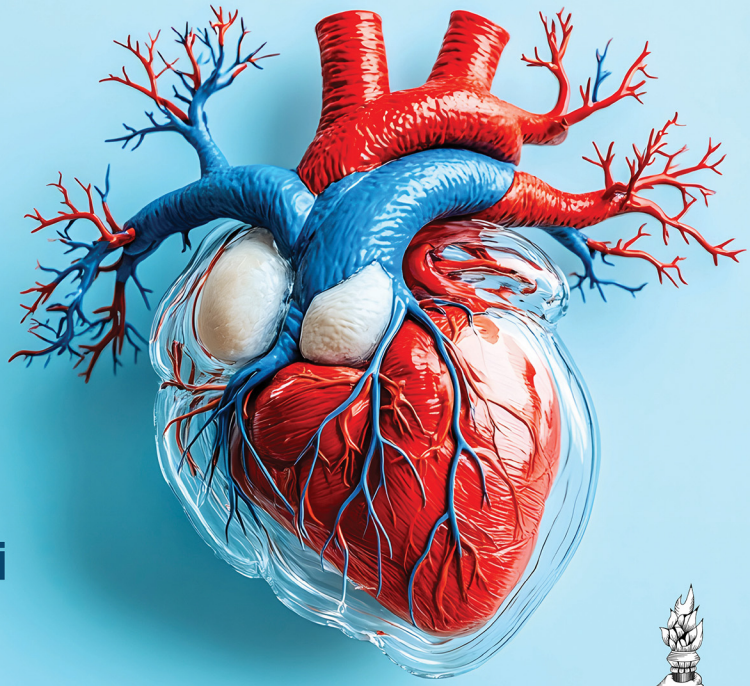
ebsite www.ejaypee.com, for detailed information on cardiology books, visit our website www.ejaypee.com, for detailed information on cardiology books, visit our website www.ejaypee.com

Volume 1

Cardiological Society of India

CARDIOLOGY UPDATE 2025



Editor-in-Chief
Dhiman Kahali

Editorial Advisors
Debabrata Roy • D P Sinha

JAYPEE

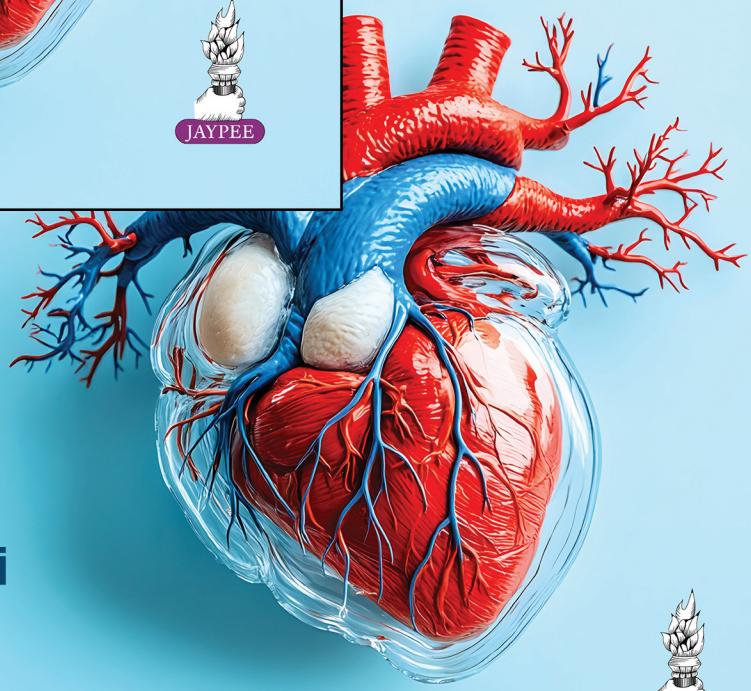
ailed information on cardiology books, visit our website www.ejaypee.com

Volume 2

ty of India

LOGY

025



Editor-in-Chief
Dhiman Kahali

Editorial Advisors
Debabrata Roy • D P Sinha

JAYPEE

Contents

VOLUME 1

SECTION 1: PREVENTIVE CARDIOLOGY

1. **Improving Community-level Cardiac-health Awareness through School-based Education Program in India** 3
   Debabrata Biswas, Debabrata Roy
2. **Air Pollution and Cardiovascular Disease in India: Current Perspective** 8
   Debabrata Biswas, Kaushik Manna, DP Sinha
3. **Can We Cancel Out the Excess Cardiovascular Risk Caused by Chronic Kidney Disease?** 12
   Farhin Iqbal, Chitra Priyadarshini
4. **Smoking Cessation: Never too Early, Never too Late!** 17
   Saumitra Ray, Sumanta Chatterjee, Srina Ray

SECTION 2: HYPERTENSION

5. **Implications of Systolic Blood Pressure Time in Target Range** 25
   AK Trivedi, Abhinit Gupta, Bijay Prakash Yadav
6. **Artificial Intelligence: An Emerging Tool for the Diagnosis and Management of Hypertension** 29
   C Venkata S Ram
7. **Clinical Management of Primary Aldosteronism** 37
   Dharmendra Jain, Vikash Kumar Maurya, Pratap Kumar
8. **Implications of Myocardial Interstitial Fibrosis in Hypertensive Heart Disease** 43
   Debasis Ghosh, Navanil Biswas
9. **Renovascular Hypertension: Kidney Intrinsic Mechanism as Novel Target** 47
   Manu Gupta, Anuj Gupta, Pooja Sharma Gupta, Rajeev Gupta
10. **The Complexity of Resistant and Refractory Hypertension** 56
    Somya Mahlawat, Umesh Tripathi, Sharad Chandra

SECTION 3: CARDIOMETABOLIC

11. **Slowing Cardiovascular Aging by Promoting Cardiometabolic Health** 69
Bhabatosh Biswas, Pankaj Sharma, Tapas K Kundu

12. **Obesity and Cardiovascular Diseases** 76
Amit Malviya, Md Amish Shikoh, Aman Asthana, Animesh Mishra

13. **Myocardial Abnormalities Across the AHA-ACC Heart Failure Spectrum in Diabetic Patients** 83
Umeshwar Pandey, Kumar Himanshu

SECTION 4: DYSLIPIDEMIA MANAGEMENT

14. **Implications of Lipid-lowering Therapy for Premature Coronary Artery Disease** 89
AK Pancholia

15. **The Challenges in Reducing Non-high-density Lipoprotein Cholesterol** 95
Arvind Kumar, Vipin Kumar

16. **Particle Number and Characteristics of Lipoprotein(a), Low-density Lipoprotein, and ApoB: Perspectives on Contributions to Atherosclerotic Cardiovascular Disease** 101
JPS Sawhney, Rohan Patel

17. **Childhood LDL Cholesterol, Non-HDL Cholesterol and Adult Atherosclerotic Cardiovascular Events** 105
Rajeev Gupta, Sonali Sharma

SECTION 5: HEART FAILURE

18. **Worsening Heart Failure: Definition and Management** 117
Dhiman Kahali, Debdatta Kar, Padma Madhab Bisoi

19. **Pulmonary Hypertension in Heart Failure: The Good, the Bad, and the Ugly** 126
A Purnanand

20. **Progression from Pre-heart Failure, Heart Stress to Subclinical Heart Failure** 132
Arpita Katheria, Ankit Kumar Sahu, Aditya Kapoor

21. **Immunology of Heart Failure: Deconstructing Inflammatory Risk** 138
Amal Kumar Khan, Anish Kumar Khan, Amartya Khan

22. **Iron Deficiency States and Effective Iron Repletion Strategies in Chronic Heart Failure** 146
Ankit Kumar Sahu, Arshad Nazir, Pranjal Raparia

23. Risk Scores in the Management of Heart Failure **157**
Ashish Jha, Abhijit Bharali

24. Issues in Reversing Advanced Heart Failure **164**
Awadhesh K Sharma, Sayar Ahmad Pandit

25. Early Initiation of GDMT in HFrEF: Accelerating Outcomes with Timely Evidence-based Titration **169**
Dikshit Byomakesh, Behera Soumen Prasad

26. Mixed Cardiogenic-vasodilatory Shock **174**
Biswajit Majumder, Somnath Maji, Suvadeep Biswas, Ratul Ghosh

27. Chronic Right-sided Heart Failure and Tricuspid Regurgitation: "No Longer a Forgotten Entity" **180**
Chandrakanta Mishra

28. Neuromodulation Interventions in the Management of Heart Failure **192**
Manoj Bansal

29. Congestion and Diuretic Resistance in Worsening Heart Failure **198**
HK Chopra

30. Role of Imaging in Heart Failure Risk Stratification **205**
Haresh Mehta, Raghav R Nagpal, Kayan Siodia

31. Can Left Ventricular Wall Strain Predict Heart Failure? **212**
Jagdish Chander Mohan, Madhu Shukla

32. Medical Therapy of Cardiogenic Shock: Contemporary Use of Inotropes and Vasopressors **220**
Kashinath Ghosh Hazra, Ahitagni Banerjee

33. Continuum of Preshock to Classic Cardiogenic Shock **230**
MU Rabbani

34. Triaging of Patients of Acute Decompensated Heart Failure **236**
Pranab Jyoti Bhattacharyya, Maitreyee Bhattacharyya

35. Gut Hypothesis of Heart Failure: Role of Gut Microbiota–Derived Metabolites **241**
Puneet Rastogi

36. Diuretic Potentiation Strategies in Acute Heart Failure **246**
SK Dwivedi, Somil Verma

37. Approaches in Heart Failure with Mildly Reduced and Preserved Ejection Fraction **254**
Vidyut Jain, Avani Jain

38. **Characteristics and Outcomes of Patients with Valvular Cardiogenic Shock** 259
Sumanyu Suresh, Harikrishnan Sivadasanpillai

39. **Hemodynamic Assessment by Right Heart Catheterization in Management of Heart Failure** 267
Bijay Prakash Pandey, Rajat Kar

SECTION 6: CARDIOMYOPATHY

40. **Sudden Cardiac Death in Hypertrophic Cardiomyopathy** 275
R Alagesan, C Narasimhan, Muthiah Subramanian

41. **Polygenic Inheritance in Hypertrophic Cardiomyopathy** 289
Ajay Bahl

42. **Dual (Ischemic and Nonischemic) Cardiomyopathy: A Wolf in Sheep's Clothing** 292
Chandra Bhan Meena, Himanshu Mahla, Mayank Nausran

43. **Vasovagal Syncope: What Treatment Can We Offer in 2025?** 300
Nishad Chitnis, Hygriv B Rao

44. **Role of Clonal Hematopoiesis in the Pathogenesis of Dilated Cardiomyopathy** 306
Ganesan Manohar, Karthikaa Saminathan

45. **Dilated Cardiomyopathy in Systemic Immune-mediated Diseases** 313
Ganesh Seth, Mahima Saran, Himanshu Gupta

46. **Arrhythmia-induced Cardiomyopathy** 318
Arindam Mitra, Aditi Rastogi, Jayanta Saha

47. **Alcoholic Cardiomyopathy** 326
Shishu Shankar Mishra, Biswaranjan Mishra, Asharam Panda

SECTION 7: CONGENITAL HEART DISEASE

48. **Expanding Future of Sinus Venosus Atrial Septal Defect Closure** 335
Rishika Mehta, Amitabha Chattopadhyay

49. **Clinical Risk Assessment and Prediction in Congenital Heart Disease Across the Lifespan** 342
Anita Saxena

50. **Early Intervention for Tetralogy of Fallot, but at What Cost?** 348
Mahua Roy, Sucheta Barman

51. **Novel Imaging Techniques for Congenital Heart Disease** 353
D Seshagiri Rao, Ramya Pechetty

52. Evaluation and Management of Chronic Heart Failure in Children and Adolescents with Congenital Heart Disease 373
Jonaki Pal, Debasree Gangopadhyay

53. Advancing New Solutions for Adult Congenital Heart Diseases-related Heart Failure 381
Prafulla Kerkar, Ujjwala Tulluri

54. Care for Congenital Heart Disease in India: The Evolving Landscape 386
R Krishna Kumar

55. Echocardiography for Childhood Left Ventricular Noncompaction 393
Sura Kishore Mishra, Bitan Mohanty

56. Adults with Congenital Heart Disease: What Every Cardiologist Should Know About Their Care? 398
Arun Gopalakrishnan, Shyam S Kothari

57. Quest for a Lifelong Pulmonary Valve in Repaired Tetralogy of Fallot 408
Ronak Sheth, Snehal Kulkarni

SECTION 8: VALVULAR HEART DISEASE

58. Multiparametric Approach to Asymptomatic Aortic Stenosis 419
Ajay Kumar Pandey, Nikhil Gupta, Prashant Kumar Pandey

59. Secondary Mitral Regurgitation: Phenotypes, Proportionality, and Evolving Management 424
Arijit Ghosh, Arup Dasbiswas, Subhasis Roy Chowdhury, Mainak Mukhopadhyay

60. Mitral Annular Disjunction in Mitral Valve Prolapse 433
Biswaranjan Mishra

61. An Update on High-gradient Moderate Aortic Stenosis 439
Debika Chatterjee

62. Comprehensive Risk Phenotyping in Aortic Stenosis 443
Dipankar Ghosh Dastidar

63. When to Treat Young and Low-risk Patients with Aortic Stenosis 451
Gopala Krishna Koduru, Raghuram Palaparti, Venkata RS Subrahmanya Sarma

64. Acute Rheumatic Fever and Rheumatic Heart Disease: A Continuum (Recent Advances) 456
Mohit D Gupta, Girish MP, Gaurav Sharma, Mayank Shami

65. Comprehensive Approach to Aortic Valve Pathophysiology by Fibro-Calcific Imaging 473
Johann Christopher, Raja Ramesh Nukavarapu

66. Reimagining Valvular Heart Disease Management: Insights from the 2025 ESC/EACTS Guidelines 481
Mrinal Kanti Das

67. Rheumatic Heart Disease in India: An Imperative Tale to Tell 486
Sanjeev Asotra, Vinay Bhardwaj, Preetam Thakur

SECTION 9: CARDIO-OBSTETRICS

68. Cardiac Interventions during Pregnancy 499
S Anne Princy, R Archana, G Justin Paul

69. Antepartum Cardiovascular Risk Assessment and Management of High-risk Cardiac Delivery 505
Monika Bhandari, Saket Ramraika

70. Understanding and Managing Heart Failure during Pregnancy—What is New in Peripartum Cardiomyopathy? 515
Roopali Khanna, Sumang Mohan, Harshit Khare

71. Hypertensive Disorder of Pregnancy and Long-term Cardiovascular Outcome 520
S Anne Princy, G Justin Paul

72. Understanding and Managing Anticoagulant during Pregnancy in Women with Heart Valves 528
Abhishek Garg, Shibba Takkar Chhabra

SECTION 10: CORONARY ARTERY DISEASE

73. Sarcopenia and Coronary Microvascular Dysfunction 537
Nakul Sinha

74. Spontaneous Coronary Artery Dissection 540
Prakas Chandra Mondal

75. Platelet Biology and Function: Plaque Erosion versus Rupture 545
Ranjit K Nath, MD Asif Iqbal, Shreya Gupta

76. Coronary Artery Aneurysm: A Therapeutic Dilemma 549
Ramesh Thakur, Kumar Himanshu

77. Atherosclerosis, Aortic Dissection, and Peripheral Artery Disease: New Therapeutic Targets 554
Akhilesh Kumar, Suman Bhandari

SECTION 11: CARDIAC ARRHYTHMIA

78. **VT Ablation as Stand Alone Procedure without ICD in Stable Scar VT in Mild or Moderate LV Dysfunction** 565
Anees Thajudeen

79. **Atrial Fibrillation and Long-term CV Outcome** 570
Bhuban Majhi, Rajarshi Halder

80. **Effect of Left Atrial Dyssynchrony on Long-term Clinical Outcomes during Cardiac Resynchronization Therapy** 575
Anil Mishra

81. **Divergence from Guideline Directed Management of Cardiac Implantable Electronic Device Infections** 584
Ashish Nabar, Amit Vora

82. **Leadless Pacing: Past, Present, and Future** 591
Aftab Khan, Navanil Biswas, Arif Nabi Bhat

83. **Atrial Fibrillation in Heart Failure: Role of Catheter Ablation** 598
Sharath K Kumar, Calambur Narasimhan

84. **Ventricular Tachycardia Ablation in the Emergency Setting** 612
Aditya Mulgaonkar, Deepak Padmanabhan

85. **Prevention of Sudden Cardiac Death beyond Automated External Defibrillators and Implantable Cardioverter Defibrillators** 620
Girish B Navasundi

86. **Pulsed Field Ablation—in Present Perspective** 625
Vadivelu Ramalingam, Atul Verma, KK Talwar

87. **Para-Hisian Ventricular Arrhythmias** 634
Sathish S Reddy, Priyanka Agarwal

SECTION 12: IMAGING

88. **Risk Stratification with Coronary Computed Tomography Angiography-derived Fractional Flow Reserve and Fractional Flow Reserve Gradient** 641
Lekha Adik Pathak, Ronak V Ruparelia

89. **Role of Multimodality Imaging in Multivalvular Heart Disease** 646
Rajendra Kumar Jain, Sanjana R Badami

90. Role of Left Atrial Indices in Management of Chronic Severe Asymptomatic Aortic Regurgitation **657**
Satish K Parashar

91. Application of Emerging Hybrid Intracoronary Imaging Technologies in Clinical Practice and Research **664**
Harilalith Kovvuri, Nagendra Boopathy Senguttuvan

92. Current Concepts and Clinical Implications of Coronary Artery Calcification **670**
Satyavan Sharma

93. Cardiac CT: Emerging Role in Microvascular Dysfunction **677**
VS Prakash, Varsha Rakshitha Prakash

94. Role of Cardiac Imaging for Optimizing Medical Therapy **684**
Vilas Magarkar

Index ***i1–i13***

VOLUME 2

SECTION 13: ST-ELEVATION MYOCARDIAL INFARCTION (STEMI)

95. P2Y12 Inhibitor Pretreatment in STEMI **693**
Amar Narayan Patnaik

96. ST-elevation Myocardial Infarction Revascularization in India: Lessons Learned from Punjab (Mission AMRIT) **696**
Ashu Gupta, Hitinder Kaur, Bishav Mohan

97. Cardiac Magnetic Resonance Evaluation of Left Ventricular Remodeling after Myocardial Infarction **703**
Vineeta Ojha, Sanjeev Kumar

98. Recurrent Thrombosis after Myocardial Infarction **711**
Sundar Chidambaram, Manokar P, Mahesh Babu, Mahadevan R, Deepchand Raja, Jebaraj

99. STEMI Revascularization in India: Lessons Learnt from Tamil Nadu—5 Years Experience **715**
S Anne Princy, JB Vincil Jito, G Justin Paul

100. Thrombolysis in STEMI in the Primary PCI Era: Current Relevance in India **723**
Padmanabh Kamath

101. STEMI Revascularization in India—Lessons Learnt from Goa **729**
Guruprasad Datta Naik

102. Role of Novel Risk Factors in ST-segment Elevation Myocardial Infarction Among Young Women **735**
M Mashhadi, Sameer Dani, Harsh Chaudhary

103. Transition from ST-segment Elevation Myocardial Infarction to Occlusion Myocardial Infarction **739**
Rajiv Bajaj

104. ST-elevation Myocardial Infarction Revascularization in India: Role of Thrombolysis in Ambulance **746**
Mohsin Raj Mantoo, Chandini Suvarna, Sivasubramanian Ramakrishnan

105. Addressing Delays in Reperfusion Therapy—Developing Chest Pain Clinics: A New Initiative from STEMI India **749**
Thomas Alexander, Varshini Neethi Mohan, Ajit S Mullasari

106. Advanced Cardiac Patches in the Treatment of Myocardial Infarction **752**
Nitharsha Prakash M, R Praveen Babu, V Murugesan

SECTION 14: CORONARY INTERVENTION

107. Thrombus Aspiration in Primary Angioplasty **761**
BKS Sastry

108. Evaluation of Microvascular Dysfunction during Diagnostic Coronary Angiography **765**
B Kesavamoorthy, P Sabari Krishnan, AD Arun Mohan

109. Prevention of Progression of Obesity and Cardiometabolic Disease: Intervention in School-aged Children **773**
Bhuwan Chandra Tiwari, Sandeepan Saha

110. Diagnosis and Management of Coronary Artery Perforation **779**
Chetan P Shah, Charan Reddy KV

111. Coronary Physiology by Different Approaches for Guiding Percutaneous Coronary Intervention **782**
DB Pahlajani, Kayan Siodia

112. Interventional Treatment for Left Main Bifurcation In-stent Stenosis **792**
DS Gambhir

113. Management of Drug-eluting Stent ISR **798**
Gaurav Chaudhary, Sajeet Kumar Verma, Ayush Shukla

114. Bailout Strategies in Chronic Total Occlusion Percutaneous Coronary Intervention **809**
Prathap Kumar N, Manu Rajendran, Blessvin Jino

115. Metal-less Percutaneous Coronary Intervention: Current Evidence, Techniques, and Future Directions 817
Madhupada Kiran Kumar, PC Rath

116. Percutaneous Coronary Intervention in High-risk Renal Disorders: Strategies for Renal Protection 825
PK Asokan

117. Effect of Anatomical and Viability-guided Completeness of Revascularization on Clinical Outcomes in Ischemic Cardiomyopathy 834
Rajesh Vijayvergiya, Anirudh Mukherjee

118. Dual Antiplatelet Therapy in CKD: Duration and Bleeding Risk in Post-percutaneous Coronary Intervention Patients 845
Satyendra Tewari, Satya Prasad Mahapatra

119. Technological Progress in Treating Calcified Coronaries 850
Sridhar Kasturi

120. Expanding the Indications of Multivessel Angioplasty: Review of Emerging Evidence and Clinical Implications 862
Vijay Bang, Kaushal Chhatrapati, Ashish Deshpande

SECTION 15: STRUCTURAL INTERVENTION

121. Transcatheter Aortic Valve Replacement in Heart Failure 873
Ajit S Mullasari, Praveen Ashok Kumar

122. Antithrombotic Selection Post-left Atrial Appendage Occlusion 881
Bhavana M, Atul Mathur

123. Predictors of Outcome of Reinterventions after TAVR 886
Bharat V Purohit, Vinay Kumar Sajja

124. Implications of Left Bundle Branch Block in Aortic Stenosis beyond Pacemaker Implantation 891
Raghu Cherukupalli, Chakrapani Vuppala

125. Imaging of Transcatheter Valve Failure: An Update 901
Manoj Chopda, Kavish Chopda, Anish Chugh, Rahul Shewale

126. Transcatheter Treatment of Pure Aortic Regurgitation: Current Evidence, Challenges, and Future Directions 910
Prasant Kr Sahoo, Nitish Prasad, Abhishek Dash, Shyam Prasad Sahoo

127. Changing Context and Goals for Transcatheter Mitral Therapy 923
Deepti Yadav, Siddarth Varshney, Praveen Chandra

128. Unveiling Right Ventricle Remodeling Following Tricuspid Valve Intervention **928**
Rajneesh Kapoor, Kumar Shubham

129. Resolving the Unmet Need for Treatment of Tricuspid Regurgitation **932**
Sadhanandham Shanmugasundaram, Akshay Prashanth G

130. Bleeding after Transcatheter Structural Valve Interventions **939**
Shabbir Ali Shaik

SECTION 16: HOT TOPICS

Part 1: Heart Failure

131. Mitral Regurgitation in Heart Failure **955**
A Kader Sahib, P Vijay Shekar

132. Aging in Heart Failure **963**
Ashish Kumar Jha

133. Consequences of Discontinuing Long-term Drug Treatment in Patients with HFrEF **966**
Rohan Patel, RR Mantri

134. Tackling Metabolic Defects in Heart Failure with Preserved Ejection Fraction **970**
Vikas Singh, Rajiv Krishna

135. Timing of Physical Activity and Cardiovascular Health: Walk the Talk! **973**
Prayaag Kini, Reeta Varyani

136. Impact of the EAT-Lancet Diet in Preventing Heart Failure **977**
Subhashis Dey

137. Controversies and Conundrums in Cardiac Cachexia **980**
Sunandan Sikdar, Rathindra Nath Karmakar, Gaurav Agarwal

138. Therapeutic Inertia in Treating Heart Failure with Reduced Ejection Fraction **984**
Vipin Kumar, Arvind Kumar

139. ARNI-induced Hypotension in HFrEF: A Feared Side Effect or a Marker of Modifiable Risk? **989**
Arindam Pande, Durlabh Debbarma, Pranabes Chakraborti

140. Why have We Not been Able to Demonstrate Reduced Mortality in Patients with HFmrEF and HFpEF? **993**
Ravi Vishnu Prasad, G Kumar, CB Chandan

141. HFrEF and HFpEF: How they Differ in Advanced Heart Failure—A Global Perspective **999**
Ranabrata Sen, Subhashis Dey, Kaushik Manna

142. **Decongestion in Acute Heart Failure—Beyond the Diuretic-centred Paradigm** 1002
MS Ravi, TR Muralidharan, SR Sharath Shanmugam

143. **Hepatic Biomarker Abnormalities in the Cardiac Intensive Care Unit Proposed Criteria for Cardiohepatic Syndrome** 1005
K Roshan Rao, Sarita Rao, Achukatla Kumar

144. **Bridging Atrial and Ventricular Failure Through Biomarkers** 1012
Mahesh Rameshrao Deshpande

145. **Therapeutic Options in Ambulatory Advanced Heart Failure** 1017
Hetan C Shah, Bhavik S Shah

146. **Hypoalbuminemia and Heart Failure: State-of-the-Art 2025** 1022
Mainak Mukhopadhyay, Sandipta Ray, Subhasis Roy Chowdhury, Arijit Ghosh, Kajal Ganguly

147. **Implications of Atrial Fibrillation for GDMT in Heart Failure** 1026
Ayush Shukla, Nilay Tripathi

148. **Why has it been Challenging to Modify Kidney Disease Progression in Patient with Heart Failure?** 1032
Pankaj Singh, Debasish Das

Part 2: Hypertension

149. **Supranormal Left Ventricular Ejection Fraction, Concentric Remodeling, and Long-term Survival** 1035
Viveka Kumar, Anil Yadav, Mitendra Singh Yadav, Sangeeta Dhir, Anupam Goel

150. **Brain Pathways in Blood Pressure Regulation** 1039
Akhilesh Dubey, Shishir Soni, Harishankar Pratap Singh Chandel

151. **Low-renin Hypertension: Current Understanding and Future Directions** 1044
Shilanjan Roy

152. **Sodium, Interstitium, Lymphatics, and Hypertension—A Tale of Hydraulics** 1047
Tapan Ghose

153. **Arterial Stiffness as a Predisposing Factor for Chronic Kidney Disease** 1051
Shantanu Deshpande, Samhita Purandare

Part 3: Coronary Artery Disease

154. **Association between Coronary Artery Spasm and Atherosclerotic Disease** 1055
Subhasis Roy Chowdhury, Arijit Ghosh, Mainak Mukhopadhyay

155. Prognostic Significance of Peri-infarct Ischemia 1058
Brig Navreet Singh, Lt Col Ankush Gupta, Col Nitin Bajaj, Col Balwinder Singh

156. Hemorrhagic Myocardial Infarction: Pathophysiology, Diagnosis, and Clinical Implications 1061
Col Anil Dhall

157. Stent Failure after Percutaneous Coronary Intervention in Diabetes Mellitus 1066
Lipika Adhikari, Samriddhi Yasha

158. Red Blood Cells as a New Target for Atherosclerotic Cardiovascular Disease 1072
Sachin Narendra Patil

159. Residual Chest Pain after Percutaneous Coronary Intervention 1076
Ranabrata Sen, Siddhartha Mani

Part 4: Dyslipidemia Management

160. Enhancing High-density Lipoprotein Function to Prevent Atherothrombosis 1080
Debabrata Biswas

161. Cholesterol Screening and Management in Young Adults 1085
Shamshad Alam, Ajay Kumar Sinha, Shaheen Ahmad, Sushil Kumar

Part 5: Ischemic Heart Disease

162. Role of Vitamin D in Heart Disease 1089
Bijay Narayan Jha, Dharmendra Kumar Singh

163. Testosterone and Cardiovascular Health 1095
Jayanta Sharma, Abhinandan Saha

164. Primary Prevention for Intermediate Risk 1100
Ashok Kumar, Nishant Tripathy, Arundhati

165. Exposomes in the Ischemic Heart Disease—beyond Traditional Risk Factors 1103
Prasannakumar CK, Lt Col Arun N

166. Interaction between Dietary Calcium and Vascular Calcification 1111
Mohamed Iesa M

167. Stabilizing Stable Coronary Artery Disease without Beta-blockers 1115
Nikhil Agarwal, Girish MP, Mohit D Gupta, Vishal Batra

Part 6: Structural Intervention

168. Closing Patent Foramen Ovales to Prevent Stroke: A False Sense of Security 1121
Ruchit Shah, Anagh TS, Kalyan Munde

Part 7: Heart and Brain

169. Left Atrial Stiffness in Cryptogenic Stroke **1125**
Vibhav Sharma, Vivek Chaturvedi

Part 8: Cardiac Arrhythmia

170. Which Patients with Nonischemic Cardiomyopathy should Receive a Defibrillator? **1130**
Vaidehi Agarwal, Ruman Kugashiya, Sanjiv Sharma

171. Predicting Risk of Sudden Cardiac Death in Hypertrophic Cardiomyopathy: Role of Radiomics **1134**
Akshay Ashok Bafna, Adeeb Shakeel Sheikh, Ajit Namdeorao Hange, Nikhil Gadade

172. Anticoagulation for Atrial Fibrillation in Patients with Intermediate Stroke Risk: Is the Gray Zone Becoming Less Gray? **1141**
Vibhav Sharma, Satyavir Yadav

173. Should We Stop Prescribing Digoxin? **1146**
Navanil Biswas, Nayanika Bose

Part 9: Amyloidosis

174. Linking Amyloid Burden to Prognosis **1150**
Kayan Siodia

175. Predicting the Future for Amyloid Light Chain Amyloidosis in Patients with Cardiac Involvement **1153**
Jhala Malav, Jhala Darshan A

SECTION 17: TOP 10 PAPERS

176. The Year in Cardiovascular Medicine (2025): The Top 10 Papers in Diabetes and Metabolic Disorders **1161**
Neha Chopra, Shitij Chaudhary, Nitish Naik

177. Top Papers of 2025 on Antithrombotic **1168**
PS Banerjee, Tanmay Mukhopadhyay, Kaushik Mondal

178. Top 10 Lipid Trials of 2024–2025 **1177**
Prerna Garg, Sumit Kumar, Rakesh Yadav

179. Top 10 Papers of 2024 on Intervention **1182**
Subrahmanya Murti V, Sameer Gupta, VK Bahl

SECTION 18: VIEWPOINT

Part 1: Obesity Paradox is a Fact

180. **An Unexpected Relationship Between Body Weight and Health Outcomes (Proponent)** 1195
Mahesh Nalin Kumar, Ampady Sreedhar

181. **Myth or Reality (Opponent)** 1198
M Subroto, D Nishtha, Ankur U, Rajeev Gupta, S Bhushan

Part 2: Time Matters When Considering Treatment for Patients with Mitral Regurgitation

182. **Time Matters When Considering Treatment for Patients with Mitral Regurgitation (Proponent)** 1205
Rajeev Garg

183. **Time Matters When Considering Treatment for Patients with Mitral Regurgitation (Opponent)** 1208
Dipak Ranjan Das

184. **CHA_2DS_2-VASc of 1: Not Same for Every Patient with AFib** 1211
Chhabi Satpathy, Trinath Kumar Mishra, Biraja Prasad Beura

185. **How to Resolve the Prosthesis–Patient Mismatch Debate?** 1215
Harinder K Bali, Amreen Dhindsa

186. **Artificial Intelligence will Replace Clinical Cardiology: Against the Motion** 1221
Abhijit Chatterjee

SECTION 19: MISCELLANEOUS

187. **Takayasu Arteritis: What is New?** 1225
Sanjay Tyagi

188. **Treatment of Obstructive Sleep Apnea and its Impact on Cardiovascular Disease** 1234
Arijit Kumar Ghosh, Vidya PL, Poyla Ghosh

189. **Participation in Sports by Athletes with Cardiovascular Disease** 1245
Ashish Deshpande

190. **Donor Selection for Heart Transplantation in 2025** 1252
Bagirath R, Meemansa Buch, Sabarish S

191. Antithrombotic Therapies in Patients with Peripheral Artery Disease **1258**
Hem Chandra Kalita, Karthik Thangamuthu

192. Cardiology Training in India: Past, Present, and Future **1263**
Kajal Ganguly, Sandipta Ray, Mainak Mukhopadhyay, Subir Sen

193. Recent Insights into Native Valve Infective Endocarditis **1266**
Satya Narayan Routray, Dipak Ranjan Das

194. Pulmonary Hypertension—No Longer an Orphan Disease **1271**
Shanmugasundaram Somasundaram

195. Unraveling the Unsolved Mysteries of the Athletic Heart **1284**
Sudarshan K Vijay, Upadhyay Aditya Chandradhar

196. Cardiac Sarcoidosis and Management **1291**
Sunil Lhila, Debasish Das, Koushik Chaki

197. Marantic Endocarditis **1299**
Saumya Sagar, Anupam Prakash

198. Epilepsy and the Heart—Can "Brain Arrhythmia" Lead to Cardiac Arrhythmia? **1305**
Adrita Banerjee, Amit Sanghvi

Index ***i1–i15***

CHAPTER

6

Artificial Intelligence: An Emerging Tool for the Diagnosis and Management of Hypertension

C Venkata S Ram

JAYPEE BROTHERS

ABSTRACT

Hypertension remains a major global health concern, affecting over one-third of adults worldwide. While progress in understanding the pathophysiology of hypertension has slowed down in recent years, artificial intelligence (AI) has created opportunities to improve hypertension care via precision medicine. AI algorithms have the ability to integrate and analyze vast multimodal datasets, including electronic health records, electrocardiograms, and wearable device outputs, to predict hypertension risk, enable early diagnosis, and personalize treatment strategies. AI can also facilitate individualized treatment recommendations based on environmental and patient-specific factors, including comorbidities and genetic traits, and shows promise in enhancing medication adherence and lifestyle modification through autonomous coaching systems. These innovations could promote anticipatory, patient-centered care and reduce long-term cardiovascular risks and healthcare costs at the community level. This chapter outlines the current status of AI in hypertension management and expounds on evolving challenges and potential solutions.

Keywords: Algorithms, artificial intelligence, blood pressure, cardiovascular disease, deep learning, hypertension, machine learning.

INTRODUCTION

Hypertension remains one of the most significant modifiable risk factors for cardiovascular disease and premature mortality worldwide. Notably, low- and middle-income countries, including India, have experienced a steady increase in the prevalence of hypertension since 1990.[1,2] Despite its high burden, hypertension continues to be underdiagnosed and inadequately managed: Only about 50% of individuals with hypertension are aware of their condition, fewer than half of those diagnosed receive treatment, and merely one in five achieve optimal blood pressure (BP) control.[3]

Traditional approaches to hypertension management have certain disadvantages. These include missed diagnoses due to asymptomatic presentation, limited access to routine screening and monitoring, poor adherence to treatment regimens, and a lack of personalized therapeutic strategies.[4-6] Innovative solutions and emerging technologies, particularly artificial intelligence (AI), have the potential to address these inherent limitations **(Fig. 1)**.[2]

FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE IN MEDICINE

Artificial intelligence has rapidly become a transformative force in modern medicine. Various AI models, each offering unique capabilities and applications, have been developed and implemented across healthcare domains. The most commonly employed models include:

- *Machine learning (ML):* ML involves the use of algorithms trained on clinical data to identify patterns, make predictions, and support automated decision-making. Common ML algorithms include decision trees, random forests, support vector machines, and neural networks.[2]
- *Deep learning (DL):* A specialized subset of ML, DL utilizes multilayered neural networks to process complex, high-dimensional data such as medical images and unstructured clinical text. DL models have demonstrated superior performance in tasks such as image interpretation and natural language processing.[2,7]

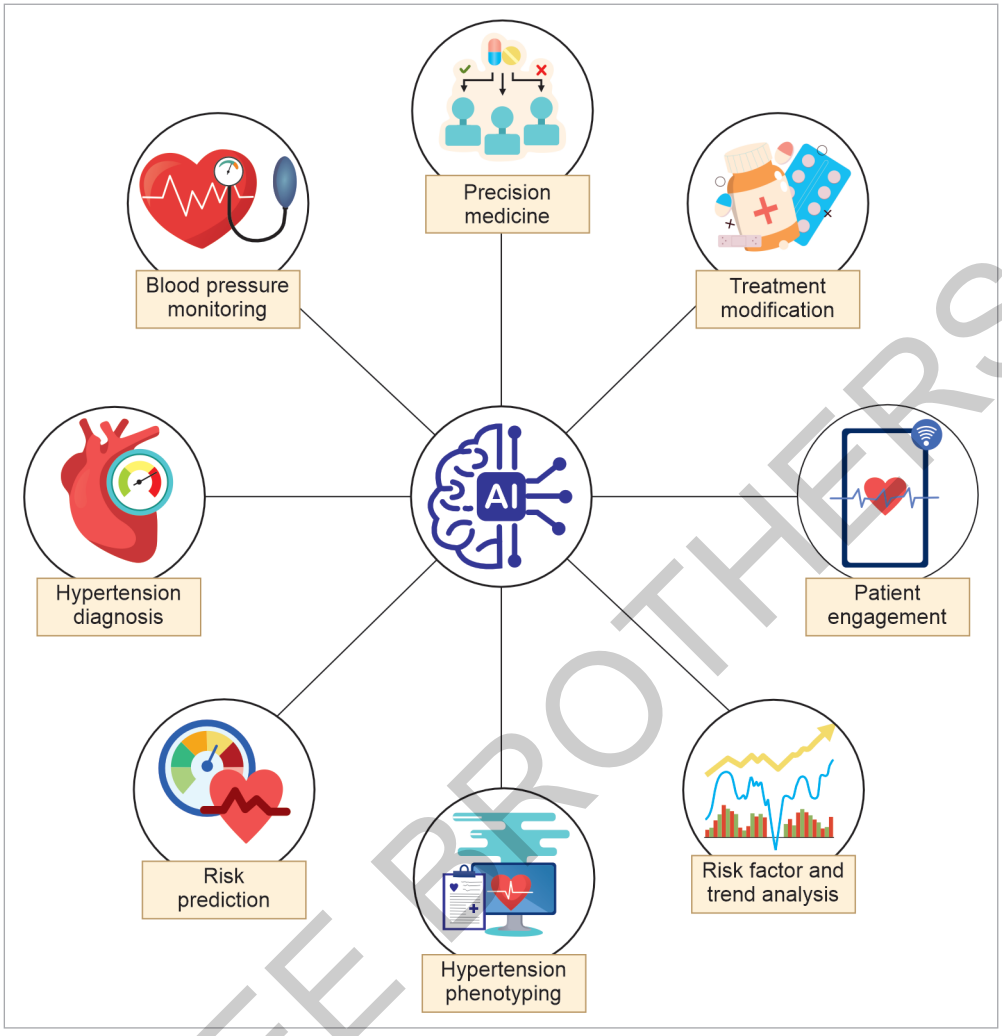


FIG. 1: Multifaceted applications of AI in hypertension management.

JAYPEE BROTHERS

- *Generative AI and large language models (LLMs):* Recent advancements in generative AI, including LLMs, have introduced new capabilities such as natural language understanding, clinical note generation, and AI-assisted decision-making.[8]

In the context of hypertension, ML- and DL-based AI algorithms can be applied to a wide range of clinical tasks. Supervised learning algorithms, including regression models, classification trees, and neural networks, are trained on labeled datasets and can be used to predict hypertension risk, facilitate diagnosis, and enable patient stratification.[9] In contrast, unsupervised learning algorithms study unlabeled data to identify previously unrecognized patterns, allowing for the discovery of novel patient phenotypes and subgroups and improving our understanding of the heterogeneity within hypertensive populations.[9,10] Reinforcement learning, which determines optimal actions through feedback and reward mechanisms, can be employed to tailor personalized treatment regimens, including the dynamic adjustment of antihypertensive therapies.[2] Together, these AI methodologies have enabled not only predictive modeling and diagnostic support but also novel approaches to BP monitoring **(Table 1)**.[11]

BLOOD PRESSURE MEASUREMENT AND MONITORING

Blood pressure is traditionally measured in clinical or home settings using an inflatable cuff. However, this traditional approach fails to capture short-term BP variability, causing clinically significant fluctuations related to daily activities, stress, or circadian rhythms to be overlooked. Furthermore, phenomena such as the "white coat effect", where patient anxiety can result in elevated readings, may lead to misdiagnosis or inappropriate treatment modifications.[12,13]

Artificial intelligence is completely transforming BP monitoring through wearable devices. AI algorithms can

TABLE 1: Comparison of traditional versus AI-enhanced hypertension management.

Aspect	Traditional methods	AI-enhanced methods
Blood pressure monitoring	Manual measurement at home or in the clinic	Continuous and automated measurement with wearable devices
Risk prediction	Risk scores (e.g., Framingham score)	Machine learning-based, including multifactorial risk assessment
Treatment	Guideline-based management	Personalized, dynamic, and adaptive
Patient engagement	In-person, pamphlets	Digital, interactive, tailored, and easily accessed on demand

improve the accuracy of BP measurement with automatic oscillometric BP monitors. AI-based noninvasive, automated, cuff-less BP monitors have now arrived for the clinic, offering advantages such as ease of use and improved adherence to repeated BP measurements. By using continuous, noninvasive sensing technologies—such as photoplethysmography (PPG), mechanoelectrical sensors, and piezoelectric systems—wearables such as smartwatches can collect real-time physiological data, including pulse waveforms, heart rate, and blood flow dynamics.[14-17] The ML algorithms embedded within these systems can analyze the collected signals to estimate BP values, identify trends, and generate actionable health insights.[18] Using a DL approach, Chu et al.[19] developed an AI system capable of estimating arterial BP from PPG signals. In a related study, Li et al.[20] designed a wearable device featuring a flexible piezoelectric sensor array, a dynamic pressure adjustment unit, and a sophisticated signal processing module driven by advanced ML algorithms. This device analyzed pulse waveforms and could forecast BP up to a week in advance with an error margin under 10 mm Hg. Another recent study demonstrated that ChatGPT 4.0 can effectively interpret ambulatory BP monitoring data, achieving accuracy rates of 87% for hypertension detection, 89% for identifying nocturnal hypertension, and 81% for recognizing nocturnal dipping behavior.[21] Interestingly, data obtained via ultrasound, CT, and thermal imaging have also been analyzed via AI to estimate BP. Luo et al.[22] used an ML model to predict systolic and diastolic BP based on hemoglobin signals obtained through transdermal optical imaging with a smartphone camera, achieving 94.8% and 95.8% accuracy, respectively.

Beyond such hardware, AI also forms the basis of mobile health (mHealth) platforms that integrate data from wearable devices, electronic health records (EHRs), and patient-reported outcomes. Through these systems, users can self-monitor their BP, receive automated alerts for hypertensive episodes, and access personalized health recommendations.[16] For instance, some AI models can notify the patient (and, when integrated with clinical systems, alert healthcare providers) when a potentially dangerous BP spike is detected, thus facilitating timely intervention and reducing the risk of acute adverse cardiovascular events.[23] In the future, continued advancements in sensor design, signal processing algorithms, and clinical validation will be crucial for incorporating these tools into routine hypertension management in clinical practice.

RISK PREDICTION AND DETECTION OF HYPERTENSION

Artificial intelligence-based technologies are often superior to traditional statistical approaches in handling large amounts of complex, multidimensional data. Thus, they are emerging as vital tools for individual-level risk assessment and population-level surveillance.[24]

Contemporary ML models for hypertension risk stratification incorporate diverse data sources, including demographic information, clinical measurements, genetic profiles, behavioral patterns, and environmental exposures, frequently showing enhanced predictive performance compared to conventional models. For instance, one study utilizing health check-up data and the Light Gradient Boosting Machine (LightGBM) algorithm demonstrated that variables such as age, triglyceride levels, and alkaline phosphatase levels are key predictors of hypertension, achieving high predictive accuracy.[25,26] In a related study, Liao et al.[27] designed a predictive model for hypertension and hyperlipidemia utilizing data from electronic medical records (EMRs). Similarly, Sau et al.[28] trained the AIRE-HTN algorithm using over 1.1 million electrocardiogram (ECG) recordings from approximately 190,000 individuals. This algorithm could forecast the onset of hypertension as well as associated cardiovascular and kidney-related risks based solely on ECG data, enabling earlier medical interventions and mitigating future health complications. Notably, some modern AI systems that combine genetic data with imaging and clinical information have also been found to estimate 10-year cardiovascular risk more accurately than traditional risk scoring methods.[29] Such ML models have demonstrated success in predicting the onset of hypertension within 1 year in normotensive populations, enabling proactive interventions for high-risk individuals.[30] Additionally, interactive web-based risk prediction tools, powered by ML and interpretability features such as Shapley Additive Explanations (SHAP), support shared decision-making by making risk assessments understandable and actionable for both clinicians and patients.[25]

At the population level, AI enables comprehensive epidemiological modeling and forecasting. By analyzing large-scale datasets—such as EHRs, national health surveys, registries, and biobank data—ML can automate risk screening, monitor disease prevalence, and project future

JAYPEE BROTHERS

hypertension trends.[31] For instance, Zhao et al.[32] showed that various ML algorithms can successfully predict the risk of incident hypertension in sample populations, even in the absence of detailed clinical and genetic variables. Such insights could support strategic public health planning, enabling more efficient resource allocation and targeted interventions.[26,33,34]

Finally, the predictive powers of AI can also be used to uncover novel genetic markers and environmental risk factors associated with hypertension. By integrating multi-omics data with environmental and lifestyle variables, DL models can uncover previously unrecognized biomarkers and causal pathways.[18] Notably, Hrytsenko et al. developed nonlinear ML prediction models to detect the risk of hypertension using demographic and clinical variables and polygenic risk scores (PRSs).[35] These capabilities provide deeper insights into hypertension pathophysiology and pave the way for precision prevention strategies.[18]

PHENOTYPING OF HYPERTENSION

Artificial intelligence is enabling the improved diagnosis and phenotyping of hypertension by leveraging large-scale health data and advanced pattern recognition techniques to deliver faster, more accurate, and individualized assessments. Using EHR-derived clinical data, ML models such as neural networks and decision trees have demonstrated diagnostic accuracies of up to 95% for early hypertension detection.[36,37] These models excel at identifying subtle patterns and trends across large, heterogeneous datasets, often revealing associations that may be missed through conventional clinical wisdom. Therefore, AI can support more objective and timely diagnoses, particularly in primary care and high-volume clinical settings.[36,37]

Imaging and Detection of Target Organ Damage

Deep learning models are capable of interpreting a variety of inputs from imaginal modalities—such as retinal scans, ECG, and vascular imaging—to detect hypertensive target organ damage. This includes the early identification of complications such as left ventricular hypertrophy, retinal microvascular changes, and vascular remodeling.[23] A recent systematic review demonstrated that AI-based retinal image analysis can enable the early detection and grading of hypertensive retinopathy, offering higher accuracy, consistency, and potential for earlier clinical intervention than manual evaluation.[38]

Differentiating Primary and Secondary Hypertension

Accurately distinguishing between primary (essential) and secondary hypertension remains challenging for clinicians. Drawing on high-dimensional datasets—including laboratory results, imaging studies, genetic profiles, and longitudinal patient histories—AI models can identify patterns indicative of secondary hypertension in hypertensive individuals.[2,39] In 2021, researchers developed a two-stage DL framework that uses natural language processing (NLP) to analyze clinician notes and integrates structured laboratory data to diagnose common causes of secondary hypertension, such as primary aldosteronism, thyroid disease, nephritis/nephrotic syndrome, and aortic stenosis.[40] Meanwhile, an XGBoost-based model tested on retrospective EMR data also exhibited excellent discrimination capacity in predicting secondary hypertension caused by renovascular hypertension, primary aldosteronism, thyroid dysfunction, and aortic stenosis.[41] By automating the rapid and accurate differential diagnosis of secondary hypertension, such models could facilitate clinical decision-making and targeted BP management.

ARTIFICIAL INTELLIGENCE-DRIVEN PRECISION MEDICINE AND THERAPEUTIC OPTIMIZATION

Precision hypertension treatment can be achieved by customizing therapeutic strategies based on the individual genetic, clinical, and lifestyle characteristics of each patient. Unlike traditional, standardized treatment, precision medicine acknowledges the complex interactions between genetic predispositions, environmental exposures, and behavioral factors, which influence both hypertension onset and patient-specific therapeutic responses. AI can realize this vision and support individualized care decisions by processing vast, multimodal datasets.[42,43]

Personalized Antihypertensive Therapy

Artificial intelligence technologies, particularly ML models, enable the personalization of antihypertensive treatment by optimizing drug selection, dosage, and predicting treatment efficacy.[44] These models recommend tailored therapeutic regimens based on patient-specific inputs such as medical history, genetic profiles, comorbidities, and prior treatment outcomes to maximize clinical benefits while minimizing the risk of adverse effects and drug interactions.[18,43] The PRECISION model, developed using data from the SPRINT and ACCORD BP trials, assesses 59 variables including kidney function and comorbidities to personalize treatment targets and identify individuals who could benefit most from intensive BP lowering.[45] Meanwhile, a LASSO-based ML model forecasts individual BP responses to different antihypertensive medications, enabling rational drug selection.[46]

Beyond initial therapy recommendations, AI systems can also adapt treatment plans dynamically in response to evolving clinical trajectories. Some AI models can detect early deviations from expected treatment responses and suggest timely adjustments.[18,43] In fact, ML models have

JAYPEE BROTHERS

been deployed to forecast patient trajectories and proactively adjust treatment plans before clinical deterioration.[18] A reinforcement learning model trained on over 11 years of EHR data was found to accurately predict the need for transitioning from mono- to dual or triple therapy in hypertensive individuals with type 2 diabetes, supporting the shift toward anticipatory care.[47]

Integration with Omics Technologies

A major advancement in hypertension care is the integration of AI with omics technologies such as genomics, proteomics, and metabolomics. AI algorithms can identify genetic variants or molecular signatures associated with drug responses, side effects, and resistance, thus enabling refined risk stratification and the selection of targeted therapies.[2,18,43] When applied to multi-omics datasets, ML can reveal disease mechanisms and potential therapeutic targets, enabling the development of integrated systems biology frameworks.[48] Such AI-based systems biology approaches can uncover previously unknown molecular networks and causal genotype–phenotype–environment interactions, enabling biomarker-driven interventions.[49] By combining multi-omics data, AI can identify rare monogenic forms of hypertension and deepen our understanding of polygenic hypertension, in which numerous genetic loci interact with environmental and behavioral factors.[12,24] Studies are combining PRS with clinical and microbiome parameters to improve hypertension risk prediction on an individual level beyond genetics alone.[50] Such integrated approaches could facilitate a more precise and biologically informed, lucid classification of hypertension. By aligning therapy with the unique characteristics of each patient and adapting care over time, AI-driven precision medicine could support the proactive and personalized management of hypertension across the disease continuum.[24]

PATIENT ENGAGEMENT, ADHERENCE, AND BEHAVIORAL MODIFICATION

In addition to direct use by clinicians, AI can also help patients by improving engagement and facilitating behavioral modifications. Today, AI-powered chatbots and virtual assistants can deliver real-time, personalized support and education for hypertension patients, providing instant responses to common questions, customized information on hypertension management, and timely reminders for medication intake and BP monitoring.[12,24] By leveraging NLP and ML, such platforms could understand user intent, adapt to individual communication styles, and respond empathetically, thereby improving patient satisfaction, trust, and engagement.[24,51] Thus, healthcare providers and patients can become copartners in disease prevention and treatment.

Integration with mHealth and Lifestyle Interventions

Integrating AI technologies with mHealth and telehealth platforms is a valuable way to offer personalized lifestyle guidance. By analyzing real-time data from wearable devices, EHRs, and self-reported behaviors, AI systems can generate tailored recommendations on dietary habits, physical activity, sleep quality, and stress management based on patient-specific risk profiles. In a cohort of hypertensive adults managed over 24 weeks, a fully autonomous AI-driven lifestyle coaching platform that delivered such personalized guidance led to average reductions of approximately 8.1 and 5.1 mm Hg in systolic and diastolic BP, respectively.[52] Such platforms could allow patients to exert control of their own health status, eliminating the need for continuous clinician involvement.

Improvement of Medication Adherence and Empowerment

Artificial intelligence technologies can also enhance medication adherence and promote patient self-efficacy.[53,54] Automated reminders, educational messaging, and interactive interfaces help patients consistently follow their prescribed medication regimens and recommended lifestyle changes. AI-powered platforms can provide users with feedback on their progress, including BP control trends, reinforcing motivation, and encouraging sustained behavioral changes.[53] One digital intervention combining tailored text messaging and interactive voice messaging for hypertension patients achieved high user engagement over a 12-week period, with participants reporting improved awareness and motivation to take their medications.[55] A recent meta-analysis of 74 randomized controlled trials (covering >92,000 patients) found that mHealth interventions significantly improved medication adherence in hypertension, contributing to better BP control.[56] These studies show that through intelligent automation and data-driven personalization, AI can empower patients to take a proactive role in managing their condition, ultimately improving health outcomes.

CHALLENGES AND LIMITATIONS

Despite the immense potential of AI, its clinical integration is hindered by some critical challenges.[57] The first technical barrier is related to the limited availability of large, well-annotated, and representative datasets for training AI models, which can compromise model accuracy.[45] Additionally, AI models remain prone to overfitting (perform well on training data but poorly on new data) and underfitting (are too simple to capture key patterns).[29] Importantly, most complex algorithms have a "black box" nature and suffer from a lack of transparency because users cannot see their internal workings or how they arrive at their predictions or

JAYPEE BROTHERS

decisions, which undermines trust among clinicians and patients. Operational integration into clinical workflows also poses a major challenge, since several AI tools cannot be incorporated easily into EMR systems due to interoperability issues and the lack of universal data standards.[57]

From an ethical perspective, the use of AI in medicine raises concerns about patient privacy, informed consent, and data security. Legal uncertainties also persist, particularly around liability and accountability when AI systems influence medical decisions. Equity is another critical concern, since AI tools may perform poorly in marginalized populations if they are not trained on diverse datasets and thereby perpetuate health disparities and gaps in care. Finally, regulatory guidelines for AI in healthcare are still evolving, and tools such as AI-powered BP monitors still need to be standardized and validated in real-world settings.[57] Finally, questions arise regarding who is the custodian of medical records—AI technology, healthcare providers, or patients?

FUTURE DIRECTIONS AND RESEARCH PRIORITIES

As AI continues to evolve, its role in hypertension management will expand.[58] To fully harness the potential of AI in hypertension management, multidisciplinary collaboration, transparent algorithm design, equitable access, and strong regulatory structures will be essential. One key priority is the development of explainable AI tools, such as SHAP, which will help clarify how AI models generate their outputs.[12] For the long-term success of AI systems, we need a roadmap for responsible and equitable deployment, ensuring data quality, reproducibility, algorithmic transparency, and ethical oversight. Therefore, it is essential to train models and validate them in diverse populations. Additionally, we must focus on the integration of multimodal data, including clinical records, genetic information, imaging data, and wearable sensor outputs, as this could enable better risk prediction, the identification of new hypertension subtypes, and deeper insights into disease mechanisms. Institutions can collaborate to train models without sharing raw data, preserving patient confidentiality and data ownership. Further, prospective clinical trials and real-world validation studies must be conducted to determine how AI tools perform in diverse, real-life settings and identify barriers to clinical integration. Collaborative intelligence, where AI supports healthcare practitioners instead of replacing them, could help in enhancing diagnostic accuracy, streamlining workflows, and improving patient education. Active collaboration among clinicians, patients, technologists, and policymakers is needed to drive these efforts **(Fig. 2)**.[59,60]

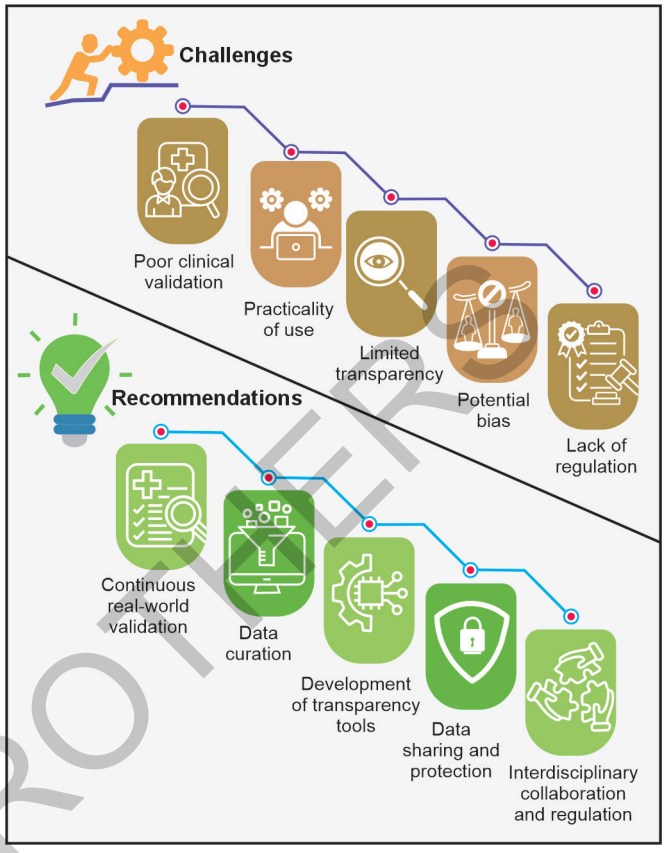


FIG. 2: Challenges and best practices for the application of AI in hypertension management.

CONCLUSION

Artificial intelligence is revolutionizing hypertension management through personalized, data-driven strategies that surpass traditional treatment approaches. Through advanced ML and DL algorithms and large-scale data integration, AI can facilitate hypertension risk prediction, early diagnosis, continuous monitoring, and individualized therapy, improving BP control and patient outcomes. Clinicians can leverage AI-powered decision-making tools that enhance diagnostic precision and optimize treatment plans based on patient-specific factors. As digital health technologies advance, AI can bridge care gaps at both the individual and population levels, supporting precision medicine and improving hypertension outcomes for millions globally. Continued collaboration among healthcare providers, data scientists, patients, and regulatory bodies will be essential to align AI tools with evolving clinical needs. Yes, AI is rapidly reshaping our lives. However, it cannot completely replace human traits—compassion and empathy—which are the two legs of medical care. AI may also inspire the medical practitioners to live and work for a deeper purpose and fulfillment. Interestingly, AI technologies actually enhance empathetic awareness and moral foundations of health care; however, such qualities are best translated directly by the medical community.

ACKNOWLEDGMENT

The author thanks Ms Zeba Sohel Khatri for her immense assistance in proofreading the manuscript, editing, and in the references verification process.

JAYPEE BROTHERS

REFERENCES

1. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223-37.
2. Chaikijurajai T, Laffin LJ, Tang WHW. Artificial Intelligence and Hypertension: Recent Advances and Future Outlook. Am J Hypertens. 2020;33(11):967-74.
3. Kario K, Okura A, Hoshide S, et al. The WHO Global report 2023 on hypertension warning the emerging hypertension burden in globe and its treatment strategy. Hypertens Res. 2024;47(5):1099-102.
4. Kario K. Management of Hypertension in the Digital Era: Small Wearable Monitoring Devices for Remote Blood Pressure Monitoring. Hypertension. 2020;76(3):640-50.
5. Zhou X, Zhang X, Gu N, et al. Barriers and Facilitators of Medication Adherence in Hypertension Patients: A Meta-Integration of Qualitative Research. J Patient Exp. 2024;11:23743735241241176.
6. Parati G, Lombardi C, Pengo M, et al. Current challenges for hypertension management: From better hypertension diagnosis to improved patients' adherence and blood pressure control. Int J Cardiol. 2021;331:262-9.
7. Mohsen F, Ali H, El Jahh N, et al. Artificial intelligence-based methods for fusion of electronic health records and imaging data. Sci Rep. 2022;12:17981.
8. Yu P, Xu H, Hu X, et al. Leveraging Generative AI and Large Language Models: A Comprehensive Roadmap for Healthcare Integration. Healthcare (Basel). 2023;11(20):2776.
9. Layton AT. AI, Machine Learning, and ChatGPT in Hypertension. Hypertension. 2024;81(4):709-16.
10. Cai A, Zhu Y, Clarkson SA, et al. The Use of Machine Learning for the Care of Hypertension and Heart Failure. JACC Asia. 2021;1(2):162-72.
11. Karnik A, Yang E. Artificial Intelligence to Improve Blood Pressure Control: A State-of-the-Art Review. Am J Hypertens. 2025;38(8):519-26.
12. Armoundas AA, Ahmad FS, Attia ZI, et al. Controversy in Hypertension: Pro-Side of the Argument Using Artificial Intelligence for Hypertension Diagnosis and Management. Hypertension. 2025;82(6):929-44.
13. Mizuno H, Choi E, Kario K, et al. Diagnostic Accuracy of Office Blood Pressure Measurement and Home Blood Pressure Monitoring for Hypertension Screening Among Adults: Results From the IDH Study. J Am Heart Assoc. 2023;12(24):e030150.
14. Manga S, Muthavarapu N, Redij R, et al. Estimation of Physiologic Pressures: Invasive and Non-Invasive Techniques, AI Models, and Future Perspectives. Sensors (Basel). 2023;23(12):5744.
15. Tan P, Xi Y, Chao S, et al. An Artificial Intelligence-Enhanced Blood Pressure Monitor Wristband Based on Piezoelectric Nanogenerator. Biosensors (Basel). 2022;12(4):234.
16. Sinou N, Sinou N, Koutroulakis S, et al. The Role of Wearable Devices in Blood Pressure Monitoring and Hypertension Management: A Systematic Review. Cureus. 2024;16(12):e75050.
17. Tsoi K, Yiu K, Lee H, et al. Applications of artificial intelligence for hypertension management. J Clin Hypertens (Greenwich). 2021;23(3):568-74.
18. Visco V, Izzo C, Mancusi C, et al. Artificial Intelligence in Hypertension Management: An Ace up Your Sleeve. J Cardiovasc Dev Dis. 2023;10(2):74.
19. Chu Y, Tang K, Hsu YC, et al. Non-invasive arterial blood pressure measurement and SpO2 estimation using PPG signal: a deep learning framework. BMC Med Inform Decis Mak. 2023;23:131.
20. Li J, Jia H, Zhou J, et al. Thin, soft, wearable system for continuous wireless monitoring of artery blood pressure. Nat Commun. 2023;14:5009.
21. Alam SF, Thongprayoon C, Miao J, et al. Advancing personalized medicine in digital health: The role of artificial intelligence in enhancing clinical interpretation of 24-h ambulatory blood pressure monitoring. Digit Health. 2025;11:20552076251326014.
22. Luo H, Yang D, Barszczyk A, et al. Smartphone-based blood pressure measurement using transdermal optical imaging technology. Circ Cardiovasc Imaging. 2019;12(8):e008857.
23. Alam SF, Gonzalez Suarez ML. Transforming Healthcare: The AI Revolution in the Comprehensive Care of Hypertension. Clin Pract. 2024;14(4):1357-74.
24. Dzau VJ, Hodgkinson CP. Precision Hypertension. Hypertension. 2024;81(4):702-8.
25. Du J, Chang X, Ye C, et al. Developing a hypertension visualization risk prediction system utilizing machine learning and health check-up data. Sci Rep. 2023;13:18953.
26. Islam SMS, Talukder A, Awal MA, et al. Machine Learning Approaches for Predicting Hypertension and Its Associated Factors Using Population-Level Data From Three South Asian Countries. Front Cardiovasc Med. 2022;9:839379.
27. Liao B, Jia X, Zhang T, et al. DHDIP: An interpretable model for hypertension and hyperlipidemia prediction based on EMR data. Comput Methods Programs Biomed. 2022;226:107088.
28. Sau A, Barker J, Pastika L, et al. Artificial Intelligence-Enhanced Electrocardiography for Prediction of Incident Hypertension. JAMA Cardiol. 2025;10(3):214-23.
29. Cho JS, Park JH. Application of artificial intelligence in hypertension. Clin Hypertens. 2024;30(1):11.
30. Kanegae H, Suzuki K, Fukatani K, et al. Highly precise risk prediction model for new-onset hypertension using artificial intelligence techniques. J Clin Hypertens (Greenwich). 2020;22(3):445-50.
31. Chen S, Yu J, Chamouni S, et al. Integrating machine learning and artificial intelligence in life-course epidemiology: pathways to innovative public health solutions. BMC Med. 2024;22:354.
32. Zhao H, Zhang X, Xu Y, et al. Predicting the Risk of Hypertension Based on Several Easy-to-Collect Risk Factors: A Machine Learning Method. Front Public Health. 2021;9:619429.
33. Naik A, Nalepa J, Wijata AM, et al. Artificial intelligence and digital twins for the personalised prediction of hypertension risk. Comput Biol Med. 2025;196(Pt A):110718.
34. Khamissi FZ, Sun L, Johnson P, et al. Machine Learning and Artificial Intelligence for Research on Hypertension. Am J Hypertens. 2025;38(11):867-71.
35. Hrytsenko Y, Shea B, Elgart M, et al. Machine learning models for predicting blood pressure phenotypes by combining multiple polygenic risk scores. Sci Rep. 2024;14:12436.
36. Gudigar A, Kadri NA, Raghavendra U, et al. Automatic identification of hypertension and assessment of its secondary effects using artificial intelligence: A systematic review (2013-2023). Comput Biol Med. 2024;172:108207.
37. Datta S, Morassi Sasso A, Kiwit N, et al. Predicting hypertension onset from longitudinal electronic health records with deep learning. JAMIA Open. 2022;5(4):ooac097.
38. Kankrale R, Kokare M. Artificial intelligence in retinal image analysis for hypertensive retinopathy diagnosis: a comprehensive review and perspective. Vis Comput Ind Biomed Art. 2025;8:11.
39. Adeleke O, Adebayo S, Aworinde H, et al. Machine learning evaluation of a hypertension screening program in a university workforce over five years. Sci Rep. 2024;14:30255.
40. Wu L, Huang L, Li M, et al. Differential diagnosis of secondary hypertension based on deep learning. Artif Intell Med. 2023;141:102554.

UNDER FREE BROWSERS

41. Diao X, Huo Y, Yan Z, et al. An Application of Machine Learning to Etiological Diagnosis of Secondary Hypertension: Retrospective Study Using Electronic Medical Records. JMIR Med Inform. 2021;9(1):e19739.
42. Sethi Y, Patel N, Kaka N, et al. Precision Medicine and the future of Cardiovascular Diseases: A Clinically Oriented Comprehensive Review. J Clin Med. 2023;12(5):1799.
43. Layton A. A Heart-to-heart with ChatGPT: AI Applications in Hypertension. Am J Hypertens. 2025 ;38(9):621-7.
44. Khude H, Shende P. AI-driven clinical decision support systems: Revolutionizing medication selection and personalized drug therapy. Adv Integrative Med. 2025;12(4):100529.
45. Shimbo D, Shah RU, Abdalla M, et al. Transforming Hypertension Diagnosis and Management in The Era of Artificial Intelligence: A 2023 National Heart, Lung, and Blood Institute (NHLBI) Workshop Report. Hypertension. 2025;82(1):36-45.
46. Yi J, Wang L, Song J, et al. Development of a machine learning-based model for predicting individual responses to antihypertensive treatments. Nutr Metab Cardiovasc Dis. 2024;34(7):1660-9.
47. Oh SH, Lee SJ, Park J. Precision Medicine for Hypertension Patients with Type 2 Diabetes via Reinforcement Learning. J Pers Med. 2022;12(1):87.
48. Lin M, Guo J, Gu Z, et al. Machine learning and multi-omics integration: advancing cardiovascular translational research and clinical practice. J Transl Med. 2025;23(1):388.
49. Wu Y, Xie L. AI-driven multi-omics integration for multi-scale predictive modeling of genotype-environment-phenotype relationships. Comput Struct Biotechnol J. 2025;27:265-77. [Erratum in: Comput Struct Biotechnol J. 2025;27:1089.]
50. Aryal S, Manandhar I, Mei X, et al. Combating hypertension beyond genome-wide association studies: Microbiome and artificial intelligence as opportunities for precision medicine. Camb Prism Precis Med. 2023;1:e26.
51. Hare AJ, Chokshi N, Adusumalli S. Novel Digital Technologies for Blood Pressure Monitoring and Hypertension Management. Curr Cardiovasc Risk Rep. 2021;15:11.
52. Leitner J, Chiang PH, Agnihotri P, et al. The Effect of an AI-Based, Autonomous, Digital Health Intervention Using Precise Lifestyle Guidance on Blood Pressure in Adults With Hypertension: Single-Arm Nonrandomized Trial. JMIR Cardio. 2024;8:e51916.
53. Funes Hernandez M, Babakhanian M, Chen TP, et al. Design and Implementation of an Electronic Health Record-Integrated Hypertension Management Application. J Am Heart Assoc. 2024;13(2):e030884.
54. Korb-Savoldelli V, Tran Y, Perrin G, et al. Psychometric Properties of a Machine Learning–Based Patient-Reported Outcome Measure on Medication Adherence: Single-Center, Cross-Sectional, Observational Study. J Med Internet Res. 2023;25:e42384.
55. Kassavou A, Mirzaei V, Brimicombe J, et al. A Highly Tailored Text and Voice Messaging Intervention to Improve Medication Adherence in Patients With Either or Both Hypertension and Type 2 Diabetes in a UK Primary Care Setting: Feasibility Randomized Controlled Trial of Clinical Effectiveness. J Med Internet Res. 2020;22(5):e16629.
56. Yap HJ, Lim JJJ, Tan SD, et al. Effectiveness of digital health interventions on adherence and control of hypertension: a systematic review and meta-analysis. J Hypertens. 2024;42(9):1490-504.
57. Padmanabhan S, Tran TQB, Dominiczak AF. Artificial Intelligence in Hypertension: Seeing Through a Glass Darkly. Circ Res. 2021;128(7):1100-18.
58. Amaratunga D, Cabrera J, Sargsyan D, et al. Uses and opportunities for machine learning in hypertension research. Int J Cardiol Hypertension. 2020;5:100027.
59. El-Geneedy M, El-Din Moustafa H, Khater H, et al. A comprehensive explainable AI approach for enhancing transparency and interpretability in stroke prediction. Sci Rep. 2025;15(1):26048.
60. Mueller FB. AI (Artificial Intelligence) and Hypertension Research. Curr Hypertens Rep. 2020;22(9):70.

JAYPEE BROTHERS

for detailed information on cardiology books, visit our website www.ejaypee.com, for detailed information on cardiology books, visit our website www.ejaypee.com, for detailed information on

Cardiological Society of India

CARDIOLOGY

UPDATE 2025

This latest edition of "CSI Cardiology Update 2025" presents state-of-the-art, concise, and comprehensive coverage of the most recent advances in cardiology, contributed by a distinguished panel of experts. The 2025 edition features insightful chapters on the latest developments in diagnostic imaging, coronary interventions, preventive cardiology, cardiovascular pharmacology, heart failure care, and breakthroughs in cardiac genetics and precision medicine.

Crafted to meet the evolving needs of modern cardiologists, fellows, and medical students, this volume highlights emerging therapies, updated evidence-based guidelines, and innovative approaches to patient management across the full spectrum of cardiovascular disease. Authored by leading clinicians and researchers, this resource blends cutting-edge scientific knowledge with practical clinical insights, offering a reliable and authoritative guide for everyday practice in a rapidly advancing field.

The "CSI Cardiology Update 2025" continues the Society's commitment to delivering high-quality educational content, ensuring that readers remain aligned with global standards and remain well-equipped to navigate the dynamic landscape of cardiovascular medicine.

Dhiman Kahali MD DM FESC FSCAI
Director – Interventional Cardiology
BM Birla Heart Research Centre
Kolkata, West Bengal, India
President Elect – Cardiological Society of India (CSI)
Ex-Chairman – National Intervention Council, Cardiological Society of India (CSI)
Ex-Convener – STEMI Council, Cardiological Society of India (CSI)
Ex-Vice President – Cardiological Society of India (CSI) 2020–2024

Shelving Recommendation
CARDIOLOGY

ISBN 978-93-7202-345-9
9 789372 023459

Buy from ejaypee

JAYPEE BROTHERS