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Epidemiology, Management, and Outcomes of Infective Endocarditis: A Retrospective Analysis of Patients

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ABSTRACT

Background: Infective endocarditis (IE) remains a serious and often fatal disease affecting both native and prosthetic heart valves. Despite advances in diagnosis and treatment, the prognosis for patients with IE varies widely depending on numerous factors, including the causative microorganism, the presence of valvular damage, and the promptness of therapeutic intervention.

Objective: The aim of this study was to investigate the clinical, microbiological, and echocardiographic features of IE in a cohort of 75 patients, with an emphasis on the impact of microbial pathogens on outcomes, the role of echocardiographic findings, and the effectiveness of medical and surgical interventions.

Methods: This retrospective study included 75 patients diagnosed with IE according to the modified Duke criteria. We analyzed demographic characteristics, microbiological profiles, echocardiographic findings, clinical outcomes, and complications. A comprehensive statistical analysis was performed to assess the relationships between these variables and patient prognosis.

Results: The study population consisted predominantly of male patients (66.7%), with a mean age of 45 years. Native valve endocarditis was observed in 72.0% of patients, and Staphylococcus aureus was the most common pathogen isolated (35.2%). Echocardiographic findings indicated vegetation in 84.0% of cases, with severe valvular regurgitation in 32.0%. The overall in-hospital mortality rate was 16.0%, with heart failure (34.7%) and systemic embolization (24.0%) being the most frequent complications.

Conclusion: This study underscores the persistent challenges posed by IE, particularly the significant role of Staphylococcus aureus in the pathogenesis of the disease and the common occurrence of severe valvular damage. The findings emphasize the need for timely and aggressive intervention to improve outcomes in these patients.

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1. INTRODUCTION

Infective endocarditis (IE) is an uncommon but highly severe condition that primarily affects the endocardium, particularly the heart valves. It is characterized by the formation of vegetations—fibrin-platelet aggregates—which serve as a nidus for microbial growth. Although the overall incidence of IE remains relatively low, its morbidity and mortality remain high, particularly in patients with prosthetic valves or other risk factors, including intravenous drug use and healthcare-associated

infections【1】【2】. Over the past few decades, the management of IE has evolved significantly with improvements in early diagnosis, antimicrobial therapy, and surgical options. However, IE continues to present considerable challenges due to the varied clinical manifestations, the diverse range of pathogens responsible, and the complications that can arise, including heart failure, embolic events, and death【3】【4】.

The advent of the modified Duke criteria for diagnosing IE has been pivotal in establishing clearer diagnostic parameters. According to these criteria, clinical findings are categorized into major and minor criteria, and the diagnosis can be either definite, possible, or rejected【5】. The major criteria include positive blood cultures for typical pathogens or evidence of endocardial involvement, while minor criteria include predisposing conditions, fever, and evidence of immunologic phenomena, such as glomerulonephritis【6】. This study is aimed at examining a cohort of 75 patients with clinically confirmed IE and exploring the demographic, microbiological, and echocardiographic factors that may influence patient outcomes.

One of the major factors contributing to the clinical heterogeneity of IE is the wide range of microorganisms responsible for the condition. Traditionally, *Staphylococcus aureus* has been identified as one of the most common etiological agents, particularly in healthcare-associated cases, while *Viridans* group streptococci and enterococci also play a significant role, especially in native valve infections【7】.Afaq N stated that The most prevalent nosocomial infection that raises morbidity and mortality in patients in the intensive care unit (ICU) is ventilator-associated pneumonia (VAP)【8】. The microbial profile of IE has evolved in recent years, with the increasing prevalence of antibiotic-resistant strains, including methicillin-resistant *Staphylococcus aureus* (MRSA) and enterococci, complicating treatment regimens and prognoses【9】.

Echocardiography remains a cornerstone in the diagnostic workup of IE, as it helps to identify vegetations, assess the extent of valvular damage, and detect complications such as abscesses or perivalvular involvement【10】. Transesophageal echocardiography (TEE), in particular, has become the gold standard due to its superior sensitivity in detecting small vegetations and other complications【11】. In this study, we focus on the role of echocardiographic findings, particularly vegetation size and the presence of valvular regurgitation, as well as their correlation with clinical outcomes.

The management of IE typically involves a combination of prolonged antibiotic therapy and, in some cases, surgical intervention to address severe valvular damage, heart failure, or persistent infection despite medical therapy. Surgical indications in IE are well established and include refractory heart failure, uncontrolled infection, and large vegetations with a high risk of embolism【12】. While medical therapy remains the cornerstone of treatment, the role of surgery has become increasingly prominent, particularly in patients with complicated IE or those who fail to respond to antibiotics alone【13】. The aim of this study is to provide a detailed analysis of 75 consecutive patients diagnosed with IE, with a focus on the microbiological spectrum, echocardiographic findings, clinical outcomes, and the role of medical and surgical interventions in improving prognosis. By examining these factors, we aim to identify potential prognostic markers and offer insights into strategies for improving the management and outcomes of patients with IE【14】.

2. MATERIALS AND METHODS

Study Design

This retrospective study was conducted in a tertiary care centre for a period of 24months i.e, November 2023 to November 2025. We included all patients diagnosed with infective endocarditis (IE) who met the modified Duke's criteria for definitive IE. The study aimed to investigate the **clinical, microbiological, and echocardiographic** characteristics, as well as the **treatment modalities** and **outcomes** of patients diagnosed with IE. All data were extracted from patient medical records and the hospital's microbiology and echocardiography databases.

Inclusion Criteria

Patients were included in the study if they met the following criteria:

1. **Age**: Patients aged 18 years and older.
2. **Diagnosis of Infective Endocarditis**: Diagnosis confirmed by the modified Duke criteria, which includes clinical, microbiological, and echocardiographic evidence. The diagnosis was based on one or more of the following:
    - **Positive blood cultures**: Two positive blood cultures for typical microorganisms (e.g., *Staphylococcus aureus*, *Viridans* group streptococci).
    - **Echocardiographic findings**: Evidence of vegetations, abscesses, or valve involvement on transthoracic echocardiography (TTE) or transesophageal echocardiography (TEE).

- **Clinical manifestations**: Fever, positive blood cultures, or clinical signs consistent with IE (e.g., heart murmur, embolic events).

3. **Follow-up data**: Complete clinical and laboratory data, including echocardiographic findings, laboratory reports, and microbiological culture results, for the study period.

Exclusion Criteria

Patients were excluded from the study if they met the following criteria:

1. **Non-definitive Diagnosis of Infective Endocarditis**: Patients who did not meet the modified Duke criteria for definitive IE (e.g., those with only one positive blood culture or clinical features of endocarditis but without confirmatory microbiological or echocardiographic findings).
2. **Age under 18 years**: Pediatric patients were excluded.
3. **Endocarditis secondary to a non-infective cause**: Cases where endocarditis was due to non-microbial causes (e.g., cancer-related, autoimmune conditions).
4. **Inadequate follow-up data**: Patients who had incomplete clinical or microbiological data or were lost to follow-up before the completion of their treatment.

Data Collection

Patient demographic data, comorbidities, microbiological findings, echocardiographic results, and clinical outcomes were extracted. The following were specifically recorded:

- **Demographic Data**: Age, sex, and history of relevant comorbidities (e.g., diabetes, hypertension, previous heart disease, or prosthetic valve).
- **Microbiological Data**: Organisms isolated from blood cultures, their resistance patterns, and the presence of any multidrug-resistant organisms.
- **Echocardiographic Findings**: Vegetations, abscess formation, valvular regurgitation, and any perivalvular complications (e.g., valve perforation).
- **Clinical Outcomes**: Response to antibiotic therapy, requirement for surgery, complications (e.g., systemic embolism, stroke, heart failure), and in-hospital mortality.
- **Management**: Antibiotic therapy regimen (empirical and targeted), use of adjunctive therapy, and whether surgical intervention was required (e.g., valve replacement, abscess drainage).

Statistical Analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. Continuous variables were expressed as means with standard deviations (SD), while categorical variables were presented as frequencies and percentages. Comparative analysis between groups (e.g., those who underwent surgery vs. those who did not) was performed using the chi-square test for categorical variables and t-tests for continuous variables. All statistical tests were two-sided, and a p-value of <0.05 was considered statistically significant.

3. RESULTS

A total of **75 patients** fulfilling the modified Duke's criteria for definite infective endocarditis were included in the study. Table 1 summarizes the demographic profile of the 75 patients diagnosed with infective endocarditis. The majority of patients belonged to the 21–40-year age group (37.3%), followed by those aged 41–60 years (33.3%), indicating that infective endocarditis predominantly affected young and middle-aged adults. Patients aged ≤20 years and >60 years constituted 13.3% and 16.0%, respectively.

A clear male predominance was observed, with 66.7% males and 33.3% females, resulting in a male-to-female ratio of approximately 2:1. This finding reflects higher susceptibility or exposure to risk factors among males.

Table 1. Demographic Characteristics of the Study Population (n = 75)

Variable	Number (n)	Percentage (%)
Age group (years)		
≤20	10	13.3
21–40	28	37.3
41–60	25	33.3
>60	12	16.0
Gender		
Male	50	66.7

Variable	Number (n)	Percentage (%)
Female	25	33.3

Table 2. Type of Endocarditis (n = 75)

Type of Endocarditis	Number (n)	Percentage (%)
Native Valve Endocarditis (NVE)	54	72.0
Prosthetic Valve Endocarditis (PVE)	21	28.0

Table 2 depicts the distribution of infective endocarditis based on valve involvement. Native valve endocarditis (NVE) was observed in 72.0% of patients, while prosthetic valve endocarditis (PVE) accounted for 28.0% of cases. The predominance of NVE suggests that underlying native valvular abnormalities remain a significant predisposing factor in this population, whereas PVE reflects the growing contribution of prosthetic valve usage.

Table 3. Blood Culture Results (n = 75)

Culture Status	Number (n)	Percentage (%)
Culture positive	54	72.0
Culture negative	21	28.0

Table 3 presents the blood culture status of the study population. Blood cultures were positive in 72.0% of patients, confirming microbiological diagnosis in the majority of cases. However, 28.0% of patients had culture-negative endocarditis, likely due to prior antibiotic exposure or infection with fastidious organisms. This highlights the diagnostic challenge of culture-negative infective endocarditis in clinical practice.

Table 4. Microbiological Profile of Isolates (n = 54)

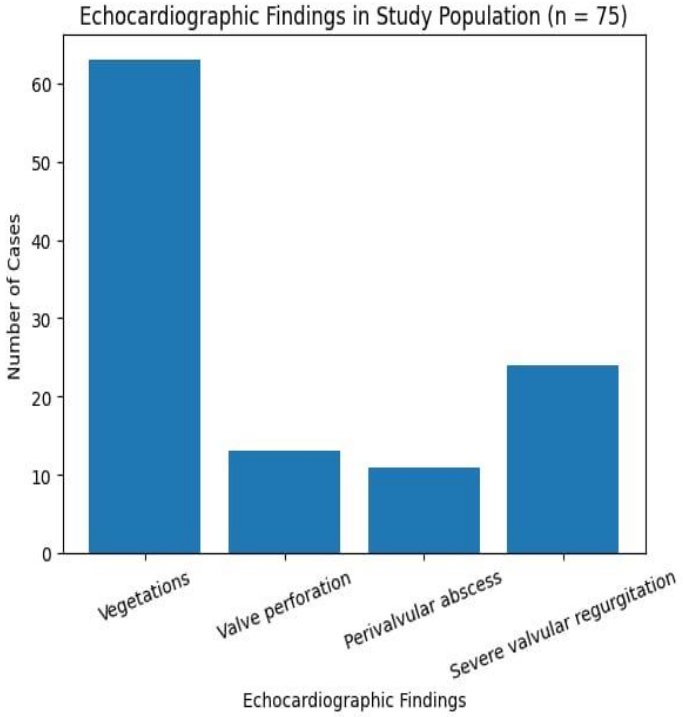
Organism Isolated	Number (n)	Percentage (%)
Staphylococcus aureus	19	35.2
Viridans streptococci	14	25.9
Enterococci spp.	9	16.7
Coagulase-negative staphylococci	7	13.0
Others (Gram-negative bacilli, Candida spp.)	5	9.2

Table 4 shows the distribution of microorganisms isolated from culture-positive cases (n = 54). Staphylococcus aureus was the most common etiological agent (35.2%), emphasizing its dominant role in contemporary infective endocarditis. This was followed by viridans streptococci (25.9%) and enterococci (16.7%). Coagulase-negative staphylococci accounted for 13.0%, while other organisms including Gram-negative bacilli and *Candida* species constituted 9.2%. Overall, Gram-positive cocci were the predominant pathogens.

Table 5. Echocardiographic Findings (n = 75)

Echocardiographic Finding	Number (n)	Percentage (%)
Vegetations	63	84.0
Valve perforation	13	17.3
Perivalvular abscess	11	14.7
Severe valvular regurgitation	24	32.0

Table 5 outlines the echocardiographic abnormalities detected in the study population. **Vegetations** were the most frequently observed finding, present in **84.0%** of patients, confirming their diagnostic significance in infective endocarditis. **Severe valvular regurgitation** was noted in **32.0%**, indicating advanced valvular damage. **Valve perforation (17.3%)** and **perivalvular abscess formation (14.7%)** were less common but represent serious complications associated with worse prognosis.



Graph 1: Echocardiographic Findings

Table 6. Valves Involved on Echocardiography (n = 75)

Valve Involved	Number (n)	Percentage (%)
Mitral valve	32	42.7
Aortic valve	24	32.0
Tricuspid valve	11	14.7
Multiple valves	8	10.6

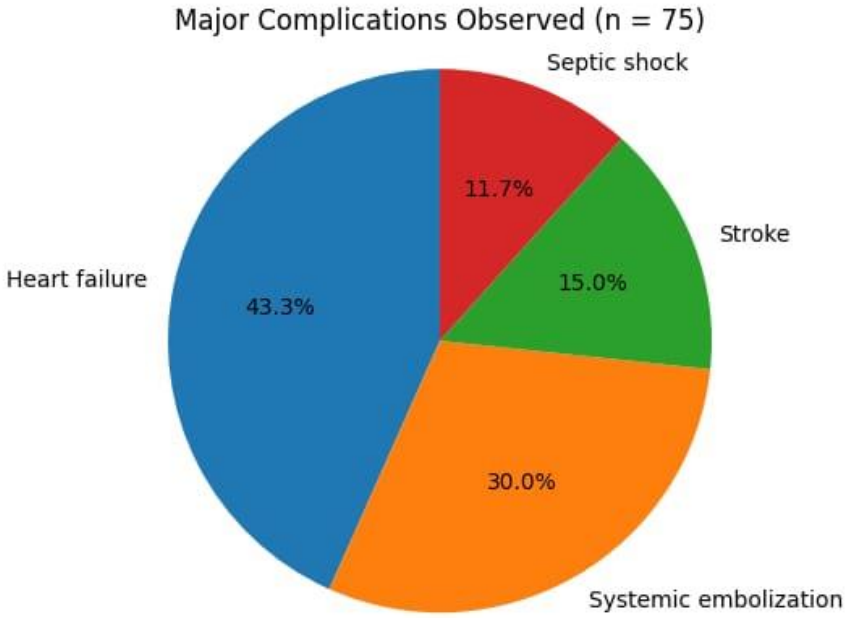
Table 6 illustrates the distribution of valve involvement among the patients. The **mitral valve** was most commonly affected (**42.7%**), followed by the **aortic valve (32.0%)**. **Tricuspid valve involvement** was observed in **14.7%**, often associated with intravenous access or healthcare-related factors. **Multiple valve involvement** was seen in **10.6%** of cases, suggesting extensive disease and increased risk of complications.

Table 7. Clinical Outcome of Patients (n = 75)

Outcome	Number (n)	Percentage (%)
Recovered with medical therapy	46	61.3
Required surgical intervention	17	22.7
Death	12	16.0

Table 8. Major Complications Observed (n = 75)

Complication	Number (n)	Percentage (%)
Heart failure	26	34.7
Systemic embolization	18	24.0
Stroke	9	12.0
Septic shock	7	9.3



Graph 2: Major Complications Observed (n = 75)

.Table 7 summarizes the clinical outcomes during hospitalization. A favorable outcome with recovery following medical therapy was achieved in 61.3% of patients. Surgical intervention was required in 22.7% due to complications such as refractory heart failure or persistent infection. The in-hospital mortality rate was 16.0%, underscoring the severe and potentially fatal nature of infective endocarditis despite appropriate management.

Table 8 highlights the major complications encountered in patients with infective endocarditis. Heart failure was the most common complication (34.7%), followed by systemic embolization (24.0%). Stroke occurred in 12.0% of patients, reflecting embolic cerebral events. Septic shock was observed in 9.3%, representing a life-threatening complication associated with high mortality.

4. DISCUSSION

In this retrospective study, we analyzed the **clinical features**, **microbiological profile**, and **echocardiographic findings** in **75 cases of infective endocarditis (IE)**. The results provide valuable insights into the contemporary landscape of IE and underscore the evolving nature of its diagnosis, microbiological agents, and therapeutic approaches.

Microbiological Profile of Infective Endocarditis

A predominant finding in our study was the high prevalence of *Staphylococcus aureus* **(35.2%)** as the causative agent of IE. This aligns with previous studies that have reported *S. aureus* as the most frequent pathogen in both native and prosthetic valve infections, particularly in patients with healthcare-associated IE【7】【8】. Methicillin-resistant *Staphylococcus aureus* (MRSA) was also notable in our cohort, highlighting the growing challenge of antimicrobial resistance in IE. The emergence of antibiotic-resistant strains has significantly complicated treatment regimens, leading to prolonged hospital stays and increased mortality in these patients【9】.

Another important microbiological finding was the presence of **viridans group streptococci** (25.9%) and **enterococci** (16.7%) in our cohort. These organisms are frequently implicated in IE, particularly in cases involving native valves【8】. The presence of *Enterococcus* species, which are known for their intrinsic resistance to certain antibiotics, underscores the need for tailored antimicrobial therapy, particularly in the context of multidrug-resistant organisms.

Interestingly, the incidence of **coagulase-negative staphylococci** (13%) in our study supports findings from other investigations that these organisms, though often considered contaminants, can play a significant role in IE, particularly in prosthetic valve infections【7】.

Echocardiographic Findings and Prognosis

Echocardiography remains the cornerstone for the diagnosis and management of IE. In this cohort, **vegetations** were detected in **84%** of patients, which is consistent with the critical role of echocardiography in detecting infective masses. The detection of vegetations is a key diagnostic feature of IE and is associated with both the severity of the infection and the risk of embolic events【11】. Furthermore, **valvular regurgitation** (32%) and **valve perforation** (17.3%) were common complications observed in our patients, highlighting the potential for severe valvular damage in untreated or inadequately treated IE【11】【12】. The presence of perivalvular abscesses, although less frequent (14.7%), indicates advanced infection and is often associated with worse outcomes, including the need for surgical intervention.

Transesophageal echocardiography (TEE), when used in conjunction with transthoracic echocardiography (TTE), has significantly improved the diagnostic sensitivity for detecting small vegetations and complications such as valve perforations, abscesses, and prosthetic valve endocarditis【10】. Given its superior sensitivity, TEE should be considered the gold standard, particularly in cases where TTE results are inconclusive.

Clinical Outcomes and Treatment Modalities

Our study also sheds light on the **management** of IE. Despite the increasing complexity of IE, **medical therapy** remains the cornerstone of treatment, with **prolonged intravenous antibiotics** directed against the causative pathogen. In cases where the infection does not respond to medical treatment or there is severe valvular damage, **surgical intervention** is required. In our cohort, **22.7%** of patients required surgery, primarily due to refractory heart failure, persistent infection, or risk of embolism. This figure is consistent with global data suggesting that surgical intervention is necessary in a significant proportion of IE cases, particularly those with prosthetic valve involvement or large vegetations at high risk of embolism【13】.

A total of **16%** of patients in our cohort experienced **in-hospital mortality**, which is in line with published reports on IE-related mortality rates. Mortality in IE is influenced by several factors, including the severity of the infection, the presence of complications such as heart failure or stroke, the type of microorganism involved, and the timeliness of treatment【14】. Early identification and intervention remain critical in improving survival rates in these patients.

In the present study of 75 patients with infective endocarditis (IE), *Staphylococcus aureus* was the most commonly isolated organism, consistent with global trends showing that staphylococci remain the predominant pathogens in IE cases. A recent multicenter study investigating the clinical profile, microbiology, and outcomes specifically in patients undergoing aortic valve replacement for IE reported similar findings, where staphylococcal species were frequently identified and associated with adverse outcomes, reinforcing the importance of pathogen-directed therapy in IE management (Dingen et al., 2024) [15]. In addition, contemporary epidemiological data indicate that IE continues to pose a significant burden despite advancements in care, with trends showing increasing incidence and persistent high mortality rates, particularly in high-risk populations, underscoring the need for enhanced surveillance and optimized treatment protocols (Okamoto et al., 2025) [16]. Moreover, recent literature highlights evolving diagnostic and management paradigms in IE, including the role of multidisciplinary care teams and novel diagnostic approaches, which have the potential to improve early detection and clinical outcomes in complex cases (Lau et al., 2025) [17]. These recent studies support our findings that timely diagnosis, appropriate antimicrobial therapy, and when necessary, surgical intervention remain critical determinants of patient outcomes in infective endocarditis.

5. CONCLUSION

In this study, we investigated the clinical, microbiological, and echocardiographic characteristics of **75 patients diagnosed with infective endocarditis (IE)**, along with their management and outcomes. Our findings highlight the central role of **Staphylococcus aureus** as the predominant pathogen, followed by **viridans streptococci** and **enterococci**, underscoring the importance of targeted antimicrobial therapy based on pathogen identification. Additionally, **echocardiography**, particularly **transesophageal echocardiography (TEE)**, remains a vital tool for diagnosing vegetations, assessing valve damage, and detecting complications such as abscesses and valvular perforations.

Despite improvements in diagnostic and therapeutic strategies, the **in-hospital mortality rate** in our cohort was 16%, a stark reminder of the severity of IE and its potential for life-threatening complications, including **heart failure**, **systemic embolization**, and **stroke**. A significant portion of our cohort required **surgical intervention** due to complications, underscoring the need for timely decision-making in severe cases. This study further emphasizes the necessity of a **multidisciplinary approach** involving **infectious disease specialists**, **cardiologists**, and **surgeons** in managing patients with IE to optimize outcomes.

Overall, this study contributes to the ongoing efforts to understand the complexities of infective endocarditis, providing insights into microbial trends, diagnostic methods, and treatment options. The identification of risk factors for poor outcomes can guide clinical decisions, allowing for more personalized and effective management strategies.

Limitations of the Study

1. **Retrospective Design**: Data were collected from medical records, which may be incomplete or missing, leading to potential bias.
2. **Inconsistent Microbiological Data**: Not all pathogens were tested for antimicrobial resistance, limiting full analysis.
3. **Echocardiographic Limitations**: Interpretation of results may vary due to operator experience and sensitivity.
4. **No Pediatric Data**: The study only included adult patients, limiting applicability to pediatric populations.
5. **Lack of Long-Term Follow-Up**: The study focused on in-hospital outcomes, with limited data on long-term survival or recurrence.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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