

# Modern Approaches to the Development of Chronic Obstructive Pulmonary Disease and Its Complications (Literature Review)

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**Abstract** In recent years, chronic obstructive pulmonary disease (COPD) has become one of the most common diseases in the world, and changes such as inflammation, endothelial dysfunction, oxidative process, as well as hypoxia of the lungs and other organs play a leading role in its pathogenesis. This article presents a review of scientific sources on the prevalence, diagnosis and treatment of COPD.

**Keywords** Chronic obstructive pulmonary disease, Pulmonary hypertension

## 1. Introduction

In recent years, chronic obstructive pulmonary disease (COPD) has become one of the most common diseases in the world, and changes such as inflammation, endothelial dysfunction, oxidative process, as well as hypoxia of the lungs and other organs play a leading role in its pathogenesis. According to the results of some authoritative surveillance, the death rate from OSOK ranks fourth among all diseases and averages 4%. It is noted that this disease causes not only respiratory tract, pulmonary and other extrapulmonary systemic complications, including pulmonary hypertension (PH). Among them, O'G is of special clinical importance. Therefore, when pulmonary hypertension is observed in COPD, its specific course, and the death rate is twice as much as in patients without complications of pulmonary hypertension, the need for early diagnosis, effective treatment and prevention of this pathological process is an urgent problem of medicine.

On a global scale, a number of scientific studies are being conducted in order to study the mechanisms of development of pulmonary hypertension in COPD and to achieve high efficiency of treatment coordination. In this regard, it is important for practical medicine to fully study the causes and pathogenesis of pulmonary hypertension observed in patients with COPD, their early diagnosis and the creation of effective treatment methods. Also, to determine cardiac hemodynamics, external respiratory activity, and gas exchange of arterial blood, which play an important role in the progression and decompensation of OSOK, in patients with pulmonary hypertension, justifying that these factors play an important role in the pathogenesis of the disease;

development of rational bases of ways of effective influence on the pathological process and monand treatment methods; improving measures aimed at improving the quality of life of patients is one of the urgent issues of scientific research on this problem.

Chronic Obstructive Pulmonary Disease (COPD) is a process characterized by a sharp decrease in the speed of air flow in the lungs and airways, as well as activation of the chronic inflammatory process in response to the effects of harmful particles or gases. is one of the urgent problems of medicine. According to the official data of the World Health Organization (WHO), about 600 million people of the world are diagnosed with OSOK. The death rate caused by this disease and its consequences is observed to increase over the years. In recent years, despite the progress made in the treatment and diagnosis of the disease in medicine, the disability and death rate among the population due to OSOK and its complications is still high [3,5,8,9].

Today, the prevalence of OSOK among the population, delayed diagnosis, insufficient level of knowledge of primary care physicians about this disease and its consequences require the continuation of scientific research on the development and implementation of effective measures for its diagnosis and treatment [10,8].

In the Russian Federation, the number of patients with OSOK among the elderly population is 6.68% and has increased by 27.2% over the last 7 years [5]. However, in the GARD study, this indicator was 21.8%, and it was justified that the rate of this disease among the Russian population is higher than the figures indicated in official data [1-3,15].

Today, information on the prevalence of OSOK is contradictory, and this is due to the different methods and criteria of examination and late diagnosis of the disease. According to the conclusion of European respiratory and

American Thoracic Society scientists, only 25% of cases of COPD are detected on time. In the remaining cases, pulmonary hypertension (HG) is diagnosed as a result of the disease, and then chronic lung-heart syndrome (CHS) is developed [11]. A meta-analysis of the conducted studies shows that OSOK is more common in men, smokers or former smokers, people over 40 years of age, and urban residents. O'G has a special place among the complications of this disease [12].

## 2. Materials and Methods

According to the recommendations of the experts of the VI World Symposium on OG, its 5 clinical groups are distinguished: 1 group - idiopathic and hereditary, congenital cardiovascular defects, connective tissue systemic diseases, human immunodeficiency syndrome, schistosomiasis, portal hypertension, under the influence of drugs and toxins advanced pulmonary arterial hypertension; 2 - group - advanced heart failure due to damage to the left heart; 3 – group – O'G developed due to lung diseases and/or hypoxemia; 4 - group - OG caused by chronic thromboembolism and 5 - group - OG of uncertain or mixed genesis (City of Nice, 2018). Due to the fact that various diseases cause the development of OG in each group, the pathogenetic mechanisms of its occurrence, clinic, course, consequences, as well as recommendations for treatment, differ from each other.

Therefore, a separate study and deeper understanding of the pathogenetic mechanisms of these groups of OG (including those developed on the basis of OSOK), and the continuation of clinical randomized trials dedicated to the implementation of modern methods of early diagnosis are of great importance in prescribing alternative treatment suitable for its groups [11,14].

It is known from a large number of studies conducted in different countries of the world and published literature that the death rate from OSOK ranks fourth among all diseases and is 4% on average [6,8]. The reason for this is that it leads to respiratory tract, pulmonary and other extrapulmonary systemic complications, including pulmonary hypertension (PH). Among them, O'G is of particular clinical importance (Global Initiative for Chronic Obstructive Lung Disease (GOLD), 2019). The development of complications has a negative impact on the quality of life of patients and is important from a prognostic point of view [11].

According to the available data, about 20% of patients with OSOK and treated in the hospital were diagnosed with OG. In OSOC with severe clinical symptoms, OG was recorded in more than 50% of cases. According to ExoKG, 10.5% of 4579 examined patients, i.e. 483, were diagnosed with O'G. In 78.7% of them, the left ventricle of the heart, in 9.7% of respiratory organs and hypoxemia, and in the remaining cases, diseases leading to O'G of another group [3,7,14,15].

In Europe, the incidence and prevalence of OG is on average 15-60 people per 1,000,000 population and increases by an additional 10 per year [4].

OG is considered a multifactorial pathophysiological condition in which vasoconstriction, obstructive remodeling, inflammatory and biochemical changes and other processes take part in pulmonary vascular wall. Among them, vasoconstriction occurs early in the formation of O'G, and pathological activity of potassium channels in smooth muscle cells and endothelial dysfunction are of certain importance. Endothelial dysfunction Chronic depletion of vasodilators such as nitric oxide and protocylin leads to concomitant overproduction of vasoconstrictors such as thromboxane A2 and endothelin-1. Most of these noted changes increase vascular tone and cause remodeling [12].

The remodeling process covers all layers of the vessel wall with obstructive changes involving endothelium, smooth muscle cells and fibroblasts (Prasad A., 2010). In addition, the adventitia increases the production of extracellular matrix, including collagen, elastin, fibronectin, and tenascin. Also, thrombotic disorders are detected in patients, thrombi occur in the microcirculatory area and elastic pulmonary arteries [10].

In most cases, irreversible obstructive changes in the lungs are accompanied by a decrease in its diffuse state, which develops on the basis of COPD (Pellegrino R., 2005).

In recent years, special attention has been paid to the violation of gas exchange, which plays an important role in the progression and decompensation of OSOK. It is important to determine the content of gases in arterial blood in the assessment of sufficient saturation of tissues with oxygen (oxygenation) and acid-alkaline balance in the body. During the course of the disease, blood environment (PH), arterial blood oxygen (PaO<sub>2</sub>) and partial pressure of carbon dioxide (SO<sub>2</sub>) gas (PaCO<sub>2</sub>), bicarbonate (HCO<sub>3</sub>) content, hemoglobin oxygen saturation (SaO<sub>2</sub>) monitoring are used for early detection of acidosis or alkalosis process in the body and alternative makes it possible to prescribe treatment [11,13]. Therefore, the early detection of these indicators when COPD is accompanied by pulmonary hypertension plays a special role in the alternative evaluation of the course of the disease and the correct selection of treatment principles.

According to the World Health Organization, COPD is the fourth leading cause of death in the population, and 2.75 million people die from this disease per year [2].

Obstructive-type ventilation disorder in COPD, chronic inflammatory process and mucociliary dysfunction, structural changes in the microcirculatory system and bronchial tree lead to the aggravation of the course of the disease and the development of unpleasant complications. The number and occurrence of reported cases increases depending on the degree of bronchial obstruction. In a number of studies, it was noted that the mortality rate due to the pathology of the cardiovascular system in patients with OSOK is 2-3 times higher. However, in recent years, in spite of the widespread use of modern methods in the remodeling of the cardiovascular system and the diagnosis of CVD in patients with OSOC, many questions about the early detection of damage to the heart and pulmonary vessels are still waiting to be answered

[7].

It is known that instrumental examinations have a special place in the diagnosis of OSOK. However, in practice, drawing conclusions based on pathological changes in only one of them is a complicated process. Therefore, according to the 2017 recommendation of the International Global Initiative Society for OSOK (GOLD), it is recommended to carry out the following tests when diagnosing the disease. Spirometry is the most convenient way to determine the speed of air flow through the bronchi. With its help, the forced vital capacity of the lungs (FFC) and the forced expiratory volume in one second (FNChH1) and their ratio are determined to diagnose COPD. In physiological conditions, the normative indicators of OFHS, FNChH1, Tiffno index are higher than 80%. If these indicators are below 70%, it is considered a pathological condition, and OSOK decreases depending on the level of severity. According to the GOLD recommendation, the ratio of FNChH1 / OFHS  $< 0.7$  is a criterion for the diagnosis of OSOK. When analyzing the results of spirometry, the patient's age, gender and anthropometric parameters (height, weight, body structure and body composition) are taken into account.

X-ray examination reveals hyperinfiltration of the lungs, thinning of the vascular image, and an increase in the clarity of the X-ray image. Depending on the severity of the disease, the pulmonary artery trunk is enlarged, the vessels in its peripheral part are rare/invisible, and the right lobe and ventricle are enlarged in severe cases [13]. An important factor in the early diagnosis of the disease is the use of examinations such as computed tomography, ventilation-perfusion scintigraphy, lung diffusivity index, pulse oximetry, and determination of gas content in arterial blood. However, in most cases, patients turn to a doctor after developing complications of the disease, including OG and lung-cardiac syndrome. In such cases, one of the methods of examination widely used in practice should be recommended to conduct the ExoKG examination [11].

At present, transthoracic ExoKG plays an important role in the early detection of structural and functional changes in the heart in patients with OSOK, and it is possible to evaluate O'G and its effect on cardiac remodeling using continuous wave dopplerography. However, the process of conducting ExoKG examination in COPD has its own complexity, in which a narrow acoustic window occurs due to emphysema and hyperinfiltration of the lungs, and the quality of visualization decreases. Nevertheless, ExoKG is considered one of the non-invasive methods that provide relatively high information in evaluating the pressure in the pulmonary artery, the thickness of the wall of the heart chambers and the size of the cavities, myocardial contractility and diastolic activity [4,5,9]. In ExoKG, O'ASB is determined by Bernoulli's equation, taking into account the peak rate of tricuspid regurgitation (TR) and pressure in the right ventricle. In cases where it is difficult to determine the highest rate of TR, contrast ExoKG is used. According to the recommendation of the European Society of Cardiovascular Imaging (2015), several criteria were proposed for the correct determination

of O'ASB, including the ratio of the diameter of the basal part of the right and left ventricles, the index of LV eccentricity, the rate of early regurgitation in O'A during diastole from 2.2 ms high, the blood flow rate in the O'K-carrying part exceeds 105 ms, the diameter of the inferior vena cava is greater than 21 mm and it is reduced by 50% at the peak of inspiration, the right ventricular area is 1.8 cm<sup>2</sup> at the end of systole [3,6]. Determining these criteria makes it possible to measure the O'K size, compressive stress, flow rate outside the O'K, O'K diameter and pressure in the right compartment [12,15]. Examination of ExoKG in patients with COPD is important not only to diagnose COPD, but also to evaluate its effect on cardiac departments and exclude primary cardiac pathology [3,6].

It is known that in patients with COPD, the increase in heart rate is the basis of COPD growth based on the formation of left and right myocardium hypertrophy [5,8]. For this reason, the timely detection of the growth of LVH in patients with LVH using the tissue wave dopplerography method is important in the early diagnosis of hidden systolic and diastolic dysfunction of the heart ventricles, allowing to control the mechanisms of compensatory adaptation of LV strain [15]. In this case, the ratio of the isovolumetric contraction and relaxation periods of the OC to the total blood circulation time, i.e. Tei - index (Teya index), is determined and the global activity of the OC is evaluated. An increase in this index indicates increased O'K dysfunction [15]. In the conducted studies, it was found that the time of isovolumetric relaxation of the basal segment of the free part of the O'Q is correctly related to the pressure in the O'A, and its normative indicators substantiated the reliable exclusion of the O'G [9]. According to the experts' conclusion, in patients with OSOC, the process of obstruction progresses in parallel with the level of diastolic dysfunction not only of the LV, but also of the LV [4,8,13].

There are also a number of complications in conducting ExoKG examination in patients with OG developed due to respiratory diseases of the lungs [4,14]. For this reason, active research is being continued to determine the non-invasive criteria for determining the severity of OG, based on the final data of clinical-biochemical and instrumental examinations. In fact, transthoracic ExoKG maintains its position in modern medicine as a screening test for OG, a non-invasive test method that provides information on the condition of the right and left heart sections [4].

### 3. Conclusions

To conclude from the above, ExoKG examination in patients with OSOC allows early detection of OG and cardiovascular system remodeling, and elimination of unpleasant complications of the disease based on the selection of alternative treatment. At the same time, the wide application of this diagnostic method in practice can prevent early differentiation of comorbid conditions and high-risk groups in patients with COPD, and the prescription of drugs with cardiac side effects or their dose increase.

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