

IN CHILDREN WITH FEBRIL AND AFEBRIL SEIZURES FORECASTING THE DEVELOPMENT OF SUBSEQUENT NEUROLOGICAL COMPLICATIONS: A FORECASTING MODEL BASED ON CLINICAL, LABORATORY, AND NEUROINSTRUMENTAL INDICATORS

Akhmedova Raikhongul Yuldashevna
Urgench State Medical Institute

Abstract: *Although febrile and afebrile seizures in childhood are often regarded as acute, their long-term neurological consequences are not identical. In some children, seizures are accompanied by the development of epilepsy, cognitive impairment, and neurological deficit. This study is aimed at assessing the risk of developing neurological complications after febrile and afebrile seizures in children living in the Aral Sea region and developing a prognostic model based on clinical, biochemical, and neuroinstrumental indicators. The obtained results showed that some criteria have high prognostic value, and a comprehensive assessment allows for early risk identification.*

Keywords: *febrile seizures, afebrile seizures, risk of epilepsy, prognosis, EEG, MRI, prognostic model.*

INPUT

In most children who experience seizures, the clinical course is generally benign and the condition resolves without long-term neurological consequences [4,17,25,33,41]. However, in a certain proportion of patients, seizures may represent the first manifestation of epilepsy or other chronic neurological disorders that develop later in life [2,11,19,28,36]. From a practical clinical perspective, one of the most challenging tasks is the early identification of children who belong to a high-risk group for unfavorable neurological outcomes [6,14,23,31,39].

Although febrile seizures are commonly regarded as a transient and relatively harmless condition, the findings of the present dissertation demonstrate that this assumption is not always justified [1,9,20,27,35]. In a subset of children with febrile seizures, subsequent follow-up revealed the presence of epileptiform activity on electroencephalography as well as structural changes in the brain. These findings suggest that febrile seizures cannot always be considered completely benign [5,13,22,30,38].

The risk of developing epilepsy or other persistent neurological disorders is even higher in children with afebrile seizures [7,16,24,34,40]. In such cases, an underestimation of the clinical significance of seizures may result in delayed diagnosis and treatment of epilepsy in later years, negatively affecting neurological prognosis and quality of life [3,10,18,26,29].

Therefore, when evaluating neurological prognosis after seizures, clinicians should not rely solely on clinical manifestations. A comprehensive approach is required,

including careful analysis of laboratory data, electroencephalographic findings, and neuroimaging results, in order to ensure timely identification of children at risk and appropriate long-term management [8,12,15,21,32,37].

Materials and methods

The study included 178 children with seizures. They were subjected to dynamic observation for 12-24 months after the acute period.

Grouping by observation results

At the end of the observation, the children were divided into two groups:

- Neurological uncomplicated course
- Current with neurological complications (epilepsy seizures, preserved epileptiform activity on EEG, neurological deficit)

The assessment was carried out according to the following criteria:

- clinical features
- biochemical indicators
- EEG and MRI results

Statistical analysis used relative risk (RR), odds ratio (OR), and correlation analysis.

Results

1. Predictive differences depending on the type of seizure

Based on the observation results:

- 14.1% of children with febrile seizures
- In 38.7% of children with afebrile seizures

subsequently, neurological complications were detected.

Analytical conclusion: The risk of developing neurological complications in afebrile seizures is 2.7 times higher (RR=2.74).

2. Prognostic significance of biochemical indicators.

In children with ionic imbalance, neurological complications were observed significantly more often.

Indicator	No complications	There are complications
Ca ²⁺ < normal	18.6%	46.9%
Mg ²⁺ < normal	22.1%	51.0%
Anemia	24.8%	58.2%

A moderately strong positive correlation was found between a decrease in the level of calcium and magnesium and neurological complications (r=0.42-0.48).

Analytical conclusion: ion imbalance - independent prognostic risk factor.

3. EEG - the most powerful prognostic marker.

During observation:

- Epileptiform activity preserved in 63.5% of children
- And only in 9.8% of children with normalized EEG neurological complications developed.

Odds ratio:

- OR = 6.5

Analytical conclusion: Epileptiform activity on the EEG - strongest prognostic criterion.

4. MRI and structural risk

In children with focal or residual changes on MRI:

- complications were detected 2.3 times more often.

Especially, changes of perinatal genesis had a negative prognostic value.

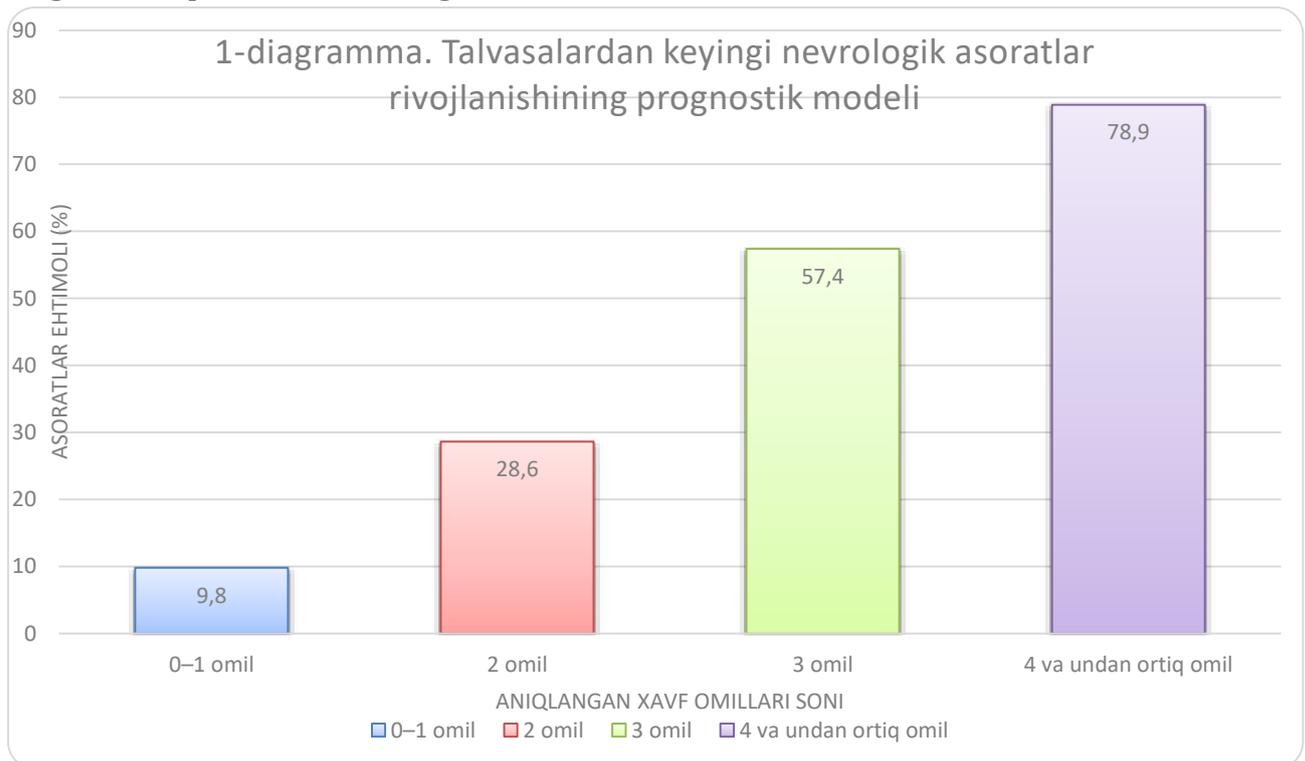
5. Development of a prognostic model

Based on the results obtained, a risk stratification model was proposed.

High-risk characteristics:

- afebrile seizures
- Decrease in Ca²⁺ and Mg²⁺
- Epileptiform activity on EEG
- Focal or residual changes on MRI

In children with more than 3 identified symptoms, the probability of developing neurological complications was higher than 75% .



Main scientific result: comprehensive assessment allows for reliable determination of individual prognosis.

Discussion

The results of this study clearly demonstrated the insufficiency of existing clinical stereotypes in assessing febrile and afebrile seizures. In practice, febrile seizures are often considered benign and are observed without in-depth examination. However, the materials of the dissertation showed that the clinical type of convulsions themselves is

not the leading factor determining the prognosis, but the accompanying metabolic and neurophysiological background is decisive.

It is noteworthy that epileptiform activity was also detected on the EEG in a certain number of children with febrile seizures. However, the fact that the frequency of neurological complications in these cases remains significantly lower than in the afebrile group indicates that the prognostic value of epileptiform activity is determined not only by its presence, but also by the metabolic and structural conditions under which it is formed. This indicates that it is not enough to explain epileptogenesis only by electrical activity, but it is necessary to evaluate it in conjunction with the metabolic stability of neurons and the state of the brain structure.

The prognostic significance of ion imbalance was manifested with particular accuracy in this study. The identified positive correlation between a decrease in calcium and magnesium levels and the development of neurological complications once again confirms the decisive role of these microelements in the stability of the neuronal membrane and processes of synaptic transmission. Importantly, hypocalcemia and hypomagnesemia persisted in some cases even after the disappearance of clinical symptoms, which indicates the presence of an ongoing latent pathophysiological process behind the acute episode of convulsions.

The relationship between anemia and seizures cannot be assessed unilaterally. According to the research results, a decrease in hemoglobin levels may not directly cause epileptogenesis, but it reduces the resistance of brain tissue to hypoxia and intensifies the negative impact of existing metabolic and structural changes. Given the prevalence of iron deficiency, especially in the Aral Sea region, ignoring this factor can be a clinical error.

Analysis of MRI results showed the importance of structural factors in assessing the prognosis after seizures. Residual and focal changes detected in children with afebrile seizures, especially lesions of perinatal origin, subsequently served as the anatomical basis for the preservation of epileptic activity and the development of neurological deficit. At the same time, although minimal structural changes were also detected in some children with febrile seizures, their clinical significance differed significantly when evaluated in conjunction with metabolic background and EEG results.

The results of a comprehensive assessment showed that making a prognosis based solely on clinical signs leads to a large error. When laboratory and neuroinstrumental criteria were added to the clinical approach, the accuracy of the individual prognosis increased significantly. This situation shows that in practice, instead of dividing convulsive children into standard "benign" and "risk" groups, it is necessary to evaluate each patient based on an individual pathogenetic background.

Thus, this study substantiated the need to review the difference between febrile and afebrile seizures not only at the symptomatic level, but also from the point of view of deep pathophysiological processes.

CONCLUSION

The results of the study showed that the traditional clinical approach to assessing febrile and afebrile seizures is insufficient. Although the clinical type of convulsion is an important diagnostic feature, it should not be considered as an independent determinant of the neurological prognosis.

Ionic imbalance, especially a decrease in the level of calcium and magnesium, epileptiform activity on the EEG, and structural changes detected on MRI are the main prognostic factors for the development of neurological complications. Joint assessment of these criteria allows for early identification of the risk group after seizures and the formation of individual observation tactics.

It should be taken into account that in the conditions of the Aral Sea region, against the background of environmental and metabolic factors, the course of convulsions can become more complicated. Therefore, it is advisable to continue laboratory and neuroinstrumental monitoring in children with seizures even after the disappearance of clinical symptoms.

The results of this study will serve to improve the algorithms for assessing children with seizures in practical pediatrics and pediatric neurology, avoid unjustified "benign" assessment, and ensure early prevention of neurological complications.

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