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EDITORIAL



Valvular heart disease and atrial fibrillation: advances in mechanisms, risk stratification, and therapeutic approaches

Valvular heart disease (VHD) and atrial fibrillation (AF) are major, often interconnected causes of cardiovascular morbidity [1–5]. Recent work highlights increased research activity on valvular disease, particularly its links with heart failure, infective endocarditis, and vascular dysfunction in mitral stenosis [6,7]. Clinical risk assessment has evolved through improved use of functional status, imaging biomarkers, and artificial intelligence tools [8]. In atrial fibrillation (AF), age-related factors such as clonal haematopoiesis, along with hypoxia-induced electrical remodeling, are gaining attention [9,10]. Procedural innovations, including safer superior vena cava isolation techniques, and refined echocardiographic measures such as left atrial mechanical dispersion, improve rhythm control strategies [11]. Hemodynamic indices like pulmonary artery pulsatility provide prognostic insights in patients with combined rhythm and pump failure [12,13]. In this editorial, we highlight recent studies that illustrate emerging trends in the understanding and clinical management of VHD and AF.

VHD has been increasingly studied in relation to heart-related diseases (HRDs), yet a comprehensive bibliometric overview has been lacking. A total of 4,235 publications from 2000 to 2023 were identified, showing a steady rise in annual output, particularly after 2010 [14]. The United States led in publication volume, followed by China and Germany, while Harvard University and the Mayo Clinic ranked among the most productive institutions. Co-occurrence analysis of keywords indicated strong research interest in ageing, sex differences, diagnostic tools, and treatment strategies (Figure 1). In recent years, heart failure emerged as a central theme in the VHD-HRD research network. Collaboration mapping revealed limited intercontinental cooperation, highlighting opportunities for broader international partnerships. These findings outline current research patterns and support targeted investigations into VHD-related mechanisms and clinical outcomes.

Infective endocarditis (IE) continues to pose significant clinical challenges, with high morbidity and mortality despite improvements in diagnosis and treatment [15–19]. A total of 145 adult patients diagnosed with IE between 2005 and 2018 were evaluated to identify clinical and laboratory parameters associated with outcomes [20]. The average age was 53 years, with rheumatic valve disease present in 34% and mitral valve involvement in 48.3% of cases. In-hospital mortality reached 31.7%, and one-year mortality 40.6%. Patients treated with combination therapy, including surgery after two weeks of antibiotics, had significantly lower in-hospital mortality (23%) than those treated with medical therapy alone (40.8%).

Heart failure was the most common and lethal complication, and NYHA class was an independent predictor of in-hospital mortality, highlighting the importance of early risk stratification and timely surgical intervention.

Accurate detection of valve vegetations in IE remains difficult, especially in patients with mechanical valves where artefacts limit standard imaging interpretation [21]. Esmaily et al. investigated the use of radiomics and machine learning to classify mitral and aortic valves—both native and prosthetic—as infected or not [22]. A total of 286 transesophageal echocardiography (TEE) scans from suspected IE cases and 113 control cases were processed using an advanced image filter, and radiomic features were extracted for classification. Among various models tested, Support Vector Machine (SVM) performed best for native valves, achieving AUCs between 0.86 and 0.88 with high sensitivity and specificity. Mechanical valves were also accurately classified, with Random Forest and SVM providing strong results depending on the valve type. These results suggest that integrating machine learning into TEE interpretation could significantly improve IE diagnosis, particularly when advanced imaging like PET/CT is not available.

The impact of mitral stenosis on aortic elastic properties has received limited attention in the literature. It is increasingly recognised that severe mitral stenosis may be associated with altered vascular compliance, potentially contributing to systemic hemodynamic burden [23]. In a cohort of 32 patients undergoing percutaneous balloon mitral valvotomy (BMV), significant improvements in aortic elastic properties were observed within 24–48 h post-procedure [24]. Specifically, aortic strain increased while the aortic stiffness index decreased, suggesting a rapid vascular response following mitral valve intervention. Hemodynamic benefits included a reduction in mitral valve gradient and pulmonary artery pressure, alongside a marked increase in mitral valve area. These findings support the concept that BMV not only alleviates valvular obstruction but may also improve vascular function, highlighting the interplay between cardiac and vascular pathology in mitral stenosis.

Aortic stenosis is a common and progressive valve disease in the elderly, with important prognostic implications [25–26]. Among its forms, normal-flow low-gradient aortic stenosis (NF-LG AS) is frequently encountered and often misclassified as non-severe. Accurate assessment of flow rate is essential, as low values (<200 mL/sec) may conceal true severe disease [27]. A clinical case illustrated how post-extrasystolic beats can transiently raise flow and reveal pseudo-severe AS. Findings were confirmed by dobutamine stress echocardiography and CT calcium

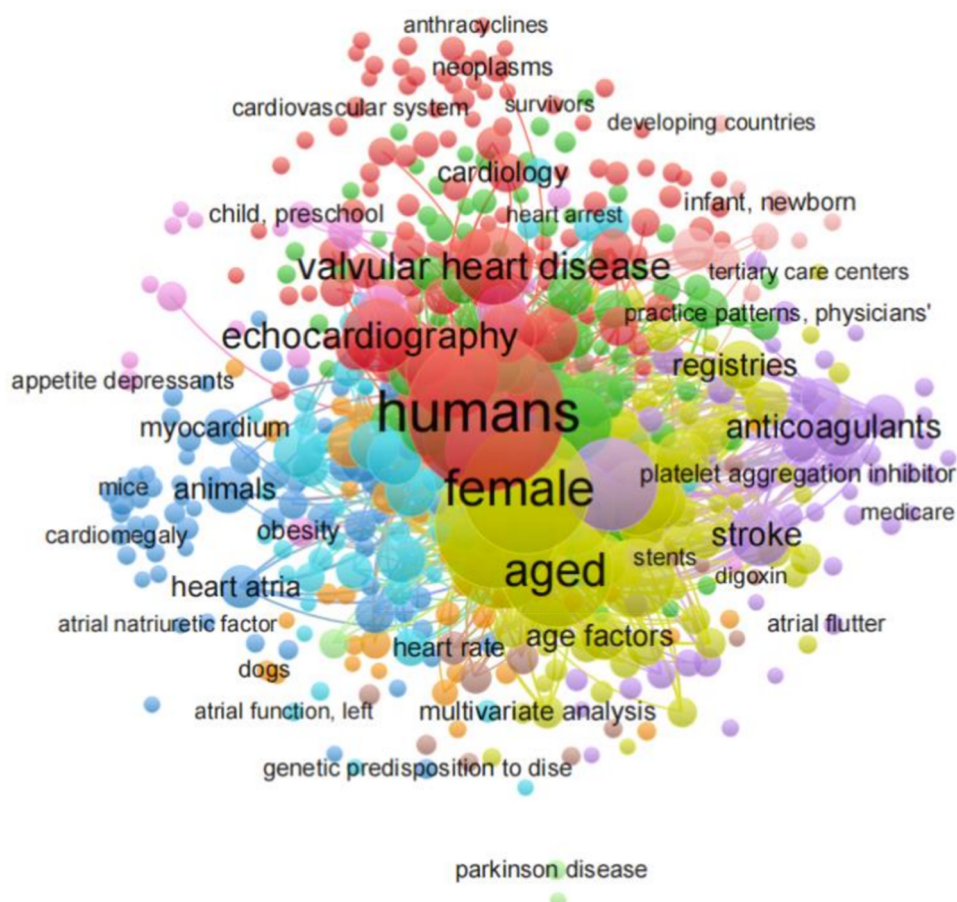


Figure 1. Keyword co-occurrence network in valvular heart disease and related cardiovascular research (2000–2023). This visual map displays the most frequent and interconnected keywords from publications on valvular heart disease and associated cardiovascular topics. Each node represents a keyword; its size reflects frequency of appearance, and colours indicate thematic clusters. Prominent terms include ‘humans’, ‘female’, ‘aged’, ‘valvular heart disease’, ‘echocardiography’, ‘stroke’, and ‘anticoagulants’, highlighting core areas of research. The proximity and linkage between nodes illustrate conceptual relationships and research trends. This bibliometric analysis reveals a strong focus on demographics, imaging, comorbidities, and therapeutic strategies [14].

scoring. These insights highlight the need for a systematic, flow-guided approach to better characterise AS severity and guide management (Figure 2).

Transcatheter aortic valve implantation (TAVI) has become a cornerstone therapy for severe aortic stenosis, especially in elderly and high-risk patients [28–34]. Despite technical progress, bleeding and thrombotic complications remain prevalent due to associated coagulation disturbances [35]. A cohort of 117 patients undergoing TAVI with CoreValve EvolutR® devices was analysed for procedural outcomes, haematologic changes, and survival. In-hospital mortality reached 7%, with stroke and major bleeding among the most common complications [36]. Elevated post-procedural white blood cell counts were significantly associated with increased mortality, while platelet reactivity and other blood parameters showed limited prognostic value. These results highlight the potential role of inflammation in post-TAVI outcomes and support closer monitoring of haemostatic responses.

AF is a common arrhythmia associated with adverse cardiovascular outcomes, particularly when sustained by structural and electrical remodelling [4,37]. In rat models of chronic intermittent hypoxia, sustained low-oxygen

exposure increased AF susceptibility by slowing epicardial conduction, enhancing conduction inhomogeneity, and reducing calcium and potassium currents, while upregulating pro-arrhythmic pathways such as phosphorylated CaMKII and RyR2 [38].

AF and right ventricular dysfunction are both recognised as important prognostic indicators in patients with heart failure, but their interplay is not fully understood. An analysis of patients with stable heart failure undergoing right heart catheterisation examined the clinical relevance of the pulmonary artery pulsatility index, a marker of right ventricular function [39]. Individuals with AF exhibited lower index values compared to those in sinus rhythm. Statistical analysis confirmed that AF was independently linked to impaired right ventricular hemodynamics. Furthermore, a low pulsatility index was associated with a higher risk of death or hospitalisation for heart failure. These findings support the value of this index as a prognostic tool to refine risk stratification and management in heart failure patients with AF.

The superior vena cava (SVC) is a recognised non-pulmonary vein trigger for AF, and its targeted isolation may enhance ablation outcomes [5,6]. A modified

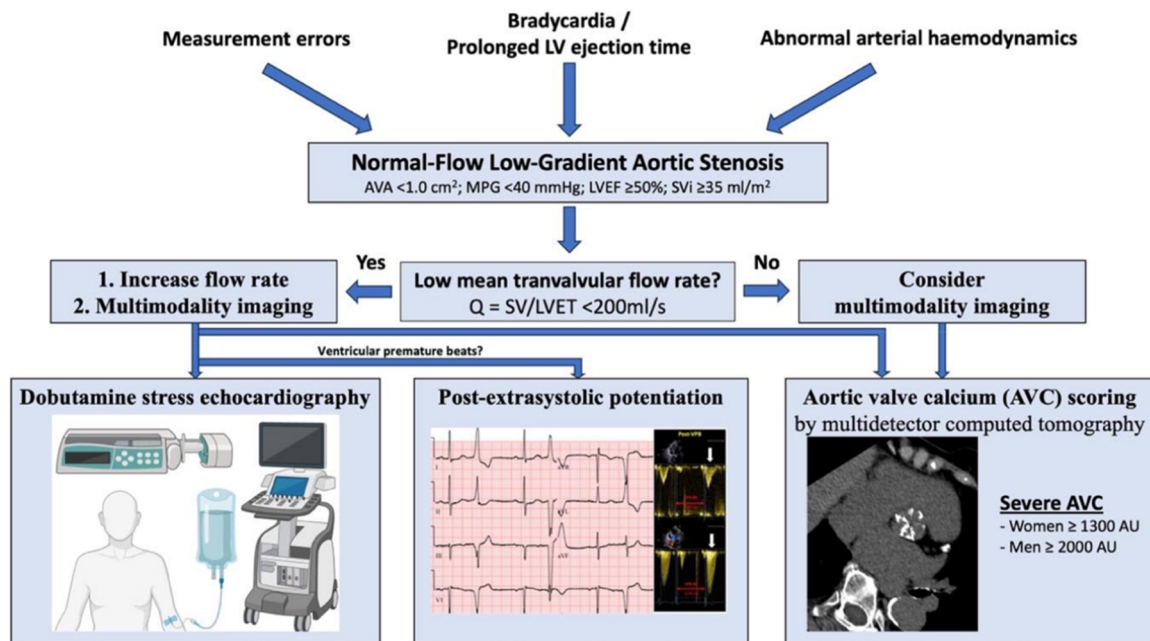


Figure 2. Proposed diagnostic workup for patients with normal-flow low-gradient aortic stenosis. AVA, aortic valve area; AVC, aortic valve calcium score; LV, left ventricle; LVEF, left ventricular ejection fraction; LVET, left ventricular ejection time; MPG, mean pressure gradient; Q, blood flow; SV, stroke volume; SVi, indexed stroke volume; and VPB, ventricular premature beat [27].

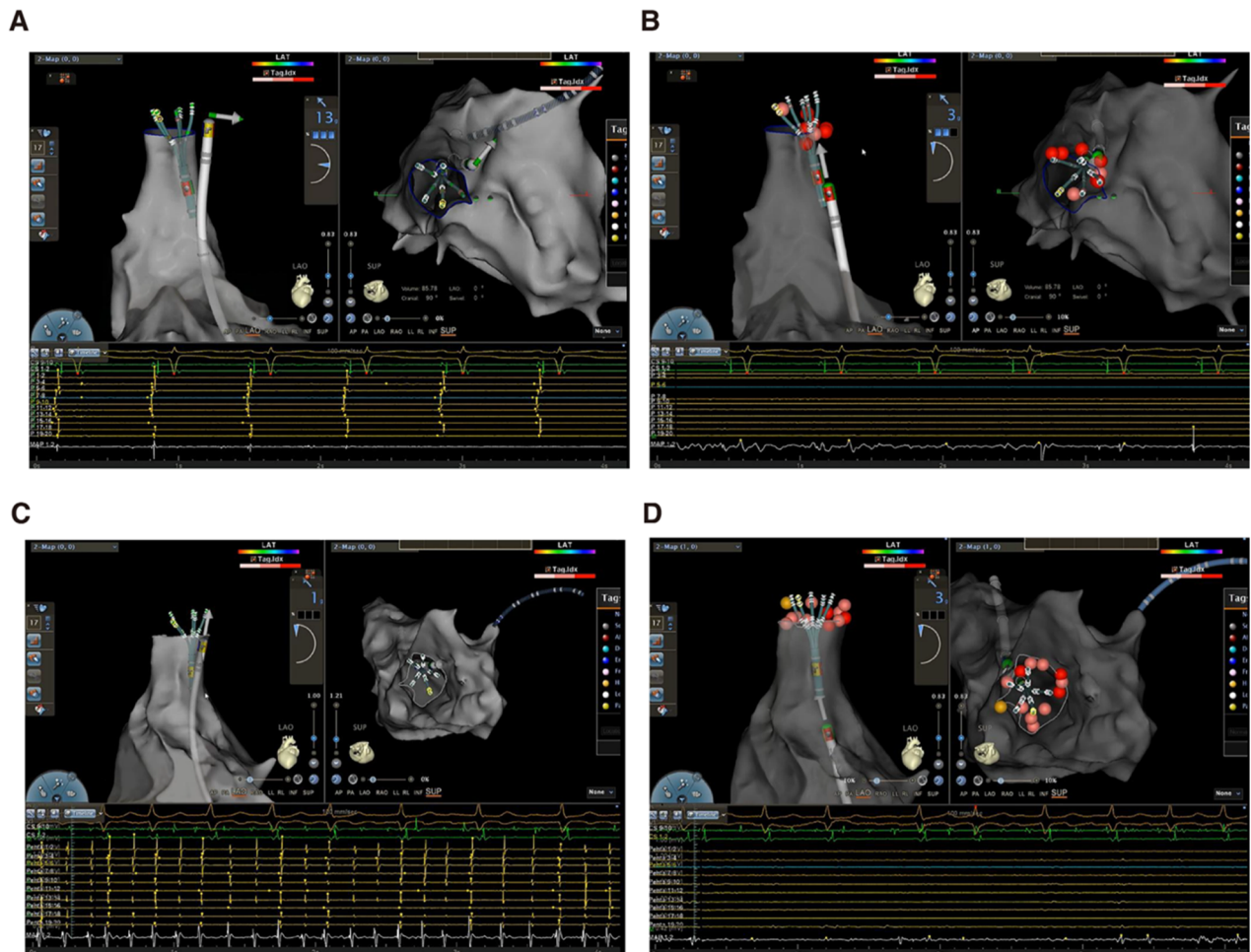


Figure 3. Superior vena cava (SVC) isolation by the three-step ablation approach during sinus rhythm. The PentaRay catheter was located at the SVC in the LAO and SUP views. The pre-isolation potential was shown in the upper panel (a), while the post-isolation potential was shown in the lower panel (B), the pre-isolation potential was shown in the figure above (C), while the post-isolation potential was shown in the figure below (D). LAO=left anterior oblique, SUP=superior [40].

isolation technique, designed to avoid phrenic nerve capture and follow a more precise anatomical path, was associated with fewer ablation sites, shorter procedure times, and a lower risk of nerve injury (Figure 3) [40]. Over long-term follow-up, patients treated with this approach experienced better rhythm control compared to those undergoing conventional SVC isolation. These findings support the safety and efficacy of the modified technique in improving outcomes in AF ablation.

Nonetheless, AF remains a major clinical challenge due to its high recurrence rate following catheter ablation [6]. Traditional risk scores like DR-FLASH offer some prognostic value but often lack precision in identifying patients at highest risk of late recurrence [5,11]. A total of 102 patients with AF and 31 healthy controls were analysed to assess predictors of late recurrence after catheter ablation [41]. Patients who experienced recurrence showed significantly greater left atrial mechanical dispersion (LAMD) compared to those without recurrence. Multivariate logistic regression identified LAMD as an independent predictor of late recurrence. When LAMD was combined with the DR-FLASH score, predictive performance improved markedly, with an area under the curve (AUC) of 0.875, sensitivity of 77.8%, and specificity of 88.0%. This combined model outperformed the DR-FLASH score alone, which showed lower discriminatory power. These results support the added value of LAMD in improving post-ablation risk stratification for AF recurrence.

Remote monitoring of cardiac implantable electronic devices is critical for timely patient care but faces several real-world challenges. A global survey of device clinics revealed that most respondents identified at least one major obstacle in daily practice, including data overload, staffing limitations, and reimbursement issues [42]. Patient connectivity was a prominent concern, largely driven by limited health literacy, poor awareness of remote monitoring benefits, technological barriers, and financial constraints. These challenges were more frequently reported by non-physician staff and clinics operating under per-patient reimbursement models. The findings highlight the need for tailored strategies to support broader implementation and improve adherence to remote monitoring programs.

In this issue of *Acta Cardiologica*, several focus images highlighting interesting cases have also been reported [43–51].

Disclosure statement

No potential conflict of interest was reported by the author(s).

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