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FEATURES OF DIAGNOSIS AND OBSERVATION OF CHILDREN WITH COMMUNITY-ACQUIRED PNEUMONIA AND PNEUMONIA CAUSED BY THE SARS-COV-2 VIRUS ACCORDING TO MODERN GUIDELINES

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Topicality. Pneumonia is an actual problem of practical medicine. The diagnosis of pneumonia is complex and requires a comprehensive study taking into account many factors.

Purpose is generalization of literature data on modern methods of pneumonia diagnosis.

Methods. Analysis of scientific publications in international electronic scientometric databases for the last 10 years.

The results. New guidelines for the diagnosis and treatment of pneumonia are analyzed. The modern classification of pneumonia is described. The characteristics of different types of pneumonia diagnostics depending on the severity of the patients are given. The advantages and disadvantages of each diagnostic method are described. The advantages of acoustic diagnosis of pneumonia at different stages of treatment are given.

Conclusions. Pneumonia remains an actual problem, and its diagnosis needs improvement. The use of new methods of acoustic diagnostics is a promising method in pediatrics in children.

Key words: pneumonia, children, COVID-19, SARS-CoV-2, laboratory-instrumental diagnosis.

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ОСОБЛИВОСТІ ДІАГНОСТИКИ ТА СПОСТЕРЕЖЕННЯ ДІТЕЙ ІЗ ПОЗАЛІКАРНЯНОЮ ПНЕВМОНІЄЮ ТА ПНЕВМОНІЄЮ, ВИКЛИКАНОЮ ВІРУСОМ SARS-COV-2, ЗГІДНО ІЗ СУЧАСНИМИ ПРОТОКОЛАМИ

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Актуальність. Пневмонія становить актуальну проблему практичної медицини. Діагностика пневмонії складна і потребує комплексного дослідження з урахуванням багатьох факторів.

Метою є узагальнення даних літератури щодо сучасних методів діагностики пневмонії.

Методи. Аналіз наукових публікацій в міжнародних електронних наукометричних базах даних за останні 10 років.

Результати. Проаналізовані нові настанови для діагностики і лікування пневмонії. Описана сучасна класифікація пневмонії. Наведена характеристика різних видів діагностики пневмонії залежно від тяжкості стану пацієнтів. Описані переваги та недоліки кожного методу діагностики. Наведені переваги акустичної діагностики пневмонії на різних етапах лікування.

Висновки. Пневмонія залишається актуальною проблемою, а її діагностика потребує удосконалення. Застосування нових методів акустичної діагностики є перспективним методом в педіатрії у дітей.

Ключові слова: пневмонія, діти, COVID-19, SARS-CoV-2, лабораторно-інструментальна діагностика.

Topicality. Evidence-based medicine has now penetrated very deeply into medical life [1]. The modern development of medicine requires constant improvement of diagnostics and treatment [2]. That is why the system of standardization of medical care plays an important role in the practice of a doctor. This system is focused on the development of medical and technological documents. It is these documents that help the doctor to act correctly and avoid wrong decisions [3; 4].

Purpose is generalization of literature data on modern methods of pneumonia diagnosis.

Methods. Analysis of scientific publications in international electronic scientific and metric databases for the last 10 years.

Results and discussion. From August 2, 2022, the order of the Ministry of Health of Ukraine (MHU of

Ukraine) No. 1380 [4] entered into force. And the order of the Ministry of Health of Ukraine dated January 13, 2005 No. 18 "On approval of protocols for providing medical care to children in the specialty "Pediatric pulmonology" became invalid. At the same time, the Ministry of Health of Ukraine approved the Evidence-Based Clinical Guideline (KH 2022-1380) [3]. The working group working on the guideline used the German guideline S2k-Leitlinie "Management der ambulanten erkrankten Pneumonie bei Kindern und Jugendlichen (pädiatrische ambulante erkrankte Pneumonie, pCAP)", 2017, as an example of the best medical guideline for care with children. The German guideline is based on evidence-based medicine. The German clinical guideline was chosen by the working group of the Ministry of Health of Ukraine on the basis of objective evaluation criteria using an international tool – the Questionnaire on Expertise and Evaluation of Guidelines AGREE II.

AGREE II guideline examination and attestation tool is a tool that assesses the methodological clarity, transpar-

ency and quality with which the guideline was developed to improve medical care. AGREE II is a universal tool that can be applied to guidelines for specific diseases that relate to all stages of providing medical care, namely public health, screening, diagnosis, and treatment [5].

The 2022 clinical guideline "Pneumonia in children" [3] aims to provide qualified assistance to both the doctor and the patient in making rational decisions in various clinical cases. This guideline is also an information pillar for improving the quality of clinical practice, based on evidence of the effectiveness of the use of certain medical technologies, drugs, and organizational resources of medical care. The instruction clearly describes and substantiates such main points as therapeutic, preventive, and diagnostic measures, for the prevention of which the patient does not need a wide range of diagnostic procedures or medicines. The authors paid great attention to the rational use of antibiotics and the prevention of antibiotic resistance. Antimicrobial therapy is carried out only according to indications and is aimed at the shortest possible time. The severity of pneumonia is evaluated clinically, and due to this, the scope and type of its treatment and diagnosis will be determined.

The main tasks of this guideline [3] are to improve the quality of treatment, diagnosis, and prevention of pneumonia. This instruction can be used both by doctors who work in the ambulatory chain and by doctors who provide inpatient care. However, this guideline is not used for the treatment of nosocomial pneumonia and pneumonia in newborns.

The update of recommendations and guidelines is due to the fact that pneumonia continues to be a leading cause of morbidity and mortality in young children worldwide. According to the World Health Organization (WHO), lower respiratory tract infections, 90% of which are pneumonia, cause about 20% of child deaths worldwide [6; 7; 8]. Also, according to WHO, pneumonia most often affects children from countries with limited resources [8].

Pneumonia is an infectious disease caused by microorganisms that leads to inflammation in the alveoli with or without bronchial involvement. That is why it is necessary to carry out a clear differential diagnosis of bronchitis, bronchiolitis, and other diseases of the respiratory system [9]. The 2022 Pneumonia in Children clinical guideline applies only to community-acquired pneumonia (CAP). CAP is pneumonia, the symptoms of which occurred outside a medical facility or 48 hours after hospitalization. The clinical guideline also provides an up-to-date classification of pneumonia. According to the origin, the following are distinguished: community-acquired, hospital-acquired, aspiration pneumonia and pneumonia in patients with immunodeficiency [3; 4]. According to the prevalence and nature of lung tissue damage, there are: focal, segmental, lobar and interstitial pneumonia. According to complications, pneumonia is divided into complicated and uncomplicated. The course of pneumonia is acute or prolonged.

The clinical picture depends on the type and localization of the pathological process, as well as on the age characteristics of the patients [10]. If CAP is suspected, the patient should undergo a physical examination to determine the main symptoms of the disease and identify the pathological process in the lungs and assess the severity

of the patient's condition. Usually, children with CAP may have symptoms such as fever, shortness of breath, tachypnea, and cough [11].

According to Clark J.E. symptoms of fever and tachypnea have high sensitivity and specificity in the diagnosis of pneumonia [12]. According to other studies, a strong correlation between the acceleration of the breathing rate and the decrease in oxygen saturation was found.

According to Palafox M, in babies with a respiratory rate of more than 70 per minute, the sensitivity is 89%, and the specificity is 63% for the diagnosis of PP. And in infants, in the presence of hypoxemia, the sensitivity of detecting pneumonia is 74%, and the specificity is 67% [13].

According to the literature, the auscultatory picture in CAP may differ, which greatly complicates the diagnosis of the disease. Likewise, the combination of fever and rapid breathing can be caused by the same fever. We remember that the respiratory rate depends on the age of the child and the duration of the observation, which is why the 2022 guideline "Pneumonia in children" prescribes a clear algorithm for measuring the respiratory rate. To measure the breathing rate, you first need a calm environment, where the breathing rate is counted for 30 seconds. Other symptoms, such as difficulty breathing and pathological noises during lung auscultation, have much lower sensitivity and specificity, but they also help to describe the patient's clinical picture.

According to the 2014 WHO classification, 2 types of pneumonia are distinguished, namely mild pneumonia and severe pneumonia with additional danger symptoms [14]. Mild pneumonia is diagnosed depending on age characteristics when counting the respiratory rate per minute. If the respiratory rate is more than 50/min in children 2-11 months, more than 40/min in children 12-59 months, and more than 20/min in children older than 59 months, mild CAP is exhibited. Patients with severe pneumonia have additional danger symptoms, including dehydration, convulsions, fainting, and other life-threatening symptoms.

According to the 2022 clinical guideline "Pneumonia in children", the diagnosis of CAP is made clinically, and examinations are carried out depending on the severity and individual characteristics of the child [3; 4].

The following examinations should be included in the examination plan of a patient with a severe form of PP: general analysis of peripheral blood, level of CRP, blood serum electrolytes and blood gases. Peripheral blood analysis is not necessarily performed for patients with a mild form of CAP, since it is impossible to establish the viral or bacterial nature of the inflammatory process. Also, with a mild form of CAP, routine microbiological diagnosis is not performed for all patients.

Based on the 2022 clinical guideline "Pneumonia in children", when the diagnosis of PP is made clinically, radiological examination is used in special cases. Routine X-ray examination is not recommended for patients with a mild form of CAP [15]. If, according to individual indications, X-ray examination is necessary, it is performed only in direct projection. At present, in case of mild CAP, radiography of the chest cavity organs is not performed in the lateral projection.

According to the literature, the application of the x-ray method to children should be carried out with caution, due

to the high biological sensitivity of children to X-ray radiation [10; 11; 15; 16].

According to Bradley J.S. overdiagnosis of pneumonia is currently an actual problem. A group of scientists analyzed 184 case histories of children with pneumonia and assessed the expediency of prescribing a chest x-ray. As a result of the research, it was found that every fifth patient had overdiagnosis, and 32.3% of patients had signs of obstructive bronchitis on the X-ray. The researchers also established that hyperdiagnosis was most often carried out in children of the first three years of life [17].

However, the radiological method also has advantages. One of these advantages is the high accuracy of the results and the speed of the research. In pneumococcal pneumonia, the sensitivity of the X-ray method is 93% (CI 80-98%) [18].

The use of the x-ray method in the diagnosis of SARS-CoV-2 lung damage is less effective, due to the inability to see the characteristic specific changes caused by the pathological process [19].

According to the 2022 clinical guideline "Pneumonia in children", it is impossible to identify the etiology of a mild form of CAP using the radiographic method. That is why, in this guideline, it is recommended not to routinely use the radiographic method for all patients with a mild form of CAP [3; 4; 9].

However, chest x-ray examination should be performed in patients with persistent but non-pathognomonic symptoms of CAP. It is the radiographic method that will make it possible in this case to correctly verify the diagnosis of CAP. Also, the X-ray method is used in patients with severe CAP to verify complications, such as atelectasis, pleural effusion, abscesses. All pathological processes in the lungs and the main complications can be detected in a direct projection, research in a lateral projection is not done [20].

Currently, it is not relevant to carry out an X-ray examination of the chest organs in patients with PP after 3-7 days. According to Virkki R., up to 30% of pathological residual changes remain in the lungs, even with full clinical recovery of the patient. These changes are not associated with the development of recurrent pneumonia [21].

Therefore, it can be concluded that repeated X-ray examinations of the chest with CAP are not recommended, and patients with a mild form of CAP do not need to undergo X-rays.

Patients with CAP undergo pulse oximetry. Pulse oximetry is a non-invasive method of diagnosing hemoglobin saturation of arterial blood with oxygen and measuring pulse rate. A pulse oximeter is used for such measurements. The device has sensors that are attached to a finger or an auricle and with the help of transmission spectrometry, SaO_2 is measured.

With $\text{SaO}_2 \leq 92\%$ when breathing atmospheric air, patients with CAP need to receive oxygen therapy to the level of $\text{SaO}_2 > 92\%$ [3; 4]. According to the 2022 clinical guideline "Pneumonia in children", breathing exercises have no effect on the duration of therapy and are not used in patients with a mild form of CAP. Treatment of patients with mild and severe forms of pneumonia is carried out with the use of antibiotics.

Ultrasound examination (US) is widely used for the diagnosis of CAP. According to Lu W., ultrasound is highly

effective in triaging patients, especially if it is not possible to do CT [22]. Currently, ultrasound is widely used as a bedside diagnostic method [23].

Mayo P.H. et al. conducted a blind randomized study. The basis was a comparison of the results of ultrasound and CT of the chest organs in patients with COVID-19. It was found that the sensitivity of ultrasound in patients with mild, moderate, and severe pneumonia was 68.8%, 77.8%, and 100.0%, and the specificity was 85.7%, 76.2%, and 92.9%. Thanks to the conducted research, a conclusion was made about the high diagnostic value of using ultrasound in medical practice [24]. That is why ultrasound is currently widely used to diagnose pneumonia in children. Ultrasound diagnostics allows you to assess the condition of the lungs without X-ray exposure.

Sonography is also actively used in pediatric pulmonology. Sonography is used for differential diagnosis of parapneumonic effusion and pleural empyema. These data are not inferior in their significance and accuracy to the data of computed tomography (CT) [25].

The CT method can diagnose parenchymal, and intra-grade pathological processes with a high level of resolution. One of the disadvantages of using CT in children to diagnose complications of CAP is the need for sedation [25; 26].

Currently, respiratory acoustics is a relevant method of lung diagnostics. In recent years, respiratory acoustics has become widely used, especially in the diagnosis of CAP. This method has no external radiation and is completely safe for patients.

The main tasks of respiratory acoustics are the development of the theory of sound propagation in the lungs and the creation of devices that improve the diagnosis of diseases. For example, one of these methods is the method of pulmophonography. The purpose of this method is to determine local lung ventilation. Acoustic analysis of sound phenomena is based on a statistical model of sound propagation along the tracheobronchial tree.

Currently, the digital method of applying acoustic models for simulating sound propagation in the lungs is relevant. It is thanks to this method that it is possible to construct an acoustic image of the lungs. When using acoustic methods, breathing noises are registered at special points above the lungs. Sound signals are recorded by electronic microphones, after which the signal is filtered and digitized.

On May 5, 2023, during a briefing, the Director General of the WHO announced that the Covid-19 pandemic has officially ended. The spread of the coronavirus infection is no longer considered an emergency of international importance.

However, this does not mean that COVID-19 has ceased to be a global threat to human health.

Pneumonia may develop in case of SARS-CoV-2 infection. There may be different illness categories of COVID-19 and some of them depend on the level of the severity of lower respiratory disease.

According to the Coronavirus Disease 2019 (COVID-19) Treatment Guidelines from NICE and Order No. 762 dated 04.02.2020 on the approval of the protocol "Provision of medical assistance for the treatment of coronavirus disease (COVID-19)", moderate illness of COVID-19 include signs evidence of lower respiratory disease during clinical

assessment or imaging and oxygen saturation measured by pulse oximetry $SpO_2 \geq 94\%$.

Severe SARS-CoV-2 infection – is a lower respiratory tract disease detected on clinical assessment or imaging, with 1 or more of the following signs of respiratory failure: respiratory rate greater than 30 breaths/min, dyspnea, cyanosis, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO_2 / FiO_2) <300 mm Hg, and blood saturation with oxygen less than $SpO_2 94\%$, the presence of lung infiltrates more than 50% [27; 28].

Therefore, timely diagnosis of pneumonia acquires great practical importance. And that is why respiratory acoustics is the safest method of diagnosing pathological changes in the lungs.

According to the definition of WHO, health is a state of complete physical, mental, and social well-being, and not just the absence of disease. That is why studying the quality of life in patients with diseases of the respiratory system, especially CAP, is currently very relevant. A new direction of research is the development of a methodology for the study of the quality of life in pediatrics. In pediatric practice, the Pediatric quality of life questionnaire – PedsQL 4.0 Generic Core Scales (PedsQL) [29] is used to study the quality of life of patients.

The PedsQL measurement model is a modular approach used to measure health-related quality of life (HRQOL) in healthy and ill children. Pediatric Quality of Life Inventory – PedsQL is one of the most popular questionnaires in the world, which is currently translated into 25 languages. Pediatric tools for measuring health-related quality of life should be highly sensitive to a child's cognitive develop-

ment. the PedsQL measurement model consists of 4 forms of tests that are used depending on age [30].

The test has been tested in multicenter studies in the USA, Canada, Great Britain and European countries. It has been recognized as a simple, reliable and sensitive method for assessing the quality of life. The questionnaire has special blocks that describe physical, emotional, social and role functioning. One of the advantages of the questionnaire is the presence of specific modules (PedsQLTM4.0 Disease Specific Modules), which are used for various diseases. Such modules are used both to assess the general quality of life and specific properties that are characteristic of a certain pathology [31].

The use of this specific module for children with CAP will improve the diagnosis of the disease and determine the degree of the child's quality of life after the disease.

Therefore, pneumonia is an urgent problem of modern pediatrics. Currently, new guidelines and protocols for diagnosing CAP in children have been developed. There are many methods used to diagnose pneumonia, and a new method of acoustic respiratory diagnosis is attracting special attention.

Conclusions. Pneumonia remains an urgent problem of modern pediatrics. Currently, new guidelines and recommendations for the diagnosis and treatment of pneumonia have been developed in the world and in Ukraine.

New protocols of the Ministry of Health of Ukraine are used to diagnose and monitor children with CAP. There is a wide range of different methods of diagnosing pneumonia, among which acoustic methods and methods of quality of life assessment attract special attention.

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