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LABORATORY ASSESSMENT OF INFLAMMATORY BIOMARKERS IN PULMONARY DISEASES

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Abstract. Inflammatory lung diseases are among the most common causes of morbidity and mortality and are accompanied by the development of systemic and local inflammatory responses. This article reviews the main inflammatory markers used in the laboratory diagnosis of lung diseases and discusses their diagnostic and prognostic significance. Particular attention is given to indicators such as C-reactive protein, procalcitonin, interleukins, ferritin, and parameters of the complete blood count. The role of laboratory investigations in the differential diagnosis of bacterial and viral infections, assessment of inflammatory activity, monitoring of treatment effectiveness, and prediction of disease course is demonstrated. A comprehensive laboratory approach facilitates timely diagnosis, rational selection of therapeutic strategies, and improvement of clinical outcomes in patients with lung diseases.

Keywords: inflammatory biomarkers, pulmonary diseases, laboratory diagnostics, C-reactive protein, procalcitonin, interleukins, ferritin, complete blood count, bacterial infections, viral infections, differential diagnosis, disease monitoring

Relevance. Inflammatory lung diseases remain one of the most pressing problems of modern clinical medicine, occupying a significant place in the structure of population morbidity and mortality. Pneumonia, chronic obstructive pulmonary disease, bronchial asthma, and interstitial lung diseases are often accompanied by a pronounced inflammatory response, which determines the severity of the clinical course and the risk of complications [3,8,11].

Clinical manifestations of inflammatory lung diseases are often nonspecific and may vary depending on the etiology and stage of the pathological process, which complicates early diagnosis and the differentiation of bacterial and viral infections. In this regard, laboratory methods for assessing inflammatory markers acquire particular importance, as they allow objective evaluation of inflammatory activity and timely detection of pathological changes [6,7,10].

Modern laboratory parameters such as C-reactive protein, procalcitonin, interleukins, ferritin, and complete blood count indices are widely used to confirm the diagnosis, assess disease severity, and monitor the effectiveness of therapy. Their application contributes to the rational use of antibacterial drugs, reduces the risk of antibiotic resistance, and improves clinical outcomes.

Inflammatory lung diseases develop as a result of exposure to infectious and non-infectious factors that lead to damage of the respiratory epithelium and activation of immune-inflammatory mechanisms. The most common etiological agents include bacterial and viral infections, as well as allergens, toxic substances, and autoimmune processes [1,4,6].

The primary link in pathogenesis is the activation of innate immune cells—alveolar macrophages and neutrophils—which recognize pathogens and damaged cells. In response, pro-inflammatory cytokines and mediators, including interleukins (IL-1, IL-6), tumor necrosis factor-α, and chemokines, are released, leading to increased vascular permeability, leukocyte migration to the site of inflammation, and the development of a local inflammatory process in lung tissue [3,12,15].

The systemic inflammatory response is accompanied by an increase in the concentration of acute-phase proteins, such as C-reactive protein and ferritin, which are synthesized predominantly in the liver under the influence of cytokines. In bacterial infections, the production of procalcitonin is activated, and its level correlates with the severity of the inflammatory process and the extent of lung tissue involvement. Changes in complete blood count parameters, including leukocytosis, neutrophilia, and an increased erythrocyte sedimentation rate, reflect the degree of inflammatory activity [3,7,15].

In chronic or prolonged inflammation, remodeling of bronchopulmonary tissue occurs, with activation of fibroblasts and the development of fibrotic changes, leading to impaired gas exchange and progression of respiratory failure. Thus, the pathogenesis of lung diseases is closely associated with the dynamics of inflammatory markers, the laboratory assessment of which is of great importance for diagnosis, monitoring, and prognosis of the disease [1,7,15].

The clinical manifestations of inflammatory lung diseases are characterized by considerable variability and depend on the etiology, localization, and extent of the inflammatory process, as well as the patient's age and the presence of comorbidities. The most common clinical forms include pneumonia, acute and chronic bronchitis, exacerbations of chronic obstructive pulmonary disease, and interstitial lung diseases [9,14,15].

The main symptoms of inflammatory lung diseases include cough, which may be dry or productive with mucous or purulent sputum, dyspnea of varying severity, fever, general weakness, and fatigue. Fever and chills are more often observed in bacterial etiologies and are accompanied by pronounced signs of intoxication. When alveolar tissue and the pleura are involved in the pathological process, chest pain may occur, intensifying during breathing and coughing. Impaired gas exchange manifests as cyanosis, tachypnea, and decreased oxygen saturation. In patients with severe disease, signs of acute respiratory failure may develop [3,13].

The clinical picture of inflammatory lung diseases is often combined with systemic manifestations of inflammation, such as tachycardia, arterial hypotension, and deterioration of the general condition. In some cases, especially in elderly individuals and patients with immunodeficiency states, symptoms may be subtle, which emphasizes the importance of laboratory diagnostics of inflammatory markers for timely disease detection and assessment of its activity [6,10].

Laboratory diagnostics of inflammatory lung diseases plays a key role in identifying the activity of the inflammatory process, determining its etiology, and assessing disease severity. A comprehensive set of laboratory investigations objectively complements clinical and instrumental data and allows timely determination of treatment strategy. One of the main laboratory diagnostic methods is the complete blood count, which reveals signs of systemic inflammation such as leukocytosis, neutrophilia, a left shift of the leukocyte formula, and an increased erythrocyte sedimentation rate. These changes reflect the intensity of the inflammatory response and often correlate with the clinical severity of the disease [7,15].

Among the most informative biochemical markers of inflammation is C-reactive protein, the level of which increases during acute inflammatory processes and is used to assess disease activity and monitor the effectiveness of ongoing therapy. Procalcitonin is a specific marker of bacterial infection and is widely used for the differential diagnosis of bacterial and viral lung diseases, as well as to justify the initiation of antibacterial therapy. Additional diagnostic value is provided by ferritin and interleukins, which reflect the systemic inflammatory response and the immune status of the body. In certain cases, arterial blood gas analysis is performed to assess the severity of respiratory failure. Microbiological examination of sputum and serological tests make it possible to identify the etiological agent of the disease [6,11].

Inflammatory lung diseases, in the absence of timely diagnosis and adequate treatment, may lead to the development of serious complications that significantly worsen prognosis and quality of life. The severity of complications largely depends on the etiology of the disease, the extent of the inflammatory process, and the general

condition of the patient. One of the most dangerous complications is acute respiratory failure, which develops as a result of pronounced inflammation of the alveolar tissue and impaired gas exchange. Progression of the inflammatory process may lead to the formation of lung abscesses, pleuritis, and pleural empyema, especially in bacterial infections.

The systemic inflammatory response may result in the development of sepsis and septic shock, accompanied by multiple organ failure. In patients with chronic lung diseases, exacerbation of the underlying condition, increased bronchial obstruction, and progression of chronic respiratory failure may occur [7,14,15].

Prolonged inflammatory processes contribute to the development of fibrotic changes in lung tissue, reduced lung elasticity, and impairment of ventilation–perfusion relationships. In this context, laboratory inflammatory markers remain important indicators for the early detection of complications, assessment of their severity, and monitoring of treatment effectiveness [5].

Conclusion. Inflammatory lung diseases represent an important medical and social problem due to their high prevalence, severity of clinical course, and risk of complications. In the presence of variability and nonspecificity of clinical manifestations, laboratory assessment of inflammatory markers becomes particularly significant, as it allows objective evaluation of the activity of the pathological process and its etiological characteristics. Determination of indicators such as C-reactive protein, procalcitonin, interleukins, ferritin, and complete blood count parameters plays a key role in the early diagnosis of lung diseases, differentiation between bacterial and viral infections, and monitoring the effectiveness of ongoing therapy. Dynamic monitoring of changes in laboratory markers contributes to the timely detection of complications and adjustment of therapeutic strategies.

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