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EXPERIENCE OF USING COMPUTER BRONCHOPHONOGRAPHY IN PEDIATRIC PRACTICE

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Abstract:

Thanks to innovative developments in the field of information technology, computer acoustic diagnostics is beginning to be actively introduced into clinical practice. Computer bronchophonography is one of the promising domestic developments in the field of methods for assessing the functional state of the respiratory system. This method can be used at any stage of medical care to identify bronchial obstruction, monitor the effectiveness of treatment and preventive measures for bronchopulmonary pathology, which is especially important in early and preschool age. However, further research is required in this area, which is relevant both from a scientific and practical point of view.

Keywords: children, respiratory function, respiratory acoustics, computer bronchophonography.

INTRODUCTION

Most sounds that occur in the respiratory tract have a wide frequency range - from 22 to 2800 Hz. But a modern stethoscope ensures high-quality transmission of sounds in the frequency range from 20 to 300 Hz, and a phonendoscope - from 300 to 1400 Hz. It should be recognized that, despite the availability and high clinical information content of lung auscultation, the relevance of the search for methods of objective acoustic assessment of auscultatory phenomena is quite obvious [1-5]. In this regard, along with traditional methods of functional lung research, such as spirometry, pneumotachometry, body plethysmography, oscillometry, peak flowmetry and others, respiratory acoustics methods based on the latest achievements in acoustoelectronics and computer technologies have been widely introduced into clinical practice [2].

MATERIALS AND METHODS

The advantages of digital respiratory acoustics methods are:

- the possibility of studying the function of external respiration without the active participation of the patient, required by the traditional spirometry method;
- the possibility of saving and repeatedly using the obtained data for analysis;
- the possibility of transmitting respiratory sounds through a telecommunications system;
- elimination of terminology problems, more correct recognition, measurement and classification of various respiratory noises.

The world is actively developing methods for acoustic diagnostics of respiratory disorders using computer analysis of voice conduction to the chest; phonopneumography using piezoelectric contact sensors; automatic recognition of sound characteristics of cough; combined acoustic devices for daily monitoring of episodes of wheezing and coughing; tracheophonography; transthoracic computer bronchophonography, etc.

RESULTS AND DISCUSSION

A current trend in the study of respiratory tract acoustics is auscultation using an electronic stethoscope (Littmann, CARDIONICS, JABES ANALYZER, CADIscope, FSE-1M, I-Scope 200, Master Elite, Harvey DLX, etc.) [15-16]. One of the non-invasive promising methods of acoustic assessment of the functional state of the bronchopulmonary system is computer bronchophonography (CBPH) [4]. The CBPH method was developed in the early 80s of the twentieth century under the guidance of Russian scientists Professor V.S. Malyshev and Professor S.Yu. CBPH is, in fact, both electronic auscultation of the lungs and computer analysis of respiratory noises. The method of computer bronchophonography allows recording acoustic respiratory noises with subsequent analysis of their frequency-amplitude characteristics using a special computer software package. The graphic display of the bronchophonogram obtained in this way is called a "breathing pattern". The main parameters assessed using computer bronchophonography are: the presence of high-frequency oscillations, the amplitude of oscillations, the parameters of the respiratory cycle, the power of breathing - the area under the graphic curve of the pattern in the frequency domain, the work of breathing - an integral indicator measured by the area under the graphic curve of the pattern in the time domain. In other words, as a result of determining

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these parameters, an acoustic portrait of breathing is created, characterizing the energy assessment of specific acoustic phenomena that arise during the respiratory cycle [5].

Over the past 16 years, the range of key research areas to determine the diagnostic value of CBFG in pediatrics has expanded significantly. This method was used in chronic bronchopulmonary pathology in children living in areas contaminated with radionuclides [1]; bronchial asthma of varying severity [3]; acute obstructive bronchitis [2]; in newborns and premature babies [1]; bronchopulmonary dysplasia [4]; in assessing the effectiveness of various rehabilitation methods for preschool children with frequent respiratory diseases [5]; in screening programs for identifying bronchial asthma in preschool children [3]; in determining the prognosis of bronchial asthma development in young children [2]; in diagnostic algorithms for diseases with prolonged and chronic cough in children [3].

As a result of examination by the method of computer bronchophonography (the software package "PatternMAK") in a polyclinic of 250 children aged 2 to 7 years with frequent respiratory diseases due to various causes, we found that for patients with allergic diseases of the respiratory tract (allergic rhinitis, bronchial asthma in remission) with frequent exacerbations against the background of acute respiratory viral infections are characteristic: high-amplitude oscillations in the high-frequency acoustic range (from 5000 to 12500 Hz); a positive pharmacological test with salbutamol in the form of a reliable decrease by more than 15% of the acoustic work of breathing indicators ($p < 0.05$) (in the overwhelming majority (75%) of children). It has been shown that CBFG is an objective method for assessing the functional state of the respiratory organs and the effectiveness of health measures in preschool children with acute and chronic respiratory diseases [4].

During the examination of 210 children with frequent respiratory diseases aged 2 to 7 years in a polyclinic, high diagnostic efficiency (95.1%), sensitivity (95.2%) and specificity (95.0%) of CBFG in screening for bronchial asthma in early and preschool age were established. This study established that CBFG can be considered as one of the central links in the algorithm for early diagnosis of bronchial asthma in early and preschool age children with frequent respiratory diseases [5].

As a result of our examination of 272 children with prolonged (more than 4 weeks) and chronic cough (more than 8 weeks) of various origins in an outpatient setting using the KBFG method (the Pat-1A-2016 software package), the vast majority of them showed an increase in the φ3 coefficient ($p<0.05$), which is probably due to the presence of bronchial tree hyperreactivity (Fig. 5). More significant changes in this indicator were observed in patients with cough due to bronchial asthma (BA) and acute obstructive bronchitis (AOB), in contrast to other groups ($p<0.05$). The bronchodilator test conducted on patients with a significant increase in the φ3 level was positive in all children. However, in BA, a more significant decrease in φ3 was observed compared to patients with AOB ($p<0.05$).

However, the analysis of data from various researchers indicates a significant variability in the absolute values of the CBFG indicators. The greatest differences were obtained when assessing the absolute parameters of the ACRD. The values of ACRD1 varied from 28 to 660%; ACRD2 - from 17 to 333%; ACRD3 - from 10 to 602% ($p < 0.05$). The most constant value, regardless of the change in the level of ACRDtotal, was the coefficient φ, which allows for a differentiated assessment of the proportion of ACRD in each frequency range.

CONCLUSION

Thus, computer bronchophonography is one of the promising domestic developments in the field of methods for assessing the functional state of the respiratory organs. This method can be used at any stage of medical care for early diagnosis of bronchial asthma, which is especially important in early and preschool age; for monitoring the effectiveness of treatment and preventive measures for bronchopulmonary pathology in children. However, further research is required in this area, which is relevant both from a scientific and practical point of view. Of course, the time is not far off when computer bronchophonography will take its rightful place in the pediatrician's diagnostic arsenal.

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