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HEART-ATTACK PREDICTION USING AI

[1]Sushma A, [2]Venu Prasad, [3]Shrisha Joshi, [4]Shishir S Dheep, [4]Sunila

[1]Assistant Professor, [2]UG Student, [3]UG Student, [4]UG Student, [5]UG Student,

[1]Department of Computer Science & Design

[1] K S Institute of Technology, Bengaluru, India

Abstract: Cardiovascular diseases (CVDs), especially myocardial infarctions (heart attacks), represent a leading cause of death globally. Traditional diagnostic approaches such as ECGs, biomarkers, and clinical assessments often fall short due to delayed response and limited sensitivity. The integration of Artificial Intelligence (AI) and Machine Learning (ML) introduces novel possibilities for early prediction, personalized diagnostics, and continuous patient monitoring. This paper presents a comprehensive review of AI's role in cardiovascular risk assessment by highlighting the limitations of conventional techniques, the structure of AI architectures, their clinical advantages, key case studies, and future potential involving hybrid and federated learning systems. Furthermore, it emphasizes data privacy, ethical concerns, and regulatory preparedness to ensure real-world deployment and trust in AI-driven systems.

***Index Terms* -** Artificial Intelligence (AI), Machine Learning (ML), Myocardial Infarction, Cardiovascular Disease (CVD), ECG, Risk Stratification, Predictive Modeling, Explainable AI (XAI)

I. Introduction

Cardiovascular diseases (CVDs) contribute to 32% of global deaths, with heart attacks being among the deadliest. Despite advancements, up to 50% of heart attacks remain asymptomatic, emphasizing the necessity for predictive and preventive technologies. Artificial Intelligence (AI) is revolutionizing cardiology through subclinical condition detection, wearable-based real-time monitoring, and customized treatments using polygenic risk scoring. This paper delves into AI-enabled prediction models, architecture, real-time clinical integrations, and regulatory frameworks aiming to make early detection of heart attacks a scalable, affordable, and reliable tool.

II. Background & Clinical Foundations

2.1 Limitations of Traditional Techniques

- ECGs: 30-40% false negatives for posterior wall infarctions.
- Biomarkers: High-sensitivity troponins have a 4–6-hour diagnostic window and early false negatives.

2.2 AI in Cardiovascular Health

AI leverages large-scale data (genomics, clinical, imaging) to outperform traditional diagnostics. Techniques include ML (e.g., Random Forests, SVM), DL (e.g., CNNs for image classification), and NLP for clinical notes analysis.

III. AI Model Architecture

3.1 Multimodal Integration

Multimodal Integration Combines data from wearables, EHRs, imaging, and genomics. Feature engineering involves signal processing (e.g., wavelet transforms), radiomics, and dimensionality reduction.

3.2 Hybrid Architecture

Examples include Mayo Clinic's Cardio AI-X, which fuses vision transformers, BiLSTM, and clinical knowledge graphs, achieving >96% AUROC for 6-month prediction.

3.3 AI Model Types

- Supervised: Logistic Regression, Random Forest, SVM, Neural Networks
- Unsupervised: K-means for risk clusters
- Reinforcement: Real-time decision-making

3.4 Validation and Deployment

AI systems undergo cross-validation, clinical trials (e.g., Corti's dispatcher AI), and integration with hospital EHR systems.

IV. Benefits of AI in Heart Attack Prediction

- Improved accuracy: Neural networks surpass 90% in ECG prediction accuracy.
- Speed: Corti AI recognized cardiac arrest 2.5x faster than humans.
- Cost-effective: Wearables reduce hospital visits.
- Personalized care: AI adapts based on lifestyle, genetics, and microbiome.

V. Challenges and Ethical Concerns

- Data Quality: Mislabelled ECGs (12-15%) resolved using active learning.
- Bias: Mitigated via adversarial debiasing and oversampling.
- Regulation: Tools like Ultromics and Eko DUO approved by FDA, EU MDR compliance enforced.

VI. Case Studies

- Mayo Clinic: CNN model predicted left ventricular dysfunction (EF<35%) with 93% sensitivity.
- Google Health: Predicted CVD from retinal images with 0.94 AUC.
- Siemens CorPath GRX: AI-guided stenting in Cath labs improves outcomes.

VII. Future Scope

- Digital Twins: Personalized cardiovascular simulations for risk and treatment planning.
- Federated Learning: Privacy-preserving AI training across institutions.
- Quantum AI: Accelerated genomic data processing.
- National AI screening: Deployed in UK and Singapore.
- Autonomous Systems: Drones for AED deployment and wearable-triggered emergency responses.

Conclusion

AI-driven models are significantly transforming preventive cardiology. With enhanced prediction accuracy, cost efficiency, and personalized approaches, AI promises to reduce the cardiac mortality burden by 2030. However, challenges related to interpretability, data privacy, and standardized validation must be addressed to ensure responsible and impactful adoption.

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