How Does AI Support Structural Heart Disease Diagnosis?

Rasit Dinc

Rasit Dinc Digital Health & AI Research

Published: December 13, 2015 | AI in Cardiology

DOI: 10.5281/zenodo.17999265

Abstract

Structural heart disease (SHD) represents a significant and growing global health concern, encompassing a range of conditions affecting the heart's valves, w...

How Does AI Support Structural Heart Disease Diagnosis?

Author: Rasit Dinc

Structural heart disease (SHD) represents a significant and growing global health concern, encompassing a range of conditions affecting the heart's valves, walls, and chambers. Despite its prevalence and the serious health implications, SHD remains largely underdiagnosed, primarily due to the limitations of current diagnostic methods. However, the integration of artificial intelligence (AI) into cardiovascular medicine is poised to revolutionize the diagnostic landscape, offering new hope for earlier and more accurate detection.

The Challenge of Diagnosing Structural Heart Disease

The definitive diagnosis of SHD has traditionally relied on echocardiography. While effective, this imaging modality is not without its drawbacks. The cost, the need for specialized expertise to perform and interpret the scans, and the logistical challenges of widespread screening have limited its accessibility. Consequently, many individuals with SHD remain unaware of their condition until symptoms become severe, at which point the opportunities for early intervention and improved outcomes are diminished. This diagnostic gap highlights the urgent need for more accessible and efficient screening tools.

AI-Powered ECG Analysis: A New Frontier

The 12-lead electrocardiogram (ECG) is a widely available and relatively inexpensive diagnostic tool. While it has long been a staple in cardiac care, its ability to detect SHD has been limited. The advent of AI, and specifically deep learning, is changing that. Researchers have developed sophisticated deep

learning models, such as EchoNext, which have been trained on vast datasets containing millions of heart rhythm and imaging records [1].

These AI-powered ECG analysis tools can detect a wide array of SHDs with a high degree of accuracy, in some cases even outperforming human cardiologists in controlled settings. A key advantage of these models is their consistent performance across diverse patient populations and clinical contexts. Clinical trials have already demonstrated the real-world utility of these models in identifying previously undiagnosed heart disease, heralding a new era of proactive and accessible cardiac screening [1].

Enhancing Cardiovascular Imaging with AI

Beyond ECG analysis, AI is also making significant inroads into advanced cardiovascular imaging techniques like cardiac magnetic resonance (CMR). AI algorithms are being employed to enhance nearly every aspect of the CMR workflow, from image acquisition to interpretation. Deep learning models, for instance, can accelerate image acquisition and reconstruct high-quality images from under-sampled data, significantly reducing scan times and improving the patient experience [2].

Furthermore, AI is automating the tedious and time-consuming process of segmenting cardiac structures from images. AI-based tools, such as those utilizing the U-net architecture, can delineate cardiac chambers and myocardium with remarkable precision and consistency, leading to more accurate and reproducible measurements of cardiac function. AI is also enhancing myocardial tissue characterization, enabling the automated detection and quantification of fibrosis, edema, and infarction. This allows for a more precise phenotyping of cardiomyopathies and ischemic heart disease, which is crucial for tailoring patient management and predicting outcomes [2].

The Future of AI in Cardiac Diagnosis

The application of AI in the diagnosis of SHD is still in its early stages, but its potential is undeniable. By leveraging the power of AI, we can move towards a future where the early detection of SHD is the norm rather than the exception. AI-driven tools can help to risk-stratify patients, identify those who would benefit most from further diagnostic testing, and ultimately, facilitate earlier and more effective interventions.

The continued development and validation of these technologies will require a collaborative effort between clinicians, data scientists, and engineers. The public release of large, de-identified datasets and AI models, as advocated by leading researchers, will be instrumental in fostering innovation and ensuring that these powerful tools are accessible to all [1].

Conclusion

Artificial intelligence is set to transform the diagnosis of structural heart disease. From enhancing the diagnostic capabilities of the humble ECG to revolutionizing advanced imaging modalities like CMR, AI is providing clinicians with powerful new tools to detect and manage SHD more effectively.

As these technologies continue to mature, they hold the promise of improving patient outcomes, reducing healthcare costs, and ultimately, saving lives.

References

[1] Poterucha, T.J., Jing, L., Ricart, R.P. et al. Detecting structural heart disease from electrocardiograms using AI. *Nature* (2025). https://doi.org/10.1038/s41586-025-09227-0

[2] Fortuni, F., Ciliberti, G., De Chiara, B., Conte, E., Franchin, L., Musella, F., ... & Oliva, F. (2024). Advancements and applications of artificial intelligence in cardiovascular imaging: a comprehensive review. *European Heart Journal-Imaging Methods and Practice*, *2*(4), qyae136. https://doi.org/10.1093/ehjimp/qyae136
