

UDC 616.831-053.2-036.86-037

DOI: 10.21668/health.risk/2016.4.06.eng

RISK FACTORS AND PREDICTION OF PHYSICAL PROBLEMS IN CHILDREN INDUCED BY NERVOUS SYSTEM DISEASES

E.A. Vorobieva, O.M. Filkina, N.V. Dolotova

Ivanovo Research Institute of Maternity and Childhood named after V.N. Gorodkova, 109 Shuvandina Str.,
Ivanovo, 153045, Russian Federation

It was shown that in the conditions of intensive development of resuscitation techniques, newborn care and infant mortality reduction, including born with extremely low birth weight, one of the consequences of the process is the growing number of children with disabilities. In Russia, the disability of children under 4 years due to diseases of the nervous system consistently takes second place as on prevalence, as on the share in the structure of disability in this age. The purpose of the study was to identify risk factors and the development of prognostic tables for the most common early childhood disorders of physical health of children with disabilities due to diseases of the nervous system. A clinical examination of 178 children with disabilities due to diseases of the nervous system (with spastic forms of cerebral palsy) at the age of 1–3 years was carried out. To identify the risk factors and to draft the expectancy table, the method of sequential mathematical analysis of Wald has been used. It is shown that the priority kinds of physical health disorders of studied children with disabilities are frequent acute respiratory infections, deficient anemia, malnutrition, atopic dermatitis. It was found that during the formation of the frequent incidence of disabled children with acute respiratory diseases and atopic dermatitis neonatal and post-neonatal factors in the formation of deficiency anemia and malnutrition – antenatal and neonatal risk factors are of the greatest importance. Tables of health disorders suitable for practical use of these predictions were designed. Pediatricians recommended to include children with poor prognosis in the risk group for the formation of these health problems and prescribe preventive measures that reduce the likelihood of risk realization.

Key words: risk factors, prognosis of health problems, children with disabilities, cerebral palsy.

Despite recent efforts on improving maternity and child welfare services, up to 40% children are born ill or become ill in the neonatal period [3]. Owing to an intensive development of resuscitation technologies and newborn care, infant mortality, including of extremely low-birth-weight newborns, decreased more than twice in the recent years [1, 3, 20]. Among other reasons, this led to an increase in the number of handicapped children aged up to 4 years old [14, 19, 24]. Infant disability is one of the indices that characterize children's state of health and the efficiency of public organizations that provide medical care to children [9, 11, 13]. Disability due to neuropathy consist-

ently ranks second as in the prevalence, as well as in the share of disability state in children under the age of 4 years old [10, 13]. In occurrence thereof, perinatal factors, abnormal pregnancy and mokitocia are of critical importance [9, 17]. Infantile cerebral palsy (ICP) refers to the most severe consequences of the neural axis perinatal affections (NA PAs) and remains one of the main causes of infant disability [7, 16].

It is known that physical health of children with disabilities due to neuropathy suffers as well, which, in turn, has a significant impact on the rehabilitation potential and efficiency of complex rehabilitation [15]. Pediatric compo-

Ó Vorobieva E.A., Filkina O.M., Dolotova N.V., 2016

Elena A. Vorobieva – Doctor of Medical Sciences; a Leading Researcher at the Department of Child Health (e-mail: ivniideti@mail.ru; tel.: +7 (493) 233-70-55).

Olga M. Filkina – Doctor of Medical Sciences, Professor, Honored Doctor of the Russian Federation; Head of the Department of Child Health (e-mail: omfilkina@mail.ru; tel.: +7 (493) 233-70-55).

Natalia V. Dolotova – Candidate of Medical Sciences; Senior Researcher of the Department of Child Health (e-mail: ivniideti@mail.ru; tel.: +7 (493) 233-70-55).

ment therefore is an important part of the complex rehabilitation. Pediatrician involvement in rehabilitation of children with disabilities due to neuropathy is the prediction and prevention of somatic pathology. Prediction is important in the formation of children's health, since it identifies not only the risk, but also positive factors determining the application points in preventive activities to create a "preponderance" of safety factors [4]. Based thereon, both an impact of individual factors, as well as all factors in combination should be analyzed [4, 18, 21]. Prediction of the most frequent health deteriorations allows timely, targeted and differentiated preventive measures that are most effective provided their early prescription to the children at risk [2, 22, 23].

The purpose of the study was to identify risk factors and to develop prognostication for the most common early childhood physical health problems (frequent acute respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis) in children with disabilities due to neuropathy.

Materials and Methods. We performed clinical examination of 178 children with disabilities due to neuropathy (infantile cerebral palsy in spastic forms), aged 1-3 years old, among them of 86 girls (48.3%) and 92 boys (51.7%), $p > 0.05$. The children examination included clinical examination, evaluation of the physical growth and development, resistance, blood and urine clinical analysis. Data of the bio-anamnesis and social history were collected by data copying from the infant's records (Form No. 112-1/u), questionnaire surveys and by interviewing parents. In identifying risk factors for the most common health problems and drawing up the prognostic tables, we used sequential mathematical analysis method by Wald [5, 6]. After proving the significance of differences in the occurrence of the factor under study in the groups of children with and without disabilities ($p < 0.05$), we calculated the prognostic coefficients (PC) per each factor grade. The prognostic coefficient was calculated by the formula $PC = 10 \lg (P1/P2)$ in the presence of the factor, $PC = 10 \lg (1-P1/P2-1)$ in the absence of the factor, where P1 and P2 are the factor's occurrence in the ref-

erence groups compared. The positive sign of the value obtained testified to poor prognosis. Wald method of mathematical analysis is widely used in medicine, in particular, for prediction of diminished hearing [12], physical growth and development abnormalities, neurodevelopmental delays, frequent acute respiratory infections, formation of cerebral palsy in children with very low and extremely low birth weight [22], for prediction of disease progression in patients with chronic hepatitis C [8], etc., that makes this method topical, informative and authentic.

Results and Discussion. At clinical examination of the disabled children with cerebral palsy in spastic forms, it's found that one third of children (34.2%) are considered frequently ill, in 34.2% malnutrition is detected, in 32.6%: deficient anemia, in 18%: atopic dermatitis. In the analysis of the social history and biological anamnesis, we identified the prognostic-significant risk factors for the formation of the most common early childhood health disorders.

The most prognostic-significant for the frequent incidence of *Acute Respiratory Disease* formation in these children at early age are the following factors: premature birth of less than 30 weeks gestational age, birth weight less than 1500 grams, IVH of 1-2 degree, according to neurosonography in the neonatal period, severe neural axis perinatal affections (NA PAs), artificial respiration (AR) for more than three days, conjugation jaundice, pneumonia in the neonatal period, open fetal communication (patent foramen ovale), anemia in prematurity, adenoid hypertrophy, acute conjunctivitis history, hypertrophy of the tonsils, atopic dermatitis history, deficit of body weight, a child's ability to walk.

For deficiency anemia formation, factors of prognostic significance are: mother's age over 30 years at the time of birth, birth of the third pregnancy and more, threatened miscarriage in the first trimester, *Chronic Fetoplacental Insufficiency* during the given pregnancy, intrauterine growth restriction syndrome (IGR), 1st minute Apgar score: 6 points or less, severe NA PAs, pneumonia in the neonatal period, prematurity anemia, acute pyelone-

phritis history, intestinal dysbiosis history, spastic tetraparesis in child.

Such factors as mother's anemia during pregnancy, intrauterine growth restriction syndrome, premature birth of less than 30 weeks gestational age, birth weight less than 1500 grams, acute hypoxia and asphyxia at birth, Apgar score at the 1st minute: 0-1, 2-3rd grade IVH, according to neurosonography, 3rd-degree cerebral ischemia in the neonatal period, severe NA PAs, artificial ventilation for more than 3 days, conjugation jaundice in the newborn period, prematurity anemia, acute respiratory infections in the first year of life 4 times and more, late biekost introduction, spastic tetraparesis in child are prognostic-unfavorable for the formation of malnutrition.

For the formation of atopic dermatitis in early childhood, the following socio-biological factors are of prognostic significance: mother's age over 30 years at the time of birth, threatened miscarriage in the first trimester, acute respiratory infections in mother during pregnancy, allergic diseases in mother, chronic diseases of upper respiratory tract in mother, infectious inflammatory diseases in the neonatal period, gastrointestinal pathology in the

neonatal period, obstructive bronchitis history, intestinal dysbiosis history, chronic constipation history, frequent acute respiratory infections in the first year of life, chronic diseases of upper respiratory tract of the child, food allergy history, living in a city, late biekost introduction, child's ability to walk. Therefore, when predicting frequent acute respiratory infections and atopic dermatitis in children with disabilities due to neuropathy, the largest share belongs to the neonatal and post-neonatal factors, in predicting the deficiency anemia and malnutrition – to the antenatal and neonatal risk factors.

At diagnosing and disability assessment in handicapped children due to neuropathy, at a time of preventive medical examination, pediatrician identifies social and biological risk factors of frequent acute respiratory infections, deficiency anemia, malnutrition, atopic dermatitis at the early age by interviewing parents and copying data from a child's development history.

According to the proposed prognostic table (Table), the PC values of the risk factors for each health problem revealed in a child are summed up.

Table

Prognostic table of early age frequent respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis in children with disabilities as a result of neuropathy

Risk Factors	value	Prognostic Coefficients of			
		fre-quent ARDs	deficiency anemia	malnutriti on	atopic dermatitis
Mother's age over 30 years at the time of birth	Yes		+0.90		+1.38
	No		-0.90		-1.30
Birth of the third pregnancy and more	Yes		+3.17		
	No		-1,03		
Threatened miscarriage in the first trimester	Yes		+5.3		2.43
	No		-0.98		-0.77
ARD history in the given pregnancy	Yes				+2.84
	No				-1.23
Anemia in mother during pregnancy	Yes			+3.53	
	No			-0.9	
Allergic diseases in mother	Yes				+2.45

	No				-1.12
Chronic diseases of upper respiratory tract in mother	Yes				+4.74
	No				-0.39
CFPI ¹ during the given pregnancy	Yes		+2.76		
	No		-1.16		
IGR, hypotrophic by type	Yes		+5.03	+7.55	
	No		-0.73	-0.28	
Premature birth of less than 30 weeks gestational age	Yes	+3.02		+7.55	
	No	-2.15		-0.28	
Birth weight less than 1500 grams	Yes	+2.93		+10.56	
	No	-1.8		-0.64	
Acute hypoxia and asphyxia at birth	Yes			+2.56	
	No			-0.57	
1 st minute Apgar score: 6 points or less	Yes		+1.04		
	No		-2.27		
1 st minute Apgar score: 0-1 points	Yes			+6.14	
	No			-0.39	
IVH of 1-2 ^d grade, according to neurosonography, in neonatal period	Yes	+1.6			
	No	-0.78			
IVH of 2-3 ^d grade, according to neurosonography, in neonatal period	Yes			+4.46	
	No			-0.46	
3 rd -degree cerebral ischemia in neonatal period	Yes			+2.62	
	No			-1.1	
Severe NA PAs in neonatal period	Yes	+1.3	+1.24	+2.43	
	No	-1.76	-1.69	-3.25	
Artificial ventilation for more than 3 days in neonatal period	Yes	+1.47		+1.07	
	No	-0.96		-1.59	
Conjugation jaundice in neonatal period	Yes	+1.82		+2.36	
	No	-0.94		-1.43	
Infectious-inflammatory diseases in neonatal period	Yes				+4.0
	No				-1.19
Pneumonia in neonatal period	Yes	+1.98	+1.42		
	No	-0.75	-0.73		
Gastrointestinal tract pathology in neonatal period	Yes				+7.55
	No				-0.28
Open Fetal Communications (OFC)	Yes	+2.29			
	No	-1.3			
Anemia in prematurity	Yes	+2.12	+2.6	+1.82	
	No	-1.25	-1.61	-0.98	
Obstructive bronchitis history	Yes				+2.43
	No				-0.77
Adenoid hypertrophy	Yes	+7.75			
	No	-1.15			
Acute conjunctivitis history	Yes	+7.02			

	No	-0.66			
Hypertrophy of tonsils	Yes	+7.2			
	No	-0.64			
Atopic dermatitis history	Yes	+3.02			
	No	-1.0			
Acute pyelonephritis history	Yes		+2.6		
	No		-1.61		
Intestinal dysbiosis history	Yes		+2.54		+4.68
	No		-0.81		-0.29
Chronic constipation history	Yes		+2.6		+4.69
	No		-1.61		-0.5
ARDs in the first year of life 4 times and more	Yes			+2.06	+2.65
	No			-1.0	-1.47
Chronic diseases of upper respiratory tract of the child	Yes				+2.97
	No				-0.88
Food allergy in anamnesis	Yes				+6.5
	No				-5.22
Living in city	Yes				+1.71
	No				-6.17
Late biekost introduction	Yes			+2.62	+2.62
	No			-1.1	-1.1
Body weight deficit in a mother???? or a child	Yes	+1.68			
	No	-1.37			
Spastic tetraparesis in a child	Yes		+2.29	+2.06	
	No		-1.24	-1.0	
An ability of a child to walking	Yes	+2.8			+2.56
	No	-2.0			-2.06

The total value of summed-up PCs determines individual prognosis. The value of the predictive threshold (PT), which allows assess the measure of confidence in the formation of health problems at early age (frequent respiratory diseases, deficiency anemia, malnutrition, atopic dermatitis) was determined by Wald formula [5]. Considering the allowable error probability in prediction below 5%, we determined that PT possibility of health disorders equals to +13, and the absence thereof: -13.

If the sum of PCs is equal to or more than 13 points, it means poor prognosis, predicting the formation of early frequent ARDs (by the

sum of the 2nd column PCs), deficiency anemia (by the sum of the 3rd column PCs), malnutrition (by the sum of the 4th column PCs), atopic dermatitis (by the sum of the 5th column PCs), with a 95% accuracy of prediction.

If the PCs sum is equal to or less than -13 points, it means favorable prognosis, predicting the absence of the health disorder in question.

If the PCs sum is in the range of +12 to -12 points, the prognosis is uncertain, insufficient data to make a decision on a prognosis (the group of attention).

As for children with poor prognosis, pediatrician is to include them in a group at risk on the formation of the given health problems and prescribe the preventive measures reducing probability of risk occurrence.

Conclusion. Thus, the study revealed biological and social risk factors for the most common early age somatic disorders in children with disabilities due to neuropathy: frequent acute respiratory infections, deficiency

anemia, malnutrition, atopic dermatitis. In the formation of frequent ARDs and atopic dermatitis in these children, neonatal and post-neonatal factors are the most important, in the formation of deficiency anemia and malnutrition: antenatal and neonatal risk factors. We developed easy-to-use prognostic tables for the given health disorders to be applied in pediatrician practice.

References

1. Baibarina E.N., Degtyarev D.N. Perinatal'naja medicina: ot teorii k praktike [Perinatal medicine: from theory to practice]. *Rossijskij vestnik perinatologii i pediatrii*, 2013, no. 5, pp. 4–7 (in Russian).

2. Baranov A.A. Profilakticheskaya pediatrija: rukovodstvo dlya vrachej [Preventive pediatrics: a guide for physicians]. Moscow, Sojuz pediatrov Rossii Publ., 2012, 692 p. (in Russian).

3. Baranov A.A., Il'in A.G. Aktual'nye problemy sohraneniya i ukrepleniya zdorov'ja detej v Rossijskoj Federacii [Children's health preservation and promotion in the Russian Federation: Topical problems]. *Rossijskij pediatricheskij zhurnal*, 2011, no. 4, pp. 7–12 (in Russian).

4. Bocharova E.A., Sidorov P.I., Solov'ev A.G. Mediko-biologicheskie faktory riska formirovaniya psihorechevoj patologii v detskom vozraste [Speech and mental pathology forming in children – medical and biologic risk factors]. *Pediatriya*, 2002, no. 1, pp. 91–93 (in Russian).

5. Val'd A. Posledovatel'nyj statisticheskij analiz [Sequential Statistical Analysis]. Moscow, Fizmatlit Publ., 1960, 328 p. (in Russian).

6. Gubler E.V. Vychislitel'nye metody analiza i raspoznavaniya patologicheskikh processov [Computational methods of analysis and detection of pathological processes]. Leningrad, Medicina Publ., 1978, 94 p. (in Russian).

7. Nemkova S.A., Namazova-Baranova L.S., Maslova O.I., Zavadenko N.N. [et al]. Detskij cerebral'nyj paralich: diagnostika i korekcija kognitivnyh narushenij [Infantile cerebral palsy: Diagnosis and correction of cognitive impairment]. Moscow: Sojuz pediatrov Rossii, 2012, 60 p. (in Russian).

8. Doncov D.V., Romanova E.B., Ambalov Ju.M. Metod al'ternativnogo analiza Val'da kak sposob prognoza progressirovaniya zabolevaniya u bol'nyh hronicheskim gepatitom C [The method of alternative analysis wald for prognosis progression of disease in patients with chronic hepatitis C]. *Kubanskij nauchnyj medicinskij vestnik*, 2011, no. 4 (127), pp. 69–72 (in Russian).

9. Zelinskaya D.I. Detskaya invalidnost' kak problema zdavoohraneniya [Childhood disability as a problem of public health care]. *Zdavoohranenie Rossijskoj Federacii*, 2008, no. 2, pp. 23–26 (in Russian).

10. Dolotova N.V., Fil'kina O.M., Vorob'eva E.A., Malysheva T.M., Slabinskaja T.V., Malysheva T.M. Invalidnost' detej 0–4 let i struktura po zabolevaniju ejo obuslovivshemu v 2005–2014 g.g. po Ivanovskoj oblasti [Disability in children 0–4 years and its structure by disease in 2005–2014 in the Ivanovo Region]. *Social'nye aspekty zdorov'ja naselenija*, 2016, no. 1 (47). DOI: 10.21045/2071-5021-2016-47-1-7. Available at: <http://vestnik.mednet.ru/content/view/734/30/lang,ru/> (15.10.2016) (in Russian).

11. Baranov A.A., Al'bickiy V.Ju., Zelinskaya D.I., Terleckaya R.N. Invalidnost' detskogo nase-lenija Rossii [Росси Disability of Russian child population]. Moscow, Centr mezhsektoral'nyh programm Publ., 2008, 240 p. (in Russian).

12. Snopkov V.N., Kisljuk G.I., Poshibajlova A.V., Kirichenko S.O. Ispol'zovanie metoda al'ternativnogo analiza Val'da dlja prognoza tugouhosti u novorozhdennyh detej [Using alternative analysis wald for prediction hearing loss in newborns]. *Izvestija Jugo-Zapadnogo gosudarstvennogo universiteta. Serija Upravlenie, vychislitel'naja tehnika, informatika*, 2014, no. 3, pp. 41–45 (in Russian).

13. Lavrova D.I. Dinamika invalidnosti detskogo naselenija Rossijskoj Federacii [Child disability dynamics in the Russian Federation]. *Nauka i mir*, 2015, vol. 25, no. 9, pp. 113–114 (in Russian).

14. Lazurenko S.B. Analiz struktury patologicheskikh sostojanij novorozhdennyh detej, privodjashhij k invalidizacii, i ih otdalennye posledstvija [Analysis of the pattern of neonatal morbidities resulting in disability and their late sequels]. *Rossijskij pediatricheskij zhurnal*, 2009, no. 1, pp. 49–51 (in Russian).

15. Lil'in E.T., Doskin V.A. Detskaya rehabilitologija [Children rehabilitology]. Moscow, Medkniga Publ., 2008, 291 p. (in Russian).

16. Tkachenko E.S., Goleva O.P., Shherbakov D.V., Korzhov I.S. Mediko-social'nye aspekty detskogo cerebral'nogo paralicha [Medical and social aspects of infantile cerebral palsy]. *Social'nye aspekty zdorov'ja naselenija*, 2016, vol. 47, no. 1, pp. 8 (in Russian).

17. Stupak V.S., Podvornaja E.V., Fil'kina O.M., Pyhtina L.A. Rezul'taty issledovanija social'no-biologicheskikh faktorov riska razvitija perinatal'noj patologii u detej pervyh treh let zhizni [Results of the study of social and biological risk factors for perinatal pathology in children of the first three years of life]. *Jakuskij medicinskij zhurnal*, 2013, no. 4, pp. 41–44 (in Russian).

18. Rumjancev A.M., Timakova M.V., Chechel'nickaya S.M. Nabljudenie za razvitiem i sostojaniem zdorov'ja detej: rukovodstvo dlja vrachej [Monitoring the development and health of children: a guide for physicians]. Moscow, Medpraktika Publ., 2004, 388 p. (in Russian).

19. Saharova E.S., Keshishjan E.S., Aljamovskaja G.A. Nevrologicheskie ishody u nedonoshennyh detej k trehletnemu vozrastu (nabljudavshiesja v specializirovannom centre) [Neurological outcomes in preterm infants by age three (observed in a specialized center)]. *Medicinskij sovet*, 2015, no. 1, pp. 50–53 (in Russian).

20. Baranov A.A., Al'bickij V.Ju., Ivanova A.A., Terleckaya R.N., Kosova S.A. Tendencii zaboлеваemosti i sostojanie zdorov'ja detskogo naselenija Rossijskoj Federacii [Trends and the health status of the child population of the Russian Federation]. *Rossijskij pediatricheskij zhurnal*, 2012, no. 6, pp. 4–9 (in Russian).

21. Tonkova-Jampol'skaja R.V. Sostojanie zdorov'ja detej s uchedom faktorov ante- i postnatal'nogo riska [Health status of children, taking into account factors of the ante- and postnatal risk]. *Rossijskij pediatricheskij zhurnal*, 2002, no. 1, pp. 61–62 (in Russian).

22. Fil'kina O.M., Vorob'eva E.A., Dolotova N.V., Matveeva E.A., Malyshkina A.I., Gdzhimuradova N.D. Faktory riska i algoritm prognozirovanija narushenij zdorov'ja k godu zhizni u detej, rodivshijsja s ochen' nizkoj i jekstremal'no nizkoj massoj tela [Risk factors and prediction chart of violations of health of the one-year-olds born with very low and extremely low birth weight]. *Analiz riska zdorov'ju*, 2016, no. 1, pp. 68–75 (in Russian).

23. Fil'kina O.M., Pyhtina L.A., Vorob'eva E.A., Kocherova O.Ju., Dolotova N.V., Shanina T.G. Faktory riska otklonenij fizicheskogo razvitija u detej rannego vozrasta s perinatal'nymi porazhenijami central'noj nervnoj sistemy [The risk factors of departures in physical development in children of early age with perinatal affection of central nervous system]. *Lechenie i profilaktika*, 2015, no. 1, pp. 16–19 (in Russian).

24. Tsibul'skaya I.S. Mediko-social'nye aspekty formirovanija zdorov'ja detej. – [Medical and social aspects of the formation of children's health]. Tver', Tverskaja gorodskaja tipografija Publ., 2013, 290 p. (in Russian).

Vorobieva E.A., Filkina O.M., Dolotova N.V. Risk factors and prediction of physical problems in children induced by nervous system diseases. Health Risk Analysis, 2016, no. 4, pp. 41–48. DOI: 10.21668/health.risk/2016.4.06.eng

Received: 28.08.2016

Accepted: 18.12.2016

Published: 30.12.2016