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PREDICTION OF INDIVIDUALIZED TREATMENT IN CHILDREN WITH DRUG-RESISTANT EPILEPSY BASED ON CLINICAL, GENETIC AND NEUROIMMUNOLOGICAL PREDICTORS USING ARTIFICIAL INTELLIGENCE

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ANNOTATION. Drug-resistant epilepsy in children is one of the major challenges in modern pediatrics and neurology and is associated with recurrent epileptic seizures, impaired psychomotor and cognitive development, and reduced quality of life. Early identification of the risk of drug resistance and prediction of treatment response are important for selecting an individualized therapeutic strategy. This article discusses the potential of comprehensive assessment of clinical, genetic, and neuroimmunological characteristics of drug-resistant epilepsy in children and the application of artificial intelligence technologies to predict response to individualized treatment. Integration of clinical, genetic, immunological, electroencephalographic, and neuroimaging data is proposed to identify the risk of drug resistance and predict treatment effectiveness. This approach may contribute to improving early diagnosis and personalized treatment strategies in pediatric epilepsy.

Keywords: children, epilepsy, drug-resistant epilepsy, clinical predictors, genetics, neuroimmunology, artificial intelligence

ПРОГНОЗИРОВАНИЕ ИНДИВИДУАЛЬНОГО ЛЕЧЕНИЯ ДЕТЕЙ С ЛЕКАРСТВЕННО-РЕЗИСТЕНТНОЙ ЭПИЛЕПСИЕЙ НА ОСНОВЕ КЛИНИКО-ГЕНЕТИЧЕСКИХ И НЕЙРОИММУНОЛОГИЧЕСКИХ ПРЕДИКТОРОВ С ИСПОЛЬЗОВАНИЕМ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА

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АННОТАЦИЯ. Лекарственно-резистентная эпилепсия у детей является одной из актуальных проблем современной педиатрии и неврологии и характеризуется повторными эпилептическими приступами, нарушениями психомоторного и когнитивного развития и снижением качества жизни. Раннее выявление риска формирования лекарственной резистентности и прогнозирование эффективности терапии имеют важное значение для выбора индивидуальной лечебной тактики. В статье рассматриваются возможности комплексной оценки клинических, генетических и нейроиммунологических характеристик лекарственно-резистентной эпилепсии у детей с последующим использованием технологий искусственного интеллекта для прогнозирования ответа на индивидуализированное лечение. Предполагается интеграция клинических, генетических, иммунологических, электроэнцефалографических и нейровизуализационных данных для определения риска лекарственной резистентности и прогнозирования эффективности терапии. Использование данного подхода может способствовать совершенствованию ранней диагностики и персонализированного лечения детей с эпилепсией.

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Ключевые слова: дети, эпилепсия, лекарственно-резистентная эпилепсия, клинические предикторы, генетика, нейроиммунология, искусственный интеллект

BOLALARDA DORIGA REZISTENT EPILEPSIYANING KLINIK-GENETIK VA NEYROIMMUNOLOGIK PREDIKTORLARI ASOSIDA SUN'IY INTELLEKT YORDAMIDA INDIVIDUAL DAVOLASHNI PROGNOZLASH

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ANNOTATSIYA: Bolalarda doriga rezistent epilepsiya pediatriya va nevrologiyaning dolzarb muammolaridan biri bo‘lib, takroriy epileptik xurujlar, psixomotor va kognitiv rivojlanishning buzilishi hamda hayot sifatining pasayishi bilan kechadi. Kasallikning dori vositalariga rezistent kechishini erta aniqlash va davolash samaradorligini prognozlash individual davolash taktikasini tanlashda muhim ahamiyatga ega. Mazkur maqolada bolalarda doriga rezistent epilepsiyaning klinik, genetik va neyroimmunologik xususiyatlarini kompleks baholash hamda ushbu ko‘rsatkichlar asosida sun’iy intellekt texnologiyalaridan foydalanib individual davolashga javobni prognozlash imkoniyatlari yoritiladi. Klinik, genetik, immunologik, elektroensefalografik va neyrovizualizatsion ma’lumotlarni integratsiyalash asosida dori-rezistentlik xavfini aniqlash va davolash samaradorligini prognozlashning yangi yondashuvini ishlab chiqish ko‘zda tutiladi. Mazkur yondashuv pediatrik nevrologiyada erta tashxislash va individual davolashni takomillashtirishga xizmat qilishi mumkin.
Kalit so‘zlar: bolalar, epilepsiya, doriga rezistent epilepsiya, klinik prediktorlar, genetika, neyroimmunologiya, sun’iy intellekt

Introduction: Epilepsy is one of the main diseases of pediatric psychoneurology, due to the fact that in 70% of patients it debuts in early childhood and adolescence with a peak in the first months of life [1]. It has been shown that the highest prevalence of epilepsy is in the first year of life, amounting to 120 per 100,000 population, decreasing by the age of 10 years and amounting to 40-50 per 100,000 population, while in adolescence it is 20 per 100,000 population [2]. Epilepsy in 29% of cases debuts before the age of 3 years with a prevalence of the disease ranging from 5-10 cases per 1000 people [3,4], while according to other studies it ranged from 1.5 to 50 cases per 1000 population with an average an indicator of 15 cases per 1000 [5]. It is known that epilepsy and epileptic seizures are more common in males [6].

Epileptic encephalopathy (EE) in early childhood is a severe pathological condition that significantly impacts children's development. Patients experience an increase in seizure frequency, neurological impairments, and a decline in cognitive and motor functions. Developing effective clinical and immunological criteria for early diagnosis can help prevent the severe consequences of this condition. Additionally, studying immunological indicators (IL-6, IL-10, TNF-α) and their roles enhances the relevance of the research. This study is crucial for improving clinical diagnosis, identifying effective treatment methods, and enhancing the quality of life for affected children.

The purpose of the study: To study the clinical and immunological characteristics of early childhood epileptic encephalopathy and the nature of the course of the disease.

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Materials and methods of research: Changes in 82 children aged 0 to 3 years with various forms of epilepsy were analyzed in the neurology department of the TashPMI clinic. The patients were divided into 2 groups: group 1 consisted of 30 patients with epileptic encephalopathy (main group); group 2 consisted of 32 patients with other forms of epilepsy (comparison group). The control group consisted of 20 healthy volunteers.

The study used the general clinical, neurological, neuropsychological development assessment scale (Bailey III) and instrumental research methods (EEG, MRI). The level of anti-inflammatory cytokines (IL-1, IL-10, TNF-α) was measured by immunological analysis.

Research results: According to the obtained results, the clinical syndromes of the disease in the main group were distributed as follows:

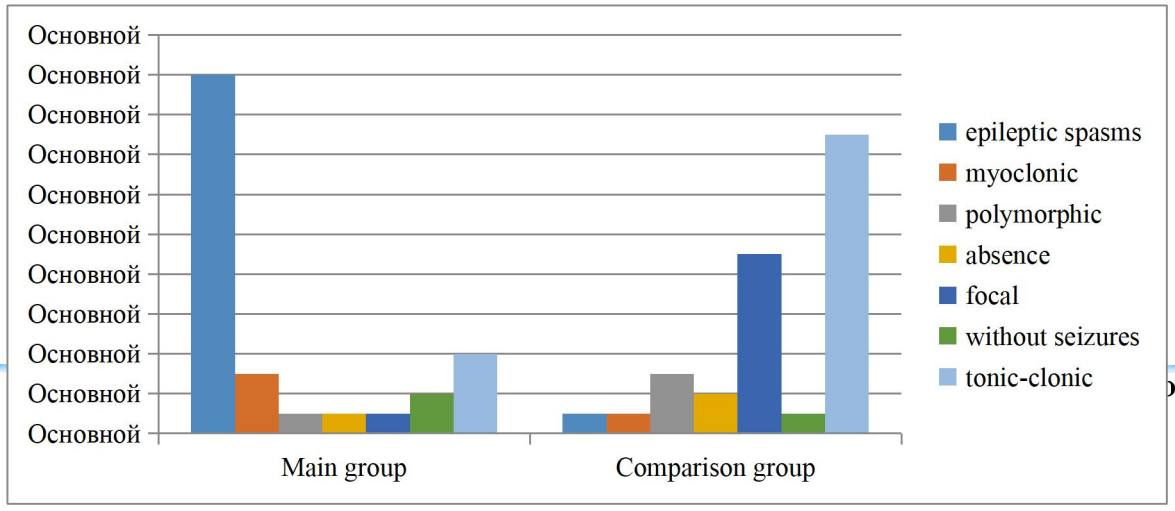
- West syndrome – 17 (56,7%)
- Lennox-Gastaut syndrome – 4 (13,3%)
- Landau-Kleffner syndrome – 3 (10%)
- Dravet syndrome – 3 (10%)
- Ohtahara syndrome – 2 (6,7%)
- Early myoclonic encephalopathy – 1 (3,3%).

Average age ratio in children: 2.1±0.32 years. Patients in the main group were divided into 4 groups according to age distribution:

- 1st group (0-6 months) – 8 (26.7%)
- 2nd group (6-12 months) – 10 (33,3%)
- 3rd group (12-24 months) – 9 (30%)
- 4th group (24-32 months)– 3 (10%)

Of the 30 children examined, 11 (36.7%) were girls, and 19 (63.3%) were boys.

The following clinical and neurological signs were observed in the main group: delay or regression in motor development, daily myoclonic and tonic spasms, complete regression of development; Neurological signs: increased pathological reflexes, increased muscle tone (hypertonus), gross motor disorders (ataxia, hyperkinesia). In the comparison group, localized or generalized seizures, developmental delay, but without complete regression; Neurological signs: neurosensory disorders: localized muscle weakness or tremor were observed. When analyzing the nature of epileptic seizures observed in children, differences were observed between the main and comparison groups, while children in the control group did not have epileptic seizures. In the main group, epileptic (infantile) spasms - 18 (60%), tonic-clonic seizures - 4 (13.4%), myoclonic seizures - 3 (10%), polymorphic seizures - 1 (3.3%), absence seizures - 1 (3.3%), focal seizures - 1 (3.3%) and 2 (6.7%) cases of seizures observed without attacks (Figure 1).



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Figure 1. Character of seizures observed in the examined children.

Neuropsychological indicators. The main problem of patients with EE is the lag in mental and physical development. We used the Bailey (III) scale to assess this problem. Its results (Table 1):

Table 1.

The result of neuropsychological indicators in the examined children

Score	Form	Main group (30)	Comparison group (32)	Control group (20)
0-69	Severe	20 (66.7%)	9 (28.1%)	-
70-84	Moderate	8 (26.7%)	11 (34.3%)	-
85-100	Norm	2 (6.6%)	12 (37.6%)	20 (100%)

Neuroradiological indicators. To assess the morphological state of the brain, an MRI scan was performed in children. Its results are presented in the following table (Table 2):

Table 2.

The result of neuroradiological (MRT) indicators in examined children

Changes in MRI	Main group (30)	Comparison group (32)	Control group (20)
Congenital malformations	7 (23.3%)	2 (6.2%)	-
Tuberous sclerosis complex (TSC)	2 (6.7%)	-	-
Hippocampal sclerosis	1 (3.3%)	-	-
Focal cortical dysplasia	3 (10%)	-	-
Atrophy	8 (26.7%)	13 (40.7%)	-
Periventricular leukomalacia (PVL)	1 (3.3%)	1 (3.1%)	-
Demyelinating diseases	1 (3.3%)	1 (3.1%)	-
Ventriculomegaly	2 (6.7%)	2 (6.2%)	-
Edema	1 (3.3%)	1 (3.1%)	-
Others	4 (13.4%)	6 (18.8%)	1 (5%)
Norm	-	6 (18.8%)	19 (95%)
General	30	32	20

Immunological parameters. The levels of anti-inflammatory cytokines (IL-1, IL-10, TNF-α) were measured by immunological analysis.

The level of IL-1 in the patients of group 1 was 9.13±0,73 pg/ml (P<0,001), in group 2 – 7.31±0,74 pg/ml, reliably differentiated (P<0,05) about the control. In patients of group 1, the level of IL-10 was 10.53±1,55 pg/ml, and in group 2- 14.98±0,97 pg/ml (P<0,001). The level of TNF- in the patients of group 1 differed reliably from the control. Thus, in patients of group 1, this parameter

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accounted for 6.18±0,05, in group 2 – 5.7±0.05 pg/ml, and in the control group –4.89±0.08 pg/ml (P<0,001).

Conclusion: The following results were achieved in the framework of this study:

1. In the analysis of clinical syndromes of epileptic encephalopathy in early childhood, Vesta syndrome took the highest place in terms of frequency of occurrence and amounted to 56.7%. The average age ratio in children: 2.1±0.32 years. The disease was observed more often in boys than in girls (1.7:1).

2. Clinical characteristics: Children with epileptic encephalopathy in early childhood had a high incidence of seizures, developmental regression and severe neurological disorders. They were clearly distinguished when compared with other forms of epilepsy.

3. Immunological changes: It was confirmed that high levels of indicators such as IL-1, IL-10 and TNF-α are associated with the inflammatory mechanism of epileptic encephalopathy. These indicators are important in distinguishing it from other forms of epilepsy.

4. Diagnostic methods: hypsarrhythmia in EEG, cortical atrophy and white matter lesions in MRI serve as important criteria for diagnosing epileptic encephalopathy.

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