THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 14 Issue 4

RESEARCH ARTICLE

Infective Endocarditis in Southern Morocco: The Ongoing Burden of Rheumatic Heart Disease

Mehdi Berrajaa [1,2], Mohamed El Minaoui [1,2]

[1] Department of Cardiology, Mohammed VI University Hospital Center, Agadir, Morocco
[2] Faculty of Medicine and Pharmacy, Ibn Zohr University, Agadir, Morocco

OPEN ACCESS

PUBLISHED
30 April 2026

CITATION
Berrajaa, M., and El Minaoui, M., 2026. Infective Endocarditis in Southern Morocco: The Ongoing Burden of Rheumatic Heart Disease. Medical Research Archives, [online] 14(4).

COPYRIGHT
© 2026 European Society of Medicine. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

ISSN
2375-1924

ABSTRACT

Background: Infective endocarditis remains a life-threatening infection of the endocardium and cardiac valves, with substantial morbidity and persistently high mortality. In regions where rheumatic heart disease persists, it continues to be a major substrate for infective endocarditis, including among patients with prosthetic valves implanted for rheumatic indications.

Aims: To evaluate the frequency of major risk factors for infective endocarditis, particularly rheumatic heart disease, and to describe the epidemiological and echocardiographic profile of infective endocarditis in a tertiary-care hospital in southern Morocco.

Methods: We performed a retrospective descriptive study in the Cardiology Department of Souss Massa (Agadir, Morocco) university hospital, including patients managed between September 2022 and December 2025 with definite or possible infective endocarditis according to the modified Duke criteria. Demographic characteristics, underlying cardiac conditions, clinical presentation, microbiological findings, echocardiographic features, management, and in-hospitfal outcomes were extracted from medical records.

Results: 34 patients were included (mean age 45 years), with male predominance (21 patients, 61.8%). A pre-existing cardiac condition was present in 28 patients (82.4%), and rheumatic heart disease was the most common underlying disease (14 patients, 41.2%). Prosthetic valve endocarditis was identified in 8 patients (23.5%); 7 of these (87.5%) had prosthetic valves implanted for rheumatic valvular disease. Left-sided IE predominated, mainly involving the mitral and aortic valves. Vegetations were detected in 31 patients (91.2%); significant valvular regurgitation was present in 32 patients (94.1%). Echocardiography showed perivalvular abscesses in 4 patients (11.8%) and valvular perforations in 2 patients (5.9%). Blood cultures were obtained in all patients; 29 patients (85.3%) were culture-positive, most commonly Staphylococcus aureus. All patients received intravenous antibiotics; penicillin plus gentamicin was the most frequent empirical regimen (25 patients, 73.5%). Surgery was indicated in 4 patients (11.8%). In-hospital mortality was 5.9% (2 patients).

Conclusion: In southern Morocco, infective endocarditis predominantly affects relatively young patients and remains closely linked to rheumatic heart disease, including among those with prosthetic valves placed for rheumatic disease. Its high proportion among infective endocarditis cases highlights the ongoing burden of rheumatic valve disease and supports strengthening prevention and long-term management strategies in this setting.

Keywords: Infective endocarditis, Rheumatic heart disease, Prosthetic valve endocarditis, Echocardiography, Staphylococcus aureus

Introduction:

Infective endocarditis (IE) remains a severe and potentially life-threatening infection of the endocardium and cardiac valves, associated with substantial morbidity and persistently high mortality, which may reach 25% despite advances in diagnosis and treatment.[1] Its clinical importance lies not only in the infection itself, but also in its major complications, including heart failure, systemic embolism, and the frequent need for surgery. Prosthetic valve endocarditis, which accounts for nearly 20% of cases, represents a particularly serious form of the disease because of its diagnostic complexity and poorer prognosis.[2]

Over recent decades, the incidence of IE has increased, partly driven by the expanding use of prosthetic valves, intracardiac devices, and other healthcare-associated interventions. IE is a multifactorial disease that develops on a wide range of predisposing cardiac substrates. In high-income settings, degenerative valvular disease, prosthetic material, and device-related infections have become increasingly prominent. In contrast, in developing countries, rheumatic heart disease (RHD) and congenital heart disease remain major underlying conditions.[3] This distinction is important because it reflects persistent inequalities in cardiovascular prevention, access to care, and timing of diagnosis. In such settings, delayed presentation and limited access to advanced investigations may contribute to worse outcomes.[3] Microbiologically, Staphylococcus aureus and streptococci remain the leading causative organisms.[4]

Rheumatic heart disease is a chronic sequela of acute rheumatic fever and results in permanent valvular damage that predisposes to endothelial injury, thrombus formation, and subsequent microbial colonization during bacteremia.[5] In regions where RHD remains prevalent, its contribution to IE may therefore be substantial. The present study aimed to evaluate the frequency of major risk factors for IE, with particular emphasis on RHD, and to assess its role as a predominant underlying condition in patients diagnosed with infective endocarditis.

Material and Methods:

STUDY DESIGN AND SETTING:

We conducted a retrospective descriptive study in the Cardiology Department of the Souss Massa University Hospital in Agadir, southern Morocco. The study period extended from September 2022 to December 2025. This study aimed to describe the epidemiological profile, predisposing cardiac conditions, microbiological findings, and echocardiographic characteristics of infective endocarditis in a region where rheumatic heart disease remains prevalent.

STUDY POPULATION:

The study population consisted of consecutive patients hospitalised in or managed by the Cardiology Department for suspected IE during the study period. Cases were identified through hospital medical records, admission registers, discharge summaries, and cardiology registries. The diagnosis of IE was established according to the modified Duke criteria, based on the combination of clinical, microbiological, and echocardiographic findings. Both native-valve and prosthetic-valve IE were considered.

INCLUSION CRITERIA:

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

- Patients evaluated at Souss Massa University Hospital between September 2022 and December 2025.
- Fulfilled the criteria for definite or possible IE according to the modified Duke criteria.
- Had available medical records containing at least the minimum clinical and paraclinical data required for analysis, including demographic characteristics, underlying heart disease, echocardiographic assessment, and outcome data.

EXCLUSION CRITERIA:

Patients were excluded if they:

- Did not meet the modified Duke criteria for definite or possible IE.
- Had incomplete or insufficient medical records preventing confirmation of eligibility or extraction of key study variables, including demographics, cardiovascular risk factors, underlying heart disease, microbiological results, echocardiographic findings, treatment, and in-hospital outcomes (**Figure 1**).

© 2026 European Society of Medicine

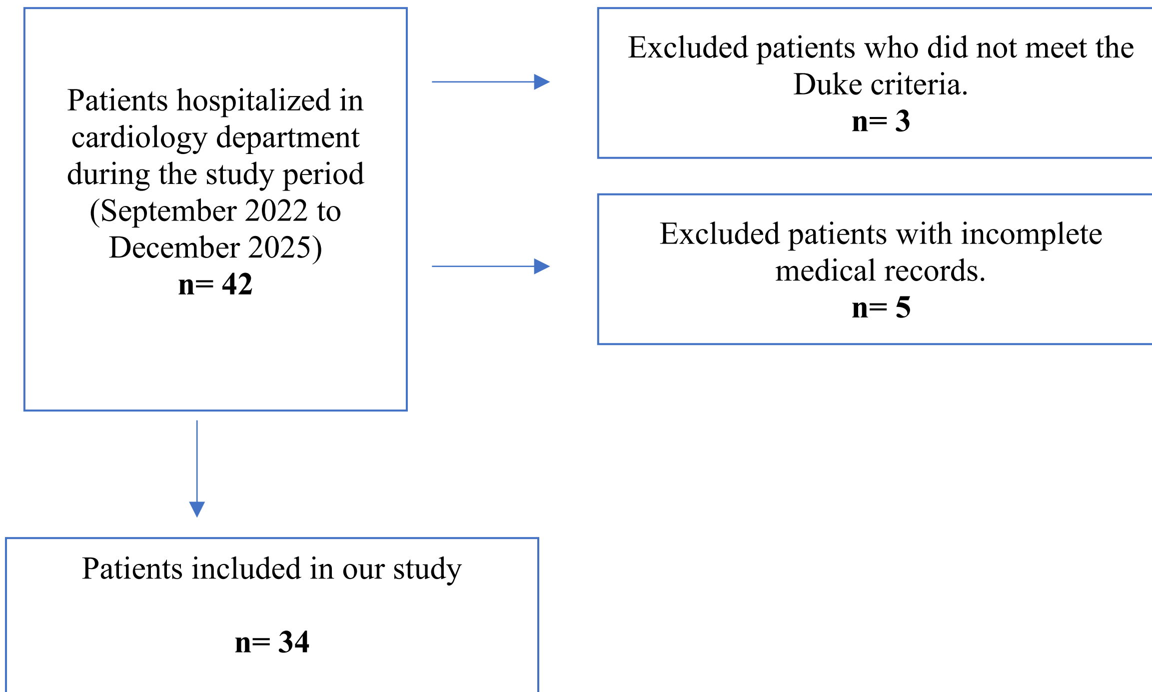

Figure 1: Flow diagram of study selection, including inclusion and exclusion criteria.

DATA COLLECTION:
Data were extracted retrospectively from patient records using a predefined data collection form. The variables collected included age, sex, past cardiac history, presence of RHD or congenital heart disease, type of valve involvement, native or prosthetic valve status, blood culture results, echocardiographic findings, complications, and in-hospital evolution.

STATISTICAL ANALYSIS:
Data were entered and analysed using Microsoft Excel 2019. A descriptive statistical analysis was performed. Results were presented as absolute frequencies and percentages.

Results:

A total of 34 patients were included (mean age 45 years), with a male predominance (21 men, 61.8%; 13 women, 38.2%; male-to-female ratio 1.6). A pre-existing cardiac condition was present in 28 patients (82.4%). Rheumatic heart disease was the most common underlying cardiac disease, identified in 14 patients (41.2%), making it the leading predisposing condition in our cohort. Degenerative valvular disease was identified in 9 patients (26.5%), and 1 patient (2.9%) had pacemaker-related infective endocarditis. In addition, 4 patients (11.8%) had untreated non-cyanotic congenital heart disease, including 2 patients (5.9%) with ventricular septal defects and 2 patients (5.9%) with atrial septal defects (**Table 1**).

Table 1: Different risk factors observed in our cohort.

Predisposing cardiac condition	n (%)
Rheumatic heart disease	14 (41.2%)
Degenerative valvular disease	9 (26.5%)
Untreated non-cyanotic congenital heart disease (total)	4 (11.8%)
Ventricular septal defect	2 (5.9%)
Atrial septal defect	2 (5.9%)
Pacemaker	1 (2.9%)

Prosthetic valve endocarditis was documented in 8 patients (23.5%); among these, 7/8 (87.5%) had prosthetic valves implanted for rheumatic valvular disease. Left-sided IE predominated, mainly involving the mitral and aortic valves. Vegetations were detected in 31 patients (91.2%), with a mean size of 13.6 mm and high mobility in most cases. Echocardiography revealed perivalvular and periprosthetic abscesses in 4 patients (11.8%), and valvular perforations in 2 patients (5.9%). Additional complications included prosthetic valve dehiscence (1 patient, 2.9%), rupture of chordae tendineae (1 patient, 2.9%), intracardiac fistula (1 patient, 2.9%), and mycotic aneurysm (1 patient, 2.9%). Significant valvular regurgitation was present in 32 patients (94.1%).

Diagnosis was established using a combination of clinical findings, microbiological data, and echocardiographic criteria. Fever was present in 28 patients (82.4%), and a new or changing cardiac murmur in 12 patients (35.3%). Embolic manifestations were recorded in 5 patients (14.7%), including cerebral events in 1 patient (2.9%), splenic/renal events in 3 patients (8.8%), and peripheral events in 1 patient (2.9%). Heart failure at presentation

© 2026 European Society of Medicine

was documented in 2 patients (5.9%). Blood cultures were obtained in 34 patients (100%), with culture-positive IE in 29 patients (85.3%); the most frequently isolated organisms were Staphylococcus aureus in 19 patients (55.9%), Streptococcus spp. in 10 patients (29.4%), and Enterococcus spp. in 3 patients (8.8%), while negative blood culture endocarditis was noted in 5 patients (14.7%).

All patients received intravenous antibiotic therapy, the most commonly used empirical regimens included penicillin plus gentamicin in 25 patients (73.5%) and ceftriaxone in 5 patients (14.7%), and targeted therapy was administered when microbiological identification was available in 28 patients (82.4%). Surgical management was indicated in 4 patients (11.8%), most commonly due to heart failure in 2 patients (5.9%), uncontrolled infection/abscess in 1 patient (2.9%), and large or mobile vegetations in 1 patient (2.9%). The in-hospital outcome showed mortality in 2 patients (5.9%), while 32 patients (94.1%) recovered and were discharged with planned follow-up.

Discussion:

Infective endocarditis is an infective disease involving the endocardium or heart valves.[6] Data describing IE in developing countries remain limited and sometimes inconsistent.[7] Although IE is likely not uncommon, some records suggest that it may account for nearly 0.5% of cardiovascular admissions.[8] Infective endocarditis tends to affect younger patients and shows a male predominance, with a high prevalence among patients with RHD and congenital heart disease, alongside emerging contributors such as intravenous drug use and immunocompromised states, including HIV infection.[9] The relatively young age profile of our patients is consistent with reports from low and middle-income countries, where infective endocarditis develops on a background of rheumatic rather than the degenerative heart diseases in older populations.[3,9] Importantly, the association between RHD and increased IE risk is well documented in developing countries, whereas it has become less prominent in many developed settings.[10,11]

Clinically, diagnosing IE requires high clinical suspicion supported by appropriate laboratory investigations.[9] The likelihood of IE increases substantially in the presence of known predisposing conditions, notably congenital heart disease, immunosuppression, intravenous drug use, and prosthetic valves.[12] In our cohort from southern Morocco, the high prevalence of pre-existing cardiac disease, dominated by RHD, supports the continued central role of structural valve disease in shaping IE epidemiology in this region. Most prosthetic valve endocarditis cases in our cohort occurred in patients treated for rheumatic valvular disease, which suggests the impact of rheumatic heart disease that extends beyond native-valve susceptibility and continues even after surgical valve replacement.[13]

From a pathophysiological perspective, RHD represents a chronic consequence of acute rheumatic fever, which follows pharyngotonsillitis caused by group A β-haemolytic streptococcus.[14] Rheumatic fever predominantly affects children aged 5-15 years.[15] The disease is immune-mediated, producing inflammatory lesions that can involve multiple organs, including the heart, joints, and the brain in the form of chorea.[16] Antibodies generated against streptococcal antigens cross-react with host cardiac proteins, leads to valvular inflammation and, after healing, permanent structural damage.[17] These altered valve surfaces promote endothelial injury, thrombus formation, and subsequent microbial adherence when transient or sustained bacteraemia occurs, resulting in vegetations that can embolize to distant organs such as the kidneys, spleen, and brain.[10] In addition, valvular deformation may contribute to atrial fibrillation and increasing intracardiac thrombosis rik.[18] The high frequency of vegetations and significant valvular regurgitation in our cohort underlines the central role of echocardiography in early recognition of destructive lesions and embolic risk.[19]

Microbiological identification remains fundamental to enable targeted antimicrobial therapy.[20] However, when pathogen identification is not feasible, empirical antibiotic therapy is commonly used.[9] Penicillin-based regimens with or without an aminoglycoside remain frequently employed, while ceftriaxone can also be used.[9] The proportion of culture-negative infective endocarditis in our cohort remains relevant, since prior antibiotic exposure is recognized as major causes of negative blood cultures, and these cases may benefit from adjunctive serology.[21] In severe disease or when valve destruction is significant, particularly in the setting of heart failure, surgical intervention may be required.[16] Our relatively low surgical rate should be interpreted cautiously, because contemporary prospective data show that mortality increases when surgery is indicated but not performed, especially in patients with heart failure, abscess, or large vegetations.[13] Preventive strategies are therefore essential in high-risk groups: New Zealand IE prophylaxis guidelines emphasize prophylactic antibiotics in patients with RHD, reflecting the higher prevalence and risk profile in that region.[22] In contrast, the European Society of Cardiology and the American Heart Association do not specifically list those patients among high-risk populations requiring antibiotic prophylaxis.[23] In light of the persistent burden of IE observed in our southern Moroccan cohort, preventive strategies, including prophylaxis policies adapted to local epidemiology and reinforced dental prevention programmes, appear especially warranted.[24]

Despite diagnostic and therapeutic advances, IE remains associated with substantial mortality that can reach 20%, with worse outcomes in older patients and those with comorbidities.[9,25] Prosthetic valve endocarditis is associated with higher mortality than native-valve IE, reflecting the need for frequent and technically challenging surgery and a higher risk of recurrence requiring redo surgery.[24] In our study, the contribution of RHD was marked, which was present in 41.2% of patients and Prosthetic valve endocarditis representing nearly one-quarter of cases, most prostheses having been implanted for rheumatic valvular disease, highlighting the long-term consequences of this predisposing heart disease and its role in sustaining the IE burden. These findings are consistent with reports from other populations

© 2026 European Society of Medicine

in which RHD remains relevant among IE cohorts, including studies reporting a proportion around 14% among IE cases, by Alsamarrai et al.[26] and other series, its presence in a substantial proportion of patients and heart failure was frequent, according to Prasanna et al.[27] Collectively, these observations support renewed emphasis on controlling rheumatic fever and RHD as upstream interventions to reduce IE risk. Taken together, our findings support an integrated strategy combining primary prevention of streptococcal infection, secondary prevention of rheumatic fever recurrence, follow-up of rheumatic valvular disease, and dental prevention in order to reduce the long-term risk of infective endocarditis in this region.[28, 29]

Accordingly, reducing the incidence of acute rheumatic fever through early recognition and timely treatment of group A β-haemolytic streptococcal pharyngotonsillitis is critical for preventing immune-mediated valvular damage and the downstream risk of IE.[16] This remains especially important because rheumatic fever and RHD continue to represent major causes of heart disease among children and young adults in developing settings.[30, 31]

This study has limitations inherent to its retrospective, single-centre nature, which may introduce selection bias and limit generalizability to other Moroccan regions. Some variables may have been underreported or inconsistently documented in medical records, and the small sample size (n=34) limits statistical precision and subgroup analyses. Finally, echocardiographic findings relied on available reports and measurements, and advanced imaging was not performed uniformly, which may have resulted in under-detection of certain complications.

Conclusion:

Infective endocarditis in southern Morocco affects relatively young patients and remains strongly associated with underlying structural valve disease, particularly rheumatic heart disease. Rheumatic heart disease was the leading predisposing condition and also contributed substantially to prosthetic valve endocarditis, reflecting the persistent burden of rheumatic valvular disease in this region. These findings underscore the need for strengthened prevention of rheumatic fever and rheumatic heart disease, improved long-term follow-up of valvular disease, and early recognition and management of infective endocarditis to reduce complications and adverse outcomes.

Conflicts of Interest Statement:

The authors have no conflicts of interest to declare.

Funding Statement:

This research received no external funding.

References:

1. Slipczuk L, Codolosa JN, Davila CD, Romero-Corral A, Yun J, Pressman GS, Figueredo VM. Infective endocarditis epidemiology over five decades: a systematic review. *PloS one*. 2013 Dec 9;8(12):e82665.
2. Murdoch DR, Corey GR, Hoen B, Miró JM, Fowler VG, Bayer AS, Karchmer AW, Olaison L, Pappas PA, Moreillon P, Chambers ST. Clinical presentation, etiology, and outcome of infective endocarditis in the 21st century: the International Collaboration on Endocarditis–Prospective Cohort Study. *Archives of internal medicine*. 2009 Mar 9;169(5):463-73.
3. Noubiap JJ, Nkeck JR, Kwondom BS, Nyaga UF. Epidemiology of infective endocarditis in Africa: a systematic review and meta-analysis. *The Lancet Global Health*. 2022 Jan 1;10(1):e77-86.
4. Viljoen CA, Seedat A, Manning K, Ntsekhe M, Van der Westhuizen C, De Villiers MC, Graham M, Rath M. The changing landscape of infective endocarditis in South Africa. *South African Medical Journal*. 2019 Aug 1;109(8):592-6.
5. Komorovsky RR, Boyarchuk OR, Synytska VO. Streptococcus gordonii-associated infective endocarditis in a girl with Barlow's mitral valve disease. *Cardiology in the Young*. 2019 Aug;29(8):1099-100.
6. Kumar V, Abbas AK, Fausto N, Aster JC. Robbins and Cotran pathologic basis of disease, professional edition e-book. *Elsevier health sciences*; 2014 Aug 27.
7. Njuguna B, Gardner A, Karwa R, Delahaye F. Infective endocarditis in low-and middle-income countries. *Cardiology clinics*. 2017 Feb 1;35(1):153-63.
8. Yew HS, Murdoch DR. Global trends in infective endocarditis epidemiology. *Current infectious disease reports*. 2012 Aug;14(4):367-72.
9. Mutagaywa RK, Vroon JC, Fundikira L, Wind AM, Kunambi P, Manyahi J, Kamuhabwa A, Kwesigabo G, Chamuleau SA, Cramer MJ, Chillo P. Infective endocarditis in developing countries: An update. *Frontiers in cardiovascular medicine*. 2022 Sep 12;9:1007118.
10. Tleyjeh IM, Steckelberg JM, Murad HS, Anavekar NS, Ghomrawi HM, Mirzoyev Z, Moustafa SE, Hoskin TL, Mandrekar JN, Wilson WR, Baddour LM. Temporal trends in infective endocarditis: a population-based study in Olmsted County, Minnesota. *Jama*. 2005 Jun 22;293(24):3022-8.
11. Choudhury R, Grover A, Varma J, Khattri HN, Anand IS, Bidwai PS, Wahl PL, Sapru RP. Active infective endocarditis observed in an Indian hospital 1981–1991. *The American journal of cardiology*. 1992 Dec 1;70(18):1453-8.
12. Neto RA, Lopes MS, Silva PL. Mitral stenosis as a sequel in patients with rheumatic fever. *Braz J Health Rev*. 2021;4(5):21099-111.
13. Habib G, Erba PA, Iung B, Donal E, Cosyns B, Laroche C, Popescu BA, Prendergast B, Tornos P, Sadeghpour A, Oliver L. Clinical presentation, aetiology and outcome of infective endocarditis. Results of the ESC-EORP EURO-ENDO (European infective endocarditis) registry: a prospective cohort study. *European heart journal*. 2019 Oct 14;40(39):3222-32.
14. Cahill TJ, Baddour LM, Habib G, Hoen B, Salaun E, Pettersson GB, Schäfers HJ, Prendergast BD. Challenges in infective endocarditis. *Journal of the american college of cardiology*. 2017 Jan 24;69(3):325-44.
15. Naidoo NS, Ponnusamy S, Naidoo DP. A 10-year retrospective analysis of the clinical profile and outcomes of infective endocarditis at a tertiary hospital in KwaZulu-Natal, South Africa. *Cardiovascular Journal of Africa*. 2022 Jul 1;33(4):194-9.
16. Costa RE, Nicoletti SD, Amaral KS, Matola MF, Alves SP, Vellano PO, Damasceno IA, Herrera SD, Mendes SU, Paiva MJ. Rheumatic fever and infective endocarditis: A review. *Journal of Advances in Medicine and Medical Research*. 2023 Jun 27;35(16):121-7.
17. Carapetis JR, Beaton A, Cunningham MW, Guilherme L, Karthikeyan G, Mayosi BM, Sable C, Steer A, Wilson N, Wyber R, Zühlke L. Acute rheumatic fever and rheumatic heart disease. *Nature reviews Disease primers*. 2016 Jan 14;2(1):15084.
18. Shmueli H, Thomas F, Flint N, Setia G, Janjic A, Siegel RJ. Right-sided infective endocarditis 2020: challenges and updates in diagnosis and treatment. *Journal of the American Heart Association*. 2020 Aug 4;9(15):e017293.
19. Delgado V, Ajmone Marsan N, de Waha S, Bonaros N, Brida M, Burri H, Caselli S, Doenst T, Ederhy S, Erba PA, Foldager D. 2023 ESC guidelines for the management of endocarditis: developed by the task force on the management of endocarditis of the European Society of Cardiology (ESC) endorsed by the European Association for Cardio-Thoracic Surgery (EACTS) and the European Association of Nuclear Medicine (EANM). *European heart journal*. 2023 Oct 14;44(39):3948-4042.
20. Cahill TJ, Prendergast BD. Infective endocarditis. Lancet. 2016 Feb 27;387(10021):882-93. doi: 10.1016/S0140-6736(15)00067-7. Epub 2015 Sep 1. PMID: 26341945.
21. Dähler R, Brugger SD, Frank M, Greutmann M, Sromicki J, Marques-Maggio E, Imkamp F, Bauernschmitt R, Carrel T, Zinkernagel AS, Hasse B. A retrospective analysis of blood culture-negative endocarditis at a tertiary care centre in Switzerland. *Swiss Medical Weekly*. 2022 Dec 10;152(4950):40016-.
22. Ralph AP, Noonan S, Wade V, Currie BJ. The 2020 Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease. *Medical Journal of Australia*. 2021 Mar;214(5):220-7.
23. Writing Committee Members, Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin III JP, Gentile F, Jneid H, Krieger EV, Mack M, McLeod C. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Journal of the American College of Cardiology*. 2021 Feb 2;77(4):e25-197.

© 2026 European Society of Medicine

24. Alsamarrai A, Saavedra C, Bryce A, et al. Infective endocarditis in patients with rheumatic heart disease: a single-centre retrospective comparative study. N Z Med J. 2022;135(1550):62-73.
25. Baskerville CA, Hanrahan BB, Burke AJ, Holwell AJ, Rémond MG, Maguire GP. Infective endocarditis and rheumatic heart disease in the north of Australia. *Heart, Lung and Circulation*. 2012 Jan 1;21(1):36-41.
26. Alsamarrai A, Saavedra C, Bryce A, Dimalapang E, Leversha A, Briggs S, Wilson N, Wheeler M. Infective endocarditis in patients with rheumatic heart disease: a single-centre retrospective comparative study. *The New Zealand Medical Journal* (Online). 2022 Feb 25;135(1550):62-73.
27. Subbaraju P, Rai S, Morakhia J, Midha G, Kamath A, Saravu K. Clinical–microbiological characterization and risk factors of mortality in infective endocarditis from a tertiary care academic hospital in southern India. Indian Heart Journal. 2018 Mar 1;70(2):259-65.
28. Maharaj B, Vayej AC. Oral health of patients with severe rheumatic heart disease: cardiovascular topics. *Cardiovascular Journal of Africa*. 2012 Jul 1;23(6):336-9.
29. Ghamari SH, Abbasi-Kangevari M, Saeedi Moghaddam S, Aminorroaya A, Rezaei N, Shobeiri P, Esfahani Z, Malekpour MR, Rezaei N, Ghanbari A, Keykhaei M. Rheumatic heart disease is a neglected disease relative to its burden worldwide: findings from global burden of disease 2019. *Journal of the American Heart Association*. 2022 Jul 5;11(13):e025284.
30. Medrado AVDS, Costa SA, Ribeiro RHF, et al. Acute rheumatic fever and its epidemiological profile in Brazil over the last 5 years. Rev Ibero-Am Humanid Cienc Educ. 2022;8(4):1175-1184.
31. Shimanda PP, Shumba TW, Brunström M, Iipinge SN, Söderberg S, Lindholm L, Norström F. Preventive interventions to reduce the burden of rheumatic heart disease in populations at risk: a systematic review. *Journal of the American Heart Association*. 2024 Mar 5;13(5):e032442.

© 2026 European Society of Medicine