EVALUATION AND TREATMENT OF ENDOTHELIAL DYSFUNCTION IN PATIENTS WITH COVID-19 BASED ON CHRONIC HEART FAILURE

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Abstract
Assessment and treatment of endothelial dysfunction in patients with chronic heart failure who have undergone COVID-19 are discussed. Heart failure - causes, symptoms, diagnosis, treatment, prevention. Heart failure is an acute or chronic condition caused by weakening of the myocardial contractility and damping events within the large or small blood circulation. It is manifested by panting at rest or with some activity, rapid fatigue, swelling, cyanosis (bruising) of the nails and the lip-nasal triangle. Acute heart failure is dangerous with the development of pulmonary edema and cardiogenic shock, and chronic heart failure leads to the development of organ hypoxia. Heart failure is one of the most common causes of human death.

Keywords: COVID-19, treatment methods, heart failure, chronic disease, patient.

Complete information about heart failure. In heart failure, a decrease in the contractile (pumping) function of the heart leads to an imbalance between the hemodynamic requirements of the body and the ability of the heart to meet this need. This imbalance is manifested by the superiority of the venous flow to the heart over the ability of the heart to transfer blood to the arterial system, and the resistance that the myocardium must overcome to drive blood into the veins.

Heart failure is not considered an independent heart disease and develops as a complication of various pathologies of the vessels and heart: valve defects of the heart, ischemic disease, cardiomyopathy, arterial hypertension, etc.

In some diseases (for example, arterial hypertension), the increase in the manifestation of heart failure gradually increases over the years, but in other cases (acute myocardial infarction), when a part of the functional cells die, it is time is reduced to days and hours. In the acute development of heart failure (minutes, hours, days), we talk about its acute form. In other cases, heart failure is considered chronic.

Chronic heart failure affects 0.5% to 2% of the population, and its prevalence in people over 75 years old is about 10%. The urgency of the problem of heart failure is determined only by the increase in the number of patients suffering from it, high mortality and disability rates.

With the daily rise in the number of confirmed cases and the accumulation of clinical data, COVID-19 infection has become a major concern of the medical community. Various studies have determined that immune system dysregulation, increased metabolic demand and procoagulant activity caused by coronavirus are likely to be responsible for the increased risk of poor outcomes in people with cardiovascular disease. [2,8,9,10]

The increasing incidence of myocardial injury, vascular dysfunction, and thrombosis in patients with COVID-19, including those with asymptomatic or minimal early infection, raises important questions about potential long-term cardiovascular events that may include heart failure, life-threatening arrhythmias and conduction disorders, sudden cardiac death, myocardial blood flow disturbance due to damage to the microvascular bed, aneurysms of the coronary arteries and aorta, arterial hypertension, lability of heart rate and blood pressure response to physical activity, accelerated development of atherosclerosis, as well as venous and arterial thromboembolism [6,7]

It was found that COVID-19 caused heart failure in 23% of 191 patients treated in hospital in Wuhan, China [13]. Cases of severe myocarditis with decreased systolic function have also been reported after a coronavirus infection [10]. Among 68 deaths out of 150 patients with COVID-19, 7% were associated with myocarditis and circulatory failure [2]. But it remains unclear whether heart failure is a consequence of exacerbation of pre-existing left ventricular dysfunction or new cardiomyopathy [1].

Cardiac pericytes with high expression of ACE2 can act as target cells for SARS-CoV-2 [5]. Patients with underlying heart failure showed increased expression of ACE2 at both mRNA and protein levels, meaning that if infected with the virus, these patients may be at higher risk of heart attack and serious illness [3].

Thus, patients with chronic heart failure (CHF) constitute a special risk group for severe COVID-19 and a very high risk of complications. It is possible to worsen the course of CHF against the background of a coronavirus infection due to the addition of respiratory failure typical for this disease, fibrotic changes in the lung tissue and aggravation of cardiopulmonary

insufficiency. In this regard, it is optimal to organize dispensary observation of patients with CHF in high-risk rooms.

In the convalescent period after COVID-19, symptoms may persist for a long time, including subfebrile condition, dyspepsia, so it is necessary to continue monitoring the volume of fluid drunk and excreted and the patient's body weight, remembering the need to increase fluid intake with an increase in its loss (significant sweating, fever body, diarrhea, etc.). In the presence of appropriate indications, monitoring of blood electrolytes and the state of kidney function is necessary. It must be remembered that increased dyspnea may be associated with both decompensated CHF and pulmonary embolism or with the development of respiratory failure.

Compared with healthy controls and risk factor-matched controls, patients recently recovered from COVID-19 had lower ejection fraction, higher volumes and higher left ventricular mass, and elevated T1 and T2 on MRI. But none of these measures correlated with time at diagnosis of COVID-19. [four]

In terms of radiographic imaging, in addition to ground glass syndrome and interlobular septal thickening, the ratio of central to gradient distribution was higher in patients with heart failure than in patients with COVID-19. In patients with heart failure, the degree of small pulmonary vein dilatation was higher, and the regression of lung lesions was significantly accelerated after effective treatment of heart failure [12].

Adjusted for age, pre-existing cardiovascular disease (hypertension, coronary artery disease, and congestive heart failure), cerebrovascular disease, diabetes mellitus, chronic obstructive pulmonary disease, renal failure, cancer, ARDS, creatinine levels above 133 μmol/L, and NT -proBNP above 900 pg/mL, Cox's multivariate adjusted proportional hazards regression model showed a significantly higher risk of death in patients with heart injury.

Given the small amount of literature describing the impact of COVID-19 on the course of CHF, this topic requires more detailed study.

Causes and risk factors for its development.

Among the most common causes of heart failure (in 60-70% of patients), myocardial infarction and MI are distinguished. They are followed by rheumatic heart diseases (14%) and dilated cardiomyopathy (11%). In the group over 60 years old, heart failure is also caused by hypertensive disease (4%). Type 2 diabetes mellitus and its combination with arterial hypertension serve as a frequent cause of heart failure in elderly patients.

Provocative factors cause the manifestation of heart failure in the reduction of compensatory mechanisms of the heart. Unlike causes, risk factors are potentially reversible, and their reduction or elimination can slow the progression of heart failure and even save the patient's life. These include:

Excessive strain of physical and psychoemotional capabilities;

Arrhythmias, pulmonary artery thromboembolism (PET), hypertensive crisis, exacerbation of ischemic heart disease (IHD);
Pneumonia, ARVI, anemia, kidney failure, hyperthyroidism;
Taking drugs that contribute to fluid retention (NYQP, estrogens, corticosteroids), increase arterial pressure (izadrine, ephedrine, adrenaline), cardiotoxic drugs;
A significant and rapid increase in body weight, alcoholism;
A sharp increase in the volume of circulating blood in massive infusion therapy;
Myocarditis, rheumatism, infectious endocarditis;
Non-compliance with recommendations for the treatment of chronic heart failure.
Mechanisms of development of heart failure.
The development of acute heart failure is often observed against the background of myocardial infarction, acute myocarditis, severe arrhythmias (ventricular fibrillation, paroxysmal tachycardia, etc.). In this case, there is a sharp decrease in minute blood pumping and blood flow to the arterial system. Acute heart failure is clinically similar to acute congestive heart failure and is sometimes called acute heart failure.
In chronic heart failure, the changes developing in the heart are compensated for a long time by the intensive work of the vascular system and adaptive mechanisms, including:
Increased heart rate;
Acceleration of the rhythm;
A decrease in pressure in diastole due to the expansion of capillaries and arterioles (this eases blood pumping in systole);
Increased tissue perfusion.
A further increase in the incidence of heart failure is characterized by a decrease in the volume of blood pumping, an increase in the amount of residual blood in the ventricles, their filling during diastole, and excessive stretching of the myocardial muscle fiber. The constant tension of the myocardium, which tries to ensure blood circulation and drive blood into the vessels, leads to its compensatory hypertrophy. However, due to the weakening of the myocardium, the development of dystrophy and sclerosing processes, the stage of decompensation begins. The myocardium itself begins to feel a lack of blood and energy supply.
At this stage, neurohumoral mechanisms are added to the pathological process. Activation of the mechanisms of the sympathetic-adrenal system leads to the narrowing of vessels in the periphery to maintain normal arterial pressure within the larger circulation when the volume of blood pumping is reduced. In this case, the development of renal vasoconstriction leads to renal ischemia, which causes fluid retention in the tissues.
An increase in the secretion of antidiuretic hormone by the pituitary gland increases the processes of water reabsorption, which increases the volume of circulating blood, as a result of which capillary and venous pressure increases, fluid transudation in tissues increases.
Thus, severe heart failure causes severe hemodynamic disturbances in the body:

Gas exchange disorder.

When the blood flow slows down, the amount of oxygen absorbed by the tissues from the capillaries increases from the normal 30% to 60-70%. The arteriovenous difference in blood oxygen saturation increases, which leads to the development of acidosis. Accumulation of unoxidized metabolites in the blood and increased work of respiratory muscles lead to activation of the main metabolism. In this case, a closed circle is created: the body's need for oxygen increases, and the circulatory system cannot satisfy it.

The development of oxygen deficiency leads to cyanosis and shortness of breath. In case of heart failure, cyanosis can be central (due to dampness and blood oxygenation in the small blood circulation) and peripheral (due to slowing down of blood flow and increased utilization of oxygen in tissues). Since heart failure is more pronounced in the periphery, acrocyanosis is observed in patients with heart failure: blueness of the extremities, ears, tip of the nose.

Swellings.

Tumors develop as a result of a number of factors:

Fluid retention in tissues due to increased capillary pressure and slowing of blood flow;

Retention of water and sodium in water-salt metabolism disorders;

Disruption of oncotic pressure of blood plasma when protein metabolism is disturbed;

A decrease in the level of inactivation of aldosterone and antidiuretic hormone in case of a decrease in liver function.

In heart failure, edema is initially hidden and is expressed by a rapid increase in body weight and a decrease in the amount of urine. Visible swelling starts from the legs if the patient is walking, and from the buttocks if he is lying down. Later, fluid accumulates in the cavities: ascites (abdominal cavity), hydrothorax (pleural cavity), hydropericardium (pericardial cavity).

Changes in organs.

Damp events in the lungs are associated with hemodynamic disturbances of small blood circulation. It is characterized by rigidity of the lungs, a decrease in the respiratory excursion of the chest, and limited movement of the edges of the lungs. Dimension events in the framework of large blood circulation cause hepatomegaly (manifested by pain under the right rib), cardiac liver fibrosis.

In heart failure, the enlargement of the cavity of the ventricles and chambers of the heart can lead to the relative insufficiency of the ventricular valves, which is manifested by the bulging of the jugular veins, tachycardia, and the expansion of the heart borders. Nausea, loss of appetite, tendency to vomiting, constipation and flatulence, and a decrease in body weight are observed during the development of gastritis. In progressive heart failure, a severe level of exhaustion - cardiac cachexia develops.

Damping events in the kidneys cause oliguria, increased relative density of urine, proteinuria, hematuria, cylindruria. Disorders of the central nervous system in heart failure are

characterized by rapid fatigue, decreased mental and physical activity, increased restlessness, sleep disorders, and depressive states.

Classification.

Acute and chronic heart failure are distinguished according to the rate of increase of decompensation symptoms.

The development of acute heart failure is divided into two types:

According to the left type (acute left ventricular or left ventricular failure);

Acute right ventricular failure.

According to the Vasilenko-Strajesco classification, three stages are distinguished in the development of chronic heart failure:

I (initial) stage — symptoms of heart failure are hidden, manifested only by shortness of breath and excessive fatigue during physical exertion; hemodynamic disturbances are not observed at rest.

II (significant) stage — long-term circulatory failure and hemodynamic disorders (dampness in small and large blood circulation circles) are expressed even at rest; severe limitation of working capacity: stage II A — moderate hemodynamic disturbances in one part of the heart (left or right ventricular failure). Shortness of breath develops during normal physical activity, work capacity is sharply reduced. Objective signs - cyanosis, swelling of the lower leg, initial signs of hepatomegaly, difficult breathing.

II period B — deep hemodynamic disorders involving the entire cardiovascular system (large and small circle). Objective symptoms - shortness of breath even at rest, severe edema, cyanosis, ascites; complete loss of working capacity.

III (dystrophic, final) stage — severe lack of blood circulation and metabolism, irreversible morphological disorders of the structure of organs (liver, lungs, kidneys), exhaustion.

Symptoms.

Symptoms of acute heart failure.

It is caused by the weakening of the function of one part of the heart: the left ventricle or ventricle, the right ventricle. Acute left ventricular failure develops in diseases in which the load mainly falls on the left ventricle (hypertensive disease, aortic valve, myocardial infarction). When the functions of the left ventricle are weakened, the pressure in the pulmonary veins, arterioles and capillaries increases, their permeability increases, as a result of which the liquid part of the blood begins to leak, and as a result, interstitial and then alveolar edema develops.

Clinical manifestations of acute left ventricular failure are cardiac asthma and alveolar edema of the lungs. Cardiac asthma attacks are usually triggered by physical or neuro-psychic stress. Cases of acute suffocation are often observed at night, causing the patient to wake up from fear. Cardiac asthma is manifested by a feeling of lack of air, palpitations, cough with hard-to-move sputum, severe weakness, cold sweats.

The patient goes into orthopnea - sitting with his legs down. During the examination, pale skin with a slightly gray tint, cold sweat, acrocyanosis, and strong panting are noted. A weak, arrhythmic pulse, expansion of the heart borders to the left, dull heart sounds, horse gallop rhythm are detected; arterial pressure often decreases.

Pulmonary edema develops with increased damping of the small blood circulation. Acute suffocation is accompanied by the release of a large amount of pink foamy sputum. Wet wheezing can be heard in the distance. The patient's position is orthopnea, the face is bruised, the veins of the neck are swollen, the skin is covered with cold sweat. The pulse is thready, arrhythmic, frequent, blood pressure is reduced, various wheezing sounds are heard in the lungs. Pulmonary edema is a life-threatening emergency that requires intensive care.

Acute left ventricular heart failure is caused by mitral stenosis (left ventricular valve). The clinical appearance is the same as acute left ventricular failure. Acute right ventricular failure is often caused by thromboembolism of large branches of the pulmonary artery. As part of the large blood circulation, dampness develops, which is accompanied by swelling of the legs, pain under the right rib, bulging and pulsation of the neck veins, shortness of breath, cyanosis, pain and pressure in the heart area. The peripheral pulse is fast and weak, the arterial pressure is sharply decreased, the central venous pressure is increased, the heart is enlarged to the right. In diseases that lead to decompensation of the right ventricle, heart failure manifests much earlier than in left ventricular failure. This is explained by the great compensatory capabilities of the left ventricle, which is the most powerful part of the heart. However, when the function of the left ventricle decreases, heart failure develops at a catastrophic rate.

Symptoms of chronic heart failure.

The initial stages of chronic heart failure can develop in left and right ventricular, left and right ventricular types. Aortic malformation, mitral valve insufficiency, arterial hypertension, coronary insufficiency develop damping in the vessels of the small circulatory circle and chronic left ventricular failure. It is characterized by vascular and gas exchange changes in the lungs. Shortness of breath, suffocation (usually at night), cyanosis, palpitations, cough (dry, sometimes with blood), rapid fatigue are observed.

More serious damping events in the microcirculation are observed in patients with mitral valve stenosis in chronic left ventricular failure. Shortness of breath, cyanosis, cough, coughing up blood are observed. Pulmonary and vascular sclerosing develops during long-term venous damping in small circle veins. In the circle of small blood circulation, an additional pulmonary barrier is formed for blood circulation. High pressure in the pulmonary artery system increases the load on the right ventricle and leads to its failure.

In case of damage to the right ventricle (right ventricular failure), damping events develop within the larger blood circulation. Right ventricular failure can accompany mitral heart defects, pneumosclerosis, pulmonary emphysema. Complaints of pain under the ribs (right side), swelling, decreased diuresis, abdominal enlargement, shortness of breath when

performing movements appear. Cyanosis (sometimes yellowish-blue), ascites develops, neck and peripheral veins become bulging, and the size of the liver increases.

Functional failure of only one part of the heart cannot be preserved separately for a long time, and eventually total chronic heart failure with venous damping in small and large circulation circles develops. In addition, the development of chronic heart failure is also noted in heart muscle damage: myocarditis, cardiomyopathy, ischemic heart disease, intoxications.

Diagnosis of heart failure.

Since heart failure is a secondary syndrome that develops as a result of certain diseases, diagnostic measures should be directed to early detection of the primary disease, even if there are no clear symptoms.

When collecting clinical anamnesis, it is necessary to pay attention to fatigue and dyspnea as the first signs of heart failure, followed by the presence of IK, hypertension, previous myocardial infarctions and rheumatic injuries, cardiomyopathy in the patient. Small calf swelling, ascites, accelerated low-amplitude heart rate, listening to the III heart tone and displacement of the heart boundaries are specific symptoms of heart failure. If heart failure is suspected, blood electrolyte and gas content, acid-base balance, urea, creatinine, cardiospecific enzymes and protein-carbohydrate metabolism indicators are checked.

ECG helps to identify myocardial ischemia and hypertrophy, as well as arrhythmia based on certain changes. Based on electrocardiography, tests are conducted during the performance of various exercises, in which a bicycle trainer (veloergometry) and a treadmill (treadmill test) can be used. Such tests, which gradually increase the level of load, make it possible to determine the reserve capacity of the heart's function.

With the help of ultrasound echocardiography, it is possible to determine the cause of heart failure, as well as evaluate the pumping function of the myocardium. With the help of heart MRI, CHD, congenital or acquired heart defects, arterial hypertension and other diseases are successfully diagnosed. In case of heart failure, X-ray of lungs and chest reveals dimming processes and cardiomegaly in the small blood circulation.

In patients, radioisotope ventriculography allows obtaining high-precision results for assessing the contractility of the ventricles and determining their volume. In severe forms of the disease, ultrasound examination of the abdomen, liver, spleen, and pancreas is used to determine the degree of damage to internal organs.

Treatment of heart failure.

Therapy is aimed at eliminating the primary cause (IHF, hypertension, rheumatism, myocarditis, etc.). In the presence of heart defects, cardiac aneurysm, adhesive pericarditis causing mechanical obstruction to the work of the heart, surgical intervention is often resorted to.

In acute or severe chronic heart failure, bed rest, complete mental and physical rest are prescribed. In other cases, it is necessary to follow an average load that does not worsen the

situation. Liquid consumption is limited to 500-600 ml, salt - 1-2 g per day. It is prescribed to follow a diet rich in vitamins and easy to digest.

Pharmacotherapy of heart failure allows to improve patients' condition and quality of life.

In this pathology, the following drug groups are prescribed:

Cardiac glycosides (digoxin, strophantin, etc.) — strengthen the contractility of the myocardium, increase its pumping function and diuresis, make endurance to physical exertion satisfactory;

Vasodilators and AAF inhibitors (enalapril, captopril, lisinopril, perindopril, ramipril) - reduce vascular tone, expand veins and arteries, and as a result, reduce vascular resistance during heart contractions;

Nitrates (nitroglycerin and its long-acting forms) - improve blood filling of ventricles, increase heart rate, expand coronary arteries;

Diuretics (furosemide, spironolactone) - reduce excess fluid retention in the body;

β-adrenoblockers (carvedilol) - reduce the rate of heart contractions, improve blood filling of the heart, increase cardiac output;

Anticoagulants (acetylsalicylic acid, warfarin) - prevent thrombus formation in veins;

Medicines that improve the metabolism of the myocardium (group B vitamins, ascorbic acid, inosine, potassium preparations).

In the development of an attack of acute left ventricular failure (pulmonary edema), patients are admitted to the hospital and given urgent therapy: diuretics, nitroglycerin, drugs that increase heart rate (dobutamine, dopamine) are introduced, oxygen inhalation is carried out. In the development of ascites, fluid from the abdominal cavity is removed by puncture, and in the case of hydrothorax, pleural puncture is performed. Patients with heart failure are prescribed oxygen therapy due to severe tissue hypoxia.

Consequences and prevention.

The five-year survival rate in patients is 50%. The subsequent prognosis is variable and is influenced by the severity of heart failure, accompanying pathologies, effectiveness of treatment, lifestyle, etc. Treatment of heart failure in the initial stages fully covers the condition of patients; the worst outcome is observed in stage III heart failure.

As a preventive measure, it is necessary to take measures to prevent diseases that cause pathology (IHF, hypertension, heart defects, etc.) and factors that contribute to its occurrence. In order to prevent the worsening of the developed heart failure, it is necessary to optimize physical activity, take the prescribed drugs and be under the constant supervision of a cardiologist.

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