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# Pericardial Diseases in Clinical Practice: Current Diagnostic Strategies, Therapeutic Advances, and Future Directions

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## Abstract

Pericardial diseases comprise a diverse spectrum of disorders, including acute and recurrent pericarditis, pericardial effusion, cardiac tamponade, constrictive pericarditis, and neoplastic pericardial involvement, all of which contribute substantially to cardiovascular morbidity. This narrative review synthesizes recent evidence on the epidemiology, pathophysiological mechanisms, contemporary diagnostic strategies, therapeutic advances, and future developments in pericardiology. Current evidence demonstrates that multimodality imaging, particularly echocardiography, cardiac computed tomography, and cardiovascular magnetic resonance, has significantly improved diagnostic precision, disease characterization, and risk stratification. Advances in understanding inflammatory pathways have facilitated the introduction of targeted therapies, including interleukin-1 inhibition, which has enhanced disease control in patients with recurrent and treatment-resistant pericarditis. Emerging innovations such as inflammatory biomarkers, artificial intelligence-assisted imaging, wearable monitoring devices, and digital health technologies are further supporting precision-based diagnosis, individualized treatment planning, and long-term surveillance. Despite these advances, recurrent disease, delayed diagnosis, heterogeneous clinical presentation, and variability in treatment response remain important challenges that continue to affect patient outcomes. Future progress will depend on integrating multidisciplinary care, standardized evidence-based clinical pathways, precision medicine, and robust clinical research to translate technological innovations into routine practice. Collectively, these developments are expected to improve diagnostic accuracy, optimize therapeutic decision-making, reduce disease recurrence, and enhance long-term outcomes for patients with pericardial diseases.

**Keywords:** Pericardial diseases, Pericarditis, Multimodality imaging, Precision medicine, Cardiovascular therapeutics

# 1. Introduction

The Pericardial Diseases are a group of heterogeneous diseases involving the Pericardium such as Acute Pericarditis, Recurrent Pericarditis, Pericardial Effusion, Cardiac Tamponade, Constrictive Pericarditis and Neoplasms of the Pericardium. While they were once thought of as rare, relative to other cardiovascular diseases, these diseases have been diagnosed more frequently in recent years and are found to be a significant burden of morbidity and health care consumption internationally. Pericardial diseases have gained increasing prominence in modern cardiovascular medicine, with recent international reviews emphasizing the remarkable advances in research into their underlying biologic pathway, diagnosis and therapy (Mardigyan et al., 2023; Klein et al., 2024).

Pericardial disease continues to be evolving with regard to epidemiology due to demographic changes, better survival after cardiac surgery, new developments in oncology and new infections and inflammatory diseases. However, recent evidence suggests that the spectrum is much broader than idiopathic pericarditis, and includes autoimmune diseases, malignancies, metabolic disorders, post-cardiac injury syndromes and a host of viral infections. Thus, there is a growing variety of presentations that demand a multidisciplinary approach to evaluation and individual management plans (Reddy et al., 2023; Yu et al., 2026). Additionally, cardiovascular conditions in developing and high income areas are still a significant contributor to disease burden and need to be given more recognition and equitable access to special cardiovascular care (Viljoen et al., 2021).

New developments in multimodality cardiac imaging have revolutionized the approach to the diagnosis of pericardial diseases. With the advent of insights gained from integrated imaging by means of echocardiography, cardiac computed tomography and cardiovascular magnetic resonance imaging, pericardial inflammation, fibrosis, effusion and constrictive physiology can now be characterized better, allowing for earlier diagnosis and more precise risk stratification. From a clinical perspective, these technological advancements have also enabled the ability to make evidence-based decisions about the treatment of patients, including a thorough investigation of the pericardium's structure and function (Klein et al., 2024). Advances in therapeutic approaches, such as the optimization of anti-inflammatory therapy, the use of biologic agents, and improvements in interventional procedures have helped improve control of the disease and its recurrence in select patient populations (Mardigyan et al., 2023).

However, there are still key issues to be addressed. Mortality analysis suggests that there are still age, sex, and underlying disease etiology-related differences in the outcomes of mortality, and that there is still a delay in diagnosis and different treatment practices remain affecting prognosis in many patients (Khan et al., 2025). Concurrently, the rise of evidence-based medicine has enhanced the creation of standardized clinical guidelines, but implementation of new evidence into practice continues to be a challenge (Agrawal et al., 2024; Subbiah, 2023). These evidence-informed diagnostic algorithms created in recent global health emergencies provide additional evidence for the value of structured clinical algorithms and timely delivery of high-quality evidence for cardiovascular care (Xu et al., 2020).

This is a narrative review of the current information on the epidemiology, pathophysiology, diagnostic approaches, therapeutic advances, and future directions of the pericardial diseases. The review incorporates

new clinical evidence and international guidelines to give healthcare professionals a single overview of the current state of the art in all aspects of the diagnosis, treatment and long-term management of patients with pericardial disorders.

## 2. Overview of Pericardial Diseases

Pericardium is a fibroserous sac consisting of visceral and parietal layers that envelopes the heart, which provides mechanical support, prevents excessive movement of the heart, minimizes friction during the cardiac cycle and acts as a barrier to prevent the spread of infection and malignancy. In addition to its structure, the pericardium also plays a role in normal cardiac hemodynamics such as regulating ventricular filling and maintaining physiological relationships between the heart and other thoracic structures. Inflammation, fluid accumulation, fibrosis, and/or neoplastic infiltration can all disrupt these functions and seriously impact cardiovascular performance, potentially causing life-threatening complications (Lazarou et al., 2022; Hoit, 2023).

Pericardial disease is a wide range of both acute and chronic conditions, with varying causes and clinical features. Acute pericarditis is the most common condition and is defined as inflammation of the layers of the Pericardium which can be associated with pleuritic chest pain, pericardial friction rub, ECG changes and raised inflammatory markers. While most patients can be completely recovered with anti-inflammatory treatment, a significant number of patients will have relapses, which can impact their quality of life, and will need long term clinical follow-up (Lazarou et al., 2022; Sanaka et al., 2025). The emergence of recurrent pericarditis as a clinical entity with persistent immune activation clearly indicates that there is a need for individual therapeutic approaches in addition to traditional therapy.

Another important manifestation of pericardial disease is pericardial effusion which is the accumulation of excessive amounts of fluid in the pericardial cavity. The underlying causes are very diverse ranging from inflammatory diseases, infections, malignancies, autoimmune diseases, renal failure, trauma, and postoperative complications. The clinical impact of the amount of fluid is also related to the rate of fluid accumulation: slowly progressive effusions may not have any symptoms, while rapid accumulations can lead to hemodynamic instability (Lazaros et al., 2023; Hoit, 2023).

If the intrapericardial pressure increases to a level that is enough to affect cardiac filling, cardiac tamponade occurs which is a cardiovascular emergency and must be recognized and acted upon quickly. As compression of the cardiac chambers increases, venous return decreases, stroke volume decreases and if left untreated, can progress to cardiogenic shock. New imaging techniques and the assessment of hemodynamics have made the early detection of tamponade possible, allowing timely pericardiocentesis and better clinical outcomes (Hoit, 2023; Adler et al., 2023).

Other chronic pericardial diseases are constrictive pericardial disease, which is a fibromuscular thickening of the pericardial leaves and loss of pericardial elasticity that make it difficult to fill the ventricles, causing chronic heart failure. Furthermore, the pericardium may be involved in the neoplastic process, and, due to the marked improvement in the survival of patients with cancer, neoplastic involvement of the pericardium has become more significant. Pericardial inflammation, recurrent effusions or tamponade can be seen in

both primary and secondary malignancies and can cause significant difficulty in diagnosis and treatment. Today, close collaboration between cardiologists, oncologists, radiologists and cardiothoracic surgeons is essential to optimize the outcome of the patient (Lorenzo-Esteller et al., 2024).

While much of the evidence of pericardial disease comes from the human medicine literature, there has been comparative cardiac research that has shown many of the pathological mechanisms are similar across species. Experimental and veterinary studies have proven to be useful in understanding the pathophysiology of pericardial disorders and cardiac tumors and have helped to broaden the understanding of progression of disease and methods of treatment (Ware et al., 2021). The growing spectrum of pericardial diseases highlights the need for a proper classification, thorough etiological assessment, and prompt adoption of evidence-based management principles to prevent complications and optimize long-term outcomes. The spectrum of clinical disease caused by pericardial disease ranges from acute inflammation to recurrent episodes, to fluid accumulation, to cardiac tamponade, to chronic constriction and to neoplastic involvement, as summarized in Figure 1.

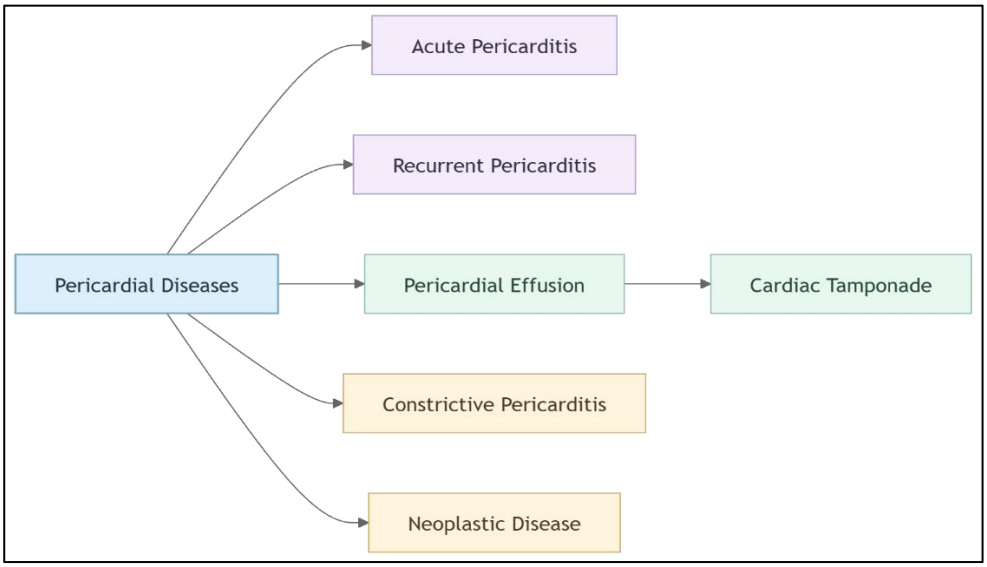


**Figure 1. Clinical Spectrum of Pericardial Diseases**

## 3. Pathophysiology and Clinical Manifestations

Pathophysiology of pericardial diseases is a combination of complex mechanisms of inflammation, immune response, infection, neoplasm, and mechanical factors that cause damage to the physiological anatomy and function of the pericardium. Injury to the pericardium causes activation of the mesothelial cells of the pericardium and immune cells followed by recruitment of inflammatory mediators and hence vascular leakage with the accumulation of fluid within the pericardial sac. Chronic inflammation causes progressive deposition of collagen and fibrosis that results in loss of compliance of the pericardium with the development of constriction. The recent advancements in science have shed light on the role of inflammatory mechanisms including interleukin-mediated signaling in causing resistance and recurrence of disease thereby paving way for precision therapy (Kim & Hwang, 2026).

It should be noted that the Pericardium is not only a protective layer, but it is also an active participant in the process of cardiac restoration. Experimental studies revealed that pericardial cells are involved in the

regulation of immunity, remodeling of the extracellular matrix, and tissue healing after myocardial damage. All these studies allowed to reveal the biological activity of the pericardium, which was earlier considered as a passive anatomical structure (Omelchenko, 2025).

Symptoms of pericardial disease differ according to the etiology of the condition, the level of inflammation and the speed of onset. The manifestations of acute inflammatory diseases are often accompanied by chest pain, fever, dyspnea, and positional chest pain, while those of chronic diseases may present with no clinical symptoms at all until an effusion or constriction occurs. The development of a large amount of pericardial effusion will lead to fatigue, lack of stamina during physical activity and symptoms of heart failure; sudden accumulation of fluid may result in the development of cardiac tamponade which presents with hypotension, high jugular venous pressure and circulatory collapse. Such symptoms can be confused with many other cardiovascular and systemic disorders.

The progression of the disease depends on several prognostic factors such as disease aetiology, recurrence, systemic inflammatory activity, associated malignancy and presence of structural cardiac abnormalities. Patients with autoimmune diseases, cancer, or chronic inflammatory activation tend to have a more complex clinical course and will need really long-term monitoring. Today, risk stratification is based on a combination of clinical and laboratory biomarkers, and multimodality imaging is used to distinguish patients who are more likely to develop recurrence, hemodynamic instability or late complications, thus allowing for more personalized treatment approaches (Kim & Hwang, 2026).

The phenotypic variability of pericardial diseases illustrates the principle that the phenotype is an expression of the biological process taking place within the specific patient. This is also true for other diseases, for which pathological subtypes have been shown to correlate with clinical differences and prognosis, highlighting the importance of considering individual patients rather than a sole approach of diagnosis (Millward et al., 2023; Yan et al., 2020). As such, the understanding of physiopathology of these diseases is of critical importance for the current pericardiological practice, providing grounds for increased certainty in diagnosis, prognosis and treatment options. The main pathogenic processes, clinical aspects and prognostic significance of the pericardial diseases are reviewed in Table 1, and the development from acute inflammatory and fluid process to fibrosis, constriction and hemodynamics deterioration is underlined.

**Table 1. Pathophysiological Mechanisms and Clinical Consequences of Pericardial Diseases**

| Pathological process | Principal mechanism | Clinical consequence | Prognostic relevance | References |
|---|---|---|---|---|
| Acute inflammation | Activation of mesothelial and immune cells with cytokine release | Pleuritic chest pain, fever, friction rub, inflammatory-marker elevation | Persistent inflammation may increase recurrence risk | Kim and Hwang (2026) |
| Increased vascular | Movement of inflammatory fluid into | Pericardial effusion, dyspnea, reduced | Rapid fluid accumulation may | Kim and Hwang |

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| permeability | the pericardial cavity | exercise tolerance | cause hemodynamic compromise | (2026) |
| Immune dysregulation | Sustained interleukin-mediated inflammatory signaling | Recurrent or treatment-resistant pericarditis | Associated with repeated episodes and prolonged therapy | Kim and Hwang (2026) |
| Fibrosis and collagen deposition | Chronic inflammation produces pericardial thickening and loss of elasticity | Impaired ventricular filling and constrictive physiology | May progress to chronic heart failure and require surgery | Kim and Hwang (2026) |
| Pericardial cellular remodeling | Resident pericardial cells influence tissue repair and extracellular-matrix regulation | Altered myocardial repair following cardiac injury | May affect myocardial recovery and adverse remodeling | Omelchenko (2025) |
| Neoplastic or systemic involvement | Malignant infiltration or systemic disease alters pericardial structure | Effusion, tamponade, nonspecific systemic symptoms | Underlying etiology strongly influences survival and recurrence | Kim and Hwang (2026) |

## 4. Current Diagnostic Strategies

A systematic approach based on clinical evaluation, laboratory studies, and multimodality imaging is needed for accurate diagnosis of pericardial diseases. Due to the overlap of clinical symptoms with other cardiovascular and systemic diseases, early detection requires careful assessment of the patient's symptoms, physical examination and selective use of diagnostic tests. A systematic diagnostic approach helps to identify the underlying cause, severity of the disease, and the appropriate treatment options in a timely manner (Rao, 2023).

Initial evaluation starts with a thorough clinical assessment which will include a review of the history of the chest pain, dyspnea, fever, past cardiac evaluations/surgeries, autoimmune diseases, malignancy, and infectious exposures. Important physical findings to clue into the inflammatory activity or hemodynamic compromise are pericardial friction rub, elevation of jugular venous pressure, pulsus paradoxus, muffled heart sounds, and peripheral edema. ECG and standard lab tests (inflammatory markers) help support the bedside assessment and direct the need for advanced imaging (Rao, 2023).

Echocardiography is the imaging modality of choice due to its widespread availability, the rapid time to obtain the image, and the ability to assess for pericardial effusion, ventricular interaction, chamber compression and features suggestive of constrictive physiology. In complex cases, however, more imaging

is often needed to further evaluate the pericardial anatomy and/or to differentiate inflammatory, fibrotic or neoplastic processes. Cardiac computed tomography is excellent for assessing the spatial resolution to identify pericardial thickening, calcification and associated structural abnormalities, and has reliable cardiac function assessments (ejection fraction) to support comprehensive cardiac evaluation (Steffani et al., 2026).

Due to its excellent tissue characterisation, cardiovascular magnetic resonance imaging has become a mainstay in the assessment of the pericardium in the modern era. It allows to visualize a pericardial edema, active inflammation, fibrosis and ventricular interdependence without the use of ionizing radiation. Advanced magnetic resonance methods also help in the staging of disease, monitoring treatment and to assess prognosis: differentiating between active inflammatory lesions and irreversible fibrotic lesions, leading to more individualised clinical decision making (Filomena et al., 2022).

Biomarkers also help improve the diagnosis as they represent the level of systemic and local inflammatory activity. No individual inflammatory marker is disease-specific, but the combination of inflammatory markers and cardiovascular MR findings can help in risk stratification and identify those who might benefit from closer monitoring and/or more aggressive anti-inflammatory treatment. This approach is compatible with precision medicine as it provides the correlation of biological activity with structural imaging findings (Koschutnik et al., 2025).

Multimodal imaging algorithms, which take advantage of the complementary strengths of echocardiography, computed tomography and cardiovascular magnetic resonance are increasingly used in modern diagnostic practice. These algorithms enhance differential diagnosis in the evaluation of the differences between pericardial disease and intracardiac masses, myocardial disease, or other structural disease with a similar clinical presentation (Sozzi et al., 2025). Multimodality imaging has an important role in the work-up of constrictive pericarditis, as it aids in confirming the presence of constrictive physiology, assessing the thickness and calcification of the pericardium, and distinguishing constriction from restrictive cardiomyopathy, thus informing the choice of management, both medical and surgical (La Mura et al., 2026). All of these integrated diagnostic approaches have greatly improved the accuracy, efficiency and prognostic value of current assessment of pericardial disease. As Table 2 indicates, none of the diagnostic modalities can fully assess pericardial disease; rather, clinical examination, echocardiography, cardiac CT, cardiac MRI, and inflammatory biomarkers provide complementary diagnostic information.

**Table 2. Comparison of Contemporary Diagnostic Approaches for Pericardial Diseases**

| Diagnostic approach | Main clinical role | Key findings | Principal limitation | References |
|---|---|---|---|---|
| Clinical examination | Initial recognition and assessment of hemodynamic | Friction rub, raised jugular venous pressure, pulsus paradoxus, muffled | Findings may be absent or nonspecific | Rao (2023) |

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| | stability | heart sounds | | |
| Electrocardiography | Supports diagnosis of acute inflammatory disease | Diffuse ST-segment elevation, PR-segment depression, electrical alternans | Limited sensitivity and variable presentation | Rao (2023) |
| Echocardiography | First-line assessment of effusion, tamponade, and constriction | Chamber collapse, respiratory variation, ventricular interdependence | Limited tissue characterization and acoustic-window dependence | Rao (2023); La Mura et al. (2026) |
| Cardiac computed tomography | Defines anatomy, calcification, thickening, and structural abnormalities | Pericardial calcification, thickening, effusion, ventricular-function measurements | Ionizing radiation and limited inflammatory characterization | Steffani et al. (2026) |
| Cardiovascular magnetic resonance | Evaluates inflammation, edema, fibrosis, and ventricular interaction | Pericardial enhancement, edema, fibrosis, and active inflammation | Higher cost, longer acquisition, and restricted availability | Filomena et al. (2022) |
| Inflammatory biomarkers | Estimates systemic inflammatory activity and assists follow-up | Raised C-reactive protein and other inflammatory markers | No single marker is specific for pericardial disease | Koschutnik et al. (2025) |
| Multimodality imaging | Resolves complex differential diagnoses and guides management | Integrated anatomical, functional, and tissue-level assessment | Requires expertise, resources, and coordinated interpretation | Sozzi et al. (2025); La Mura et al. (2026) |

## 5. Contemporary Therapeutic Approaches

Management of the pericardial diseases has shifted from a symptomatic approach to a more personalized and evidence-based approach focused on the management of underlying inflammatory mechanisms, the relief of haemodynamic compromise and reduction of disease recurrence. Treatment depends upon the disease subtype, its severity, its cause, the patient's features and the presence of complications, which requires multidisciplinary decision making throughout the whole course of the treatment (Cohen et al., 2021).

Pharmacological therapy is still the mainstay of the treatment of inflammatory pericardial diseases. Although many patients respond to conventional anti-inflammatory drugs, targeted biologic drugs that block the signaling of interleukin-1 have been developed with the emergence of immunology. The blockade of interleukin-1 has proven to be highly effective in the management of chronic inflammation, prevention of flares, and reduction of corticosteroid use in the setting of autoinflammatory diseases, making it another significant step towards precision medicine in the care of patients with recurrent pericardial disease (Malcova et al., 2021). The understanding of the inflammatory pathways has further increased the enthusiasm for personalized therapeutic strategies according to immunological profile and disease activity.

Multidisciplinary collaboration between the cardiologist, the cardiovascular surgeon, the rheumatologist, the specialist in infectious diseases, the oncologist and the imaging expert is becoming more important for optimal care of the patient. The collaborative models allow for a more holistic assessment of complex cases, better decision making around therapy, and provide a patient-centric approach to the care of patients with multiple comorbidities or systemic inflammatory disorders. In patients with severe inflammatory syndromes with the need for coordinated long-term follow-up and specialized immunomodulatory treatment, multidisciplinary care has proven to be particularly valuable (La Torre et al., 2025).

Interventional techniques play an important role in the management of significant pericardial effusion or cardiac tamponade when cardiac function is impaired. Percutaneous pericardiocentesis is the best minimally invasive technique which allows quick decompression and diagnostic and therapeutic fluid drainage. The safety of the procedure has been increased and catheter-based interventions and imaging-guided techniques have become an inseparable component of modern pericardial management (Hartnett et al., 2023).

Surgical approach is necessary in case of recurrent pericardial effusions, chronic constrictive pericarditis, purulent infection and non-responsiveness to conservative therapy. However, pericardiectomy is a gold standard in cases of advanced constrictive pericarditis, and recent expert guidelines emphasize the importance of appropriate patient selection, optimal timing of surgical intervention and uniform treatment strategy (Al-Kazaz et al., 2024). In addition, minimally invasive video-assisted thoracoscopic approach has been proven to be advantageous in terms of the procedure itself, thus contributing to optimization of surgery and postoperative care (Macrì et al., 2021).

Long-term treatment is not just about treating the acute symptoms; it is about preventing symptoms from coming back, seeing how the treatment works and enhancing a person's quality of life. The use of follow-up strategies based on risk with the help of clinical evaluation, imaging results, and inflammatory markers

allows for early identification of patients at high risk of relapse. In the context of today's Pericardiology (Cohen et al., 2021; Park et al., 2020), the use of personalized therapeutic principles in combination with the understanding of prognostic factors for recurrent disease allows for more effective long-term treatment and improve outcomes. Figure 2 illustrates the current strategy for the treatment of Pericardial disease, starting from diagnosis to medical treatment, interventional treatment and surgery followed by long term follow up.

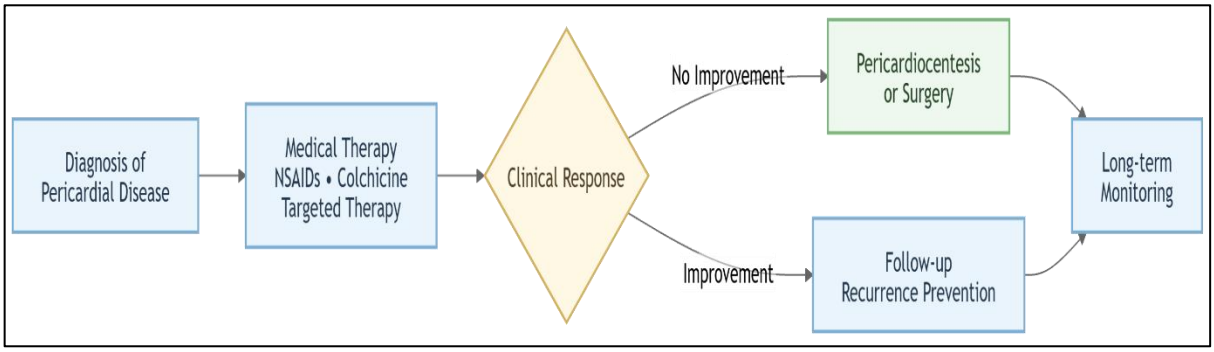


**Figure 2. Contemporary Therapeutic Approaches for Pericardial Diseases**

## 6. Emerging Advances in Pericardiology

Precision medicine, novel biomarkers, artificial intelligence (AI) and digital health technologies are transforming the diagnosis and management of pericardial disease with its rapidly evolving science. These advances are transforming the care of patients from traditional symptomatic treatment to strategies that will allow more precise diagnosis, risk stratification and personalized treatment. Future advancements in technology will likely be able to enhance clinical decision-making and patient outcomes as the understanding of the pathobiology of the pericardium continues to grow (Bhattacharya et al., 2025).

Biological markers or inflammatory markers are useful for assessing disease activity and response to treatment in patients with pericarditis and have taken on increasing significance in recent years. Conventional parameters like C-reactive protein level and erythrocyte sedimentation rate are still useful but other inflammatory markers are being studied and may better predict disease activity and risk of relapse. Biomarker signatures that reflect sustained inflammation might help to enable more timely intervention, tailor treatment duration and optimise individual patient care (Özlek et al., 2025). At the same time, the development of biosensing technologies also enables the quick detection of biomarkers in circulation with high sensitivity, which will be beneficial for future point-of-care applications and continuous monitoring of disease. (Purohit et al., 2026).

Artificial Intelligence (AI) is becoming a game-changer for cardiovascular imaging and clinical risk prediction. Multimodal clinical and imaging data can be analysed with machine learning algorithms to detect subtle changes of inflammation that are not evident in conventional assessment. In the context of inflammatory heart diseases, AI's integration with cardiac magnetic resonance imaging (CMR) has shown significant promise in enhancing diagnostic precision, assessing inflammatory burden, and aiding in personalized treatment planning in diseases such as Pericardial Diseases (Ghaffari Jolfayi et al., 2025). Furthermore, implementation of multimodal AI technologies, which combine imaging data and laboratory findings with clinical information, would make diagnosis and treatment approaches more accurate and

precise for various patient populations (Parvin et al., 2025).

In addition, the process of disease monitoring on a long-term basis is going through transformation with digital health innovations. Wearable monitoring tools, remote management system of patients and intelligent digital environments allow achieving constant assessment of physiological parameters, treatment compliance and symptoms progress. This innovative approach allows detecting early signs of clinical deterioration, engaging with the patient and adjusting the therapy in a timely manner without the necessity of making extra trips to the hospital. It is believed that combination of wearable technology and precision medicine approach would strengthen personalized monitoring of patients (Razek & Pichon, 2026).

Innovations in the field of pericardiology in the future can depend on the combination of developments in the field of biomarkers, modern imaging modalities, AI-assisted data analysis, and digital health technology. The implementation of these innovations into clinical practice will contribute to the increase in diagnostic effectiveness, improvement in risk stratification, and precise treatment decision making. However, along with development and refinement of these innovations through multidisciplinary cooperation and advanced technologies and research, it is critical that they will be effectively implemented into evidence-based management of patients with pericardial diseases (Bhattacharya et al., 2025). Major innovations and their potential clinical applications are presented in Table 3, including inflammation biomarker profiles, biosensors, AI-assisted imaging, multimodal data analysis, and wearable devices.

**Table 3. Emerging Innovations and Potential Applications in Pericardiology**

| Emerging innovation | Proposed application | Potential clinical benefit | Current challenge | References |
|---|---|---|---|---|
| Inflammatory biomarker panels | Assessment of disease activity and recurrence risk | Earlier identification of persistent inflammation and improved treatment monitoring | Limited disease specificity and need for validated thresholds | Özlek et al. (2025) |
| Advanced biosensors | Rapid or point-of-care detection of circulating biomarkers | Faster testing and potential continuous disease surveillance | Clinical validation and integration into cardiovascular care remain limited | Purohit et al. (2026) |
| AI-assisted cardiac MRI | Automated recognition and quantification of inflammatory abnormalities | Greater diagnostic consistency and improved assessment of inflammatory burden | Dataset heterogeneity, interpretability, and external validation | Ghaffari Jolfayi et al. (2025) |
| Multimodal artificial intelligence | Integration of imaging, biomarkers, and | Improved risk prediction and personalized therapeutic | Data standardization, bias, privacy, and regulatory concerns | Parvin et al. (2025) |

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| | clinical data | recommendations | | |
| Wearable monitoring | Remote tracking of symptoms and physiological variables | Earlier detection of deterioration and improved follow-up | Patient adherence, signal accuracy, and interoperability | Razek and Pichon (2026) |
| Precision digital environments | Continuous monitoring of individualized interventions | Timely treatment adjustment and enhanced patient engagement | Cost, accessibility, and clinical-workflow integration | Razek and Pichon (2026) |
| Integrated innovation platforms | Combination of biomarkers, imaging, AI, and digital monitoring | More precise diagnosis, risk stratification, and longitudinal management | Requires multidisciplinary validation and robust infrastructure | Bhattacharya et al. (2025) |

## 7. Clinical Challenges and Future Directions

Although there has been significant advances in understanding and treatment of the disease, there are still a number of difficult clinical challenges that hinder a patient's best prognosis. One of the most important unresolved issues, with a significant burden of recurrent hospitalizations, persistent symptoms, decrease in quality of life and continued dependence on anti-inflammatory treatments, is recurrent pericarditis. The uncertainty of disease presentation, disease recurrence and treatment response also complicates decision making in the clinic and calls for the development of better risk prediction models and personalized management plans (Klein et al., 2022).

Another challenge is the management of refractory pericardial disease. Targeted biologic therapies have brought more options for treatment, but for some people, traditional and cutting-edge therapy still does not bring about lasting relief from inflammation. As with other chronic immune-mediated diseases, this treatment resistance could be due to the differences in pathogenic mechanisms, suggesting the need to investigate predictive biomarkers and develop personalized treatment algorithms. Future research should therefore aim to gain a deeper understanding of the heterogeneity of the disease and selection of treatment use based on patient characteristics (Lyu & Li, 2026).

Important priorities include ongoing development of evidence-based clinical pathways. Cardiovascular practice today is becoming more and more dependent upon structured consensus recommendations that incorporate clinical assessment, multimodality imaging, assessment of biomarkers, and patient-specific risk profiles. These principles, when applied to the study of pericardial diseases, may help to increase the uniformity of diagnosis, initiate treatment earlier and help to harmonize the treatment of pericardial diseases in different health care environments. As new evidence and therapeutic options come to light, regular revision of international clinical guidelines will continue to be important (Kittleson et al., 2023).

Multidisciplinary models of care will also need to be improved in the future to ensure progress in the field of pericardiology. Management is often a multi-disciplinary process involving the cooperation of an array of specialists, including cardiologists, cardiovascular surgeons, radiologists, rheumatologists, infectious disease specialists, oncologists, pathologists and specialised nursing teams. Integrated approaches increase the accuracy of the diagnosis, facilitate the planning of treatment and facilitate long-term follow-up, especially in complicated and multisystem disease. Increased cross-disciplinary research networks will also speed up the process of research to clinical practice (Gavkare et al., 2026).

Digital healthcare and remote monitoring technologies are anticipated to become more important in the future for the management of diseases. Mobile health platforms, Telemedicine and structured recovery programs have shown promise to improve continuity of care, enable early identification of clinical deterioration, as well as increase patient engagement during long-term follow-up. These devices can be incorporated in the future management of patients suffering from pericardial disease, thus reducing the number of hospital visits that are unnecessary, improving treatment adherence and facilitating individual patient monitoring beyond the boundaries of the hospital facility (Khan et al., 2024).

In conclusion, precision medicine, interdisciplinary collaboration, evidence-based care standards, and advanced digitalization are the future of Pericardiology. Future research in the field of translational research, international cooperation, and quality clinical studies will play a very important role in filling existing gaps in knowledge and advancing the future of care for patients with pericardial disease. Figure 3 highlights the major issues with regard to the current clinical practice as well as research directions in the future which will improve the diagnostic, treatment and prognosis for patients with pericardial diseases.

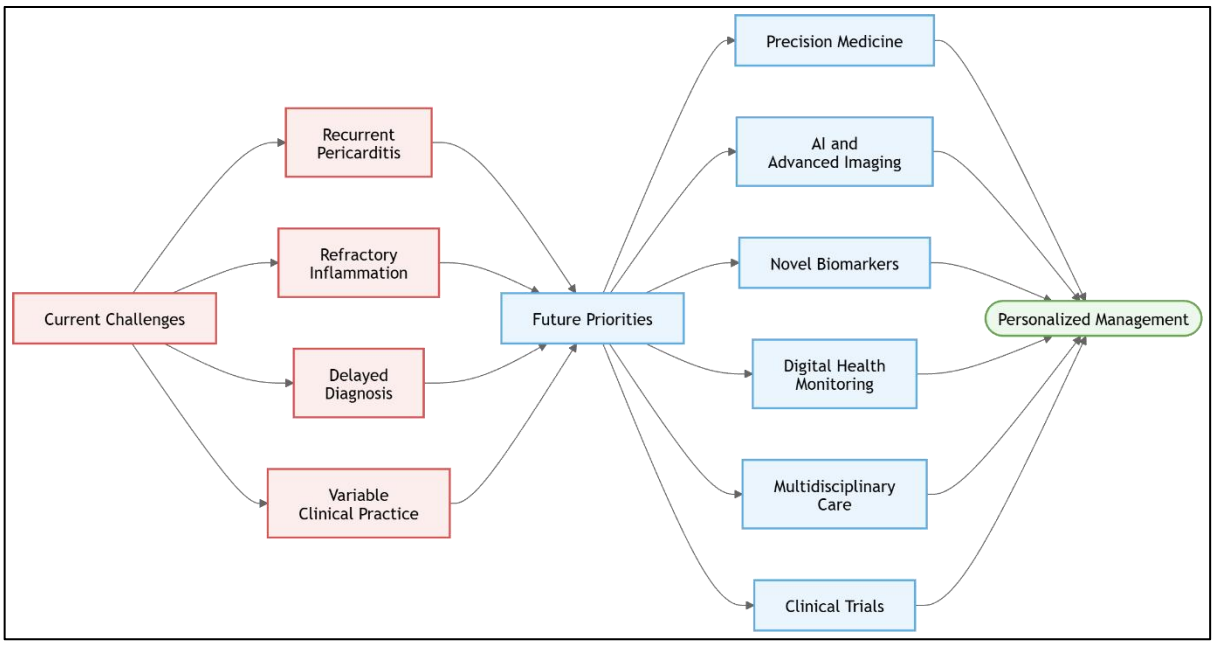


**Figure 3. Future Directions for Precision Pericardiology**

## 8. Clinical Implications and Expert Perspectives

The fast development of the field of pericardiology has reinforced the importance of combining the patient-centred approach with evidence-based medicine for optimal clinical results. Today, management is no longer limited to treatment of the underlying condition and more and more, treatment decisions are

individualized, taking into account such factors as level of disease severity, comorbidities, patient preference and quality of life. Embedding high quality clinical evidence into routine practice, in a patient-centred manner, can help facilitate shared decision-making, enhance treatment adherence and improve healthcare experiences for people with Pericardial Disorders (Engle et al., 2021).

Continuous professional education is also necessary in order to put the new scientific knowledge into practice. High fidelity simulation and competency-based training improve clinicians' diagnostic accuracy, procedural skills, and confidence in their skills for handling cardiovascular emergencies. These methods are especially helpful when it comes to acquiring skills in complex, multi-disciplinary clinical decision making in the field of Pericardiology (Bartlett et al., 2021).

Structured rehabilitation and lifestyle optimisation should also be part of the long term management of the patient. While the evidence for pericardial disease continues to grow, research in the field of cardiovascular medicine has shown that if a cardiovascular exercise program is properly prescribed and supervised follow-up is provided, functional capacity, physical endurance and overall health status can be improved. This adds to the overall idea of a holistic approach to cardiovascular disease that goes beyond medication to cardiovascular rehabilitation and ongoing patient engagement (Callaghan et al., 2021).

In all of these interventional procedures, pericardiocentesis is still a mainstay in the treatment of large pericardial effusion and cardiac tamponade. Continous improvements in imaging guidance, catheter design, and techniques have significantly increased its safety and efficacy and decreased procedure-related complications. The patient selection, procedural planning, and post-procedural follow-up procedures are expected to become increasingly sophisticated in the coming years, thereby emphasizing even more the importance of minimally invasive techniques in modern pericardial practice (Kalluri et al., 2024). Taken together, all these trends signify the evolution of pericardiology into a precise, multi-disciplinary, and patient-oriented approach that is expected to have a significant effect on the future of the field.

## 9. Conclusion

Despite significant progress in the field of cardiology, pericardial disease can be a diagnostic and therapeutic challenge and represents a variety of cardiac conditions. Advances in multimodality imaging, measuring inflammatory biomarkers and for targeted anti-inflammatory therapy have improved diagnostic accuracy, individualisation of therapy and long term disease control. Further, the use of precision medicine, AI and digital health technologies can provide further opportunities to enhance risk stratification, track disease progression and manage patient care. However, the lack of consistent good results is hampered by recurrent disease, late diagnosis and variability of clinical presentation. These challenges are addressed by the need of standardisation of care pathways based on evidence, multidisciplinary collaboration and the ongoing need to translate new scientific findings into clinical practice. The future of research in this field should involve the validation of novel biomarkers, advanced imaging modalities and personalized therapies. These innovations collectively have the potential to transform the field of pericardiology, enabling an early diagnosis with improved treatment outcomes and personalized cardiovascular care based on precision medicine principles.

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