

**NON-COMMERCIAL JOINT-STOCK COMPANY «WEST
KAZAKHSTAN MARAT OSPANOV MEDICAL UNIVERSITY»**

ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD)

Title of the topic: "Prognostic value of general movements assessment in the early diagnosis of cerebral palsy in children with perinatal pathology and the influence of movement imitation therapy on its severity"

According the educational program 8D10102 "Medicine"

Full name: Zhussupova Z.T.

Completion period: 2020-2023

Scientific advisors:

PhD, Associate Professor Ayaganov D.N.

PhD, Associate Professor Zharmakhanova G.M.

Foreign consultant:

MD, Professor Mammadbayli A.K.,

Azerbaijan Medical University

Aktobe, 2026

ABSTRACT

by Zhanna Tulegenovna Zhussupova on the topic "Prognostic value of general movements assessment in the early diagnosis of cerebral palsy in children with perinatal pathology and the influence of movement imitation therapy on its severity", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D10102 – "Medicine"

Scientific advisors:

PhD, Associate Professor Ayaganov D.N.

PhD, Associate Professor Zharmakhanova G.M.

Foreign scientific advisor: MD, PhD, Professor Mammadbayli A.K.

Azerbaijan Medical University

The relevance of the study. According to official data from the Ministry of Labor and Social Protection of the Population of the Republic of Kazakhstan for 2021, 83,462 children with disabilities were registered, among which diseases of the nervous system rank third (Resolution of the Government of the Republic of Kazakhstan, 2022). Neurological disorders and disability threaten the realization of the full social and economic potential at the family and state levels. One factor contributing to this situation is the current level of medical development, which makes it possible to save the lives of newborns with adverse perinatal events, children with neuroinfections, severe injuries of the nervous system, and congenital malformations ("Neonatal mortality 2023", 2023).

One of the common disabling neurological diseases is cerebral palsy (CP). Whereas CP used to be diagnosed between 12 and 24 months of age, it can now be identified in the first half of life. Up to 5 months of age, the most sensitive prognostic tools for identifying risk are neonatal magnetic resonance imaging (MRI) of the brain (sensitivity 86-89%) and the qualitative assessment of general movements (General Movement Assessment, GMA) with detailed evaluation using the Prechtl method at the end of the 2nd and 5th months of life (sensitivity 98%). Early diagnosis of cerebral palsy and early interventions are significant for optimizing motor and cognitive plasticity and preventing secondary complications (Novak et al., 2024). Diagnostic measures traditionally used in our country are less sensitive for this period of life, which necessitates the study and implementation of various early diagnostic methods into practice, followed by an approach to early intervention.

Identifying infants at risk of worsening motor function is challenging. Clear links between changes in brain structure and possible motor deficits are still insufficiently studied (Einspieler et al., 2019; Crowle, Jackman, and Morgan, 2023; Kniaziew-Gomoluch et al., 2023; Mohanty et al., 2023). Research has shown that subtle damage to brain matter may be associated with various motor and non-motor problems, for which advanced neuroimaging techniques, which are often invasive and expensive, are proposed for diagnosis (Shepherd et al., 2018; Einspieler et al., 2019). Therefore, the need for a functional assessment of the integrity of the developing nervous system is a

pressing task in pediatric neurology. One reliable and sensitive method for diagnosing central nervous system damage that does not require intervention is GMA (Michael-Asalu et al., 2019).

General movements are spontaneous movements (involving the whole body) of infants up to five months after full-term birth. The movements vary in sequence, speed, and amplitude. The GMA diagnostic method, based on the study of various infant movements, despite its high reliability (Einspieler and Prechtl, 2005), is used less frequently because the assessor is a specially trained physician. The fetal and neonatal nervous system generates numerous motor patterns, the main ones being general movements, which involve the whole body in a variable sequence of neck, arm, trunk, and leg movements (Einspieler and Prechtl, 2005), differing in various age periods (Einspieler and Prechtl, 2005; Hadders-Algra, 2007; Spittle, Doyle, and Boyd, 2008). General movements are generated by a neural network, central pattern generators located precisely in those brain regions that are more sensitive to adverse factors in the perinatal period (Apaydin et al., 2021; Prechtl et al., 1997; Soleimani et al., 2015). This method is more often used to predict motor dysfunction, especially CP, as evidenced by many studies (Einspieler et al., 2019; Tsuji et al., 2020; Caesar et al., 2021). Nevertheless, a more in-depth study of the variability of movement patterns is necessary for predicting other neuromotor disorders not related to CP, as well as for predicting mental disorders.

GMA is quick, non-invasive, unobtrusive, and economical. Its reliability and validity are high for predicting neurological abnormalities that indicate CP and developmental disorders at a later age. There is strong evidence that early intervention improves functional outcomes in infants with neurological disorders and is cost-effective, as it reduces the frequency and severity of subsequent impairments (Hadders-Algra, 2014; Morgan et al., 2014; Einspieler, Freilinger, and Marschik, 2016; Novak et al., 2017; Shepherd et al., 2018).

Currently, there are no early detection and intervention programs in the Republic of Kazakhstan, so it is crucial to be able to recognize early markers of neurological disorders and identify infants in need of neurological examinations. The foregoing dictates the need for a detailed and in-depth study of the variability of general movements. In the literature available to us, there are no works on assessing the variability of general movements from birth to 5 months of age within the framework of various nosologies inherent to the perinatal period. Based on the above, the aims and objectives of the study were formulated.

Aim of the study. To determine the prognostic value of the formation of general movements in children with perinatal pathology in the early diagnosis of cerebral palsy and to study the influence of movement imitation therapy on its severity.

Objectives of the study:

1. To study the characteristics of the formation of general movements in children with perinatal pathology.
2. To determine the prognostic values of general movements, identifying early predictors of cerebral palsy.
3. To evaluate the effect of movement imitation therapy on the severity of cerebral palsy and substantiate the timing of its administration.

Scientific novelty of the study:

The formation of general movements in children depending on perinatal pathology was studied.

For the first time in our sample, percentile threshold values on the GMOS-R scale for full-term and preterm children were established, which differ from reference values, and based on these, a risk group for the development of cerebral palsy in the neonatal period was identified.

The prognostic values of general movements assessment in children with cerebral palsy were determined, and early predictors were identified.

Early initiation of movement imitation therapy had a positive effect on the severity of CP in the long-term outcome.

Theoretical and practical significance:

The prognostic value of general movements in children has clinical significance for both the early diagnosis and early intervention of cerebral palsy.

The results of the dissertation work have been implemented in the educational process of the Department of Neurology with a course in Psychiatry and Narcology at NJSC "M. Ospanov WKMU", as well as in practical healthcare.

Propositions for the defense:

1. Normal writhing movements were more characteristic of perinatal pathologies in full-term children, while poor repertoire pathological movements were a non-specific marker of cerebral palsy, occurring with equal frequency in all studied nosological groups. The absence of transition from pathological movements to normal fidgety movements was an unfavorable sign and was noted in 13.8% of full-term and 10.6% of preterm children, mainly in severe CNS lesions (HIE grade III, neonatal sepsis, respiratory distress syndrome).

2. High sensitivity of the prognostic power of general movements assessment was found at early terms (42 weeks PMA), and specificity at late terms (52 weeks PMA) in full-term and preterm children. When comparing the GMOS-R and MOS assessment methods, the superiority of the latter ($\approx 100\%$) is noted, for which predictive values based on their scores in full-term and preterm children were determined.

3. When assessing the effect of movement imitation therapy on the severity of cerebral palsy, a certain prevalence of children with severe degrees according to GMFCS&ER was found in the group of children who received therapy at 52 weeks, as opposed to 42 weeks, in both full-term and preterm children, and high HINE scores were noted with its early application. The

severity levels of CP according to GMFCS&ER did not strongly depend on the timing of therapy in full-term children; however, in preterm children, late therapy was closely associated with higher (worse) scores.

Approbation of the work. The results of the conducted study were reported at:

1. International conference dedicated to the 11th anniversary of the "School of Young Neurologists", Tashkent, Uzbekistan, March 24-25, 2021, with an oral report: Assessment of general movements.
2. International scientific conference of students and young scientists "FARABI ALEMI", Almaty, Kazakhstan, April 6-8, 2021, with an oral report: Assessment of general movements in the diagnosis of cerebral palsy in children.
3. LXI International conference of young scientists "SCIENCE: YESTERDAY, TODAY, TOMORROW", Aktobe, Kazakhstan, April 27, 2022, with an oral report: Assessment of general movements and Hammersmith neurological examination in children.
4. 17th International Child Neurology Congress. Antalya, Turkey, October 3-7, 2022. Prognostic value of the Hammersmith neurological examination and general movement assessment in children with neurological disorders.
5. EPNS supported course in Baku on the journey from fetal to neonatal neurology medicine, December 19-20, 2024. General movement assessment efficacy for assessment of nervous system integrity in neonates after HIE.
6. The 67th Annual Meeting of the Japanese Society of Child Neurology, Tottori, Japan, June 4-7, 2025. Achievements in Pediatric Neurology in Kazakhstan: Early Diagnosis of Neurological Disorders.
7. The 67th Annual Meeting of the Japanese Society of Child Neurology, Tottori, Japan, June 4-7, 2025. General movement assessment efficacy for assessment of nervous system integrity in children after hypoxic-ischemic encephalopathy.

Publications on the dissertation topic:

10 scientific papers have been published on the topic of the dissertation research: 2 (two) articles in international peer-reviewed scientific journals indexed in the Web of Science Core Collection database and the Scopus Q2 database; 4 articles in scientific publications recommended by the Committee for Control in Education and Science of the Republic of Kazakhstan; 4 in the proceedings of international scientific conferences:

1. Zhanna Zhussupova, Dinmukhamed Ayaganov, Latina Tekebayeva, Altynshash Jaxybayeva, Ayten Mamedbayli, Amin Tamadon, Gulmira Zharmakhanova. General movements assessment: A bibliometric analysis. *Early Human Development*, Volume 188 105924, 2023.
2. Zhanna Zhussupova, Altynshash Jaxybayeva, Dinmukhamed Ayaganov, Latina Tekebayeva, Ayten Mamedbayli, Amin Tamadon, Gulmira Zharmakhanova. General movement assessment efficacy for assessment of nervous system

integrity in children after hypoxic-ischemic encephalopathy in middle income countries. *Early Human Development*, Volume 192 105992, 2024.

3.Zh.T. Zhussupova, D.N. Ayaganov, G.M. Zharmakhanova, A.K. Mamedbayli. Assessment of general movements in children. *Pharmacy of Kazakhstan* No. 6, 2022, pp. 35-42. 2022.

4.Zhanna Zhussupova, Dinmukhamed Ayaganov, Gulmira Zharmakhanova, Ayten Mamedbayli. Future Prospects for Assessment of General Movements in Developing Countries. *West Kazakhstan Medical Journal: Volume 65 Issue 4 / Pages 60-72*. 2024.

5.Zhanna Zhussupova, Dinmukhamed Ayaganov, Gulmira Zharmakhanova, Gulzhanat Nurlanova, Latina Tekebayeva, Ayten Mamedbayli. The Influence of Movement Imitation Therapy on Neurological Outcomes in Children Who Have Experienced Adverse Perinatal Conditions. *West Kazakhstan Medical Journal* Volume 66, Issue 4, 2024.

6.Zhanna Zhussupova, Altynay Sadykova, Dinmukhamed Ayaganov, Altynshash Jaxybayeva, Ayten Mamedbayli, Gulmira Zharmakhanova. Characteristics of General Movements Formation in Children with Perinatal Pathology. *West Kazakhstan Medical Journal* Volume 67, Issue 3, 2025.

7.Zhanna Zhussupova. The 67th Annual Meeting of the Japanese Society of Child Neurology, Tottori, Japan, June 4-7, 2025. *Achievements in Pediatric Neurology in Kazakhstan: Early Diagnosis of Neurological Disorders*.

8.Zh.T. Zhussupova, D.N. Ayaganov, G.M. Zharmakhanova. Assessment of general movements and Hammersmith neurological examination in children. Collection of materials of the LXI International Scientific Conference of Young Scientists "SCIENCE: YESTERDAY, TODAY, TOMORROW", dedicated to the 65th anniversary of the West Kazakhstan Medical University, April 27-28, 2022, pp. 71-72.

9.Zhanna Zhussupova, Dinmukhamed Ayaganov, Gulmira Zharmakhanova. Prognostic Value of The Hammersmith Neurological Examination and General Movement Assessment In Children With Neurological Disorders. 17th International Child Neurology Congress, Antalya, Turkey, October 3-7, 2022 (The International Child Neurology Association).

10.Zh.T. Zhussupova. Assessment of general movements in the diagnosis of cerebral palsy in children. Materials of the International Scientific Conference of Students and Young Scientists "FARABI ALEMI", Almaty, Kazakhstan, April 6-8, 2021, p. 26.

Implementation of research results:

The materials of the scientific research have been implemented into practical healthcare:

1.Act of implementation of research work No. 203 dated 05.01.2022, at the State Public Enterprise "Center for Maternity and Childhood Protection" on the Right of Economic Management: Use of the "General Movements Assessment" scale.

2.Act of implementation of research work No. 18 dated 28.03.2024, into the educational process: "Use of GMA in the early diagnosis of cerebral palsy" for

5th-year students of the "General Medicine" faculty in the discipline "Neurology".

Author's personal contribution:

Within the framework of this study, the author personally developed the aim and objectives for a comprehensive analysis of the research problem. Data collection and interpretation were carried out. A significant personal contribution was made to the process of statistical processing of the results, which made it possible to achieve objectivity and reliability of the conclusions. Scientifically based conclusions were also formulated, and practical recommendations were developed, which contributes to the further development of the scientific field of research. The author took a direct part in the experimental part of the work, in the organization and implementation of early intervention in the form of movement imitation, in the analysis of the obtained data, and in the interpretation and summarization of the results in the form of publications, which makes a significant contribution to the theoretical and practical significance of the conducted research. The author completed the basic and advanced levels of GMA assessment at "GM Trust".

Scope and structure of the dissertation:

The dissertation is presented on 99 pages of computer text and includes sections on introduction, literature review, materials and methods of research, research results, discussion, conclusion, findings, practical recommendations, references, and appendices, and is illustrated with 16 tables and 14 figures. The bibliography includes 142 sources.

MATERIALS AND METHODS OF RESEARCH

General characteristics of the work

The study was conducted in accordance with the ethical principles set forth in the Helsinki Declaration of the World Medical Association (LXIV WMA General Assembly, Fortaleza, Brazil, October 2013).

The dissertation research was reviewed by the local ethics committee at Marat Ospanov WKMU, Aktobe, dated 24.10.2025, protocol No. 10-2025/119-D.

The study protocol was registered on ClinicalTrials.gov under protocol number 10.04.12.2020. ClinicalTrials.gov is administered by the US National Library of Medicine (NLM) at the National Institutes of Health and is the largest clinical studies database. Identification number: ID NCT05262088.

This dissertation research was carried out between 2021 and 2023 at the Department of Neurology with a course in Psychiatry and Narcology of the Marat Ospanov West Kazakhstan Medical University. The work is an applied scientific research conducted at the clinical base of the Regional Perinatal Center in Aktobe.

In accordance with the aims and objectives of the dissertation work, a study design defining the selection of patients and research methods was developed.

Study design. This work has a combined design: cohort; open clinical study.

This study aims to solve three key tasks. The first task has a prospective design, which involves studying the characteristics of the formation of variability of general movements in children with perinatal pathology, assessed at 42 and 52 weeks PMA. Within the framework of this task, children who demonstrated suboptimal GMOS-R scores for WR movements (less than 33 points), for PR (less than 18 points), and all children with CS movements, as well as children with absence of fidgety movements, constituted the CP risk group and were referred for movement imitation therapy.

The second task aims to determine the prognostic value of the formation of general movements for identifying early markers of the risk of developing cerebral palsy.

The third task is clinical, within which the studied children are divided into 2 groups: the first group (children who received movement imitation therapy at 42 weeks PMA): children from the CP risk group (suboptimal scores for each movement type using the GMOS-R method, according to reference values) and the second group (children who received movement imitation therapy at 52 weeks PMA): children who demonstrated optimal scores for each movement type using the GMOS-R method, according to reference values at 42 weeks PMA, but with absence of "fidgety" movements at 52 weeks PMA (the second CP risk group). The effect of this therapy on the severity of CP was assessed using HINE scores (at 60 weeks PMA) and GMFCS-E&R level at 18 months of age in two groups differing by the timing of intervention initiation.

The required sample size was calculated. The total child population in Aktobe region is 77,360 people. According to official statistical reports, birth rates in the region for 2019 and 2020 ranged from 18.7 to 21.3 per 1,000 population [128]. Based on this, the planned number of newborns in the Regional Perinatal Center for 2021 was estimated at 7,000–7,500 children. Assuming an alpha error of 5% and a beta threshold of 20% (providing a study power of 80%), and to achieve a prognostic power of 0.95 in accordance with the established selection criteria, the expected number of children with cerebral palsy, according to epidemiological data, that needed to be included in the study was 155. The actual number of the study group in our sample was 327 children.

Inclusion criteria (cohort study):

- Newborns with perinatal pathology

Exclusion criteria (cohort study):

- Presence of diagnosed hereditary diseases (including chromosomal abnormalities, monogenic syndromes);
- Identification of multiple congenital malformations of any localization;
- Occurrence of death in the neonatal period or during the study phase.

Inclusion criteria for the clinical stage of the study (Task 3):

- Presence of pathological CS movements;
- GMOS-R value for Wr movement <33 points;
- GMOS-R value for PR movement <18 points;

- Absence of "fidgety" movements.

Exclusion criteria for the clinical stage of the study (Task 3):

- GMOS-R value for Wr movement ≥ 33 points;
- GMOS-R value for PR movement ≥ 18 points;
- Presence of "fidgety" movements.

Task 1. To study the characteristics of the formation of general movements in children with perinatal pathology. A prospective study was conducted. For all children, a qualitative and detailed assessment of general movements at 42 and 52 weeks PMA was performed, assessing variability according to perinatal pathologies in 120 full-term and 207 preterm children.

Task 2. To determine the prognostic values of general movements, identifying early predictors of cerebral palsy. Based on the qualitative and detailed assessment of general movements, as well as their variability at 60 weeks postmenstrual age (PMA), predictors of cerebral palsy (CP) were studied, followed by verification of the CP diagnosis. The analysis performed allowed us to assess the prognostic value of the variability of general movements.

Task 3. To evaluate the effect of movement imitation therapy on the severity of cerebral palsy and substantiate the timing of its administration. To assess the effect of movement imitation therapy on the severity of CP, a separate study design was constructed. An open-label controlled clinical trial was conducted. The selection criteria for starting early intervention at 42 weeks PMA were children who scored below optimal on the GMOS-R scale; at 52 weeks PMA – children who did not demonstrate "fidgety" movements. The criterion for evaluating the effectiveness of movement imitation therapy was the assessment of HINE scores at 60 weeks PMA and the assessment of CP severity using GMFCS-E&R at 18 months of age.

Statistical data processing methods. All statistical analyses were performed using R version 4.5.1 (R Core Team, 2025).

The study was conducted in accordance with international recommendations STARD 2015 (for diagnostic accuracy studies) and TRIPOD 2022 (for developing and validating prognostic models).

Descriptive statistics were used to analyze demographic, obstetric, and perinatal factors. The Kolmogorov–Smirnov test was used to check the normality of the distribution of continuous data. Depending on the data distribution, the Mann–Whitney test and Pearson's χ^2 test were used. For quantitative variables, one-way analysis of variance (ANOVA) with Tukey's post-hoc tests were used. Continuous variables are presented as medians using the Kruskal–Wallis test.

To determine the prognostic value of general movements and identify early predictors of cerebral palsy (CP), as well as to study the characteristics of the formation of general movements in children with perinatal pathology, a comprehensive statistical analysis was performed. ROC analysis was performed

to assess differences between children with CP, and PR curves and areas under the curves (AUPRC) were additionally calculated.

Spearman's correlation was used to identify correlations. Logistic regression was used for multivariate models. All obtained indicators underwent calibration and internal validation with 10-fold cross-validation. Comparison between time points was performed using McNemar's test. When evaluating prognostic indicators, DCA analysis and the Benjamini–Hochberg method (FDR 0.05) were used. Classical logistic regression using LASSO was used to predict the risk of CP. Model performance was evaluated using ROC-AUC and PR-AUC (precision-recall) methods. All constructed models underwent internal validation using CV-AUC and PR-AUC estimates. To assess the effect of movement imitation therapy on the severity of cerebral palsy (CP) and substantiate the optimal timing of its administration, a separate study design was constructed. Statistical analysis was performed in several stages and included both classical methods and modern approaches. ANCOVA models were used to assess the impact of the timing of movement imitation therapy on outcomes, logistic regression was used to assess the association between the timing of therapy and the presence of a CP diagnosis, and proportional odds ordinal logistic regression was used to analyze levels of functional severity.

RESULTS OF OWN RESEARCH

Main characteristics of the studied children with perinatal pathology.

The analysis conducted among 8,249 newborns showed the presence of perinatal pathology in 354 children, of which 327 children constituted our sample. Among the 327 children, 120 were full-term and 207 were preterm.

Analysis of perinatal pathologies among full-term children showed a predominance of HIE grade I and grade II (37.5% and 25.8%), while HIE grade III, neonatal hypoglycemia, neonatal jaundice, and toxic-metabolic encephalopathy accounted for 4.2%, 6.7%, 11.7%, and 14.2%, respectively.

In the group of preterm newborns, perinatal pathologies included: respiratory distress syndrome in 30.9% of cases, low birth weight in 51.7%, other respiratory disorders in 10.6%, and early neonatal sepsis in 6.8% of patients.

Results of qualitative and detailed assessment of general movements in full-term children depending on perinatal pathology.

When assessing the nature of general movements at 42 weeks postmenstrual age (PMA), an uneven distribution of motor patterns was revealed depending on the type and severity of perinatal pathology.

Normal writhing movements (Wr) predominated in children with hypoxic-ischemic encephalopathy grade I and toxic-metabolic encephalopathy in 82.2% and 70.6% of cases, respectively, serving as a marker of relatively mild brain damage. Conversely, the poor repertoire (PR) pattern, as a non-specific marker, was most common in moderate and moderately severe lesions (neonatal jaundice and hypoglycemia, in 78.6% and 75%, respectively), whereas pathological

movements of the cramped-synchronized (CS) type were the most unfavorable prognostic sign: observed in children with severe hypoxia: 40.0% in HIE grade III, and 16.1% in HIE grade II.

Analysis of the transformation of motor patterns at 52 weeks PMA showed the following. For Wr movements, a normal fidgety repertoire was formed in 86.2% of cases; for the PR pattern – 68.5%; and in the presence of CS-movements, fidgety movements were absent in 100% of cases.

Analysis of the detailed assessment using the GMOS-R method (at 42 weeks PMA) in full-term children depending on the type of movements (Wr, PR, CS) showed: for Wr – 35 [19; 38] points, for PR – 25 [13; 33] points, for CS – 8.5 [5; 10] points. The data obtained in our sample differed from reference values: for the normal motor pattern (WR), 35 points were obtained, compared to 33; for the pathological pattern of the poor repertoire type (PR) – 25, compared to 18; for the pathological pattern of the cramped-synchronized type (CS) – 8.5 points, compared to 10 points.

At 52 weeks PMA, optimal MOS scores (25-28 points) were achieved in 45.8% of children. It was established that with initial Wr and PR movements, the presence of fidgety was associated with higher MOS scores, whereas with CS-movements, fidgety was absent in all observations.

Results of qualitative and detailed assessment of general movements in preterm children with perinatal pathology.

Normal writhing movements (Wr) among preterm children were most often observed in the low birth weight group (36.4%); in other groups, the frequency was significantly lower. The pathological poor repertoire (PR) pattern prevailed in all groups of preterm children with perinatal pathology. Pathological CS-type movements were recorded only in two groups: in respiratory distress syndrome (9.4%) and in early neonatal sepsis (7.1%). Analysis of transformation into fidgety movements (52 weeks PMA): with initially normal Wr movements, normal F+ movements were formed in 100% of cases; with the PR pattern – in 89.8%; in the presence of CS-movements, normal F+ movements were absent in 100% of cases.

Analysis of the detailed GMOS-R assessment (42 weeks PMA) showed: Wr – 33 [25;36] points (normal), PR – 25 [13;27] points (above reference 18), CS – 8 [5;9] points (below reference 10); at 52 weeks PMA, MOS: optimal level (25-28 points) was achieved in 50.7% of cases; suboptimal (21-24 points) – 38.6%; non-optimal values – 10.7%. Analysis of transformation into normal fidgety showed: for Wr – F+ in 100%; for PR – MOS scores higher in the F+ subgroup; for CS – normal movements absent in 100%.

Results of analysis of general movements in children with cerebral palsy. Upon verification of the diagnosis of "Cerebral Palsy" at 5 months of age with correction for prematurity (in preterm infants), 54 children with CP were diagnosed, of which 32 (59.3%) children were full-term, and 22 (40.7%) were preterm.

In the group of full-term children with a verified diagnosis of cerebral palsy, Wr movements were noted in 13.8%, PR – in 29.6%, and CS movements in 100% of cases, and their range of GMOS-R scores was Me 19 [12:25] points at 42 weeks PMA.

In the group of preterm children with CP, Wr movements were not observed; PR movements were noted in 10.2% of cases, while CS movements were present in 100%, and their range of GMOS-R scores was Me 14 [8:21] points.

Analysis of the presence or absence of fidgety movements in children with CP showed their absence in 100% of cases in both full-term and preterm children.

In the group of full-term children, the range of MOS scores at 52 weeks PMA was Me 16 [15:17] points, compared to 25.5 points [23:27] in children without CP; in the preterm group, also 16 points, compared to 25 in children without CP, respectively.

Based on the qualitative and detailed assessment of general movements, children in the risk group for cerebral palsy were identified, for whom movement imitation therapy was initiated at 42 and 52 weeks PMA.

Prognostic analysis of movement assessment at 42 weeks PMA in full-term children showed a sensitivity of 75.0%, in preterm children – 100%, while the presence of fidgety movements at 52 weeks PMA showed high specificity (98.9-100%) in both full-term and preterm children. Both GMOS-R (AUC 0.898; AUC 0.978, for full-term and preterm, respectively) and MOS (AUC 0.985; AUC 1.000 for full-term and preterm, respectively) demonstrated high prognostic significance. The MOS marker showed high prognostic value (in full-term children, OR 0.018, 95%CI:0.00045-0.104; in preterm children – OR 0.0083, 95%CI: 5.4×10^{-6} -0.071; $p < 0.001$).

Results of evaluating the effect of movement imitation therapy on the severity of cerebral palsy.

In the group of full-term children (n=35), 27 children received movement imitation therapy at 42 weeks PMA (first group), and 8 – at 52 weeks (second group). The timing of movement imitation therapy did not significantly affect the CP outcome according to HINE (at 60 weeks) and GMFCS&ER (at 18 months) scores, with Spearman correlation analysis yielding $r = -0.765$ and $r = -0.706$ for children in the first and second groups, respectively.

In the group of preterm children (n=30), 23 children received movement imitation therapy at 42 weeks PMA (first group), and 7 – at 52 weeks (second group). Among preterm children, significant differences in the severity indicators of cerebral palsy were found, depending on the timing of movement imitation therapy. HINE scores (at 60 weeks PMA) in the first group were higher (58.70 ± 9.95 vs. 46.14 ± 1.35 , $p = 0.003$), and logistic regression analysis showed that movement imitation therapy initiated at 52 weeks was closely associated with higher (worse) GMFCS&ER scores (at 18 months of age), for which the OR was 7.57 (95%CI: 2.0–28.7), $p < 0.009$.

CONCLUSION

Thus, based on the results obtained from our study, the following conclusions were drawn:

1. PR movements were observed with equal frequency in all perinatal pathologies ($p < 0.001$), Wr movements were characteristic of children with HIE grade I, toxic-metabolic encephalopathy, and low birth weight, while CS movements were recorded in HIE grade III and neonatal sepsis. Over time, the transition to normal fidgety movements was absent in 13.8% of full-term and 10.6% of preterm children, mainly in severe CNS lesions.

2. Analysis of the prognostic power of qualitative movement assessment showed the superiority of fidgety movements (sensitivity and specificity 100%, $p < 0.05$), whereas for the detailed assessment, the MOS assessment showed high accuracy in the group of full-term (OR 0.018) and preterm (OR 0.0083) children, being a reliable predictor of CP, while GMOS-R demonstrates screening power (sensitivity 100% at 42 weeks PMA).

3. In preterm children, movement imitation therapy performed at 42 weeks (as opposed to 52 weeks) demonstrated effectiveness: HINE scale scores 58.70 ± 9.95 vs. 46.14 ± 1.35 ($p = 0.003$), despite their initial low GMOS-R scores (12.22 ± 3.80 vs. 21.29 ± 0.49 , $p < 0.001$). In children who received therapy at 52 weeks, a predominance of severe CP was revealed (OR 7.57; 95% CI: 2.0-28.7; $p = 0.009$, for GMFCS-ER). In full-term children, the severity levels of CP according to GMFCS-ER did not depend on the timing of therapy (showing no statistically significant differences).

PRACTICAL RECOMMENDATIONS

The prognostic value of general movements in children has clinical significance for both the early diagnosis and early intervention of cerebral palsy.

Based on the study of general movements and perinatal pathology, the identified statistically significant relationships will serve as a tool for predicting CP, offering practical healthcare a targeted approach for early intervention.

The obtained scientifically based conclusions and values can be used for the educational process at the university.