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ELECTRONIC SYSTEM OF DIFFERENTIAL DIAGNOSIS OF CHRONIC DISEASES OF SMALL BRONCHI IN CHILDREN

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The purpose of the study was to create an automated decision support system for the differential diagnosis of chronic nonspecific diseases of the small bronchi in children. It was based on a questionnaire used to study the prevalence of various forms of chronic nonspecific lung diseases and the features of the immunological status in children with chronic diseases of the small bronchi in children at the Research Institute of Pulmonary Diseases (Azerbaijan). The test cards were filled out and the correctness of the probability of pathology scores was assessed in 113 children with bronchial asthma, 139 children with chronic bronchiolitis and 103 children with bronchopulmonary dysplasia and with a history of bronchopulmonary dysplasia. A decision support system has been developed for the differential diagnosis of chronic nonspecific diseases of the small bronchi in children. The main feature of this technique is the ease of obtaining results after 3–5 minutes from the start of filling out the test card. The approbation of the developed automated system of early detection in children at the outpatient stage made it possible to clarify the form of diseases of the small bronchi, and to conduct informative research methods to confirm the diagnosis without using additional financial costs. For the first time, an automated decision support system has been developed for the differential diagnosis of chronic nonspecific diseases of the small bronchi in children. The application of the developed system has confirmed its practical significance in clarifying the form of chronic nonspecific diseases of the small bronchi in children.

Key words: bronchial asthma, bronchiolitis, bronchopulmonary dysplasia, children

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ЕЛЕКТРОННА СИСТЕМА ДИФЕРЕНЦІЙНОЇ ДІАГНОСТИКИ ХРОНІЧНИХ ХВОРОБ ДРІБНИХ БРОНХІВ У ДІТЕЙ

Метою дослідження було створення автоматизованої системи підтримки прийняття рішень під час проведення диференціальної діагностики хронічних неспецифічних хвороб дрібних бронхів у дітей. За основу було взято опитувальник, що використовується при вивченні поширеності різних форм хронічних неспецифічних хвороб дрібних бронхів та особливості імунологічного статусу у дітей з хронічними хворобами дрібних бронхів у дітей у НДІ легеневих захворювань (Азербайджан). Проведено заповнення тест-карт та оцінка коректності виставлених балів ймовірності патології у 113 дітей з бронхіальною астмою, у 139 дітей з хронічним бронхіолітом та у 103 дітей з бронхолегеневою дисплазією та з бронхолегеневою дисплазією в анамнезі. Розроблено систему підтримки прийняття рішень під час проведення диференціальної діагностики хронічних неспецифічних захворювань дрібних бронхів у дітей. Основною особливістю цієї методики є простота отримання результатів через 3–5 хвилин від початку заповнення тест-карти. Апробація розробленої автоматизованої системи раннього виявлення в дітей на амбулаторному етапі дозволило уточнити форму захворювань дрібних бронхів, провести інформативні методи дослідження на підтвердження діагнозу, не використовуючи додаткових фінансових витрат. Вперше розроблено автоматизовану систему підтримки прийняття рішень при проведенні диференціальної діагностики хронічних неспецифічних захворювань дрібних бронхів у дітей. Застосування розробленої системи підтвердило своє практичне значення при уточненні форми хронічних неспецифічних хвороб дрібних бронхів у дітей.

Ключові слова: бронхіальна астма, бронхіоліти, бронхолегенева дисплазія, діти.

Chronic diseases of the small bronchi belong to one of the most difficult problems of pulmonology and, above all, in the pulmonology of childhood. The complexity of the diagnosis of these diseases is reflected to a certain extent in the International Statistical Classification of Diseases and Health-related Problems (WHO Revision 10, 1995), where there are different variants and by name, course and causes of the formation of nonspecific diseases of the small bronchi, combined into a single heading. In pediatric

practice, among the acquired nonspecific chronic forms of small bronchial diseases, bronchial asthma, bronchopulmonary dysplasia, and chronic (obliterating) bronchiolitis are currently distinguished [2]. These forms of pathology are among the most severe diseases in childhood, largely determining child mortality rates [1, 2, 8, 14]. Diseases require significant financial costs to achieve control the course of the disease, which continues in patients who have reached adulthood, and are pediatric predictors of chronic obstructive pulmonary disease (COPD) development. [12, 15].

All these diseases are characterized by common symptoms of bronchial obstruction of varying severity and duration, followed by a relatively prosperous clinical condition [5, 6, 7]. The development of obstructive syndrome is based on various variants of inflammation of the mucosa of small cartilaginous bronchi and bronchioles: allergic, immuno-complex, neutrophil-bacterial [1, 7, 9]. The nature of inflammation determines the formation of one or another form of pathology, which differ significantly in relation to the cellular mechanisms of inflammatory mediators, morphological changes, responses to therapy and prognosis of the course of the disease [3, 11, 12]. At the same time, the similarity of clinical manifestations often determines the untimeness of diagnosis or even the failure to detect pathology in pediatric practice, followed by inadequate therapy [4, 6, 13]. On the one hand, this is largely due to the continuing trend of the syndromic approach in the detection of pathology and therapy, in particular the use of the bronchoobstructive syndrome (BOS). It is impossible not to agree that such a wide application of the syndromic approach greatly facilitates the work of the pediatrician, allows you to quickly achieve the effect of relieving the symptom of bronchial obstruction, but does not prevent the occurrence of the next, similar conditions, often more severe and prolonged. All this makes it difficult for many years to identify the true pathology, often determining an unfavorable outcome both immediate and in the long term and the possibility of COPD formation in mature, working age. With the growing cost of medical technologies and limited funds, one of the most pressing health problems is the effective allocation of financial resources. Timely clarification of the probability of a specific nosological form makes it possible to determine the range of informative, financially sound studies for the final diagnosis and adequate therapeutic and preventive measures already at the primary medical level. For these reasons, a detailed clarification of the clinical and anamnestic features of specific forms of chronic diseases of the small bronchi (CDSB) acquires special significance in determining the probability of the form of pathology and subsequently prescribing informative and financially sound research methods for the final diagnosis. The study was conducted on the basis of the Research Institute of Pulmonary Diseases and the City Children's Hospital No. 6 in Baku, Azerbaijan.

The purpose of the study was to create an automated decision support system for differential diagnosis of chronic nonspecific diseases of small bronchi in children.

Materials and methods. The data of observations of 113 children with BA, 139 patients with bronchiolitis and 103 patients with BPD and with a history of BPD were analyzed. Among the analyzed BA patients, boys made up the majority and exceeded the number of female children by more than 4 times. There is also a predominance of males in the group of patients with chronic bronchiolitis and bronchopulmonary dysplasia, including with a history of BPD, but there were no significant differences in the sexual composition of these groups of children. The formulation of the diagnosis of each disease was established on the basis of an assessment of the clinical course of bronchopulmonary disease and was confirmed by data from immunological, radiological and functional studies. When creating a system to support diagnostic solutions to determine the form of chronic nonspecific diseases of the small bronchi, a test card consisting of 34 questions was compiled for each patient and including data from the family genetic history, the perinatal period of the child's development, the age of onset of the disease and the features of its clinical course of the disease. The present study included not only the results of the assessment of the initial clinical symptoms of the disease, but also the features of the course of diseases, the patient's condition at the time of examination. Statistical processing of the material was carried out using the Pearson X^2 compliance criterion.

Results of the study and their discussion. All children of the analyzed group (BA, CB, BPD, BPD in anamnesis) were characterized by common symptoms of diseases, repeated obstructions of varying severity and duration, alternating with periods of relatively prosperous clinical condition. However, significant differences in the age of the appearance of the first episodes of BOS were obtained. In children with AD, the first episodes of obstruction were reliably noted at the age of 1.5–2 years and older. On the contrary, in CB, 64 % of cases of lower respiratory tract diseases with symptoms of obstruction are fixed already in the first year of life, in the intranatal period, aspiration syndrome was

diagnosed in 20 %, which required intensive respiratory therapy. Both patients with BA and CB were full-term, were born on time.

On the contrary, in all children with BPD, the prenatal period was extremely unfavorable with the threat of early termination of pregnancy and premature birth. Children were born prematurely, at the gestational age of 28 weeks. The minimum birth weight is 490g. In the early postnatal period, the development of respiratory distress syndrome with increasing respiratory insufficiency was noted, which required prolonged intensive respiratory therapy. The indicated clinical course is characteristic of BPD and on this basis, patients of this group differ from the BA and COPD groups with high reliability (X^2=187.2 at $p<0.001$).

Clinical dynamic observation of patients with BA, CB and BPD, as well as a thorough analysis of test cards, allowed us to determine that an extremely unfavorable early neonatal period with the development and progression of BOS and respiratory failure, followed by the use of a ventilator, is characteristic of BPD. Subsequently, the symptoms of obstruction persisted with the greatest frequency in the first year of life, radiologically, in addition to signs of hyperinflation, areas of hypoventilation were noted, in the long term in a quarter of observations (BPD in anamnesis) signs of uneven ventilation, areas of fibrosis and bullous bloating. Cases of aspiration and development of asphyxia were noted in CB in the early neonatal period. In the first year of life-early manifestations of BOS as a consequence of microaspiration syndrome. In this group was diagnosed (laryngomalacia, dysgenesis of the arytenoid cartilage, epiglottis anomaly). BA is characterized by a late manifestation of BOS, although clinical manifestations of atopy occur already during the first year of the child's life.

A software module has been created when filling out a test card for the purpose of early determination of the form of chronic diseases of the small bronchi in children by means of Microsoft Access. The test card contains 38 questions divided into several groups: information about the family and previous pregnancies, features of the perinatal period and the first year of the child's life, the first lower respiratory tract disease and its subsequent course, objective status.

In addition, questions are presented to which the doctor must provide answers when examining the child, including data on the objective status and assessment of the child's health status by the parents. The second task of the program module is to evaluate in points the significance of the marked signs for each specific form of chronic nonspecific bronchopulmonary pathology. The principle of calculation is as follows. Each questionnaire response represents an empirically calculated value. The lowest possible value is zero, and the highest possible value is 10. Each component of the questionnaire is counted separately and the value of all items with positive responses is summed up. The summed value of positive points determines the probability of pathology of the lower respiratory tract.

When the doctor fills out the test card, the system calculates the total score for each of the possible diseases, which is subsequently compared with the threshold value. If the threshold is exceeded, the decision-making system signals to the doctor that the interviewee has signs of illness. Diseases for which the sum of points exceeded the threshold value (100 points) are displayed by the system in descending order of exceeding the threshold.

Thus, for the first time, a software module was created in the implementation of early determination of the probability of the presence of a specific form of chronic diseases of the small bronchi (CDSB) by means of Microsoft Access. When working with the system, the doctor must enter an account on the start page that corresponds to the role of an expert.

After the doctor's name and password are entered and the “Log in” button is pressed, the doctor enters the tabs with a list of questions. After selecting a question, the doctor goes to the form where the questions and possible answers to them are displayed. It is worth noting that questions that do not involve point scores are not active for the doctor. There are also two buttons on the form. After clicking the “save” button, the doctor goes to the tab with a list of questions to select the next necessary question. The system processes, analyzes and supports decision-making.

When the doctor fills out the test card, the system calculates the total score for each of the possible diseases, which is subsequently compared with the threshold value. If the threshold is exceeded, the decision-making system signals to the doctor that the interviewee has signs of illness. Diseases for which the sum of points exceeded the threshold value (100 points) are displayed by the system in descending order of exceeding the threshold.

The main feature of this technique is the ease of application and obtaining results after 3–5 minutes.

The testing of the developed automated system was carried out at the Research Institute of Pulmonary Diseases of Azerbaijan.

The use of the system in children at the outpatient stage made it possible to determine the probability of a specific form of chronic disease of the small bronchi (CDSB) without additional financial costs [5, 6, 7].

The introduction of a standardized, automated method at the primary medical level will make it possible to determine the probability of the form of CBMB already at the initial treatment of patients within 3–5 minutes after filling out the test card, assign financially sound and informative research methods to finally establish the true pathology, develop adequate methods of preventive measures, thereby improving the quality of life of patients [3, 11, 12].

Conclusions

1. For the first time, an automated decision support system has been developed for the differential diagnosis of chronic nonspecific diseases of the small bronchi (CNDSB) in children, a software module has been created to implement the early determination of the probability of having a specific form of chronic nonspecific lung diseases by means of Microsoft Access.

2. The approbation of the developed system proved its simplicity and effectiveness of application, confirmed its practical significance in clarifying the form of CNDSB in children.

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