METHODIST DEBAKEY CARDIOVASCULAR JOURNAL

Artificial Intelligence in Cardiovascular Medicine

ISSUE INTRODUCTION

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Artificial intelligence (AI) is rapidly transforming cardiovascular medicine, offering new opportunities to improve the prevention, diagnosis, and management of cardiovascular disease. Advances in computational power, the availability of large-scale clinical datasets, and the development of complex computational algorithms have enabled AI to identify complex patterns in medical images, physiological signals, and electronic health records that may not be readily apparent through conventional approaches. From automated interpretation of cardiovascular imaging and electrocardiograms to personalized risk prediction and clinical decision support, AI has the potential to improve diagnostic accuracy, enhance clinical efficiency, and enable more individualized patient care.[1,2] Yet, despite remarkable technological progress, important questions remain regarding the generalizability, interpretability, clinical integration, and real-world impact of these emerging tools. Ultimately, the value of AI will be determined not simply by its predictive performance, but by its ability to meaningfully improve clinical decisions and patient outcomes.[3]

In this issue of the *Methodist DeBakey Cardiovascular Journal*, we explore the evolving role of AI and digital health across the spectrum of cardiovascular medicine through articles authored by experts in their respective fields. These reviews examine applications in preventive cardiology, coronary artery disease, valvular heart disease, heart failure, aortic and peripheral vascular disease, and congenital heart disease as well as the growing role of consumer wearable devices in detecting and managing arrhythmia. Together, they provide an overview of the current state of the field, highlighting both the promise of AI-driven innovations and the challenges that must be addressed before their widespread adoption into routine clinical practice.

We start with a review titled "Artificial Intelligence in Valvular Heart Disease: Imaging, Quantification, and Clinical Decision Support," in which Drs. Yeva Fakikh and Maan Malahfji explore the expanding role of AI in the detection, evaluation, and management of valvular heart disease. The authors highlight how AI-enabled electrocardiography and point-of-care ultrasound may improve early detection while advances in echocardiography, cardiac computed tomography, and magnetic resonance imaging enable more accurate and reproducible assessment of disease severity. They also discuss the potential of machine learning to identify distinct patient phenotypes, improve procedural planning, and inform the optimal timing of intervention. These applications offer opportunities to address longstanding challenges in valvular heart disease, particularly

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underdiagnosis, variability in disease assessment, and uncertainty regarding clinical decision-making.

In "Artificial Intelligence in Coronary Artery Disease: From Detection to Precision Management," Drs. Keshav Garg, Subhi J. Al'Aref, and colleagues provide a comprehensive overview of the expanding applications of AI across the continuum of coronary artery disease care. They describe how AI-enhanced electrocardiography and electronic health records may facilitate earlier disease detection, while advances in coronary computed tomography angiography enable automated calcium scoring, plaque characterization, and noninvasive assessment of coronary physiology. They also highlight the growing role of AI in the cardiac catheterization laboratory, where automated angiographic and intravascular imaging analyses may improve procedural decision-making. Beyond diagnosis, AI offers opportunities for more personalized risk stratification, treatment selection, and secondary prevention. The authors emphasize that despite these advances, prospective clinical validation, algorithmic fairness, and thoughtful integration into clinical workflows remain essential before widespread implementation.

Next, authors Joshua D. Robert, Maham Rahimi, MD, PhD, and colleagues explore "AI Applications in Aortic and Peripheral Vascular Disease: Risk Prediction, Imaging, and Longitudinal Surveillance," examining the emerging role of AI in the diagnosis and management of aortic and peripheral artery disease. The authors highlight advances in automated image analysis, particularly the detection and segmentation of abdominal aortic aneurysms, where evidence for clinical applications is beginning to emerge. They also explore the potential of machine learning for predicting disease progression, guiding interventions, and improving longitudinal surveillance. Importantly, the authors distinguish promising algorithmic performance from demonstrated clinical benefit, emphasizing that many applications remain investigational and require external validation and prospective evaluation before they can meaningfully inform clinical decision-making.

We then shift to prevention in "Artificial Intelligence in Preventive Cardiology: Risk Prediction, Exposomics, and Personalized Interventions," where authors Corrado Magnino, MD, Matthew Coker, BS, and Eleonora Avenatti, MD, explore the expanding role of AI in cardiovascular risk assessment and prevention. The authors describe how AI-enhanced electrocardiography, cardiovascular imaging, and electronic health records can identify previously unrecognized risk, while emerging approaches integrating environmental and neighborhood-level exposures offer opportunities for more comprehensive risk assessment. They also examine the potential of AI to improve the management of traditional and emerging cardiovascular risk factors, including obesity, hypertension, dyslipidemia, diabetes, and chronic kidney disease, within the evolving cardiovascular-kidney-metabolic framework. Despite promising predictive performance, the authors emphasize the need for prospective studies demonstrating that AI-guided preventive strategies translate into meaningful improvements in patient outcomes.

In "Artificial Intelligence in Heart Failure: Early Detection, Phenotyping, and Prognostic Modeling," Sanmit Jindal, MBBS, MPH, Ankita Lavi, BS, and Ashrith Guha, MD, examine the growing role of AI across the continuum of heart failure care. The authors highlight how AI-enabled electrocardiography and echocardiography may facilitate earlier detection of ventricular dysfunction and other structural abnormalities, while integration of electronic health records, laboratory data, and longitudinal clinical information offers opportunities for more precise disease phenotyping and risk stratification. They also explore the potential of AI to identify patients with advanced heart failure, guide treatment optimization, and improve prognostic assessment. Emerging applications of agentic AI may further support clinical decision-making and care coordination, although prospective validation remains essential to establish their impact on patient outcomes.

Next, Drs. Rajkumar Dhar, Darpit Dave, Animesh Tandon, and coauthors review "Artificial Intelligence in Congenital Heart Disease: A Roadmap," where they explore the potential of AI to address the unique challenges of congenital heart disease across the lifespan. Advances in cardiovascular imaging, wearable technologies, and longitudinal patient registries may improve disease assessment, physiologic monitoring, and individualized risk stratification. Given the anatomical complexity and diverse clinical trajectories of congenital heart disease, AI offers opportunities to integrate information from multiple sources and support more personalized, lifelong care. The authors also emphasize the importance of standardized data, robust validation, and equitable access to these emerging technologies before their widespread clinical implementation.

In the final article, "Management Strategies of Atrial Fibrillation Detected by Consumer Wearable Devices: A Systematic Review of Clinical Practice and Decision-Making," authors Sanjay A. Seegobin, BSc, Camelia Arsene, MD, PhD, MHS, and team examine the clinical implications of the growing use of consumer wearable devices for atrial fibrillation detection. The authors review evidence demonstrating that wearable-generated alerts frequently prompt clinical evaluation and subsequent treatment, while highlighting considerable variability in physician decision-making, particularly regarding diagnostic confirmation and thresholds for initiating anticoagulation. Despite the increasing accessibility of these technologies,

standardized approaches to managing wearable-detected atrial fibrillation remain limited. The authors propose a clinical pathway incorporating confirmatory testing and individualized stroke risk assessment, underscoring the importance of translating advances in digital detection into evidence-based clinical management.

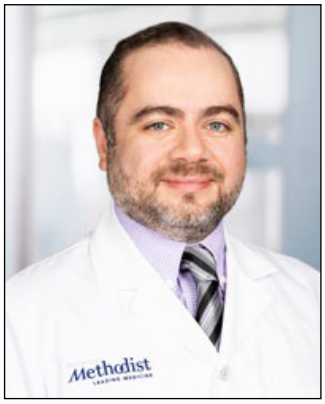
Together, these articles illustrate the remarkable potential of AI to transform cardiovascular medicine—from identifying disease before clinical manifestations arise to enabling more precise diagnosis, individualized treatment, and continuous monitoring beyond traditional healthcare settings. Yet, the rapid pace of technological innovation must be accompanied by equally rigorous clinical evaluation. High predictive accuracy does not necessarily translate into improved patient outcomes, and important challenges remain regarding algorithmic bias, data privacy, transparency, generalizability, and integration into clinical workflows. AI models trained in selected populations or healthcare systems may not perform equally well across diverse patient groups, potentially exacerbating existing health disparities. Furthermore, as increasingly autonomous AI systems enter clinical practice, questions of accountability, physician oversight, and the preservation of clinical expertise will become even more important. Addressing these challenges will require close collaboration among clinicians, scientists, engineers, regulators, and patients, with a shared commitment to ensuring that innovation translates into meaningful and equitable improvements in care.

Our sincere thanks to all the authors who contributed their expertise and perspectives to this special issue. We are witnessing a fundamental shift in how cardiovascular information is collected, interpreted, and translated into clinical decisions. For decades, cardiovascular medicine has relied on increasingly sophisticated tools to measure anatomy, physiology, and disease risk. AI now offers the opportunity to connect these measurements, uncover patterns that transcend individual tests, and move toward a more integrated understanding of cardiovascular health and disease. The ultimate promise of AI is not to replace the physician but to extend our ability to recognize disease earlier, understand each patient more completely, and deliver the right intervention at the right time. The future of cardiovascular medicine will not be defined by how much intelligence we can build into our technology, but by how effectively we translate that intelligence into better care for the patients we serve.

GUEST EDITOR BIOGRAPHIES

The editorial team of the *Methodist DeBakey Cardiovascular Journal* expresses our thanks to Drs. Sadeer Al-Kindi, Khurram Nasir, and Ashutosh Sabharwal for their guidance and expertise in curating this pioneering issue on artificial intelligence and its applications for general cardiology.

SADEER G. AL-KINDI, MD



Dr. Al-Kindi is a professor of cardiology and the Jerold B. Katz Translational Investigator at Houston Methodist DeBakey Heart & Vascular Center, where he practices preventive cardiology and cardiovascular imaging. He serves as associate director of the Division of Cardiovascular Prevention & Wellness, co-director of the Center for Cardiovascular Computational & Precision Health (C3PH), medical director of the Center for Health & Nature, and medical director for Environmental Health & Prevention.

His research integrates environmental epidemiology, cardiovascular imaging, and artificial intelligence to advance precision cardiovascular prevention. He examines how air pollution, extreme heat, neighborhood conditions, and access to nature interact with biological susceptibility and imaging phenotypes to influence cardiometabolic health and health disparities. He also develops and evaluates artificial intelligence methods to extract clinically useful information from electrocardiograms, cardiovascular imaging, and electronic health records. Integrating these tools with environmental and clinical data, his work aims to improve early detection, risk assessment, and individualized prevention. Through his leadership at C3PH and the Center for Health & Nature, he brings together clinicians, epidemiologists, engineers, and data scientists to translate research findings into practical approaches to improving cardiovascular health.

Dr. Al-Kindi has authored more than 500 peer-reviewed publications, including work in the *Journal of the American College of Cardiology*, *Circulation*, *European Heart Journal*, and *JAMA Cardiology*. His research has received support from the National Institutes of Health and other organizations, and his honors include the American College

of Cardiology's Young Investigator Award. He serves as executive editor of the *American Journal of Preventive Cardiology* and on the editorial boards of several scientific journals.

KHURRAM NASIR, MD, MSC, MPH



Dr. Nasir is the William A. Zoghbi Centennial Chair in Cardiovascular Health and holds the position of chief of the Cardiovascular Prevention & Wellness Program at Houston Methodist. He is also the founding director of the newly established Center for Cardiovascular Computational Health & Precision Medicine. Additionally, he holds academic appointments as a professor of medicine at Weill Cornell Medical College and as a professor of cardiology at the Houston Methodist Academic Institute. Recently, he was honored as a visiting professor at the London School of Economics. Prior to his current roles, Dr. Nasir served as the director of Population Health & Health System Research at Yale University School of Medicine.

Dr. Nasir received his medical degree from Pakistan followed by a Master of Public Health at Johns Hopkins University. He completed his internship at UPMC, his internal medicine residency at Boston Medical Center, and a cardiology fellowship at Yale University. He received postdoctoral research training at the division of cardiology at Johns Hopkins Hospital and was a recipient of the NIH T-32 fellowship at Massachusetts General Hospital. In 2017, he also earned a master's degree in Health Economics and Policy Management from the London School of Economics & Political Science.

Throughout his career, Dr. Nasir has demonstrated an exceptional commitment to advancing cardiovascular research and practice. To date, he has published more than 950 peer-reviewed manuscripts in high-impact journals, including the *New England Journal of Medicine*, *JAMA*, *BMJ*, *Lancet*, *Nature Reviews*, *Circulation*, and the *Journal of the American College of Cardiology*. According to Google Scholar, his work has been cited over 120,000 times, and he is part of a select group of impactful scholars worldwide with an h-index of over 110. From 2021 to 2023, he is listed among the top 2% of scientists globally as reported by Stanford University.

Nationally, Dr. Nasir has served on the board of directors for the Society of Cardiac CT and the American Society of Preventive Cardiology. He is currently associate editor for *Journal of the American College of Cardiology* and served in the same capacity for *Circulation: Quality & Outcomes Research*. He was an inaugural chair for the SCCT Future Leadership Program and was recently appointed as a Senior Advisor for the International Atherosclerosis Society. Dr. Nasir also serves as a visiting professor at the London School of Economics and is a joint investigator and Co-PI as well as steering committee member for a national study in Pakistan (Pak-Sehat).

ASHUTOSH SABHARWAL, PHD



Professor Sabharwal is the Ernest D. Butcher Professor of Engineering in the Department of Electrical & Computer Engineering and Computer Science at Rice University. Dr. Sabharwal received his B.Tech in 1993 from IIT, New Delhi, and his MS and PhD degrees in electrical engineering from The Ohio State University in 1995 and 1999, respectively. He currently works in two research areas. His first area of research is wireless, where his research spans fundamental theory and experimental systems. He is the founder of WARP project, an open-source project which is now in use at more than 125 research groups worldwide and has been used by more than 500 research articles. He also led RENEW, an NSF PAWR project, that developed the world's first open-source massive MIMO platform for a deployed city-scale national wireless testbed. He led the wireless networks thrust in the ARL-Rice Center for advanced materials and networks. He is currently leading the NSF-funded Houdini project (houdini-sdr.org). He was a co-inventor of full-duplex wireless, which has been adopted in communications standards.

His second area of research is digital health. His digital health research focus is the development of devices and data science to quantify behavior-biology pathways across many diseases. He leads the Rice Digital Health Initiative and is the codirector of the Methodist-Rice Digital Health Institute. He co-founded Cognita Labs, which has developed multiple FDA-cleared medical devices. He was the PI of "See Below the Skin" for a noninvasive bioimaging multi-university effort, and is co-PI on the NSF Engineering Research Center, PATHS-UP, that is developing cost-effective personalized technologies. His research has led to multiple commercial spinoffs and is supported by the National Science Foundation (NSF), Army Research Labs (ARL), National Institutes of Health (NIH), Qualcomm, Intel, Texas Instruments, and Facebook.

He was awarded the 2017 IEEE Jack Neubauer Memorial Award, the 2018 IEEE Advances in Communications Award, the 2019, 2021, and 2025 ACM Test-of-time Awards, the 2019 ACM MobiCom Community Contribution Award, and the 2023 ICC Best Paper Award. He is a Fellow of IEEE, ACM, and the National Academy of Inventors.

COMPETING INTERESTS

Dr. Nasir is on the advisory boards of Novo Nordisk, Novartis, Esperion, Merck Sharp & Dohme, and ER Squib & Sons; his research is partly supported by grants from the National Institutes of Health, Patient-Centered Outcomes Research Institute, Novartis, and Esperion & Ionis. He also is a member of the editorial board of the *Journal*, serving on a voluntary basis. The other authors have no competing interests to declare.

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