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**Original Article**

# Evaluation of the effectiveness of the application of physical rehabilitation program for premature infants with motor disorders of various genesis according to the INFANIB testing scale

OLENA LAZAREVA[1], YEVHEN VASYLENKO[1], YAROSLAV GALAN[2], LIDIIA DOTSIUK[2], OLEKSANDRA TSYBANYUK[2]
[1] National University of Physical Education and Sport of Ukraine, Kyiv, UKRAINE
[2] Yuriy Fedkovych Chernivtsi National University, Chernivtsi, UKRAINE

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**Abstract:**
*Purpose*: to analyse and evaluate the effectiveness of application of the algorithm of physical rehabilitation of premature infants with different gestation periods based on the results of the INFANIB (Infant Neurological International Battery) scale testing. *Materials:* The materials of the work were obtained during the research on the basis of the Children's Branch No. 6 of the Clinical and Diagnostic Centre of the Shevchenkivskyi District of the city of Kyiv. At the stage of preliminary studies, it was carefully elaborated and examined a group of the new born preterm infants of the different stage of prematurity with the congenital pathologies of the locomotor apparatus of various etiology (n = 60): I stage. (n = 23), II stage (n = 18), III stage (n= 10), IV stage (n = 9). Results: The motor functions of a preterm baby were assessed by the INFANIB scale testing. The total score in each age period corresponded to three indicators of testing: the norm, the transient impairments and pathology. The INFANIB scale testing to zero months of the corrected gestational age (CGA) showed that 73.9 % of children with the first stage of prematurity in the performance of 14 tests had a pathology and 26.1 % of infants had a transient impairment. Analysis of the total score among children with the second stage of prematurity by zero months of CGA stated that 83.3 % of children had pathology and 16.7 % of infants had a transient impairment. There were no children with the total score within the norm. In children with the third and the fourth stage of prematurity, 100.0 % had pathological changes. Under the influence of the developed program of physical rehabilitation, there were significant changes in the health condition of premature infants of all groups. Thus, in children with the first stage of prematurity, transient impairments were found in 13.0 %; and the norm - in 87.0 %, with the second stage, relatively, in 38.9 % and in 61.1 %; and with the third stage - 40.0 % and 60.0 %. Transient impairments were found in 88.9% of children with the fourth stage of prematurity, the norm – in 11.1 % of infants. There were no infants with the total score lower than 68 points. *Conclusions*: The testing made it possible to compare the parameters of the motor function changes in the premature baby at different stages with various lesions of the nervous system and concomitant diseases of other organs and systems expressed in motor impairments.
**Key words:** premature infants, locomotor impairments, physical rehabilitation, INFANIB.

## Introduction

Among the enormous number of unresolved issues in the medical field today, one of the most acute problems is the problem of physical rehabilitation of children, schoolchildren and athletes (Ilinca, 2013; Kozina, 2016; Briskin, 2016; Herasymenko, 2016; Lazarieva, 2017; Gorshova, 2017).

The problem of prematurity in the last decades has become one of the main ones, because, due to prematurity, severe lesions of various organs and systems occur, which leads to impairments in psychomotor, physical development up to disability (Blencowe, 2012). The World Health Organization in the report of 2012 and in the newsletter in November 2016 (WHO Library, 2012) highlights an increasing trend in the number of prematurely born infants in all countries, and among them there are countries with a high standard of living and medical care. One of the causes of this phenomenon is the high level of medicine, which allowed to reduce the threat of pregnancy disruption, to prevent the various intrauterine anomalies development, to reduce intrauterine mortality and infant mortality, to give the joy of motherhood and paternity to many families.

However, this breakthrough in the reproductive medicine has shown the urgent need for the restorative treatment and physical rehabilitation of the newborn children with a burdened anamnesis (Bombardyrova, 2005; Demianova, 2006; Kulakov, 2006). The development of premature infants has its own peculiarities in each of the prematurity stages, and the resuscitation measures performed on such children determine the selectivity of the


Corresponding Author: GALAN YAROSLAV, e-mail: cv.noc.cv@gmail.com

methods and techniques of physical neonatal rehabilitation and their clear coordination with the treatment process (Rybakova, 2007; Korotaieva, 2008).

Minimizing the consequences of prematurity until the physical and psychomotor functions of premature babies are fully restored are the main challenges that physical rehabilitation in the sphere of recovery poses before us (Alifanova, 2013; Vasylenko, 2016). The solution of this problem requires not only the application of optimal methods of physical rehabilitation and their optimization, but also of methods for qualitative evaluation, that provides for an opportunity to assess objectively the baseline and stage changes, to identify existing problems and determine further ways of correcting the physical rehabilitation program and prospective prognostication (Alifanova, 2013 Stepanova, 2013; Vasylenko, 2015).

**Material and methods**

The following research methods were used in the work: analysis of special and scientific-methodological literature; the content analysis of medical documentation (the results of objective research (neurosonography), observation letters, and the results of laboratory analyses); pedagogical observation, testing; anthropometric methods. The motor functions of the premature infant were evaluated by the INFANIB scale tests, which determine the state of the muscular tone at different age periods, the timeliness of the occurrence and fading of the congenital reflexes, the manifestation of various types of reactions (motor, defensive, balance) lying in the supine positioning the prone, sitting, standing, and from the seventh month "in a suspended position" - "forward parachute". The sum of the points scored in each age period corresponded to three indicators of testing: norm, transient impairments and pathology (Ellison, 1985-1986; Parmar et al, 2013). Each test was scored at 1, 3 and 5 points, where 5 is a positive test result, 3 is a deviation for one age period, and 1 for two age periods. The study involved 60 new-born infants, who were examined on the basis of the Children's Branch No. 6 of the Clinical Diagnostic Centre of the Shevchenkivskyi District of the city of Kyiv. Depending on the stage of prematurity, the children were divided into groups: I stage (n = 23), II stage (n = 18), III stage (n = 10), IV stage (n = 9). Parents of the studied children were acquainted with the tasks and main provisions of the study and signed an agreement to participate in it. Empirical materials were processed with the mathematical statistics methods. To assess the significance of the difference, in the presence of a normal distribution of the results of the studies, the Student's t-test (for independent or for dependent groups) was used, and for the indicators with the distribution which was different from the normal one, there were used the Mann-Whitney U test (for independent groups) and Wilcoxon T test (for dependent groups).

**Results**

The results of statistical analysis of estimation data at 0 months of corrected age according to the INFANIB method are presented in Table 1 for children in accordance with the stage of prematurity. When testing, all tests were not always used; it depended on the corrected age of the child.

The analysis of the total score, which children with the first stage of prematurity scored for the performance of 14 tests, allowed us to state that 73.9 % of the examined patients had pathology for determining the negative manifestation of tests of tonic reflexes. The transgression was 26.1 % of children. Among children with a second stage of prematurity, 83.3 % had pathology, and 16.7 % - a transient impairment. It should be noted that among the children with the first and second stage of prematurity there were no persons identified, they were within the norm by the total score, despite the performance of the assessment in accordance with the adjusted age, not with the passport one. In the group of premature infants with the second stage, it is worth noting the tendency of a negative manifestation of the postural tone of the lower and upper extremities, tonic reflexes and support reaction.

Table 1. The average statistical indices of the evaluation of motor activity with the INFANIB testing scale in children with different stages of prematurity (0 month of corrected age)

| Research indicators, points | I stage (n=23) | | II stage (n=18) | | III stage (n=10) | | IV stage (n=9) | |
|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | S | $\bar{x}$ | S | $\bar{x}$ | S | $\bar{x}$ | S |
| Test No.1. The hands position – hands held open or closed | 3.4 | 0.84 | 2.9 | 1.08 | 2.0 | 1.05 | 1.7 | 1.00 |
| Test No.2. The adduction of the shoulders forward | 3.1 | 0.42 | 2.9 | 1.08 | 2.0 | 1.05 | 1.9 | 1.05 |
| Test No. 3. Heel-to-ear ( the angle between the heel and the ear) | 3.3 | 0.69 | 3.0 | 0.69 | 2.6 | 0.84 | 2.6 | 0.88 |
| Test No. 4. Popliteal angle | 3.3 | 0.69 | 3.0 | 0.69 | 2.8 | 0.63 | 3.0 | 0.00 |
| Test No.5. Leg abduction angle | 3.6 | 0.94 | 3.1 | 1.08 | 2.6 | 0.84 | 2.1 | 1.45 |
| Test No. 6. Dorsiflexion of the foot | 4.0 | 1.02 | 3.6 | 1.15 | 3.2 | 0.63 | 2.8 | 0.67 |
| Test No.7. Tonic labyrinthine reflex in supine position | 1.9 | 1.69 | 1.9 | 1.71 | 1.8 | 1.69 | 1.4 | 1.33 |
| Test No.8. Foot grasp | 1.9 | 1.69 | 1.9 | 1.71 | 1.8 | 1.69 | 1.4 | 1.33 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Test No. 9. Asymmetrical tonic neck reflex | 2.0 | 1.80 | 2.3 | 1.94 | 1.8 | 1.69 | 1.4 | 1.33 |
| Test No.10. The head position when the trunk is pulled by the hands to the sitting position | 3.3 | 0.69 | 2.6 | 0.86 | 2.0 | 1.05 | 2.1 | 1.05 |
| Test No. 13. Evaluation of the prone position | 3.9 | 1.01 | 3.3 | 1.03 | 2.4 | 0.97 | 1.4 | 0.88 |
| Test No.14. Tonic labyrinthine reflex in prone position | 4.8 | 0.83 | 3.7 | 1.94 | 3.0 | 2.11 | 2.8 | 2.11 |
| Test No.15. Sitting position | 3.0 | 0.00 | 3.0 | 0.97 | 2.4 | 0.97 | 1.4 | 0.88 |
| Test No.18. Positive support reflex - weight bearing | 3.1 | 0.73 | 2.9 | 1.08 | 2.2 | 1.03 | 1.2 | 0.67 |
| Total score | 44.5 | 6.47 | 40.0 | 8.15 | 32.6 | 5.58 | 27.3 | 3.74 |

Analysis of the total score, which children scored in 14 tests, allowed to state that 100.0 % of children with a third and fourth stage of prematurity at 0 months had pathology. It should be noted that the scores of children with the third stage were closer to transient impairments.

Thus, we can state the presence in all children of changes in motor functions associated with various lesions of the nervous system, due to the stage of prematurity, the causes of its occurrence, concomitant somatic diseases and individual physiological characteristics.

The physical rehabilitation program was based on the principles of the cat amnestic observation, including interdisciplinary communication of physicians and therapists who specialize in neurology, orthopaedics, pediatrics and physical therapy and ergotherapy, which makes it possible to select the optimal set of physical rehabilitation techniques, their combination and correction in the process of implementation (Alifanova, 2013; Vasylenko, 2015). Based on the conclusions of the specialists and the evaluation according to the INFANIB testing scale, the methods of manipulation were selected depending on the overwhelming pathology: in the case of the nervous system impairments - the elements of Voit, Bobbat, Strakovska and Yatsyk techniques (ancillary: the dry immersion method, positioning, the Kangaroo Mother Care method, swimming, massage); in the case of orthopedic pathologies - elements of the techniques of Strakovska, Volkov, Yatsyk (ancillary: gymnastics in water, dry immersion method, positioning, electrophoresis, luminotherapy); in cases of the endocrine system disorders - elements of the techniques of Strakovska, Bombardyrova, Yatsyk (ancillary: vitamin therapy, balneotherapy, ultraviolet radiation).

The re-evaluation of the neurological status and the musculoskeletal system functioning in children of the I-IV stages of prematurity when using the INFANIB testing scale for ascertaining the level of values and revealing the dynamics of the results was carried out at 3, 7 and 12 months of the CA.

According to the research results and to the conclusions of doctors, specialists in orthopedics, pediatrics and neurology and physical therapists, the positive changes were observed in all the areas studied during the entire period of the physical rehabilitation program for premature infants of different gestation periods. At seven and twelve months, there were obtained test results, expressed in positive changes in psychomotor functions, and there was a complete or partial removal of diagnoses associated with orthopedic pathologies or the endocrine system disorders that affected the formation of the motor functions of the child.

In accordance with the gradation of the total score, in the children with the first stage of prematurity at the age of seven months there were no pathologies, transient impairments were detected in 39.1 % of children, and the norm was revealed in others 60.9 % of subjects. The average score increased by 19.4 points (36.4 %) and was 72.7 ± 4.79 points, with a minimum score of 63 points and a maximum score of 80 points. Changes in the total score were statistically significant ($p < 0.01$).

At the stage of the last examination in children with the first stage of prematurity, there was observed a positive dynamics of all testing factors into a normal state. It should be noted that revealed insignificant transient impairments did not affect the general state of motor functions. The total score in the group was 90.2 ± 6.46, this fact stated an increase of 17.5 points (25.5 %), and the limit values after the rehabilitation course completion were 98.0 and 70.0. The changes were significant ($p < 0.01$). According to the total score, 13.0 % of subjects had transient impairments; and the norm was revealed in 87.0 % of children.

Analysis of the dynamics of scores on the INFANIB scale in the group of children with the second stage of prematurity during the third survey (seven months of corrected age), revealed significant positive changes in a large number of tests. Considerable progress has been recorded, especially in the state of verticalization of motor functions and in the formation of equilibrium reactions. According to the total score, pathology was found in 5.5 % of children with the second stage of prematurity; transient impairments - in 88.9 %; the norm – in 5.5 % of the subjects. This was reflected in an increase ($p < 0.05$) of the total score by 17.6 (38.8 %) to 63.0 ± 5.71. Limit range values were found at the levels of 54 and 76 points. The application of the developed program led to an increase in the total score to 85.1 ± 6.94 points in children of this group at 12 months of CGA, with an absolute increase of 22.1 points and a relative increase of 35.1 points. Limit range values were set at 74 and 92 points. According to the distribution of the total score, transient disorders were detected in 38.9 %, and the norm in

61.1 % of children with the second stage of prematurity. At the stage of the final examination, a large number of statistical changes were revealed at twelve months.

In accordance with the total score levels, it was observed pathology in 30% of children with the third stage of prematurity during the study at seven months of CGA, transient disorders were detected in 70 % of infants. The average score increased by 19.2 points (50 %) and was 57.6 ± 4.50 points with a minimum score of 50 points and a maximum of 66 points. Changes in the total score were statistically significant ($p < 0.05$). Testing in this group of children has only reached the threshold of the transient impairments that is a positive dynamics. Particularly it should be noted that the results of tests reflecting the factor of the tonic reflexes and muscular tone have been improved. At the stage of the last examination of children with the third stage of prematurity, we can observe significant changes in most of the indices, which indicates the stabilization of the processes, the complete extinction of the manifestations of tonic reflexes, the normalization of the muscular tone and, as a consequence, the occurrence of equilibrium reactions. The total score in the group was 84.2 ± 5.29 points, which indicates an increase of 26.6 points (46.2 %), and the limit range values were 90 and 76 points after the completion of the rehabilitation course. The changes were statistically significant ($0 < 0.05$). According to the total score, transient impairments were found in 40.0% of infants; the norm – in 60.0 %.

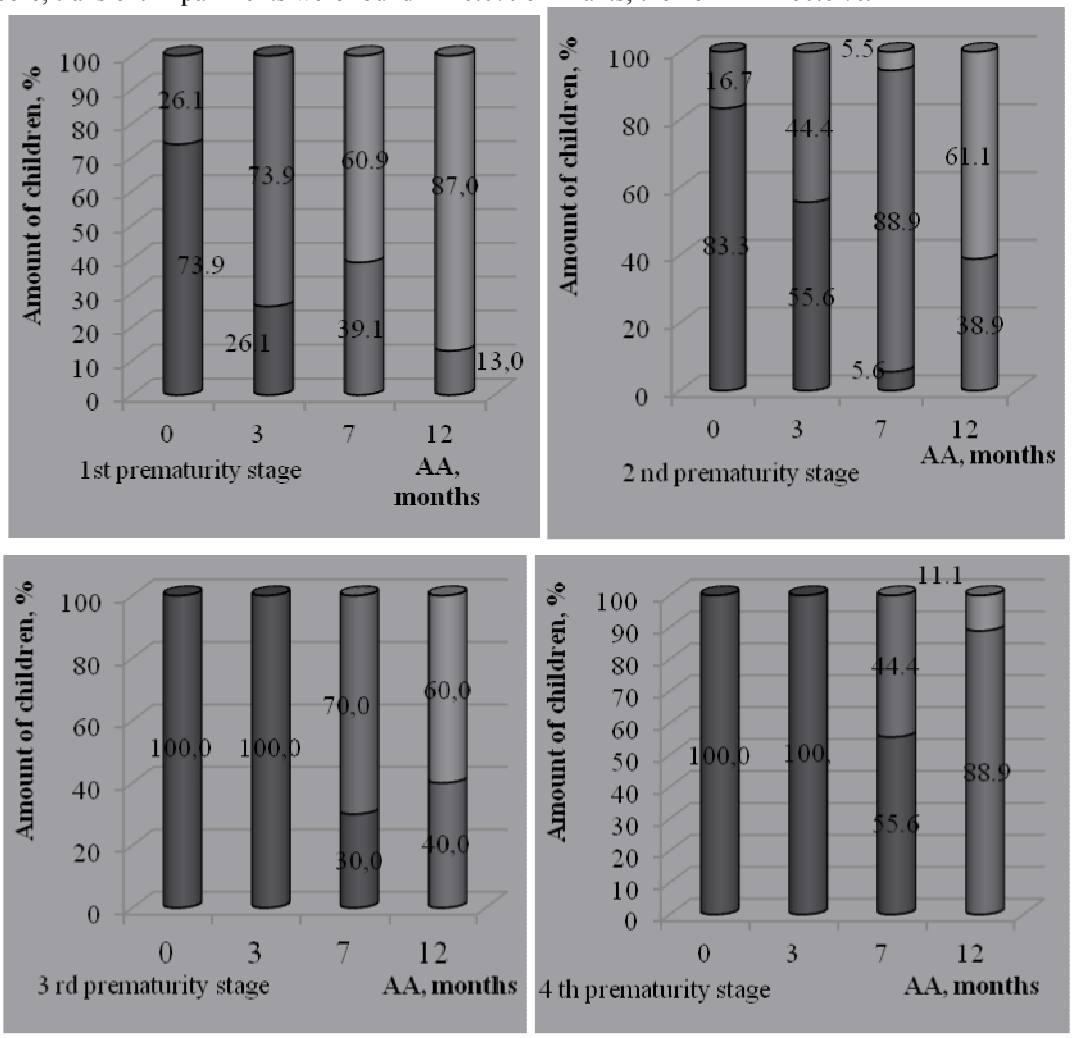


Fig. 1. Dynamics of developmental level in children with different stages of prematurity according to the INFANIB testing scale during the research stages:

– norm; – transient impairment; – pathology

Analysis of the score dynamics according to the INFANIB scale in the group of children with the fourth stage of prematurity during the third examination (at seven months of adjusted age) revealed a small number of reliable positive changes, although both absolute and relative increase was significant. This can be explained by the small size of the group. In accordance with the distribution of the total score at the seventh month of the adjusted age, in children with the fourth stage of prematurity pathology was found in 55.6 %, and transient impairments - in 44.4 %. The total score received statistical changes and was set at the level of 52.7 points, which reflected its improvement by 1.6 points or 50.1 % ($p < 0.05$). At this stage of testing, we note that

indicators indicating a pathological condition were approaching to the state of transient impairments, in particular, tests that testify to muscular tone and tonic reflexes have already reached this limit.

The tendency of positive dynamics at the stage of 12 months was reflected in the transient state of infants and in making progress on the motor functions formation by all test parameters to the state of norm.

According to the total score, transient abnormalities were found in 88.9 % of children with the fourth stage of prematurity; the norm - in 11.1 % (Figure 1). This was reflected in an increase ($p < 0.05$) of the total score by 23.5 (44.6 %) to 76.2 ± 5.14. The limit values were found at the levels of 70 and 88 points.

**Discussion**

During the physical rehabilitation program, data were added in the staging catamnestic observation by means of INFANIB testing scale of children of all stages of prematurity with motor functions of various etiologies. There was confirmed the informative value of the INFANIB scale for the adjusted age of preterm infants of all gestation periods at all stages of testing with subsequent data processing (Liao, 2012; Sanjay, 2013). Assessment on the INFANIB scale at zero months CGA, as the base line for starting the motor skills testing is an addition to the available testing approaches (Bagewadi, 2009; Krishna, 2015). Our studies at 12 months CGA using the standardized INFANIB testing scale of children with extremely low body weight (ELBW) (IV stage) - 76.2 ± 5.14 ($p < 0.05$) and very low body weight (VLBW) (III stage ) (84.2 ± 5.29 ($0 < 0.05$), confirmed the data (Alifanova, 2013) (ELBW - 82.13 ± 6.17 ($p < 0.05$); VLBW - 84.49 ± 5.33 ($p < 0.05$)) about the results of development of motor functions in children born premature with ELBW and VLBW, and were supplemented by data of testing of children after the rehabilitation program of the I and II stages of prematurity with score 90.2 ± 6, 46 points ($p < 0.01$) and 85.1 ± 6.94 points ($p < 0.01$). These data make possible to predict the manifestation of neurological pathologies and, as a consequence, the motor functions impairment in children with the score which corresponds to the ranges of "transient impairments" and "pathology". It has been confirmed the objective requirement of early application of the physical rehabilitation methods in newborns for all levels of prematurity at the hospital and home stages of the developmental care has been confirmed (Martyniuk, 2003; Korotaieva, 2008; Koziavkina, 2012). International practice of rehabilitation of premature babies, based on the methods of K. and B. Bobbat, V. Voit, Koziavkina, confirms a positive result at the stages of the formation of motor functions during the period of physiological extinction of congenital reflexes and the formation of constituent ones with subsequent transformation into motor reactions. It should be noted that in groups of the premature babies with VLBW and ELBW, respectively, of the III and IV stages of prematurity, these methods during physical rehabilitation up to one year of age can be applied selectively due to deep immaturity of organs and systems and their vulnerability, and the influence on the trigger zones by the Voit method causes such a painful and negative reaction that makes to have breaks in procedures to normalize the emotional state of the child.

In the process of studying medical records and the protocol of the management of premature infants, it was established and confirmed that, at the stage of the neonatal period, using physical rehabilitation methods especially for premature babies with VLBW and ELBW, of the III and IV stage of prematurity, respectively, maximum correctness is required, since the traditional active methods of physical rehabilitation can cause irreparable harm to this category of children (Kopochynska, 2014; Vitomskiy, 2015)

**Conclusions**

The testing made it possible to compare the parameters of the change in the motor functions of a premature baby at the different stages with various lesions of the nervous system and concomitant diseases of other organs and systems expressed in motor impairments, provided that the diseases are of the same type and they have the same stage of their manifestation. Long-term prospects of the physical and psychomotor development of children of all stages of prematurity associated with the further research, require constant monitoring of changes in the child's physical and psychomotor state continuously during the locomotor system formation. The identification of the consequences of the influence of factors on the formation of the motor functions associated with the prematurity of the child, the evaluation of the deviations of the physical and psychomotor state, require correction of these deviations, based on the core principles of physical rehabilitation. The development of rehabilitation programs for the subsequent stages of the child's formation and their implementation are important parts of the medical and social programs for the formation of a healthy child.

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