



## DISORDERS OF NEUROPSYCHOLOGICAL DEVELOPMENT OF CHILDREN WITH PERINATAL HYPOXIC DAMAGE OF CENTRAL NERVOUS SYSTEM

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### ABSTRACT

*Introduction: The adaptation problem of children with perinatal hypoxic damage of central nervous system is very important. The brain damage on early stages of ontogeny violates deterministic evolutionary scenario of pre-, intra-and postnatal adaptation, slows maturation of functional central nervous system parameters, which increases the likelihood of development of secondary cerebral defects.*

*Purpose of the work: To study the influence of perinatal hypoxic damage of central nervous system on the dynamics of neuropsychological development of children in the first year of life.*

*Materials and methods: Seventy three children born in 2011-2013 with a diagnosis of perinatal hypoxic damage of central nervous system and 20 healthy mature newborns without perinatal pathology in anamnesis were under supervision in dynamics of the first year of life. Children were divided into two groups depending on the severity of perinatal hypoxic damage of central nervous system: I group - 38 children with severe damage of central nervous system; II group - 35 children with moderate damage of central nervous system. The control group (III group) was consisted of 20 newborns without perinatal hypoxic damage of central nervous system in anamnesis.*

*The psychomotor development of children in the first year of life was assessed according to scale of L.T. Zhurba, E.M. Mastjukova, K.L. Pechora, V. Pantyukhina with the definition of groups both middle age of neuropsychological development and the individual lines of development.*

*The quantitative assessment of emotional and behavioral responses in infants was conducted using the scale of M. Studenikin and co-authors for the determination of the infants' emotional profile. The expression of negative emotions, fear, anger, cognitive activity, positive emotions, social contacts, physical activity, sleep and appetite were determined in children.*

*Results: It was established that neuropsychological development delay was dominated for 1 epicrisis period in 69.8% as to 1-2 (48.0%) and less often to 3-4 (32.8%) rates in children with neuropsychological development of central nervous system aged 1 month. At the age of 10 months the quantity of children on 2 delayed epicrisis terms were (30.1%) as to 1-2 (39.7%), 3-5 (17.8%), 4-5 (32.8%) analyzers; 3 epicrisis terms (17.8%), 1-2 (50.7%), 3-4 (12.3%) and 3-5 (17.8%) rates. At the age of 12 months, 8.2% of children had developmental multiplication for 4 epicrisis terms and in 6.8% of children - more than 5 epicrisis terms.*

*Conclusion: According to the study behavioral disorders were dominated in comparison with development disorders at the same time remaining important indicators of perinatal hypoxic damage severity in the first year of life. High level of complications from central nervous system testifies the demand of comprehensive differentiated treatment and rehabilitation actions in children with hypoxia.*

**KEYWORDS:** perinatal hypoxic damage, central nervous system, neuropsychological development, children.

### INTRODUCTION

The problem of children adaptation who have

suffered from perinatal hypoxic damage of central nervous system is very important. The brain damage on the early stages of ontogeny violates deterministic evolutionary scenario of pre-, intra-and postnatal adaptation, slows maturation of functional central nervous system parameters, which

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increases the likelihood of development of secondary cerebral defects. The effects of perinatal hypoxic damage of central nervous system reflect not only the severity of injuries, but the effectiveness of the implementation of sanogenetic mechanisms of the body and medical and social factors to timely compensate the neuroontogenesis distortion [Svirsky A, 2008; Pohilko V, 2010].

Many researchers pay attention to the study of not only various neurophysiological mechanisms of brain damage in children, but also to peculiarities of their further development [Sakaeva D, Hayretidnova T, 2011]. The first year of life is characterized by intense pace of physical, neuropsychological development and functional maturation of organs and systems. The deterioration in the status of neuropsychological development of children undergoing perinatal hypoxic damage of central nervous system has been marked lately. Even with timely pathogenetic therapy, about 70 % of children who had hypoxia did not reach the age of neuropsychological development [Znamenskaya T, 2011].

*Purpose of the work:* To study the influence of perinatal hypoxic damage of the central nervous system on the dynamics of neuropsychological development in children in the first year of life.

#### MATERIALS AND METHODS

Seventy three children born in 2011-2013 with perinatal hypoxic damage of central nervous system and twenty healthy mature newborns without perinatal pathology in anamnesis were under the supervision in dynamics of the first year of life. The children were treated in the department of intensive care and neonatal department of Sumy Region Children Clinical Hospital.

All infants with perinatal hypoxic damage of the central nervous system were born with asphyxia and corresponded to inclusion criteria in the study, according to the order № 312 of Ministry of Health of Ukraine "Approvement of clinical protocol for primary resuscitation and after newborn resuscitation" 8.06.2007 [International statistical classification of diseases ICD-10, 1998; order № 312, 2008]. All newborns were conducted neurosonography and Doppler for objectification

of clinical signs of perinatal damage of the central nervous system and observation of structural transformation of brain damage. The gestational age of patients was 38 weeks or more. The exclusion criterias were the presence of congenital malformations and chromosomal diseases from the study.

Children were divided into two groups depending on the severity of perinatal hypoxic damage of central nervous system: I group consisted of 38 children with severe damage of central nervous system (by the Apgar scale at the first minute of life less than 4 points), II group - 35 children with moderate damage of central nervous system (by the Apgar scale at the first minute of life 4-5 points). The control group (III group) was consisted of 20 newborns without perinatal hypoxic damage of central nervous system in anamnesis.

The psychomotor development of children in the first year of life was assessed according to scale of Zhurba L.T., Mastjukova E.M. (1981, 2003) and Pechora K.L. and co-authors (1996) with the definition of groups both middle age of neuropsychological development and the individual lines of development. The optimal estimate of the age according to the scale was 30 points. The assessment of 27-29 points was viewed as a variant of the age norm with further follow-up. The children with 23-26 points were attributed to the group of relative risk. The score of 13-22 points indicated the delay of neuropsychological development. The group of children with the score below 13 points had severe neuropsychological development delay as a result of possible central nervous system lesions.

The diagnostic of neuropsychological development of infants was done according to the method of Pechora K.L. and co-authors (1996). The qualitative and quantitative diagnosis of the degree of lag or lead of children neuropsychological development was conducted. Four levels of development were allocated: 1 - children with normal and advanced development; 2 - children with delay in the development of 1 epicrisis term; 3 - children with delay in development of 2 epicrisis terms; 4 - children with delay in the development of 3 epicrisis terms.

The quantitative assessment of emotional and behavioral responses in infants was conducted using

the scale for the determination of infants' emotional profile [Studenikin M et al., 1978]. The expression of negative emotions, fear, anger, cognitive activity, positive emotions, social contacts, physical activity, sleep and appetite were determined in children.

The statistical analysis of the results was carried out using Microsoft Excel, Windows XP. The Student criterion was calculated for the assessment of the statistical significance of average differences, also methods used for biomedical research were applied [Lapach S et al., 2001].

### RESULTS AND DISCUSSION

The development and behavior of children with perinatal hypoxic damage of the central nervous system in acute (the first month of life) and recovery (10-12 months of life) periods of the disease was analyzed. The behavioral analysis was conducted with the use of 6 basic indicators: emotional state, falling asleep, sleep, appetite, nature of cheerfulness and individual features.

As table 1 shows behavioral disorder dominates in children with perinatal hypoxic damage of central nervous system at the age of 1 month. The tendency of motor development delay (late head holding) is revealed in the majority of children during acute period. The number of lagging children is significantly reduced in the recovery period, but still there is high percentage of children with disabilities of general hand movements' development and skills. Not positive dynamics is observed in behavioral problems. Thus, table 1 shows that the emotional state is disturbed mostly in acute period, which is expressed by frequent trouble and wanton cry, the severity of sleep. The emotional state was normalized during recovery period, but the number of children with impaired appetite is increased by more than 2 times.

The age dependence in backlog of children was found during the review of development on separate lines (Table 2).

So, at the age of 1 month, 39.7% of children were lagging in motor responses, 19.1% children – in corresponding emotional responses, 17.8% of children – in visual response. According to the authors

TABLE 1.

Comparison of the development and behavior of children with perinatal hypoxic damage of central nervous system in different periods of disease (%)

		The period of the disease	
		Acute	Reparative
Deviations	Neuropsychological development	52.0	60.3
	Behavior	86.7	75.3
Lines of development	visual reaction	45.2	28.8
	auditory reactions	45.2	27.4
	emotional reactions	72.6	28.8
	joint motions	76.7	60.3
	hand movements (up to 6 months)	-	46.6
	active speech	-	34.2
Behavior indicators	speech understanding	-	31.5
	skills in operational processes	-	48.0
	emotional state	86.7	68.5
	falling asleep	61.6	68.5
	sleep	53.4	54.8
	appetite	15.0	34.2
	nature of courage	52.0	47.9
individual features	28.8	31.5	

TABLE 2.

Backlog of children with perinatal hypoxic damage of central nervous system along with the development lines (%)

	Age, month			
	1	10	12	Total
Visual reactions	17.8	-	-	17.8
Auditory reactions	8.2	-	-	8.2
Emotional reactions	19.1	-	-	19.1
Joint motions	39.7	36.9	32.8	39.7
Hand movements (up to 6 months)	-	37.0	38.3	30.1
Active speech	-	28.8	23.3	26.0
Speech understanding	-	26.0	17.8	21.9
Skills in operational processes	-	41.0	27.4	30.1

the delay of formation of visual and emotional reactions in children with perinatal hypoxic damage of central nervous system is the direct consequence of their physiological immaturity at birth and slow maturation in the first months of life.

At the age of 10 months the lag in the development of movements is reduced by 10%, indicating some compensation, but the lag in the development of skills and hand movements increases.

The tendency to percent decrease of lag in the development of hand movements is observed in children with perinatal hypoxic damage of the central nervous system at the age of 12 months, which predicts the delay in the development of substantive work at 2<sup>nd</sup> year of age.

The analysis of the correlation between the parameters of neuropsychological status showed the greatest correlation with other lines of development (with motor, sensory, communicative, reflexive and linguistic features). The coefficient of correlation (r) was equal to 0.3-0.4,  $p < 0.001$ , which determined the feasibility of providing early speech therapy for children with perinatal hypoxic damage of the central nervous system.

The lagging only on one line of development was found in 43 (58.9%) children, of whom 19 (44.2%) lagged behind in the development of movements, 8 (18.7%) - in the development of the tap, 6 (13.9%) - in the development of skills, 5 (11.6%) - in the development of active speech, 5 (11.6%) - in the development of emotional reactions.

It was interesting to compare children by the indicators of developmental disorder. Neuropsychological development delay was dominated for 1 epicrisis period in 69.8% as to 1-2 (48.0%) and less often to 3-4 (32.8%) rates in children with neuropsychological development of central nervous system aged 1 month. At the age of 10 months the quantity of children with 2 delayed epicrisis terms were (30.1%) as to 1-2 (39.7%), 3-5 (17.8%), 4-5 (32.8%) analyzers; 3 epicrisis terms (17.8%), 1-2 (50.7%), 3-4 (12.3%) and 3-5 (17.8%) rates. At the age of 12 months, 8.2% of children had developmental multiplication for 4 epicrisis terms and in 6.8% of children - more than 5 epicrisis terms. (Table 3).

The children with perinatal hypoxic damage of

TABLE 3.

Backlog of children with perinatal hypoxic damage of central nervous system by the number of indicators and epicrisis terms (%)

		Age, month			Total
		1	10	12	
Number of indicators	1-2	48.0	39.7	65.7	52.0
	3-4	32.8	15.0	1.4	16.4
	3-5	8.2	17.8	17.8	13.7
	4-5	10.9	32.8	15.0	19.2
Epicrisis terms	1	69.8	50.7	50.7	45.2
	2	21.9	30.1	12.3	21.9
	3	8.2	12.3	17.8	12.3
	4		8.2	8.2	8.2
	5			4.1	4.1
	more 5			6.8	6.8

the central nervous system in the critical period (10 months) show significant increase in the number of gaps up to 4-5 figures (from 10.9% to 32.8%). The most significant delay of neuropsychological development in children with the following disease from 4-5 or more epicrisis terms is showed at the age of 12 months. The debut of febrile and affective-respiratory attacks preceded the lag in neuropsychological development in 8.2% of children with central nervous system disorders.

The children with perinatal hypoxic damage of the central nervous system are characterized by prevalence of behavioral disorders in lag development (Table 4).

As table 4 shows, emotional state is the most affected in children with perinatal hypoxic damage of the central nervous system. Thus, the emotional status in children with delayed neuropsychological development who underwent perinatal hypoxic damage of the central nervous system was lower throughout early age than in children with normal development ( $11.57 \pm 1.67$  and  $24.81 \pm 0.84$  points, respectively,  $p < 0.001$ ) due to severe adverse and unstable emotions, expressions of anger and fear, increased motor activity and

**TABLE 4.**  
Comparative indicators in behavioral disorder and development of children with perinatal hypoxic damage of the central nervous system (%)

	Age, month				
	1	10	12	Total	
Behavior	<i>emotional state</i>	45.2	54.8	31.5	39.7
	<i>falling asleep</i>	41.0	72.6	60.3	53.4
	<i>sleep</i>	32.8	75.3	42.5	41.0
	<i>appetite</i>	10.9	41.0	41.0	28.8
	<i>nature of cheerfulness</i>	41.0	53.4	32.8	38.3
	<i>individual features</i>	12.3	21.9	17.8	17.8
Development	<i>emotional state</i>	31.5	8.2	24.6	23.3
	<i>falling asleep</i>	27.4	28.8	36.9	30.1
	<i>sleep</i>	12.3	28.8	10.9	13.7
	<i>appetite</i>	12.3	8.2	17.8	12.3
	<i>nature of cheerfulness</i>	8.2	13.7		10.9
	<i>individual features</i>	5.5	12.3	9.6	9.6

sleep disturbances (long falling asleep and restless sleep) during the first year of life. In addition, these children are characterized by low cognitive activity and poor appetite. The average neuropsychological development age of children in the control group was  $11.37 \pm 0.09$  months and the average neuropsychological development age was  $8.36 \pm 0.06$  months. ( $p < 0.001$ ) in children with perinatal hypoxic damage of the central nervous system. The backlog of the middle age of children with neuropsychological development from children of study group in comparison of the control group was 3 months (3 epicrisis terms). The backlog of active speech at the age of 12 months in sick children in comparison with the control group was 3.6 months, speech understanding – 3.1, movements – 2.6, skills - 1.6.

The motor coefficient in 47.9 % of children was approaching to 50%, and in 52% of children it was lower, which revealed the high risk for formation of disability (disability since childhood) in 38 children.

The violation of neuropsychological develop-

ment has close relationship with clinical presentation of perinatal hypoxic damage of the central nervous system. Thus, the syndrome of vegetative-visceral disorders in the acute period of the disease has caused the delay of neuropsychological development for 1 epicrisis term as to 1-2 analyzers, with CSF-hypertensive syndrome - 2-3 epicrisis terms by 2-3 indicators. The early delay of 3-4 epicrisis terms according to 5-7 analyzers is diagnosed with the formation of cerebral palsy.

Thus, the gap in neuropsychological development in children with perinatal hypoxic damage is characterized by multiple abnormalities (4-5 lag indicators) and significant depth (lag in 4-5 epicrisis term). The behavioral disorders prevail over development disabilities and are important indicators of severity of perinatal hypoxic damage of the central nervous system up to the first year of life.

#### CONCLUSION

The neuropsychological development delay was dominated for 1 epicrisis period in 69.8% as to 1-2 (48.0%) and less often to 3-4 (32.8%) rates in children with neuropsychological development of central nervous system aged 1 month. At the age of 10 months the quantity of children with 2 delayed epicrisis terms were (30.1%) as to 1-2 (39.7%), 3-5 (17.8%), 4-5 (32.8%) analyzers; 3 epicrisis terms (17.8%), 1-2 (50.7%), 3-4 (12.3%) and 3-5 (17.8%) rates. At the age of 12 months, 8.2% of children had developmental multiplication for 4 epicrisis terms and in 6.8% of children - more than 5 epicrisis terms.

High proportion of disability is recorded among children who underwent perinatal hypoxic damage of central nervous. This study recorded 52% (38) full-term newborns. The high rate of complications of central nervous system demonstrates the need for comprehensive differential treatment and rehabilitation of children with hypoxia, taking into consideration etiological factor, factors that act in the ante-, intra- and post-natal periods, clinical course and pathologic changes detected in neurosonography.

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