

CONTEMPORARY APPROACHES TO ETIOLOGICAL DIAGNOSIS OF SEPSIS IN CLINICAL PRACTICE

Yulayeva I.A.

Assistant of Department of Clinical Laboratory Diagnostics,
Samarkand State Medical University

Tirkashova N.B.

Student of the Department of Clinical Laboratory Diagnostics,
Samarkand State Medical University

Annotation. *Sepsis remains one of the leading causes of mortality in intensive care units worldwide, characterized by high incidence and fatality rates. The rapid progression of the disease, nonspecific clinical manifestations, and delays in etiological diagnosis significantly hinder the timely initiation of adequate antimicrobial therapy. According to evidence-based data, each hour of delay in patients with septic shock is associated with a substantial increase in mortality risk.*

In this context, the implementation of modern laboratory technologies that enable rapid identification of causative pathogens and determination of their antimicrobial susceptibility is of particular importance. Advanced diagnostic approaches make it possible to reduce the time to etiological diagnosis to one working day, optimize individualized antimicrobial therapy, and improve clinical outcomes in patients with sepsis.

Key words: *sepsis, etiological diagnosis, rapid laboratory diagnostics, antimicrobial susceptibility testing, multidrug-resistant microorganisms, individualized antimicrobial therapy, intensive care.*

Sepsis continues to represent a serious global medical and social challenge and remains one of the leading causes of death among patients treated in intensive care

units worldwide. Despite substantial progress in the development of antimicrobial agents, advances in intensive care medicine, and improvements in laboratory diagnostic methods, sepsis is still characterized by high rates of morbidity and mortality, as well as a considerable economic burden on healthcare systems. The critical relevance of this condition is primarily determined by its rapid and often unpredictable clinical course, significant difficulties in early and accurate diagnosis, and delays in the timely initiation of appropriate etiological therapy [6].

According to the World Health Organization, sepsis affects approximately 49 million people annually worldwide, accounting for nearly 11 million deaths each year, which corresponds to about 19-20% of all global deaths. Particularly high incidence and mortality rates are observed in low- and middle-income countries, where limitations in early diagnosis and access to modern diagnostic technologies persist. At the same time, sepsis remains a major cause of death even in high-income countries, especially among elderly patients, newborns, and individuals with immunodeficiency or chronic comorbid conditions [1,2].

The etiological profile of sepsis is largely dominated by bacterial pathogens. Among these, Gram-negative bacteria such as *Escherichia coli*, *Klebsiella* species, and *Pseudomonas aeruginosa*, as well as Gram-positive bacteria including *Staphylococcus aureus*, *Streptococcus* species, and *Enterococcus* species, play a central role. In addition, fungal agents, primarily species of *Candida*, are responsible for approximately 10–15% of sepsis cases, especially affecting immunocompromised individuals and patients subjected to extended periods of intensive care. The increasing incidence of multidrug-resistant microorganisms, as reported by the World Health Organization, presents a significant challenge in selecting effective antimicrobial treatments and is associated with higher mortality rates [4].

From a clinical perspective, sepsis is defined as a life-threatening condition characterized by organ dysfunction resulting from a dysregulated host response to infection. The syndrome manifests through a wide range of clinical signs, including fever or abnormally low body temperature (hypothermia), rapid heart rate

(tachycardia), accelerated breathing (tachypnea), low blood pressure (hypotension), impaired consciousness, and progressive failure of vital organs. Epidemiological studies indicate that up to 40–50% of sepsis patients develop multiple organ dysfunction syndrome (MODS), and progression to septic shock is linked to mortality rates exceeding 40%, despite the availability of contemporary therapeutic interventions [5].

The nonspecific and heterogeneous nature of early clinical symptoms often leads to delayed diagnosis. From the standpoint of evidence-based medicine, it has been demonstrated that each hour of delay in the initiation of adequate antimicrobial therapy increases mortality by approximately 7-8% in patients with septic shock. Therefore, rapid and accurate etiological diagnosis, including identification of the causative pathogen and determination of its antimicrobial susceptibility, is a key factor in improving survival and clinical outcomes in patients with sepsis. In this regard, the development and implementation of modern technological methods for the etiological diagnosis of sepsis represent a priority direction in contemporary clinical laboratory diagnostics, enabling a significant reduction in diagnostic time and optimization of individualized antimicrobial therapy.

Traditional methods for the etiological diagnosis of sepsis include: bacteriological research, serological method, mass spectrometry, polymerase chain reaction (PCR) and gas chromatography [2]. For clinical practice, the most important information regarding the choice of effective antibiotic therapy is the bacteriological method. Despite significant technological progress in relation to bacteriological studies (use of selective media, automation, accelerated diagnostic panels), the time to establish the type of pathogen and determine its sensitivity to antibacterial drugs takes at best 24- 48 hours. At the same time, from the standpoint of evidence-based medicine, it has been established that every hour of delay in adequate antibiotic therapy in patients with septic shock reduces survival by 7.6% [4].

Recent advancements in modern diagnostic technologies have enabled a significant reduction in the time required for the etiological identification of sepsis

pathogens and the selection of effective antimicrobial therapy, often allowing these processes to be completed within just a few hours. Current approaches to sepsis diagnostics can be broadly categorized into three strategies: accelerated determination of antimicrobial susceptibility combined with individualized treatment; rapid identification of microorganisms to guide empirical therapy; and integrated methods that merge the advantages of both rapid pathogen identification and expedited susceptibility testing, while also incorporating a personalized therapeutic plan. Together, these innovative approaches facilitate earlier initiation of targeted therapy, optimizing clinical outcomes and reducing the high mortality rates associated with sepsis.

Technologies belonging to the first group make it possible to monitor the growth of bacteria in broths designed specifically for human urine and biological fluids, starting from the moment of inoculation. Mathematical processing of the results of bacterial growth in real time makes it possible to obtain not only a qualitative assessment of the presence / absence of microorganisms in the sample, but also a quantitative assessment of the initial bacterial content in CFU / ml. The result of the study can be obtained within 3-6 hours, and sensitivity to antibacterial drugs can be established within the next 3 hours [6].

The second group of approaches is based on the use of modifications of the mass spectrometry method. The most actively used matrix-assisted laser desorption / ionization (MALDI). The colony material is mixed with an ionizing matrix, then the sample is irradiated with an ultraviolet laser, which ionizes the soluble proteins of microorganisms, which are distributed by mass / charge. Analysis of the mass spectrum of proteins from colonies with a database of spectra collected from known microorganisms using a database program allows you to identify the type of bacteria. Based on the established type of bacteria and analysis of the literature, the most effective antibacterial therapy is determined. Identification of the type of microorganism is carried out within a few minutes. The disadvantage of the method is that it takes time (at least 24 hours) to obtain a pure culture. The combination of 2

approaches allows you to establish the type of microorganism in patients with sepsis for a maximum of 6 hours and determine the sensitivity to antibacterial drugs for the next 3 hours [3].

Thus, modern technologies make it possible to reduce the time for the etiological diagnosis of sepsis, the determination of sensitivity to antibacterial drugs, and the choice of an individual approach to treatment to one working day of bacteriological laboratory specialists.

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