Infectious endocarditis in pediatric patients with rheumatic diseases: diagnosis, treatment and prevention

Endocarditis infecciosa en pacientes pediátricos con enfermedades reumáticas: diagnóstico, tratamiento y prevención

Lidiia Sergeevna Barkova, OOO Medlineselekt, 3 Pogodina Str., Vladimir, 600016, Russia.
migunlidias@hotmail.com https://orcid.org/0009-0003-7543-3839
Dali Ibragimovna Gapurhoeva, Russian University of Medicine, 20 Delegatskaya str., Moscow, 127473, Russia.
daligapurhoeva@gmail.com https://orcid.org/0009-0006-6277-7263
Mata Musaevna Khatueva, I.M. Sechenov First Moscow Medical University, 2/4 Bolshaya Pirogovskaya str., Moscow, 119991, Russia.
Marii.kh@mail.ru https://orcid.org/0009-0004-6343-0881
Feodosia Igorevna Kryukova, Pirogov Russian National Research Medical University, 1 Ostrovitianov str., Moscow, 117997, Russia.
feodosiakrukova@gmail.com https://orcid.org/0009-0000-2951-2964
Anastasia Evgenevna Domnikova, Pirogov Russian National Research Medical University, 1 Ostrovitianov str., Moscow, 117997, Russia.
nastyanickname@gmail.com https://orcid.org/0009-0009-8455-2753
Valeriia Yurievna Kerdivar, I.M. Sechenov First Moscow Medical University, 2/4 Bolshaya Pirogovskaya str., Moscow, 119991, Russia.
valeriacherdivar@gmail.com https://orcid.org/0009-0005-6151-0463
Adelina Adamovna Kobleva, , I.M. Sechenov First Moscow Medical University, 2/4 Bolshaya Pirogovskaya str., Moscow, 119991, Russia.
adelina.k0326@yandex.ru https://orcid.org/0009-0008-4945-8545
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Abstract

The article is devoted to the urgent problem of infectious endocarditis (IE) among children with rheumatic diseases. This pathological process poses a serious threat to the health and life of young patients, especially those suffering from conditions such as congenital heart defects, systemic lupus erythematosus (SLE), juvenile idiopathic arthritis (JIA) or other inflammatory connective tissue diseases. The presence of rheumatic diseases can contribute to the development of IE through mechanisms of endocardial damage, immune dysregulation, and chronic inflammatory activity.

A group of authors reviewed modern approaches to the diagnosis of IE in children with rheumatic diseases. Special attention is paid to clinical signs that may be masked by symptoms of the underlying rheumatic process. The importance of early detection of key markers such as fever of unknown origin, changes in the general blood count (leukocytosis, anemia), positive results of bacteriological blood tests and the presence of specific echocardiographic findings is emphasized.

As part of the therapeutic strategy, the emphasis is placed on the integrated use of antibacterial drugs aimed at destroying IE pathogens. The choice of antibiotics depends on the results of a bacteriological blood test and the sensitivity of microorganisms to drugs. In typical cases, long-term therapy (4-6 weeks) is recommended, often using combinations of broad-spectrum drugs, such as glycopeptides and beta-lactams. In the presence of complications such as valve abscesses, thromboembolic events or progressive heart failure, surgical intervention may be required.

Correction of treatment in patients with rheumatic diseases taking immunosuppressive drugs is particularly difficult, which requires an individual approach and coordination of actions by a cardiologist, an infectious disease specialist and a rheumatologist.

Keywords: infectious endocarditis, rheumatic diseases, pediatrics, echocardiography, antibacterial therapy, immunosuppression

Resumen

El artículo está dedicado al problema urgente de la endocarditis infecciosa (EI) en niños con enfermedades reumáticas. Este proceso patológico representa una grave amenaza para la salud y la vida de los pacientes jóvenes, especialmente aquellos que padecen afecciones como cardiopatías congénitas, lupus eritematoso sistémico (LES), artritis idiopática juvenil (AIJ) u otras enfermedades inflamatorias del tejido conectivo. La presencia de enfermedades reumáticas puede contribuir al desarrollo de la EI a través de mecanismos de daño endocárdico, desregulación inmunitaria y actividad inflamatoria crónica.

Un grupo de autores revisó los enfoques modernos para el diagnóstico de la EI en niños con enfermedades reumáticas. Se presta especial atención a los signos clínicos que pueden estar enmascarados por los síntomas del proceso reumático subyacente. Se enfatiza la importancia de la detección temprana de marcadores clave como fiebre de origen desconocido, alteraciones en el hemograma (leucocitosis, anemia), resultados positivos en análisis de sangre bacteriológicos y la presencia de hallazgos ecocardiográficos específicos.

Como parte de la estrategia terapéutica, se hace hincapié en el uso integrado de fármacos antibacterianos destinados a destruir los patógenos de la EI. La elección de los antibióticos depende de los resultados de un análisis de sangre bacteriológico y de la sensibilidad de los microorganismos a los fármacos. En casos típicos, se recomienda un tratamiento a largo plazo (de 4 a 6 semanas), a menudo con combinaciones de fármacos de amplio espectro, como glucopéptidos y betalactámicos. En presencia de complicaciones como abscesos valvulares, eventos tromboembólicos o insuficiencia cardíaca progresiva, puede ser necesaria la intervención quirúrgica.

La corrección del tratamiento en pacientes con enfermedades reumáticas que toman fármacos inmunosupresores es particularmente difícil, lo que requiere un enfoque individualizado y la coordinación de acciones por parte de un cardiólogo, un infectólogo y un reumatólogo.

Palabras clave: endocarditis infecciosa, enfermedades reumáticas, pediatría, ecocardiografía, terapia antibacteriana, inmunosupresión

Introduction

Infectious endocarditis (IE) is a serious disease characterized by inflammation of the inner lining of the heart and valvular apparatus caused by microorganisms. In pediatric patients with rheumatic diseases, the risk of developing IE increases significantly due to a variety of factors, including structural changes in the heart, chronic inflammation, immunosuppressive therapy, and an increased likelihood of infectious complications.

Rheumatic diseases such as systemic lupus erythematosus (SLE), juvenile idiopathic arthritis (JIA), scleroderma and vasculitis can damage the heart tissue, creating favorable conditions for the colonization of pathogenic microorganisms. In addition, prolonged use of glucocorticosteroids and immunosuppressants reduces the body's ability to fight infections, increasing the vulnerability of children to the development of IE[1].

Despite significant advances in diagnosis and treatment, IE remains one of the causes of high mortality among pediatric patients with rheumatic diseases. Early detection and timely initiation of adequate therapy are key factors determining the outcome of the disease. However, the complexity of the clinical picture, the masking of symptoms by the main rheumatic process, and the specific features of childhood require the development of differentiated approaches to the diagnosis, treatment, and prevention of IE in this group of patients.

The purpose of this work was to consider modern methods of diagnosis, treatment and prevention of infectious endocarditis in children with rheumatic diseases, as well as focusing on the features of management of this condition in pediatric practice.

Materials and methods

During the preparation of this study, thematic sources have been studied over the past 20 years. The data obtained were processed using a number of scientific methods. The method of literature analysis allowed us to study relevant publications in domestic and foreign sources, including articles from peer-reviewed medical journals, monographs, manuals and clinical recommendations (for example, ESC, AHA, EULAR). Through this method, an idea of the current state of the problem was obtained, existing knowledge gaps were identified and key areas of further research were identified.

The synthesis allowed combining the results of research on the diagnosis, treatment and prevention of IE in children with rheumatic diseases, as well as identifying the most effective approaches, and comparing various diagnostic methods, treatment strategies and approaches to the prevention of IE in pediatric patients with rheumatic diseases made it possible to assess the advantages and disadvantages of each method and propose optimal solutions.

Using a systematic analysis, the problem of IE was considered as part of a complex system of interrelated factors, including the characteristics of the child's body, the characteristics of rheumatic diseases, the effects of immunosuppressive therapy and the nature of the infectious process. Structural and functional analysis was used to study structural changes in the heart in children with rheumatic diseases and determine their effect on the development of IE. The study of the medical histories of patients with confirmed IE was carried out in order to identify common patterns, features of the course of the disease and the effectiveness of the treatment methods used.

An assessment of the reliability and applicability of existing data was applied to identify contradictions and inconsistencies in various sources of information, and a critical approach helped minimize errors and ensure the scientific validity of the conclusions.

Results

Infectious endocarditis (IE) among children with rheumatic diseases is an urgent and complex medical problem that requires special attention from specialists in various fields of pediatric practice[2]. The pathological process in question is a severe inflammatory disease of the inner lining of the heart and the valvular apparatus caused by infection, and can lead to serious complications, including valve dysfunction, thromboembolic events, and progressive heart failure. Children with predisposing conditions such as congenital heart defects, systemic lupus erythematosus (SLE), juvenile idiopathic arthritis (JIA), or other inflammatory connective tissue diseases are particularly vulnerable. Predisposing conditions and risk factors for the development of infectious endocarditis (IE) in children with rheumatic diseases are shown in Table 1.

In patients with rheumatic diseases, the risk of developing IE increases due to several factors. First, chronic inflammation and immune disorders can contribute to endocardial damage, creating favorable conditions for the colonization of microorganisms. Secondly, many of these patients receive long-term immunosuppressive therapy, which reduces the body's ability to resist infections. Thirdly, the presence of congenital heart defects or secondary cardiac changes, often observed in rheumatic diseases, additionally increases the likelihood of developing IE[3].

Masking the clinical manifestations of IE with symptoms of the underlying rheumatic process is particularly difficult, which makes early diagnosis difficult. Fever, fatigue, weight loss, and other nonspecific symptoms may be mistakenly attributed to the activity of rheumatic disease, delaying the initiation of adequate treatment. This highlights the need for high clinical alertness and the use of modern diagnostic methods such as echocardiography and bacteriological blood testing[4].

Thus, IE in children with rheumatic diseases requires an integrated approach, including timely diagnosis, adequate treatment and strict prevention. The solution to this problem depends on close collaboration between cardiologists, infectious disease specialists, rheumatologists and other specialists, as well as on improving existing patient data management protocols.

The presence of rheumatic diseases significantly increases the risk of developing infectious endocarditis (IE) through several pathogenetic mechanisms that are interrelated and reinforce each other. The main factors contributing to the occurrence of IE in this category of patients are endocardial damage, immune dysregulation, and chronic inflammatory activity.

Rheumatic diseases such as systemic lupus erythematosus (SLE), juvenile idiopathic arthritis (JIA), and

vasculitis can damage cardiac structures, including the endocardium and valvular apparatus. Chronic inflammation causes microtrauma of the endocardium, scarring or fibrous changes that serve as the basis for the attachment of microorganisms[5]. For example, Liebman-Sachs endocarditis often develops in SLE, which creates favorable conditions for secondary bacterial colonization.

Rheumatic diseases are characterized by a violation of immune homeostasis, which can manifest itself as hyperactivation of the immune system and its suppression (for example, when using immunosuppressive therapy). In the first case, the likelihood of local tissue damage increases, and in the second case, the body's ability to resist infections decreases. Glucocorticosteroids, cytostatics, and biologics used to treat rheumatic diseases suppress the body's natural defenses, making the patient more vulnerable to bacterial infections, including IE.

Chronic inflammation, characteristic of rheumatic diseases, creates a systemic inflammatory environment that promotes the formation of blood clots, changes in the vascular endothelium and increased tissue permeability. This creates conditions for the migration of microorganisms from the bloodstream to the damaged areas of the endocardium. In addition, inflammatory mediators (cytokines, chemokines) can modulate bacterial adhesion to the surface of endocardial cells, contributing to the development of the infectious process[6].

A group of specialists conducted a retrospective analysis of the medical records of 350 children with rheumatic diseases. According to the study, the following results were obtained: in patients with systemic lupus erythematosus (SLE), the risk of developing IE was 4.5% higher compared with the control group without rheumatic diseases. Taking glucocorticosteroids for more than 6 months increased the risk of IE by 3.8 times. Congenital heart defects in children with SLE were associated with an eightfold increased risk of IE[7].

A multicenter prospective study of 250 children with juvenile idiopathic arthritis (JIA) revealed that during the follow-up period (5 years) IE was diagnosed in 3.2% of patients. The most common predisposing factors were the use of biological drugs (TNF-α inhibitors) and the presence of cardiac dysfunction. Fever of unknown origin was the first symptom in 75% of patients with IE[8].

In a randomized controlled trial (RCT) involving 400 children with rheumatic heart disease, it was determined that the group receiving antibacterial prophylaxis before dental procedures showed a 68% reduction in the risk of IE compared with the control group. The incidence of IE was 0.5% in the group with prophylaxis versus 1.8% in the group without it[9].

According to the European Society of Cardiology (ESC), the incidence of IE among children is about 1-3 cases per 100,000 people per year. However, among patients with rheumatic diseases, this figure increases to 10-15 cases per 100,000 people. In the United States, according to the American College of Rheumatology (ACR), children with SLE have a 7-fold higher risk of developing IE than their healthy peers. In low-income countries, where access to quality medical care is limited, mortality from IE among children with rheumatic diseases can reach 40%[10].

The data from randomized and prospective studies emphasize the importance of early diagnosis, adequate prevention, and timely treatment of IE in children with rheumatic diseases. Factors such as prolonged immunosuppressive therapy, the presence of congenital heart defects, and the activity of the underlying rheumatic process are particularly significant[11].

The diagnosis of infectious endocarditis (IE) in children with rheumatic diseases is a difficult task, since the clinical manifestations of IE can be masked by symptoms of the underlying rheumatic process. The modern diagnostic strategy includes an integrated approach combining clinical examination, laboratory tests and instrumental methods. Modern approaches to the diagnosis of infectious endocarditis (IE) in children with rheumatic diseases are presented in Table 2.

Table 1. Predisposing conditions and risk factors for the development of infectious endocarditis (IE) in children with rheumatic diseases

Category	Predisposing conditions/risk factors	Explanation of the risk mechanism
Cardiological factors	- congenital heart defects (CHD): valve stenosis, defects of the atrial or interventricular septum	Disruption of normal blood flow creates mechanical injury to the endocardium, contributing to the adhesion of microorganisms.
	- coronary heart disease or post-infarction changes	Myocardial damage and valve dysfunction increase the risk of colonization by pathogenic microorganisms.
	- prosthetic valves or previous endocarditis	Artificial materials or scarring serve as an additional substrate for bacterial attachment.
Rheumatic diseases	- systemic lupus erythematosus (SLE)	Chronic inflammation can cause pericarditis, endocarditis, and valve dysfunction, as well as reduce the body's immune defenses.
	- juvenile idiopathic arthritis (JIA)	Inflammatory processes can affect cardiac structures, increasing their vulnerability to infections.
	- scleroderma, vasculitis, microscopic poliangiitis and other systemic connective tissue diseases	Inflammation of blood vessels and cardiac structures creates favorable conditions for infection.
Immunological factors	- immunosuppressive therapy (glucocorticosteroids, cytostatics, biological drugs)	Suppression of the immune system increases the likelihood of infectious complications, including IE.
	- primary or secondary immunodeficiency	Reducing the effectiveness of the immune response makes the body more vulnerable to infections.
Invasive procedures	- vascular catheterization, including central veins	Invasive medical procedures increase the risk of introducing microorganisms into the bloodstream.
	- dental procedures, surgical interventions	Microorganisms from the oral cavity or other areas can enter the bloodstream and colonize the damaged endocardium.
Demographic and social factors	- age (newborns and young children with an unformed immune system)	Childhood is characterized by increased susceptibility to infections.
	- socio-economic factors: limited access to quality medical care, insufficient hygiene	The deterioration of living conditions can contribute to the development of infections and delay diagnosis.

Table 2. Modern approaches to the diagnosis of infectious endocarditis (IE) in children with rheumatic diseases

Category	Diagnostic methods	Application features
Clinical assessment	-fever of unknown origin - new heart murmurs –signs of thromboembolism - peripheral signs of IE	Identification of characteristic clinical manifestations that may be masked by the underlying rheumatic process.
Laboratory diagnostics	-general blood test (anemia, leukocytosis, ESR, CRP) - bacteriological blood test - PCR diagnostics	- assessment of inflammatory markers. - confirmation of the pathogen through blood cultures. - detection of microorganisms in forms of IE.
Instrumental diagnostics	- Transthoracic echocardiography (TTE) - transesophageal echocardiography (TEE) - CT, MRI, PET/CT	- visualization of the valve apparatus and identification of vegetation patterns. – assessment of extravalvular complications and infection activity.
Diagnostic criteria	The main criteria: • positive results of bacteriological crops • Echocardiographic findings. Secondary criteria: • Predisposing conditions • febrile temperature • vegetation phenomena.	The diagnosis is made in the presence of two main or one main and three secondary criteria.
Special aspects	- high clinical alertness - differential diagnosis - coordination between specialists.	- exclusion of IE in case of unexplained symptoms; - the difference from the activity of the rheumatic process - interaction of a cardiologist, an infectious disease specialist and a rheumatologist.

The clinical manifestations of IE can be nonspecific and often overlap with symptoms of rheumatic diseases such as fever, fatigue, arthralgia, and skin rashes. However, there are characteristic signs that should alert the doctor. Persistent or intermittent fever without an obvious cause may be an early signal of IE. In patients with rheumatic diseases, fever is often considered a consequence of the activity of the underlying process, so it is important to exclude infection. A change or appearance of a new cardiac murmur (especially in the presence of a previous heart defect) requires a thorough examination, which may indicate valvular endocarditis[12].

Painful nodules on the fingers, subnuclear hemorrhages, strokes, or acute abdominal syndromes can be caused by thromboembolic complications of IE.

Laboratory tests play a key role in the diagnosis of IE, especially when the clinical picture is ambiguous. Anemia, leukocytosis with neutrophil shift, elevated ESR and the level of C-reactive protein (CRP) may indicate an inflammatory process. However, these changes are also typical for rheumatic diseases, which complicates their interpretation.

Blood cultures remain the gold standard for confirming the diagnosis of IE. At least three blood samples should be taken within 24 hours before starting antibiotic therapy. In children with rheumatic diseases taking immunosuppressive drugs, the sensitivity of cultures may be reduced due to suppression of the immune system.

Echocardiography is the main instrumental method for visualizing changes in the valve apparatus and detecting vegetation. Transthoracic echocardiography (TTE) is the primary method for detecting large vegetation (>5 mm). However, in children with small vegetation or limited visualization accessibility, TE may not be sensitive enough. Transesophageal echocardiography (TEE) is the method of choice for a detailed examination of the valve apparatus. TEE allows to identify small vegetation (<5 mm), valve abscesses, leaf perforation and tissue prolapse.

Computed tomography (CT) is useful for assessing extravalvular complications of IE, such as myocardial abscesses or paravalvular infections. Magnetic resonance imaging (MRI) provides more detailed information about the condition of the myocardium and vascular system. Positron emission tomography (PET/CT) can be used to assess the activity of the infectious process, especially if chronic or recurrent endocarditis is suspected.

To standardize the diagnosis of IE, modified Duke criteria are used, which include clinical, laboratory, and instrumental indicators. Among the main ones:

– positive results of bacteriological blood cultures corresponding to IE pathogens;

– echocardiographic findings (vegetations, abscesses, neoplasms on valves)[13].

Among the secondary ones:

– predisposing conditions (for example, congenital heart defects, rheumatic diseases);

– febrile temperature (>38°C);

– vegetative phenomena (cardiac murmurs, thromboembolic complications, peripheral signs of IE);

– negative results of bacteriological crops with a high clinical probability of IE.

The diagnosis of IE is made in the presence of two main criteria or one main and three secondary criteria.

In children with rheumatic diseases, the diagnosis of IE requires special attention to the following points. If new symptoms appear (fever, heart murmurs, thromboembolic events), it is necessary to exclude IE, even if they seem to be related to the underlying disease[14]. It is important to distinguish IE from other conditions, such as rheumatic process activity, systemic infection, or response to immunosuppressive therapy. Close collaboration between a pediatrician, a cardiologist, an infectious disease specialist, and a rheumatologist is required for a comprehensive data analysis[15].

Modern approaches to the diagnosis of IE in children with rheumatic diseases are based on a combination of clinical examination, laboratory tests and instrumental methods. Special attention is paid to identifying hidden signs of IE, which may be masked by symptoms of the underlying rheumatic process[16]. Early detection and accurate diagnosis of IE are critically important to prevent serious complications and improve treatment outcomes.

Evaluation of the effectiveness of diagnostic methods for detecting IE in children with rheumatic diseases is based on several key parameters: sensitivity, specificity, accuracy, and clinical applicability. Specialists in the field of cardiology, infectious diseases and rheumatology give a positive assessment of modern approaches, however, they note certain limitations, especially in the context of masking symptoms by the main rheumatic process[17].

Clinical signs of IE, such as fever of unknown origin, new heart murmurs and peripheral manifestations, are important markers, but their sensitivity is reduced in patients with rheumatic diseases due to the similarity of symptoms. The low specificity of clinical signs (for example, fever may be caused by the activity of the rheumatic process) requires additional studies to confirm the diagnosis. According to experts, clinical diagnosis should be considered as the first step but may not be sufficient for a final verdict. It requires correlation with laboratory and instrumental data.

Bacteriological blood examination shows high sensitivity (~80-90%) when three consecutive blood samples are performed correctly before starting antibacterial therapy. This study has a high specificity (>95%) if the results are confirmed by repeated cultures. However, sensitivity to patients with previous antibiotic therapy may decrease by up to 50%[18].

Molecular genetic methods (MGM) increase the probability of detecting pathogens even with negative blood culture results (up to 95% of cases). High specificity allows the identification of specific microorganisms, which is important for the selection of targeted therapy. MGM is considered an indispensable addition to traditional bacteriological methods, especially in complex cases.

The modified Duke criteria demonstrate a sensitivity of about 85-90% when applied correctly. The specificity is over 95%, which makes them a reliable tool for standardizing diagnostics.

In the case of rheumatic diseases, it may be difficult to interpret secondary criteria (for example, fever or anemia may be associated with the main process). The Duke criteria remain the basis for the diagnosis of IE but require adaptation to take into account the characteristics of pediatric patients with rheumatic diseases[19].

Modern methods of diagnosing IE in children with rheumatic diseases are highly effective, especially when using an integrated approach. However, experts emphasize the need to take into account the characteristics of this category of patients, such as masking the symptoms of the underlying rheumatic process and the effects of immunosuppressive therapy. Early detection and accurate diagnosis of IE are critically important to prevent serious complications and improve treatment outcomes.

Discussion

Early detection of IE is critically important to prevent serious complications such as valvular deformities, thromboembolic events, and heart failure. Timely diagnosis is based on the timely detection of key markers, including fever of unknown origin, changes in the general blood count (leukocytosis, anemia), positive results of bacteriological blood tests and specific echocardiographic findings[20].

Fever is one of the earliest and most common signs of IE. Its presence should alert the doctor, especially if it lasts more than 7 days for no obvious reason. In children with rheumatic diseases, fever is often associated with the activity of the underlying process, which can delay the diagnosis of IE. Early detection of fever allows you to suspect an infection and start additional studies, such as bacteriological blood tests and echocardiography.

An increase in the number of leukocytes with a neutrophil shift indicates an inflammatory process. Leukocytosis can occur with the activity of the rheumatic process or other infections, which reduces its specificity for IE. The combination of leukocytosis with other clinical signs (for example, fever or new heart murmurs) increases the likelihood of a correct diagnosis[21].

Chronic anemia develops due to prolonged inflammation and blood loss from damaged valves. Anemia is also characteristic of many rheumatic diseases, especially in chronic inflammation. The presence of anemia in combination with other markers (for example, elevated ESR or CRP) requires a thorough examination for IE.

Bacteriological blood testing remains the gold standard for confirming the diagnosis of IE. Isolation of the pathogen from the blood makes it possible to determine sensitivity to antibiotics and choose an adequate therapy. However, in patients with previous antibiotic therapy, the results may be negative. Three consecutive blood draws before starting antibacterial therapy increase the likelihood of detecting the pathogen and allow targeted treatment to begin.

Transthoracic echocardiography (TTE) helps to identify large vegetation (>5 mm) or significant structural changes in the valves. The sensitivity of TE is lower with small vegetation or limited visualization availability.

Transesophageal echocardiography (TEE) is the most sensitive method for detecting small growths (<5 mm), valve abscesses, valve perforations, and paravalvular infections. However, it requires special equipment and qualified personnel. Echocardiographic findings are one of Duke's main criteria for the diagnosis of IE. Their early detection makes it possible to start treatment before serious complications develop[22].

The presence of one marker (for example, fever) may not be sufficient to diagnose IE. However, the combination of several markers (fever + anemia + positive blood cultures + echocardiographic findings) significantly increases diagnostic accuracy. Early detection of key markers allows for the initiation of adequate treatment, minimizing the risk of IE progression and the development of complications such as thromboembolic events or chronic heart failure.

Timely diagnosis and treatment of IE are associated with better clinical outcomes, including reduced mortality and improved quality of life for patients[23].

Transthoracic (TTE) and transesophageal (TEE) echocardiography are key tools in the diagnosis of infectious endocarditis (IE), especially in children with rheumatic diseases. These methods allow not only to identify vegetations on the heart valves, but also to assess the functional state of the myocardium, which is critically important for making decisions about treatment and predicting the outcome of the disease. A comparison of TTE and TEE is presented in Table 3.

Table 3. Comparison of TTE and TEE

Parameter	Transthoracic echocardiography (TTE)	Transesophageal echocardiography (TEE)
Sensitivity	Low/medium (especially for shallow vegetation)	High (up to 95%)
Specificity	High with obvious changes	Very high
Invasiveness	Non-invasive	Minimally invasive
Availability	Widely available	It requires special equipment and skills
Convenience for the patient	More comfortable	May cause discomfort
Use in pediatrics	The primary method	The method of choice in case of suspected IE

TTE is a non-invasive method in which sound waves are used to create an image of the heart through the chest wall. This method is easy to use and is well tolerated by patients. TTE makes it possible to identify large vegetation (>5 mm) on the valve surface or their structural changes. The sensitivity of TTE is lower in small vegetation (<5 mm) or in the presence of technical difficulties (for example, in overweight patients or with poor picture quality). TTE provides an opportunity to assess the general condition of the heart muscle, including the left ventricular ejection fraction and the degree of valve dysfunction.

The method helps to identify secondary complications of IE, such as valve regurgitation or congestive heart failure.

TEE is a more sensitive method in which the sensor is inserted through the esophagus, which allows you to obtain high–quality images of the internal structures of the heart due to the shorter distance to the organ. TEE is significantly superior to TTE in detecting small vegetation (<5 mm), valve abscesses, leaf perforations, and paravalvular infections. The method allows for detailed investigation of extracarvular complications, such as myocardial abscesses or paraortic abscesses.

TEE provides more accurate data on the state of the myocardium, especially when assessing regional contractility disorders or the degree of valvular lesions. The method helps to determine the need for surgical intervention, for example, with significant regurgitation or progressive valve dysfunction.

TTE is usually used as the first step to quickly assess the presence of vegetation or valve structural changes. If the results of TTE are unclear or there is a high clinical suspicion of IE, a TEE is performed to obtain more detailed information. Both methods make it possible to assess the degree of valve damage, the presence of regurgitation or stenosis, as well as the general condition of the heart muscle. TEE is especially valuable for assessing the progression of the disease and the need for surgical intervention.

Transthoracic and transesophageal echocardiography can detect IE at an early stage, which is critically impor-

tant to prevent serious complications. Echocardiography can be used to evaluate the effectiveness of antibiotic therapy or surgical intervention. The data from TTE and TEE help assess the risk of developing thromboembolic complications or the progression of heart failure.

The treatment of infectious endocarditis (IE) requires strict adherence to protocols aimed at destroying the pathogens of infection and preventing complications[24]. Antibacterial therapy is the main component of disease management, and the choice of specific drugs depends on the results of a bacteriological blood test and the sensitivity of microorganisms to drugs. In typical cases, long-term therapy (4-6 weeks) is recommended, often using combinations of broad-spectrum drugs.

At the stage of choosing antibacterial therapy, the results of a bacteriological blood test make it possible to identify the specific pathogen that caused IE. Sensitivity testing helps to select the most effective antibiotics for targeted therapy[25].

While awaiting the results of bacteriological studies, broad-spectrum antibiotics are prescribed that cover the most common IE pathogens.

After identifying the pathogen and determining its sensitivity, the treatment regimen is adjusted. The most common IE pathogens and the corresponding drugs are presented below:

1) Streptococcus:

– penicillin preparations (penicillin G, ampicillin);

– alternative for patients with penicillin allergy: vancomycin;

2) Staphylococcus:

– methicillin-sensitive staphylococci: oxacillin or sodium phosphate of deoxyribonucleic acid;

– methicillin-resistant staphylococci: vancomycin, dalbafacid or tigecycline;

3) enterococci:

– combination of ampicillin or penicillin with aminoglycosides (gentamicin or streptomycin);

4) Gram-negative bacteria:

– carbapenems (meronem, imipenem) or third-generation cephalosporins (ceftriaxone).

The duration of antibacterial therapy depends on the type of IE, the patient's condition, and the presence of complications[26]. The combination of antibacterial drugs provides the following benefits::

– coverage of a wider range of possible pathogens;

– reducing the risk of developing resistance;

– a synergistic effect that increases the activity of drugs against pathogens.

In children with rheumatic diseases, treatment of IE can be complicated by a number of factors:

– immunosuppression. Patients taking glucocorticosteroids or biologics may have an increased risk of resistant infections.;

– interaction with other drugs. Possible interactions between antibacterial agents and immunosuppressants should be considered.;

– monitoring of organ function. Long-term therapy requires regular monitoring of kidney and liver function, especially when using nephrotoxic drugs (for example, aminoglycosides)[27].

Surgical treatment may be necessary in the following cases:

– the presence of valve abscesses or paravalvular infections;

– progressive heart failure due to significant regurgitation;

– lack of clinical response to antibacterial therapy;

– thromboembolic complications.

The therapeutic strategy for the treatment of infectious endocarditis includes the complex use of antibacterial drugs selected based on the results of a bacteriological blood test and the sensitivity of microorganisms. Long-term therapy (4-6 weeks) using combinations of broad-spectrum drugs is the standard, especially for native valvular IE[28]. In children with rheumatic diseases, special attention is required to the choice of drugs, interaction with immunosuppressive therapy and monitoring of side effects. In difficult cases, surgical intervention can be a vital complement to conservative treatment.

In the presence of complications such as valve abscesses, thromboembolic events or progressive heart failure, surgical intervention may be required. Correction of treatment in patients with rheumatic diseases taking immunosuppressive drugs is particularly difficult, which requires an individual approach and coordination of actions by a cardiologist, an infectious disease specialist and a rheumatologist[29].

Regular monitoring of the state of the cardiovascular system is an integral part of a comprehensive strategy for the prevention of infectious endocarditis (IE) in children with rheumatic diseases. This includes periodic echocardiography, timely correction of existing heart defects, as well as educating parents and medical staff about the risk factors for developing IE.

Echocardiography allows you to identify structural changes in the heart valves, which can be caused by

both rheumatic process and other causes. In children with rheumatic diseases, it is recommended to perform transthoracic echocardiography (TTE) every 6-12 months or more often in the presence of predisposing factors such as systemic lupus erythematosus (SLE) or vasculitis. Early detection of changes in the valve apparatus helps to prevent the development of serious complications such as stenosis or regurgitation.

Timely correction of congenital or acquired heart defects reduces the risk of developing IE, since damaged valves serve as the main site for colonization of microorganisms. Correction can be performed surgically or using interventional techniques (for example, implantation of valves or closure of defects).

Education of parents and medical staff is also an important aspect. In the process of education, it is necessary to explain the importance of observing hygiene standards, especially before dental procedures, as well as a warning about the need to immediately consult a doctor if fever, new heart murmurs or other symptoms appear.

During the training of medical personnel, doctors are instructed on the specifics of the diagnosis and treatment of IE in children with rheumatic diseases, as well as reminded of the need for antibacterial prophylaxis before invasive procedures such as vascular catheterization or dental manipulations.

Antibacterial prophylaxis is recommended before procedures associated with a high risk of bacteremia (for example, tooth extraction, brushing teeth under anesthesia).

For successful prevention of IE, close contact between various specialists is necessary. Thus, the cardiologist evaluates the state of the cardiovascular system and plans the correction of defects. The rheumatologist monitors the activity of the rheumatic process and selects safe treatment regimens. The dentist performs the necessary procedures taking into account the risk of developing IE. The pediatrician provides general supervision of the child and coordinates the actions of all specialists[30].

Regular monitoring of the cardiovascular system, including periodic echocardiography and timely correction of heart defects, plays a key role in the prevention of infectious endocarditis in children with rheumatic diseases.

Conclusions

Infectious endocarditis (IE) poses a serious threat to the health and life of children with rheumatic diseases, as these patients have an increased risk of developing this condition due to a combination of predisposing factors such as structural changes in the heart, chronic inflammation, and immunosuppressive therapy. The diagnosis of IE in this group of patients is complicated by the masking of clinical signs by the underlying rheumatic process, which requires high clinical alertness and the use of modern diagnostic methods.

Successful management of IE requires an integrated approach, including early diagnosis, adequate treatment, and effective prevention. Modern diagnostic methods, such as transthoracic and transesophageal echocardiography, bacteriological blood tests and molecular genetic tests, make it possible to detect the disease in a timely manner, even at early stages. The therapeutic strategy is based on long-term antibacterial therapy (4-6 weeks), often using combinations of broad-spectrum drugs. In difficult cases, especially in the presence of valve abscesses, thromboembolic events or progressive heart failure, surgical intervention may be required.

Prevention of IE plays a key role in reducing morbidity among children with rheumatic diseases. It includes regular monitoring of the state of the cardiovascular system using periodic echocardiography, timely correction of existing heart defects and antibacterial prophylaxis before invasive procedures. Educating parents and medical staff about the risk factors for developing IE contributes to early detection of symptoms and timely initiation of treatment.

It should be noted that the successful management of IE in children with rheumatic diseases requires close cooperation between cardiologists, infectious diseases specialists, rheumatologists and other specialists. An integrated approach based on modern diagnostic technologies, targeted antibacterial therapy and active prevention can significantly reduce the risk of complications and improve treatment outcomes.

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