacifier when he cries and mourns during painful procedures. Child's parents are allowed to visit him at the NICU only once a day between the visiting hours; hence, this child does not get much of the opportunity to interact with his parents. His parents are anxious and feeling helpless because as per the NICU policy they cannot involve much in his care during the hospitalization. At present,

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this child is receiving intravenous medications and formula feed through nasogastric tube every four hourly. Medically child's condition is improving, however, his weight gain is poor, his sleep is disturbed, and he remains inconsolable throughout the day. It is planned by his medical team that he needs close observation at least for the next two weeks at hospital.

DISCUSSION

The described early days experiences of five-day-old hospitalized child who is a sick, premature, and Low Birth Weight (LBW) indicates that the routines of the hospital environment, child's disease process, disturbed sleep pattern, feeding of formula milk instead of breast milk, and physical separation of the child from his parents were the possible stressors for him that can adversely affect his early brain development. From the discussed case study, it can be analyzed that child's high-risk situation is exposing him to multiple stressors that can serve as sources of toxic stress for him in many ways. Firstly, child's currently physiological condition, including disease process, prematurity and LBW, is putting his developing brain cells in stress. In the current state of health, child's body is trying to cope with his ill health by utilizing most of the nutrient in his recovery rather than for his brain development. Literature also supports that disease process in premature and LBW babies affects their brain development by altering the process of differentiation of neurons, synaptogenesis, and elaboration of dendrites and axons [2]. Secondly, the environmental factors including noise, bright lights, painful procedures, and physical separation from his mother can have stress-inducing effects on this premature born child and this can seriously affect his brain development by causing changes to the brain architecture [3,4]. Literature reports that exposure to the environmental stressors among premature babies during the course of their treatment at NICU leads to decreased width of the brain's frontal and parietal lobe and altered functional connectivity in the temporal lobes; consequently, premature babies manifest affected motor behavior and long-term neurodevelopmental deficits [5].

The presented case study and its analysis through literature further indicates that premature children's predispositions to toxic stress during early days of his life can adversely affect babies' brain architecture, overall development, and stress regulatory mechanism in later life [6], therefore, interventions to control the possible sources of stressors are essential. Literature suggests that the epigenetic effects of all the stressors on sick and premature babies' brain architecture can be reduced through provision of developmental stimulation and ideal nutrition i.e. breastfeeding to them, as well as through sensitive and responsive care-giving by people in their environment, especially health care professionals and parents [1,7]. As breast milk has all the essential nutrients that can promote growth, brain development, immunity, infant-mother bonding, and cognitive scores in later life [2], therefore, in NICU setups breastfeeding should be promoted as much as possible and premature babies should be fed expressed breast milk instead of formula milk. In this regard, mothers of premature babies should be extended support to establish lactation soon after her child's birth [8-10], this intervention is essential to boost self-confidence and self-efficacy of these mothers, as well as to assure breastfeeding success [11]. To assure adequate establishment of the lactation during premature babies' admission at NICU, it is essential that mother of premature babies are informed about methods of breast milk expression minimum six times a day, storage methods of breast milk, and safe transfer of stored breast milk to NICU [12]. Moreover, kangaroo mother care i.e. skin-to-skin contact between caregiver and child should be encouraged to benefit preterm infant-mother dyad in stressful environment of NICU [9,13]. This intervention not only promotes milk production and long term breastfeeding performance but also enhances mother-child bonding, stabilizes body temperature in premature babies, assures weight gain of LBW babies, and improves cognitive functions among premature and LBW babies [4,8,14].

Along with above interventions, provision of neurodevelopmental care is essential to improve behavioural, cognitive and health outcomes of premature babies who require admission in NICU [4,15,16]. These care aspects include encouraging parental involvement in child's care, promoting kangaroo mother care, utilizing pain management interventions (non-nutritive sucking), provision of soothing sensory inputs to premature babies (massage and soft music) and assuring preterm babies' regular positioning in incubator to promote their motor functions.

CONCLUSION

The presented case study of a premature baby and its analysis from literature indicates that the premature

babies who require NICU admission during early days of their lives experience multiple stressors that are detrimental to their overall health, physical growth, brain development and stress regulatory mechanism. In NICU environment, promotion of breastfeeding, encouragement of kangaroo mother care, and adaptation of neurodevelopmental care is recommended to reduce the epigenetic effects of toxic stressors on developing brains of sick premature babies. These interventions are essential to promote premature babies' growth, brain development, stress regulation, and cognitive functions in later life.

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