Review paper

Development of a preterm baby – an overview of current knowledge

Rozwój dzieci urodzonych przedwcześnie – przegląd aktualnego piśmiennictwa

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Słowa kluczowe: rozwój psychoruchowy, wcześniactwo, osiągnięcia neurorozwojowe, *Monachijska funkcjonalna diagnostyka rozwojowa*, skala Bayley.

Abstract

The psychomotor development of children is very important outcome concerning the proper growth and development of a child. We try to eliminate the risk factors that impair its course during intrauterine life, during childbirth, as well as during the first months/years of life, to provide children with optimal conditions for healthy development. Newborns born prematurely are at risk of impaired psychomotor development, including cognitive, neurological, and/or sensory outcomes. The following review presents risk factors that weaken the development of preterm infants, the areas of development in which this weakness may be visible, and methods of evaluation of this development.

Streszczenie

Rozwój psychoruchowy dzieci to bardzo ważny element oceny mówiący o prawidłowym dorastaniu i rozwoju dziecka. Staramy się zniwelować czynniki ryzyka zaburzające jego przebieg w trakcie życia wewnątrzmacicznego, w czasie porodu, jak również w pierwszych miesiącach lub latach życia, aby zapewnić dzieciom optymalne warunki do prawidłowego rozwoju. Noworodki urodzone przedwcześnie z powodu utraty optymalnych warunków rozwoju, jakie zapewnia organizm matki, znajdują się w grupie ryzyka osłabionego rozwoju psychoruchowego, obejmującego wyniki poznawcze, neurologiczne czy sensoryczne. Poniższe opracowanie przedstawia czynniki osłabiające rozwój wcześniaków, płaszczyzny rozwoju, w których to osłabienie może być widoczne, oraz metody oceny rozwoju.

Introduction

Research is still underway to identify the risk factors influencing the child's delay or abnormal development. We try to eliminate the risk factors that impair its course to optimize conditions for proper development. The child's development depends on the interaction of hereditary and environmental factors. Genetic factors determine the potential for development, and environmental factors define the extent to which this potential is achieved. The first year of life is an exceptionally intensive brain development period. The process of synaptogenesis and myelinization of the central nervous system is particularly sensitive to deficiency factors. Infants born prematurely lose optimal conditions at birth, and their further development is dependent on the environment affecting their immature organism. Preterm babies are at risk of impaired psychomotor development, including cognitive, neurological, and/or sensory outcomes. Literature data on long-term psychomotor development of preterm newborns are limited due to differences in research methods, clinical practices, and significant changes in perinatal care over the years. The progress of perinatal care in recent decades has undoubtedly improved the survival of preterm newborns, especially in the 23rd and 24th weeks of pregnancy [wks] group [1], but it is unknown how it has influence their psychomotor development. Some studies present the improvement of neurodevelopmental outcome in preterm newborns along with the improvement of survival [2, 3], while others do not confirm this [4, 5]. When evaluating the psychomotor development of preterm newborns, it seems very important to select an appropriate cohort, because the neonatological interventions used 20 years ago are clearly different from those used recently, which may significantly affect the reliability of the data.

The significance of obstetric-neonatological interventions

Some obstetric and neonatological interventions have a direct or indirect impact on psychomotor development of infant, e.g. by reducing the incidence of periventricular-intraventricular haemorrhage (PIVH). Antenatal corticosteroid therapy not only reduces perinatal mortality and the time of mechanical ventilation, but also reduces the risk of intraventricular haemorrhage, weakened psychomotor development, and the frequency of moderate and severe cerebral palsy (CP) incidence [6, 7]. Prenatal therapy with magnesium sulphate in the mother reduces the risk of CP and severe motor dysfunctions in the newborn, compared to newborns whose mothers have not received such therapy [8]. Advanced methods of noninvasive neonatal ventilation and improved strategy in mechanical ventilation reduce the risk of complications due to prematurity and indirectly influences psychomotor development. Avoiding postpartum steroid therapy in newborns reduce the risk of CP [9]. Some interventions such as surfactant therapy, despite increasing the survival of preterm newborns, have no direct effect on improving psychomotor development. Others, like erythropoietin therapy, have no beneficial effect both on survival and neurodevelopment in extremely preterm infants [10]. A multicentre study showed no significant differences in the incidence of death, intracranial haemorrhage, bronchopulmonary dysplasia (BP), or severe neurodevelopmental impairment at 2 years of age in an erythropoietin group compared to placebo [10].

Risk factors

The challenge of today's neonatology is to identify patients at risk of impaired psychomotor development and early implementation of appropriate support and treatment. Based on observational studies of large populations (includes extreme premature infants (born < 28 wks)), risk factors include newborns with multiple birth defects [11], newborns with severe PIVH or periventricular leukomalacia or other abnormalities of the brain white matter [12], newborns with severe hypoxia, meningitis, trauma or respiratory failure requiring mechanical ventilation during hospitalization. The risk factor of severe hypoxia in the prenatal, perinatal, or postnatal period undoubtedly predisposes to impaired psychomotor development in the future [13], but it is worth noting that a large proportion of children born in acidosis may not develop neurological complications in the future, and most children with CP are born with normal cord blood gasometry [8, 14]. Intrauterine growth restriction and small for gestational age newborns [15–17] or poor postnatal growth in preterm infants, especially of the head [18], are further important risk factors. On the other hand, a 2006 study showed that weight gain of extremely low birth weight (ELBW) newborns during hospitalization in a neonatal intensive care unit (NICU) had a significant and independent effect on neurodevelopmental and growth outcomes at 18 to 22 months' corrected age [19]. Preterm birth-associated neonatal conditions, which are also risk factors for impaired psychomotor development, include complications such as BPD [20, 21], NEC, sepsis, and retinopathy of prematurity (ROP). Surgical procedures during the course of their initial hospital admission increase the risk of major neurosensory disability at 8 years of life [22]. The risk of impairing psychomotor development increases with a reduction in gestational age (GA) and birth weight (BW) [23, 24]. In addition, the twin pregnancy in preterm infants with body weight < 1,000 g is the independent risk factor of death or neurodevelopmental impairment at 18 to 22 months' corrected age [25]. Literature data also indicate that among children born < 28 wks, boys had a higher prevalence of cognitive, neurological, and behavioural deficits than girls [26].

Environmental factors that improve cognition and speech-language function include sensitive parenting [27] and a higher level of maternal education [28]. However, no correlation between the level of the mother's education and the improvement of motor development has been demonstrated.

Neurodevelopmental outcome

The complex concept of neurodevelopmental outcome covers cognitive, neurological, and/or sensory outcomes (hearing, visual acuity). In order to include neurodevelopmental deficit as an endpoint in scientific research, it is necessary to demonstrate it using standardized scales such as Bayley Scales of Infant Development, Gross Motor Function Classification System (GMFCS) specific cognitive, or neurological or sensory outcomes. Behavioural, psychological, and functional outcomes are becoming more and more important because they seem to be equally crucial elements of long-term neurodevelopment. Preterm newborns have a higher risk of impaired psychomotor development than full-term newborns, and this risk increases with lowering foetal age [23]. A 2018 meta-analysis showed that despite advances in neonatology, preterm infants (< 37 wks) still have lower reading, counting, and writing skills at 5 years of age, compared to full-term infants, and are 3 times more likely to need special educational assistance [29]. In addition, the study showed that preterm children with BPD are at particular risk for poor academic outcome, which, among others, may be due to the fact that the BPD frequency is increasing among neonates with extremely low BW and GA [30]. Preterm infants are more likely to show behavioural and psychologi-

cal problems compared to full-term babies [31]. These children more often develop attention deficit hyperactivity disorder (ADHD), autism spectrum disorder, emotional and conduct problems (including anxiety and depression) or difficulties in contacts with peers. According to the literature data, the highest risk of developing such disorders is found in extremely (< 28 wks) or very preterm infants (< 32 wks). According to the reports of the National Institute of Child Health and Human Development (NICHD) Neonatal Research Network, one-third of newborns born < 27 wks showed behavioural disorders at 18–22 months of the corrected age, and one-fourth have deficits in socio-emotional competence [32]. Preterm infants are more likely to show medical and social disabilities in adulthood than full-term babies. Probably due to impaired cognitive skills, preterm infants, especially those with BW below 1500 g or GA below 32 weeks, have learning difficulties and therefore lower educational achievement. Cognitive skills presented by the mean cognitive test scores decrease with lower foetal age, and higher socioeconomic indicators seem to lower the effect of GA on cognitive test scores by 26% to 33% [33]. Preterm infants are in adult life less likely to have a permanent job, have lower earnings, experience an independent life less frequently [34, 35], and have an increased risk of disability, such as CP (relative risk for birth at 23 to 27 wks, 78.9; 95% confidence interval (CI): 56.5–110) [36]. Despite the burden of disability, adults born as ELBW infants describe their health-related quality of life as satisfactory. Structural brain damage is not only the greatest risk factor for impaired psychomotor development, but also a risk factor for developing psychiatric diseases [37, 38]. Premature infants also show an increased risk of problems with complex language function [39].

Predicting outcome methods

Apart from imaging tests, such as cranial ultrasonography (CrUSS) or magnetic resonance imaging of the central nervous system (CNS MRI), the most important prognostic method of assessing the development of newborns from risk groups is regular clinical neurological evaluation in the first 2 years of life. This assessment covers motor, social, and cognitive development as well as speech, vision, and hearing status. Although assessment of the neurodevelopmental outcome in school-age children seems to be more reliable due to the continuous development of the brain in the first years of life [40, 41], regular neurological assessment in the first 2 years of life allows the identification of children with severe developmental disorders that will not withdraw spontaneously later in life. This group of children comprise the greatest beneficiaries of the implementation of early therapeutic interventions [40, 42, 43]. Due to its plasticity, the brain of a premature infant has the ability to regain and take over the lost function of other brain areas. There are several methods of assessing psychomotor development in children in the first 2 years of life. The most popular and widely used, the Bayley scale, provides cognitive, language, and motor scores, and assesses social-emotional and adaptive behaviour up to 42 months. Another one, the Griffiths III is applied from birth to 72 months and examines the foundations of learning, language and communication; eye-hand coordination (including fine motor and visual perception); gross motor; and personal-social-emotional (including independent strengths and needs). Munich Functional Developmental Diagnosis (MFDD) is a less popular but interesting tool for assessing psychomotor development and diagnosing disorders. It is a method of assessing the psychomotor development of a child from the first month of life. The research tools are standardized tables of physical development according to Hellbrugge and Pechstein [44]. It studies 8 basic functions of psychomotor development: crawling, sitting, walking, grasping, perception, speaking, speech understanding, and social skills. The tables contain the standard pattern for a given function in each month of life. For preterm babies, using the corrected age of life is necessary. MFDD uses categorial assessment. It consists of assessing whether the task has been solved or not. Gradation of the assessment is not expected. Thanks to this, the method maintains high objectivity and avoids subjective evaluations. This method is especially important for premature infants, because it describes in detail the state of psychophysical development, avoiding global generalizations.

Conclusions

Despite huge progress in the field of neonatology, prematurely born infants still remain at risk of weakened psychomotor development, and this risk increases as the foetal age and birth weight decreases. In addition, preterm infants statistically more often manifest disorders in the area of behavioural, psychological, and functional outcomes compared to full-term newborns. Knowledge of risk factors of impaired psychomotor development is extremely important in identifying patients in whom regular neurological evaluation and early implementation of therapeutic interventions can bring many benefits and improve prognosis for further development. Specially standardized scales such as Bayley Scales or Munich Functional Developmental Diagnosis are used to assess psychomotor development.

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Conflict of interest

The authors declare no conflict of interest.

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