

Infective endocarditis: clinical features, diagnosis, and modern treatment approaches

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Abstract

Infective endocarditis (IE) is a serious infectious disease characterized by microbial infection of the endocardial surface of the heart, most commonly involving the heart valves. The condition is associated with significant morbidity and mortality despite advances in diagnostic and therapeutic methods. The disease develops when microorganisms enter the bloodstream and colonize damaged cardiac tissue, leading to the formation of vegetations. Clinical manifestations range from fever and heart murmurs to severe complications such as heart failure, stroke, and systemic embolization. Diagnosis relies on blood cultures, echocardiography, and the Modified Duke Criteria. Early identification and prompt initiation of targeted antimicrobial therapy are essential for successful treatment. In selected cases, surgical intervention may be required to prevent life-threatening complications. Recent advances in diagnostic imaging, molecular microbiology, and therapeutic strategies have improved patient outcomes. Nevertheless, infective endocarditis remains a major challenge in modern cardiology and infectious disease practice.

17

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Infective endocarditis remains a significant global health problem, with an estimated incidence of 3–10 cases per 100,000 population annually. The disease affects individuals of all ages but is more common among older adults due to the increasing prevalence of degenerative valvular disease, prosthetic heart valves, and invasive medical procedures. Men are affected more frequently than women. In developing countries, rheumatic heart disease continues to be a major predisposing factor, whereas in developed nations healthcare-associated infections and intravenous drug use are increasingly important causes.

The microbiological profile of infective endocarditis varies according to patient characteristics and healthcare exposure. Gram-positive cocci account for the majority of cases. *Staphylococcus aureus* is currently the leading pathogen, particularly in healthcare-associated infections and intravenous drug users.

Viridians streptococci are commonly associated with poor dental hygiene and dental procedures. Enterococci are frequently isolated in elderly patients and those with genitourinary infections. Fungal endocarditis is relatively rare but associated with high mortality. Common fungal pathogens include *Candida* and *Aspergillus* species. These infections are often observed in immunocompromised patients or those with prosthetic valves. Infective endocarditis may result in numerous local and systemic complications. Cardiac complications include valve destruction, acute valvular insufficiency, myocardial abscess formation, conduction abnormalities, and congestive heart failure. Heart failure remains the most common cause of death among affected patients.

Systemic complications occur when fragments of vegetations detach and travel through the bloodstream. Embolic events may affect the brain, kidneys, spleen, lungs, and peripheral arteries. Neurological complications such as ischemic stroke, brain abscess, and intracranial hemorrhage significantly worsen prognosis. Renal

complications may develop due to immune complex deposition, embolic infarction, or nephrotoxic effects of antimicrobial therapy. Septic shock and multiorgan failure can occur in severe cases. Recent advances in diagnostic technology have improved the accuracy of infective endocarditis detection. Molecular diagnostic methods, including polymerase chain reaction (PCR) and next-generation sequencing, allow identification of microorganisms even when blood cultures are negative. Cardiac computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET/CT) are increasingly used to detect perivalvular complications and prosthetic valve infections. These technologies complement traditional echocardiography and provide valuable information for treatment planning. Artificial intelligence and machine-learning algorithms are being investigated as tools for improving diagnostic accuracy and predicting disease outcomes. These emerging technologies may contribute to earlier diagnosis and more personalized treatment strategies. The prognosis of infective endocarditis depends on several factors, including patient age, causative organism, presence of complications, and timing of treatment initiation. Mortality rates remain relatively high despite advances in medical care. Early diagnosis, prompt antimicrobial therapy, and timely surgical intervention significantly improve survival rates. Patients require long-term follow-up after treatment because recurrent infection may occur, particularly in individuals with persistent risk factors. Regular clinical assessment and echocardiographic monitoring are important components of post-treatment management. Ongoing research focuses on improving preventive strategies, developing novel antimicrobial agents, and identifying biomarkers for earlier diagnosis. Advances in genomics and precision medicine may facilitate individualized treatment approaches based on pathogen characteristics and patient-specific risk factors. Improved understanding of host immune responses and bacterial virulence

mechanisms may lead to the development of targeted therapies that reduce tissue damage while enhancing pathogen clearance. Future innovations are expected to improve both survival and quality of life for patients with infective endocarditis. Infective endocarditis is a complex and potentially fatal cardiovascular infection that requires rapid diagnosis and multidisciplinary management. Despite substantial progress in diagnostic imaging, microbiological testing, and antimicrobial therapy, the disease continues to present significant clinical challenges. Early recognition, effective treatment, prevention of complications, and continued research remain essential for improving outcomes in patients with infective endocarditis.

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