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ORIGINAL ARTICLE

Neurodevelopmental Outcomes in Preterm Infants at 12 Months of Corrected Age

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ABSTRACT

Background: Preterm babies are also more susceptible to delayed neurodevelopment because their brain is not fully developed and they also experience related neonatal complications. Early testing at corrected age aids in detection of delays in development and enables prompt action.

Place and Duration of Study: This study was done in the Department of paediatrics and neonatology of Mayo Hospital Lahore from October 2022 to April 2023.

Objective: To determine neurodevelopmental outcomes in preterm babies at the age of 12 months of corrected age.

Methodology: This was a cross-sectional study of 250 preterm babies which was descriptive. The calculation of sample size was done with the use of formula of WHO sample size calculator. Infants who were born before 37 completed gestation weeks and attended follow up at 12 months of age were included. The infants with any major congenital anomalies or chromosomal disorders or severe neurological malformations were excluded. Information on gestational age, birth weight, neonatal complications and developmental milestones were taken. At 12 months corrected age, neurodevelopmental assessment was carried out using standard developmental assessment in gross motor, fine motor, language, cognitive, and social domains. The results of the data analysis were the rates of normal and delayed neurodevelopmental outcomes.

Results: Among 250 preterm babies, most of them had the developmental age when they were 12 months corrected age. However, a large proportion exhibited the evidence of developmental delay, and it was predominantly in the gross motor and language domains. Infants with low gestational age, low birth weight, prolonged stay in the NICU, sepsis, respiratory distress and mechanical ventilation had a higher likelihood of developing developmental delay.

Conclusion: Even premature infants are at risk of experiencing infancy neurodevelopmental delay. The frequent follow up at the corrected age is paramount in the early identification, parental counselling and early referral to rehabilitation services.

Keywords: Preterm infants, neurodevelopment, corrected age, developmental delay, gross motor delay, language delay, low birth weight, neonatal outcome.

INTRODUCTION

One of the most significant issues that are of public health concern throughout the world, and which are still of significant concern as causes of infant morbidity and long-term developmental impairment[1]. A preterm baby is an infant born less than 37 weeks of gestation completed. Improved resuscitation, the use of neonatal steroids, surfactant therapy, and enhanced facilities of neonatal intensive care have greatly improved survival rates of preterm babies[2]. This has however also been a matter of concern in terms of their long-term neurodevelopmental outcome especially in early childhood when rapid brain development and developmental maturation take place[3]

Pregnancy is a critical time in the development of the brain especially in the last trimester[4]. At this phase, key processes that occur include neuronal migration, formation of synapses, myelination, cortical organization, growth of white matter pathways[5]. In case of premature birth, the infant is subjected to the external environment thus not giving the infant the necessary space to undergo these developmental processes[6]. This premature exposure, in addition to medical complications associated with prematurity may impact normal brain maturation and predispose the occurrence of developmental delay 6. Other complications which can also result in the occurrence of adverse neurodevelopmental outcomes include common neonatal problems such as respiratory distress syndrome, birth asphyxia, neonatal sepsis, hypoglycaemia, jaundice, intraventricular haemorrhage, prolonged oxygen and mechanical ventilation.

Neurodevelopment is the gradual development of motor, cognitive, language, social, emotional and behaviour skills[8]. These domains might be impacted in preterm babies in different extents. A few newborns can experience mild delay which is improved with time and early stimulation, and some infants can develop serious disabilities such as cerebral palsy, hearing or vision impairment, intellectual delay or speech and language difficulties. Gross motor delay and language delay are conditions that are prevalent in early infancy and mostly among infants with very low birth weight or very early gestational age . Consequently, frequent developmental follow-up should be an important part of this high-risk cohort.

An evaluation of preterm infants must be corrected age of the preterm infants and not the chronological age of the preterm infants during the first years of life. The corrected age is determined by taking the difference between the chronological age of the infant and the number of weeks that the infant was born early. This change offers a better estimate of developmental progress and eliminates the overdiagnosis of delay. At 12 months corrected age is especially significant as various motor, cognitive, language and social milestones become more readily assessed at this point. It is anticipated that infants would exhibit better sitting, crawling or standing skills, early speech sounds, recognition of caregivers and interactive social behaviour. The lateness in the attainment of these milestones could be a sign of the necessity of additional evaluation and early intervention[9].

Clinical implications of early detection of neurodevelopmental delay are very important. Functional outcomes can be enhanced by timely referring to physiotherapy, occupational therapy, speech therapy, nutritional support, visual and hearing assessment, and parental counselling[10]. In resource limited environments, many preterm babies leave neonatal units without a formal follow up and thus developmental issues are not identified early enough. Examination of 12 months of neurodevelopmental outcome by adjusted age (12 months) can also help to estimate the burden of developmental delay among preterm infants and to emphasize the necessity to organize follow up programs. This was thus planned to evaluate neurodevelopmental outcomes in preterm infants at 12 months of

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corrected age and will also determine the rate of developmental delay in various areas.

Objective: To assess neurodevelopmental outcomes of preterm children at 12 months of corrected age and to determine the prevalence of developmental delay in the motor, language, cognitive and social domains of preterm children.

METHODOLOGY

This cross-sectional descriptive study was conducted in the Department of paediatrics and neonatology of Mayo Hospital Lahore from October 2022 to April 2023.The study involved 250 preterm babies. The size of the sample was determined based on WHO sample size calculator formula. Nonprobability consecutive sampling was used to enrol infants who were born before completion of 37 completed weeks of gestation and receiving follow up at 12 months of corrected age. They included preterm babies of both genders who had already lived 12 months of corrected age. The study did not include infants with major congenital abnormalities, chromosomal abnormalities, known metabolic disorders, severe neurological malformations or incomplete medical records. Informed consent was written and given to parents or guardians prior to data collection. Demographic and clinical data such as gender, gestational age, birth weight, mode of delivery, duration of NICU stay, respiratory distress syndrome, neonatal sepsis, jaundice, hypoglycaemia, need to receive oxygen therapy and mechanical ventilation was recorded on a structured proforma. Corrected age was obtained by calculating the difference between chronological age and the number of weeks born prior to 40 weeks of gestation. Neurodevelopmental assessment was done on the age of 12 months corrected age through clinical examination and measurement of age-appropriate milestones. The development was measured on gross motor, fine motor, language, cognitive and social domains. Infants with a delay of one or more of the developmental areas were termed as having neurodevelopmental delay. The data were typed and processed with the help of the statistical software. Categorical variables were determined using frequencies and percentages, whereas the quantitative variables were determined using means and standard deviations. The neurodevelopmental outcomes were reported as normal development, or developmental delay.

Inclusion And Exclusion Criteria

Inclusion Criteria: Included were preterm babies of either sex born less than 37 completed gestation weeks, who had had follow up at 12 months of corrected age. Infants with informed consent given by their parents or guardians, and with neonatal records available to them were also included.

Exclusion Criteria: Infants with major congenital anomalies, chromosomes abnormalities, metabolic disorders, severe neurological malformations or who had a known genetic syndrome were excluded. Infants with incomplete medical history, loss to follow up or whose parents refused consent were not included either.

Data Collection Procedure: The data were obtained upon receiving permission by the hospital ethical review committee. The preterm babies admitted to the paediatrics follow up clinic at the age of 12 months after receiving written informed consent form by parents or guardians were enrolled. All the relevant information was recorded using a structured proforma. Demographic information such as age, gender, gestational age of birth, birth weight, mode of delivery, and socioeconomic status were recorded as baseline demographic information. History of neonatal care was collected based on the hospital records, and included information on duration of NICU stay, respiratory distress syndrome, neonatal sepsis, jaundice, hypoglycaemia, oxygen therapy, mechanical ventilation and other major complications. Each infant was corrected in their age by calculating the difference between the chronological age and the number of weeks that a baby has not been born. After that, neurodevelopmental assessment was conducted at the age of 12 months corrected age. Clinical examination and assessment of age-appropriate milestones were used in developmental status evaluation in gross, fine, language, cognitive and social domains. Babies who did not meet the anticipated milestones in one or more areas were termed as having neurodevelopmental delay. The researcher recorded findings with a lot of caution on the proforma under the supervision of a consultant pediatrician. All the data collected were verified to be complete and confidentiality was upheld during the entire study.

RESULTS

A total of 250 preterm infants were included in the study. Among them, 140 newborn babies were boys and 110 were girls. In 175 infants, the outcome was normal in terms of neurodevelopment at the age of 12 months corrected age. In 75 infants, the outcome was abnormal about the neurodevelopment at the age of 12 months corrected age. The delay that was the most prevalent was the gross motor delay, followed by language, fine motor, cognitive and social delay. Among low-weight infants, with lower gestational age, a prolonged stay on NICU, with neonatal sepsis, respiratory distress syndrome, and the requirement of mechanical ventilation was more common in infants with developmental delay.

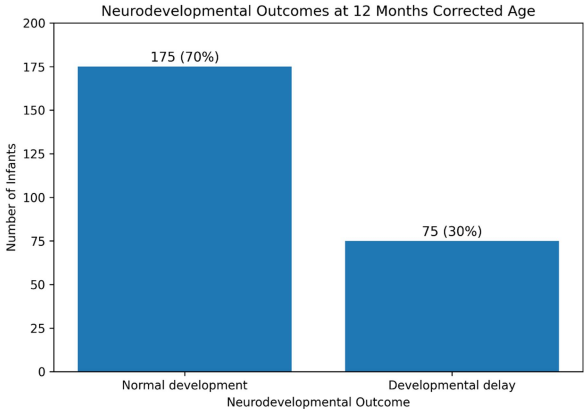
The bar chart shows neurodevelopmental outcomes of 250 preterm infants at 12 months corrected age. The majority of the infants, 175 or 70% reported normal development with 75 or 30% showing developmental delay. This shows that most were developed normally, but a significant percentage was subjected to developmental follow up and early intervention.

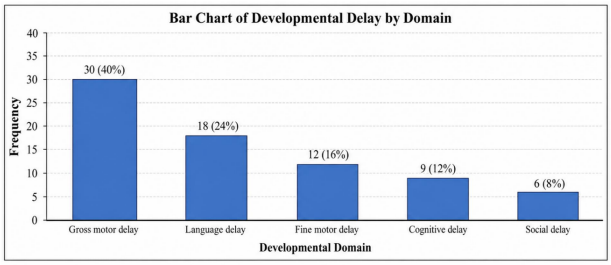
Table 2 presents the prevalence of developmental delay by 75 preterm babies at 12 months corrected age. The most common was gross motor delay as it was observed in 30 of the infants, then there was language and fine motor delay. Less prevalent were cognitive and social delays. The results highlight the importance of routine screening and early detection.

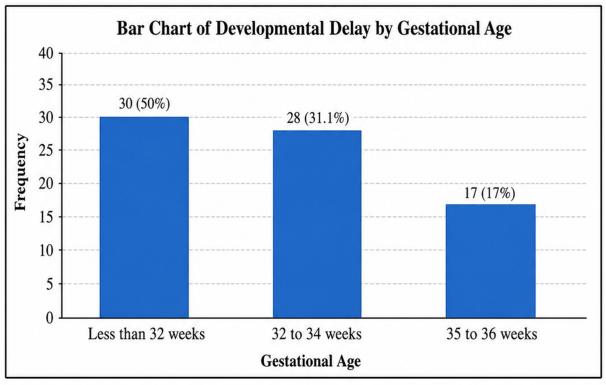
Table 3 reveals that developmental delay was more prevalent among infants who had low gestational age. The maximum frequency was found in infants born below 32 weeks, and then in those born between 32 and 34 weeks. Infants born with a 35–36-week developmental delay demonstrated the lowest frequency of developmental delay at one year.

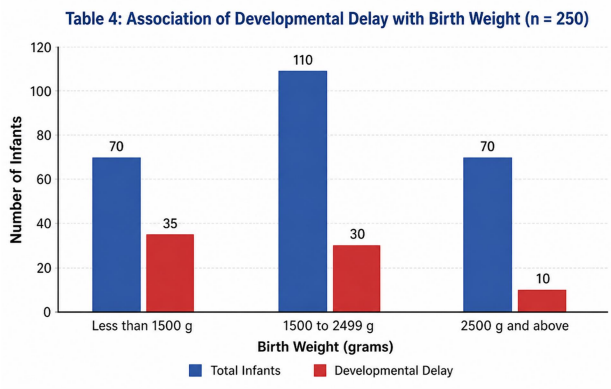
Table 4 shows that developmental delay was highest among infants with birth weight less than 1500 g. The frequency declined with an increase in birth weight. The lowest rate of development delay was observed in infants with a weight of 2500 g and above. This suggests that low birth weight is highly related to weaker neurodevelopmental outcome.

Table 5 indicates that preterm infants experiencing neonatal complications had a higher rate of developmental delay. The greatest percentage was observed in infants who need mechanical ventilation followed by neonatal sepsis, respiratory distress syndrome, and long NICU stay. Infants who did not have significant complications experienced the least developmental delay, implying that complications make neurodevelopmental outcomes worse.









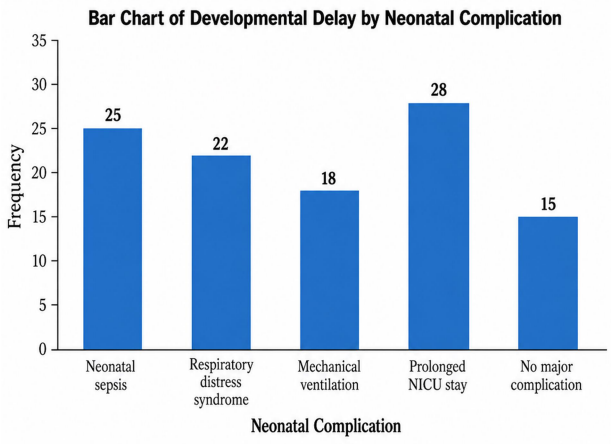


Table: Neurodevelopmental Outcomes at 12 Months Corrected Age

Neurodevelopmental Outcome	Frequency	Percentage
Normal development	175	70%
Developmental delay	75	30%
Total	250	100%

Table 2: Distribution of Developmental Delay by Domain (n = 75)

Developmental Domain	Frequency	Percentage
Gross motor delay	30	40%
Language delay	18	24%
Fine motor delay	12	16%
Cognitive delay	9	12%
Social delay	6	8%
Total	75	100%

Table 3: Association of Developmental Delay with Gestational Age (n = 250)

Gestational Age	Total Infants	Developmental Delay	Percentage
Less than 32 weeks	60	30	50%
32 to 34 weeks	90	28	31.1%
35 to 36 weeks	100	17	17%
Total	250	75	30%

Table 3: Association of Developmental Delay with Gestational Age (n = 250)

Gestational Age	Total Infants	Developmental Delay	Percentage
Less than 32 weeks	60	30	50%
32 to 34 weeks	90	28	31.1%
35 to 36 weeks	100	17	17%
Total	250	75	30%

Table 4: Association of Developmental Delay with Birth Weight (n = 250)

Birth Weight	Total Infants	Developmental Delay	Percentage
Less than 1500 g	70	35	50%
1500 to 2499 g	110	30	27.3%
2500 g and above	70	10	14.3%
Total	250	75	30%

Table 5: Association of Developmental Delay with Neonatal Complications (n = 250)

Neonatal Complication	Total Infants	Developmental Delay	Percentage
Neonatal sepsis	60	25	41.7%
Respiratory distress syndrome	55	22	40%
Mechanical ventilation	40	18	45%
Prolonged NICU stay	70	28	40%
No major complication	95	15	15.8%

DISCUSSION

Preterm birth is a significant risk factor to a poor neurodevelopment outcome in infancy and early childhood. In the current study, neurodevelopmental outcome of 250 preterm infants was evaluated at the age of 12 months of corrected age[11]. The results indicated that 175 babies had normal development, whereas 75 babies depicted developmental delay[12]. This means that even though majority of the preterm infants were able to attain age-appropriate milestones, a significant proportion of them were at risk of not developing age appropriately and needed close follow up.

This paper was able to note that developmental delay was experienced in 30% of the preterm babies in this study[13]. The results of this study point to the susceptibility of preterm babies within the initial year of life . Prematurity also has an impact on the growth of the brain because all the important development processes of the brain such as myelination, formation of synapses and maturation of the cortex take place during the last trimester of the pregnancy. In cases where birth is premature, such processes could be disrupted[14]. Moreover, neonatal diseases and long hospitalization can further be used to augment the risk of poor developmental outcome.

Gross motor delay was the most prevalent area of infants with developmental delay followed by language delay and fine motor delay. The delays in cognition and social development were less common. Gross motor delay could be attributed to immaturity in neuromuscular control, low birth weight, long term illness, and low early physical activity at the NICU admission. Language delay can also be because of immaturity in the brain development, long hospitalization and reduced early parent interaction. These results underpin the significance of the evaluation of various

developmental areas instead of basing the assessment solely on the general clinical impression[15].

The research further revealed that the lower gestational age was related to the higher rate of developmental delay[16]. Infants born below 32 weeks were the highest proportion of delay followed by those born between 32-34 weeks. Babies who were born between 35 and 36 weeks had least incidence of delay[17]. The trend indicates that the more maturity a child is born with, the more the neurodevelopment is safeguarded. Very and extremely preterm babies are more at risk of developing complications that may lead to delayed attainment of milestones, which include respiratory distress, sepsis, hypoxia, and feeding difficulties.

Another significant factor that was related to developmental outcome was birth weight. The highest developmental delay was in infants with a weight of less than 1500 g and the lowest developmental delay was in infants with a weight of 2500 g and above[18]. Low birth weight is frequently an indication of intrauterine growth restriction, inadequate nutritional condition and increased medical instability in the newborn. Such infants might need a long period of NICU care, oxygen, and close monitoring, which are linked to a higher risk of development[19].

Neonatal complications were also very significant. Infants who had mechanical ventilation, neonatal sepsis, respiratory distress syndrome, and extended NICU stay were more likely to have developmental delay. The mechanical ventilation can be a sign of serious respiratory disease and a potentiality to be subjected to hypoxia or extended oxygen treatments. The developing brain can be at risk due to inflammation, lack of oxygen, and subsystem instability. The lowest prevalence rate of developmental delay was observed in infants who did not have major neonatal health problems, which supports the role of early neonatal health in the long-term outcome .

In general, the results indicate that systematic follow up of the preterm babies after discharge is necessary. Corrected age assessment is necessary since it will give a more precise measure of development[20]. The prompt management of delay will enable prompt referral of the child to physiotherapy, speech therapy, occupational therapy, nutrition support and parental counselling. Intensification of the neonatal follow up clinic can enhance developmental outcomes and decrease long term disability in preterm infants.

CONCLUSION

This research has found that preterm infants are at significant risk of neurodevelopmental delay at 12 months of corrected age. Despite the most common developmental outcomes showed normal developmental results by most of the infants, a considerable percentage of the infants had delay in at least one of the developmental domains. The most observed problem was gross motor delay, there was language and fine motor delay, whereas cognitive and social delays were less frequent. Infants with lower gestational age, low birth weight, prolonged NICU stay, neonatal sepsis, respiratory distress syndrome, and required mechanical ventilation were more likely to have developmental delay. The results suggest that preterm birth and the related neonatal morbidity play a significant role in early neurodevelopment. To ensure early identification of developmental delay, regular follow up with corrected age assessment is necessary. Timely referral to physiotherapy, speech therapy, occupational therapy and parental counselling can be used to help in terms of improving the long-term outcomes of preterm infants.

REFERENCES

1. Adams-Chapman, I., Heyne, R. J., DeMauro, S. B., Duncan, A. F., Hintz, S. R., Pappas, A., Vohr, B. R., McDonald, S. A., Das, A., & Newman, J. E. (2018). Neurodevelopmental impairment among extremely preterm infants in the neonatal research network. Pediatrics, 141(5), e20173091.
2. Aita, M., De Clifford Faugère, G., Lavallée, A., Feeley, N., Stremler, R., Rioux, E., & Proulx, M.-H. (2021). Effectiveness of interventions on early neurodevelopment of preterm infants: a systematic review and meta-analysis. BMC pediatrics, 21(1), 210.
3. Arulkumaran, S., Tusor, N., Chew, A., Falconer, S., Kennea, N., Nongena, P., Hajnal, J., Counsell, S., Rutherford, M., & Edwards, A. (2020). MRI findings at term-corrected age and neurodevelopmental outcomes in a large cohort of very preterm infants. American Journal of Neuroradiology, 41(8), 1509-1516.
4. Baud, O., Trousson, C., Biran, V., Leroy, E., Mohamed, D., Alberti, C., & Group, P. T. (2019). Two-year neurodevelopmental outcomes of extremely preterm infants treated with early hydrocortisone: treatment effect according to gestational age at birth. Archives of Disease in Childhood-Fetal and Neonatal Edition, 104(1), F30-F35.
5. Chatziioannidis, I., Kyriakidou, M., Exadaktylou, S., Antoniou, E., Zafeiriou, D., & Nikolaidis, N. (2018). Neurological outcome at 6 and 12 months corrected age in hospitalised late preterm infants-a prospective study. european journal of paediatric neurology, 22(4), 602-609.
6. Choi, E. K., Shin, S. H., Kim, E.-K., & Kim, H.-S. (2019). Developmental outcomes of preterm infants with bronchopulmonary dysplasia-associated pulmonary hypertension at 18–24 months of corrected age. BMC pediatrics, 19(1), 26.
7. Chung, E. H., Chou, J., & Brown, K. A. (2020). Neurodevelopmental outcomes of preterm infants: a recent literature review. Translational pediatrics, 9(Suppl 1), S3.
8. Do, C. H. T., Kruse, A. Y., Wills, B., Sabanathan, S., Clapham, H., Pedersen, F. K., Pham, T. N., Vu, P. M., & Børresen, M. L. (2020). Neurodevelopment at 2 years corrected age among Vietnamese preterm infants. Archives of disease in childhood, 105(2), 134-140.
9. Favrais, G., & Saliba, E. (2019). Neurodevelopmental outcome of late-preterm infants: literature review. Archives de Pédiatrie, 26(8), 492-496.
10. Freitas, N. F. d., Nunes, C. R. d. N., Rodrigues, T. M., Valadares, G. C., Alves, F. L., Leal, C. R. V., Luz, N. M. C. d., Rabello, M. d. O., Machado, M. G. P., & Bouzada, M. C. F. (2021). Neuropsychomotor development in children born preterm at 6 and 12 months of corrected gestational age. Revista Paulista de Pediatria, 40, e2020199.
11. Malavolti, A. M., Bassler, D., Arlettaz-Mieth, R., Faldella, G., Latal, B., & Natalucci, G. (2018). Bronchopulmonary dysplasia—impact of severity and timing of diagnosis on neurodevelopment of preterm infants: a retrospective cohort study. BMJ paediatrics open, 2(1), e000165.
12. McGowan, E. C., Hofheimer, J. A., O'Shea, T. M., Kilbride, H., Carter, B. S., Check, J., Helderman, J., Neal, C. R., Pastyrnak, S., & Smith, L. M. (2022). Analysis of neonatal neurobehavior and developmental outcomes among preterm infants. JAMA Network Open, 5(7), e2222249.
13. Murki, S., Kallem, V. R., Gururaj, J., Bashir, T., Oleti, T. P., & Kiran, S. (2020). Growth and neurodevelopmental outcomes at 12 to 18 months of corrected age in preterm infants born small for gestational age. Indian Pediatrics, 57(4), 301-304.
14. Natarajan, G., Shankaran, S., Nolen, T. L., Sridhar, A., Kennedy, K. A., Hintz, S. R., Phelps, D. L., DeMauro, S. B., Carlo, W. A., & Gantz, M. G. (2019). Neurodevelopmental outcomes of preterm infants with retinopathy of prematurity by treatment. Pediatrics, 144(2), e20183537.
15. Pascal, A., Govaert, P., Oostra, A., Naulaers, G., Ortibus, E., & Van den Broeck, C. (2018). Neurodevelopmental outcome in very preterm and very-low-birthweight infants born over the past decade: a meta-analytic review. Developmental Medicine & Child Neurology, 60(4), 342-355.
16. Ruys, C. A., Hollanders, J. J., Bröring, T., van Schie, P. E., van der Pal, S. M., van de Lagemaat, M., Lafeber, H. N., Rotteveel, J., & Finken, M. J. (2019). Early-life growth of preterm infants and its impact on neurodevelopment. Pediatric research, 85(3), 283-292.
17. Shim, S.-Y., Cho, S. J., & Park, E. A. (2021). Neurodevelopmental outcomes at 18–24 months of corrected age in very low birth weight infants with late-onset sepsis. Journal of Korean Medical Science, 36(35), e205.
18. Song, I. G. (2022). Neurodevelopmental outcomes of preterm infants. Clinical and experimental pediatrics, 66(7), 281.
19. Watkins, P. L., Dagle, J. M., Bell, E. F., & Colaizy, T. T. (2020). Outcomes at 18 to 22 months of corrected age for infants born at 22 to 25 weeks of gestation in a center practicing active management. The Journal of pediatrics, 217, 52-58. e51.
20. Woythaler, M. (2019). Neurodevelopmental outcomes of the late preterm infant. Seminars in Fetal and Neonatal Medicine,

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