ABSTRACT BOOK

AIET 2025

27-28 February 2025
Olympic Hotel / Tehran-Iran

7th Conference on Cardiology & Emerging Technologies

Artificial Intelligence in Endovascular Technology

RCEI

Research Center of
Endovascular Intervention

Welcome to AIET 2025

Dear colleagues and guests,

It is our sincere pleasure to extend a very warm welcome to you on behalf of the Iranian Society of Atherosclerosis (I.R.S.A) and the Research Center of Endovascular Intervention (R.C.E.I). We are deeply grateful that you have accepted our invitation to attend the "**7th Conference on Cardiology and Emerging Technologies, Artificial Intelligence in Endovascular Technology (AIET 2025),**" to be held in Tehran, February 27–28, 2025.

This R.C.E.I Conference, organized in collaboration with I.R.S.A, has brought together scientists and healthcare professionals involved in various fields, including cardiology, anesthesia, surgery, pharmaceutical technologies, and medical devices. By hosting this Conference, our society aims to promote the highest standards of clinical practice and foster continuous education for its members.

The Conference is designed to provide an innovative and comprehensive overview of the latest research developments in Artificial Intelligence in cardiovascular medicine. The primary focus areas include AI in Endovascular Technology, coronary artery disease, anesthesia, heart failure, cardiac arrhythmias, and cardiac surgery.

This Conference offers a unique opportunity to renew connections and engage in dynamic discussions with leading scientific delegates on critical healthcare issues. Many distinguished cardiologists and scientists have joined us to contribute to this Conference. The speeches and events outlined in the agenda cover a broad spectrum of core topics in cardiovascular diseases.

We extend our best wishes to all our guests, both from Iran and abroad, for a productive and successful congress. We also hope you enjoy a pleasant stay in Tehran.

We express our heartfelt gratitude to our sponsors, whose support has made this significant gathering possible.

As we come together, surrounded by colleagues, we are humbled by our achievements yet inspired by our shared hopes and dreams—aspirations that we are committed to turning into reality. Our goal is to improve patient care and make meaningful advancements in the field.

Together, we can draw strength from our bonds, learn from one another, and expand our horizons.

Thank you.

Massoud Ghasemi MD
President of the Conference

M. Ghase

Masoud Eslami MD
Secretary of the Conference

M. Eslami

IRSA

Iranian Society of
Atherosclerosis

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7th Conference on Cardiology & Emerging Technologies

Artificial Intelligence in Endovascular Technology

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President of the Conference

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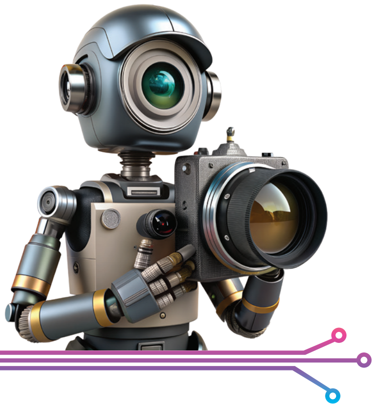
Executive Secretary of Conference

AIET 2025



CAPTURED MOMENTS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President of Congress


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President of Congress


Dr. Ali Kabir
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F. Fazelifar
S. Hashemi Fesharaki
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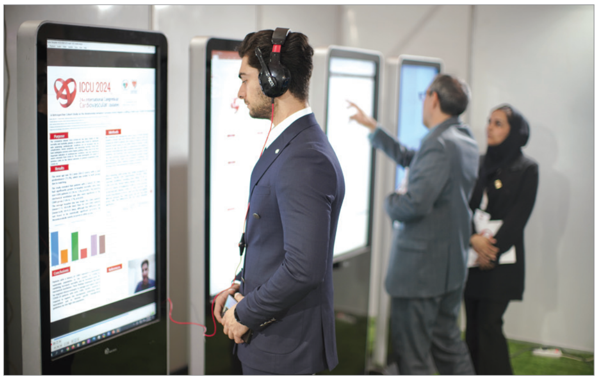
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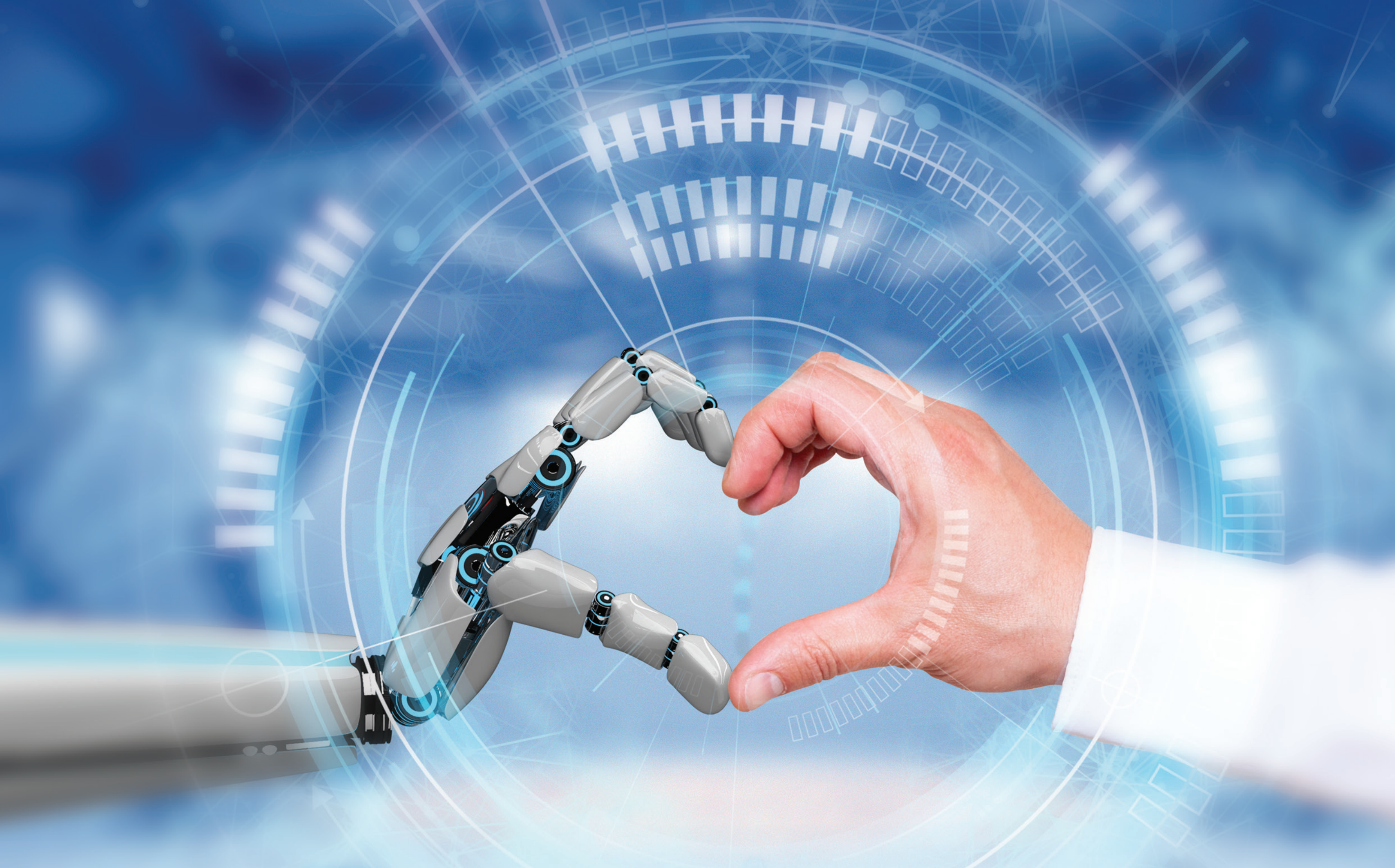

7th Conference on Cardiology & Emerging Technologies

Artificial Intelligence in Endovascular Technology

Tehran - IRAN

Contents

AI-Powered Electrocardiography for Accurate Estimation of Left Ventricular Ejection Fraction

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Introduction:

Left ventricular ejection fraction is a vital parameter in assessing cardiac function, playing a central role in the diagnosis and management of heart failure. Traditional imaging modalities like echocardiography and MRI are gold standards but are often limited by inter-modality variability, accessibility constraints, and operator dependency. Electrocardiography (ECG), a readily available and non-invasive tool, is routinely used but has been underutilized for LVEF estimation. Recent advances in artificial intelligence (AI) and deep learning have demonstrated the potential to extract meaningful cardiac function data from ECG signals. This study aims to develop and validate an AI-driven methodology to estimate LVEF using ECG images, addressing challenges of accessibility, variability, and diagnostic accuracy, while classifying EF into clinically relevant ranges for practical application.

Material & Methods:

Dataset and Labeling The dataset comprised ECG images categorized into three LVEF classes: Class 1 (EF <40%), Class 2 (EF 40–50%), and Class 3 (EF >50%), with 1,462, 1,591, and 9,465 images, respectively. Metadata files included patient details, but EF values were matched via a patient ID from an external Excel file. Regular Expression (RE) algorithms extracted IDs from metadata to assign EF class labels to corresponding ECG images. Data Augmentation To address dataset imbalance, smaller classes (Classes 1 and 2) were augmented using Keras's ImageDataGenerator, generating synthetic images through rotations, flips, and shifts. The augmented dataset contained 8,772 images for Class 1, 9,546 for Class 2, and 9,465 for Class 3, achieving balance for robust model training. Image Preprocessing Images (originally 4734×7074 pixels) were cropped to retain key diagnostic information (800×7072 pixels) and resized to 224×224 pixels to suit deep learning models. Noise reduction techniques, including GaussianBlur and MedianBlur filters, removed impulse noise for enhanced clarity. Final preprocessing involved normalization of pixel values to a [0,1] range, optimizing training stability. Deep Learning Architecture The Xception architecture, a deep-wise separable convolutional neural network, was selected for its high efficiency in image classification tasks. Pre-trained on ImageNet, the network's final layers were replaced with custom layers for classification and the training process applied. Evaluation Performance was assessed via 5-fold cross-validation using metrics such as accuracy, precision, sensitivity, and F1-score. Comparative experiments were conducted against other pre-trained architectures (ResNet, Inception, MobileNet) with identical preprocessing pipelines. Additional experiments excluded noise reduction steps to isolate their contribution to performance.

Results:

The proposed deep learning pipeline achieved exceptional performance in classifying EF into three categories: EF <40%, EF 40–50%, and EF >50%. Using the Xception architecture, the model achieved an average accuracy of 93.2%, precision of 93.5%, sensitivity of 93.1%, and F1-score of 93.4% across all categories, as confirmed by 5-fold cross-validation. Comparative evaluations against other pre-trained architectures demonstrated the superior performance of the Xception-based model, with improvements of 3–7% in key metrics. Furthermore, excluding the image filtering steps led to a notable decline in model accuracy, underscoring the importance of preprocessing in enhancing classification performance. The proposed model reliably classified imbalanced EF datasets, overcoming challenges associated with limited data in certain EF categories. These findings highlight the clinical utility of the model for non-invasive EF estimation.

Conclusion:

AI-powered ECG analysis demonstrates high accuracy in estimating EF, providing a non-invasive, accessible, and cost-effective tool for heart failure management. The proposed deep-wise separable convolution model effectively addresses the variability challenges of conventional imaging techniques. This approach enhances early detection, clinical decision-making, and resource optimization in cardiology.

Keywords:

AI ECG EjectionFraction DeepLearning

AI-Powered Non-Invasive Cardiovascular Disease Detection: Harnessing Photoplethysmography Signals for Early Diagnosis

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Introduction (Background & Objectives):
Cardiovascular diseases (CVD) remain a leading cause of mortality worldwide, emphasizing the need for early detection strategies that are both accurate and non-invasive. Conventional diagnostic methods often rely on costly, time-consuming, or invasive procedures, limiting widespread accessibility. Photoplethysmography (PPG) has emerged as a promising alternative for continuous, real-time cardiovascular monitoring, offering a simple yet powerful means of assessing vascular health. This study aims to leverage artificial intelligence (AI) and machine learning to enhance the diagnostic capabilities of PPG-based methods for CVD detection. By analyzing the intricate patterns within PPG waveforms, we propose an AI-driven approach capable of distinguishing between healthy individuals and those with cardiovascular conditions with high accuracy.

Materials & Methods:
For this research, we utilized the publicly available PPG-BP dataset, comprising 657 records from 219 individuals aged 20 to 89 years, including subjects diagnosed with hypertension and diabetes. The dataset was collected under standardized clinical conditions, ensuring reliability and consistency. To extract meaningful features from the PPG signals, we employed Mel-Frequency Cepstral Coefficients (MFCC) and Normalized Power Cepstral Coefficients (NPCC)—techniques traditionally used in speech and biomedical signal processing, now adapted to capture the subtle yet critical variations in PPG waveforms. A Random Forest classifier was employed for classification, with hyperparameter tuning and cross-validation ensuring optimal performance and robustness. Model evaluation was conducted using multiple performance metrics, including accuracy, precision, recall, F1-score, Mean Squared Error (MSE), and Mean Absolute Error (MAE).

Results:
The proposed model achieved a classification accuracy of 92.8% (±1.5%), demonstrating high reliability in CVD detection using PPG signals. Performance metrics showed a precision of 0.80 (±0.03), recall of 0.70 (±0.04), and F1-score of 0.74 (±0.02), indicating balanced classification capability. Error analysis yielded a MSE of 0.012 (±0.0013) and MAE of 0.089 (±0.007), confirming robustness in prediction. Feature importance analysis highlighted the role of MFCC and NPCC in distinguishing CVD cases, while the Random Forest model outperformed conventional

classifiers, effectively handling the nonlinear complexities of physiological signals. These findings support the potential of AI-driven PPG analysis as a reliable, non-invasive CVD screening tool.

Conclusion:
This study presents an AI-driven, non-invasive method for CVD detection with strong potential for wearable health monitoring and telemedicine. By enhancing diagnostic precision through machine learning, it offers a reliable and accessible alternative to traditional methods. Future work will focus on clinical validation and real-world implementation to advance personalized cardiovascular care.

Keywords:
CVD Photoplethysmography AI Signal Processing

An Expert System to Diagnosing Heart Attack Disease Using CF Method

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Introduction:
Expert systems [2] as one of the branches of artificial intelligence are designed to solve problems in different fields instead of experts. An expert system should provide answers to the audience's problems with a high probability by receiving minimal questions from the audience. Because of uncertain risk factors in the heart disease risks, heart disease diagnosis is sometimes hard for experts. Therefore, experts require an accurate tool considering these risk factors and show certain result in heuristic term and designing an expert system is efficient to diagnose the heart disease [3].

Material & Methods:
Expert systems have some input fields and one output field. This application is an expert system for diagnosing heart disease, which is designed based on the rules received from the cardiologist and the questions asked by the users. This expert system software, based on the Certainty Factor (CF), detects heart disease with a certain probability. The certainty factor is determined to accommodate the imprecise reasoning of an expert (e. g, a physician). Based on the role of each of the events in the occurrence of a heart attack, the certainty factor has been formulated [4]. CF = Certainty factor in the H hypothesis influenced by fact E E = Evidence (event or fact) CF[H,E]1 = CF[H] * CF[E] CF(H,E) = certainty factor of hypotheses are influenced by evidence e is known with certainty factor for rules with similarly concluded rules: CF combine CF[H,E]1,2 = CF[H,E]1 + CF[H,E]2 * (1-CF[H,E]1) CF combine CF[H,E]old,3 = CF[H,E] old + CF[H,E] 3 * (1 -CF[H,E] old) Tables 1 shows CF Value. Rule of the expert system is defined as follows: R= if C1 and C2 and C3 and C4 and C5 and C6 then Coronary heart disease.

Results:
Calculation of Coronary Heart Disease CF C1 = CF (0.8) * CF (0.5) = 0.40

(Almost certainly) CF C2 = CF (0.8) * CF (0.4) = 0.32 CF C3 = CF (0.5) * CF (0.6) = 0.30 (May be) CF C4 = CF (0.6) * CF (0.3) = 0.18 CF C5 = CF (0.8) * CF (0.8) = 0.64 CF C6 = CF (0.6) * CF (0.7) = 0.42 CFcombine1 (CF C1, CF C2) = 0.40 + 0.32 * (1-0.4) => CF old1 = 0.592 CFcombine2 (CFold1, CF C3) = 0. 592+0.3* (1-0. 592)=> CF old2= 0.7144 CFcombine3 (CFold2, CF C4) = 0. 7144+0.18 * (1-0. 7144) => CF old3= 0.765808 CFcombine4 (CFold3, CF C5) = 0. 765808+0.64 * (1-0. 765808)=> CF old4= 0.91569088 CFcombine5 (CFold4, CF C6) = 0. 91569088+0.42 * (1-0. 91569088)=> CF old5= 0.9511007104 Percentage = CFold5 * 100 = 0. 9511007104*100 = 95.11007104% From the above calculations, the value of the certainty factor from the input of symptoms leading to CHD is obtained 95.11007104%.

Conclusion:
An expert system can operate same as a specialist. Expert systems for heart diseases diagnosis and treatment show the levels of the patients' age, Blood pressure levels, Patients' heart rate levels and another factors. In this paper, an expert system is designed to diagnose heart attack disease using the certainty factor method. The diagnosis is based on the symptoms experienced by the users according to the rules and questions applied in the program. Users only need answer the questions that the data system. This expert system can help patients to make an initial diagnosis of CHD before reaching the nearest hospital.

Keywords:
Heart Disease, Expert Systems

Machine learning and computational fluid dynamics derived FFRCT demonstrate comparable diagnostic performance in patients with coronary artery disease; A Systematic Review and Meta-Analysis

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Introduction:
As a new noninvasive diagnostic technique, computed tomography-derived fraction flow reserve (FFRCT) has been used to identify hemodynamically significant coronary artery stenosis. FFRCT can be calculated using computational fluid dynamics (CFD) or machine learning (ML) approaches. It was hypothesized that ML-based FFRCT (FFRCTML) has comparable diagnostic performance with CFD-based FFRCT (FFRCTCFD). We used invasive FFR as the reference test to evaluate the diagnostic performance of FFRCTML vs. FFRCTCFD.

Material & Methods:
We searched PubMed, Cochrane Library, EMBASE, WOS, and Scopus for articles published until March 2024. We analyzed the synthesized sensitivity, specificity, and diagnostic odds ratio (DOR) of FFRCTML vs FFRCTCFD at both the patient and vessel levels. We generated summary receiver operating characteristic curves (SROC) and then calculated the area under the curve (AUC).

Results:
This meta-analysis included 23 studies reporting FFRCTCFD diagnostic performance and 18 studies reporting FFRCTML diagnostic performance. In the FFRCTCFD group, 2,501 patients and 3,764 vessels or lesions were analyzed. In the FFRCTML group, 1,323 patients and 4,194 vessels or lesions were analyzed. Our results showed that at the per-patient level, FFRCTCFD and FFRCTML had comparable pooled specificity (Z= -0.59, P= 0.55) and AUC (P= 0.5). At the per-vessel level, FFRCTCFD and FFRCTML also showed comparable specificity (Z= 0.94, P= 0.34), DOR (Z= 0.7, P= 0.48), and AUC (P= 0.74). However, the sensitivity of FFRCTML was significantly lower compared to FFRCTCFD at both patient (Z= -3.85, P= 0.0001) and vessel (Z= -2.05, P= 0.04) levels.

Conclusion:
The FFRCTML technique was comparable to standard CFD approaches in terms of AUC and specificity. However, it did not achieve the same level of sensitivity as FFRCTCFD.

Keywords:
CAD Fractional-Flow-Reserve Machine-Learning CCTA

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Big Data Management in Cardiology: Challenges and Opportunities

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Introduction:
Big data encompasses datasets that are extremely large, intricate, or generated at such high speeds that conventional computational methods struggle to process or analyze them effectively. These datasets are defined by three key attributes—Volume, Velocity, and Variety—which reflect their size, rapid generation, and diverse nature. (Stamate et al., 2024).Cardiovascular diseases (CVDs) are recognized as one of the primary causes of mortality worldwide and in Iran. According to the World Health Organization (WHO, 2023), CVDs account for 31% of all annual deaths globally. In Iran, data from the Ministry of Health indicate that this figure exceeds the global average (Najafi et al., 2021).

Material & Methods:
This study followed a systematic review approach based on the PRISMA protocol. Articles were retrieved from PubMed, Scopus, and Google Scholar using relevant keywords. Studies published between 2010 and 2025 in English or Persian, focusing on big data management in cardiology, were included. A total of 27 articles were selected for final analysis.

Results:
The review revealed both significant opportunities and notable challenges in managing big data for cardiology in Iran. Opportunities include improved disease diagnosis, personalized treatment, and predictive model development. Challenges, however, include a lack of standardized data quality, security and privacy concerns, and inadequate IT infrastructure in hospitals (Bates et al., 2018; Khosravi & Bigdeli, 2022). Big data analysis can reduce the time required for diagnosing cardiovascular diseases and enable more accurate predictions for patient management. Additionally, the use of artificial intelligence (AI) and machine learning algorithms in analyzing clinical data has been recognized as a powerful tool, particularly in early disease detection (Farahani et al., 2020).

Conclusion:
Big data management in cardiology presents vital opportunities to enhance healthcare quality and reduce mortality rates. the influence of big data continues to expand, becoming an integral and pervasive component of modern society. It offers groundbreaking opportunities in fields like biomedicine, including cardiology. By introducing a new paradigm, big data has the potential to transform cardiological practices and advance clinical research in unprecedented ways (Dai et al., 2022). However, challenges such as poor data quality and insufficient infrastructure necessitate robust policymaking and investment in Iran (Pourafshar & Yaghobi, 2018). Addressing these challenges will require collaboration between government, healthcare institutions, and international organizations to ensure the effective use of big data in cardiology.

Keywords:
Big Data cardiology Digital health

The Role of Artificial Intelligence in Early Detection and Clinical Decision Support for Cardiovascular Diseases

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Introduction:
Cardiovascular diseases are responsible for approximately 17.9 million deaths annually, making them the leading cause of morbidity and mortality worldwide (World Health Organization, 2021). Traditional diagnostic and treatment strategies rely heavily on physician expertise and manual interpretation of clinical data. However, these methods are often time-consuming, prone to inter-observer variability, and limited in their predictive capacity. With the advent of AI, there is a growing opportunity to transform cardiology by improving diagnostic accuracy, risk stratification, and treatment optimization. The rapid development of AI-powered tools in medicine, particularly in cardiology, has facilitated more precise and timely interventions. AI can analyze vast amounts of patient data, detect patterns that may not be immediately apparent to human clinicians, and provide evidence-based recommendations. This review aims to explore AI's role in early detection of CVDs.

Material & Methods:
To ensure a comprehensive review, a systematic search was conducted across multiple databases, including PubMed, IEEE Xplore, and Scopus. The search strategy involved keywords such as "artificial intelligence in cardiology," "machine learning for cardiovascular disease prediction," and "clinical decision support in cardiovascular diseases." The inclusion criteria encompassed studies published within the last decade, focusing on AI applications in early detection, risk stratification, and clinical decision support. Articles that lacked rigorous validation, had small sample sizes, or were not peer-reviewed were excluded. The selected literature was categorized based on AI methodologies, clinical applications, and outcome measures.

Results:
This study investigates the applications of Artificial Intelligence (AI) in the early detection and clinical decision support for cardiovascular diseases (CVDs). Our analysis highlights the effectiveness of machine learning (ML) models, including random forests, support vector machines (SVM), and deep neural networks (DNNs), in predicting CVD risks by processing diverse patient data, such as demographics, clinical history, and biomarkers. AI-enhanced imaging techniques, particularly convolutional neural networks (CNNs), were found to significantly improve diagnostic

accuracy in detecting coronary artery disease, myocardial infarction, and heart defects. Furthermore, AI-assisted clinical decision support systems (CDSS) demonstrated superior efficiency in diagnosing and planning treatments by analyzing patient-specific data and providing evidence-based recommendations.

Conclusion:
AI is poised to transform cardiovascular care by enhancing early disease detection, improving clinical decision-making, and enabling personalized treatment strategies. While challenges remain, continued advancements in AI algorithms, ethical frameworks, and data integration will pave the way for its widespread adoption. As AI technologies evolve, interdisciplinary collaboration among AI researchers, cardiologists, and regulatory agencies will be crucial in ensuring safe and effective implementation.

Keywords:
Artificial Intelligence, Cardiovascular

Artificial Intelligence in the Prediction of Aortic Aneurysm Rupture: A Review

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Introduction:
Aortic aneurysms are characterized by the abnormal dilation of the aortic wall, which can lead to rupture, a life-threatening event. Early prediction of aneurysm rupture is crucial for timely intervention and improved patient outcomes. The risk of rupture depends on various factors, including aneurysm size, growth rate, wall stress, and patient-specific characteristics. Traditional risk assessment tools, such as diameter-based criteria, have limitations in accurately predicting rupture. Artificial intelligence (AI), particularly machine learning (ML) and deep learning(DL), offers a data-driven approach to analyze complex datasets and improve prediction accuracy. This review explores the current state of AI applications in predicting aortic aneurysm rupture, focusing on machine learning (ML) and deep learning (DL) techniques, their methodologies, and clinical implications.

Material & Methods:
AI Techniques in Aneurysm Rupture Prediction 1. Machine Learning (ML): Supervised Learning: ML algorithms, such as logistic regression, support vector machines (SVMs), and random forests, have been employed to predict aneurysm rupture using clinical and imaging data. These models are trained on labeled datasets, where the outcome (rupture or no rupture) is known. Feature Selection: ML models often incorporate features such as aneurysm diameter, growth rate, blood pressure, and patient demographics. Advanced feature selection techniques help identify the most predictive variables. Performance: Studies have demonstrated that ML models can achieve high accuracy, sensitivity, and specificity in rupture prediction, outperforming traditional risk assessment tools. 2. Deep Learning (DL): Convolutional Neural Networks (CNNs): DL models, particularly CNNs, have been applied to medical imaging data, such as CT scans and MRIs, to automatically extract features related to aneurysm morphology and wall stress. 3D Modeling : DL techniques enable the creation of 3D models of aneurysms, allowing for more precise assessment of wall stress and rupture risk. Transfer Learning: Pre-trained DL models, such as those trained on large imaging datasets, can be fine-tuned for aneurysm-specific tasks, improving prediction accuracy with limited data.Data Sources and Preprocessing: Imaging Data: CT angiography (CTA) and MRI are the primary imaging modalities used to assess aortic aneurysms. AI models analyze these images to extract morphological and hemodynamic features. Clinical Data: Patient demographics, medical history, and laboratory results are integrated with imaging data to provide a comprehensive risk assessment.

Results:

Artificial intelligence (AI), particularly machine learning (ML) and deep learning(DL), offers a data-driven approach to analyze complex datasets and improve prediction accuracy. AI models provide individualized rupture risk predictions, enabling tailored treatment plans and timely surgical intervention.

Conclusion:

AI holds significant potential in improving the prediction of aortic aneurysm rupture, offering more accurate and personalized risk assessments compared to traditional methods. Continued advancements in ML and DL, along with the integration of multimodal data, will further enhance the clinical utility of AI in this domain. However, addressing challenges related to data privacy, model transparency, and regulatory approval is crucial for the successful implementation of AI in clinical practice.

Keywords:

Aortic Aneurysm-Rupture-Artificial intelligence -Prediction

A systemic review on the Prediction of Amputation Risk in Limb Ischemia Using Artificial Intelligence

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Introduction:
Amputation due to ischemic lower limb disease, particularly in patients with peripheral arterial disease (PAD), represents a significant challenge in clinical practice. Timely intervention is crucial, as delayed diagnosis or inadequate management can lead to irreversible tissue damage and the need for amputation. Artificial intelligence (AI) has emerged as a promising tool for early prediction and intervention. This review examines the use of AI in predicting amputation risk and highlights emergency procedures that can help reduce amputation rates.

Material & Methods:
A systematic review of studies published between 2010 and 2024 was conducted, focusing on AI models used in the prediction of amputation in ischemic lower limbs. Studies involving machine learning (ML), deep learning (DL), and natural language processing (NLP) were included. The review also examined emergency interventions, such as pharmacological therapies (e.g., thrombolysis, antiplatelet therapy), revascularization procedures (e.g., angioplasty, bypass surgery), and other acute care measures aimed at reducing the risk of amputation.

Results:
AI models, particularly deep learning techniques, showed a high degree of accuracy in predicting the risk of amputation. These models provided early alerts, allowing for timely intervention. Emergency procedures, such as revascularization (angioplasty and bypass surgery), when performed early, were found to significantly reduce amputation rates. AI-supported decision-making in emergency settings enabled clinicians to prioritize high-risk patients for immediate therapeutic interventions, leading to improved limb salvage outcomes.

Conclusion:
AI offers substantial promise in predicting amputation risk and guiding emergency interventions to prevent limb loss in ischemic lower limb disease. Early recognition through AI-driven predictions allows for prompt use of emergency procedures, such as revascularization and thrombolysis, to significantly reduce amputation rates. However, challenges related to data quality, model transparency, and integration into clinical workflows must be addressed to fully realize the benefits of AI in emergency settings. Further research is needed to refine these models and integrate them into real-time clinical decision-making.

Keywords:
Artificial Intelligence(AI),Limb ischemia, Amputation

Identification of novel diagnostic biomarkers for heart transplantation rejection: a machine learning analysis

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Introduction:
Heart transplantation (HTx) is the choice of treatment for patients with end-stage heart failure. However, transplantation rejection is a significant complication occurs in about 30% of patients during the first year following HTx. The gold standard method for diagnosis of rejection is endomyocardial biopsy (EMB), which requires hospitalization and is an invasive method. Consequently, scientists have started looking for safe replacements, including molecular biomarkers. In this work, we integrated bioinformatics and machine learning (ML), a subfield of artificial intelligence (AI), to investigate new and non-invasive biomarkers for the early detection of HTx rejection.

Material & Methods:
Here, the gene expression omnibus (GEO) was used to download microarray data for validation and analysis. Subsequently, R programming was applied to determine the differentially expressed genes (DEGs) of samples of rejection vs no rejection. Finally, the biomarkers were separated into two training and testing groups and identified using deep learning, an ML technique.

Results:
Following downloading data from 137 samples, the adjusted t-test and p-values were used to compare the candidate genes. Based on the feature importance score, the top ten genes (TYMS, WARS, AIM2, CXCL9, TRAT1, HLA-DRB3, TNFRSF9, GZMH, IL-32, and AIF1) were chosen as candidates for additional analysis, and expression of each gene had a notable rise in the rejection group. The top three genes for HTx rejection detection among these ten were CXCL9, TNFRSF9, and GZMH. The novel biomarkers for diagnosis are GZMH and TNFRSF9. However, CXCL9 was previously investigated as diagnostic gene for HTx rejection.

Conclusion:
TNFRSF9 belongs to the superfamily of tumor necrosis factor (TNF) receptors, and can be expressed by endotheliocytes, natural killer (NK) cells, activated CD8+ and CD4+ T cells. TNFRSF9 is involved in apoptosis, proliferation and cell survival. The regulation of CD8+ T cell activity is significantly influenced by TNFRSF. Granzyme H (GZMH) is

a granzyme that releases cytotoxic granzymes into target cells. They also have a role in creation of phagosomes, controlling cytokines, and remodeling of extracellular matrix. When target cells are detected, perforins are released, embedding themselves in target cell membranes to allow granzymes to enter and trigger apoptosis. It has been demonstrated that in HTx rejection, Granzyme B strongly expressed. However now, we recognized that GZMH is highly expressed in HTx rejection. CXCL9, a member of CXC subfamily of chemokines, is a non-invasive biomarker of HTx rejection, which is line with our investigation.

Keywords:
Heart-transplantation, Biomarker, Machine-learning, Bioinformatics, Rejection

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Automated Segmentation of Echocardiograms: Development and Validation of Unsupervised Domain Adaptation for Cardiac Structure Analysis

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Background and Objective:
Echocardiography is a safe and non-invasive diagnostic method that allows the visualization of all heart structures. Precise delineating cardiac structures like the Left Ventricle (LV) is essential for assessing important cardiac functional metrics. The accuracy of echocardiography largely depends on the operator's expertise prone to potential variability among different echocardiographers, which could potentially mislead or complicate the diagnostic process. This study aimed to propose an automated model based on Unsupervised Domain Adaptation (UDA) for segmenting heart structures in echocardiogram videos as well as measuring left ventricle thickness and its systolic function.

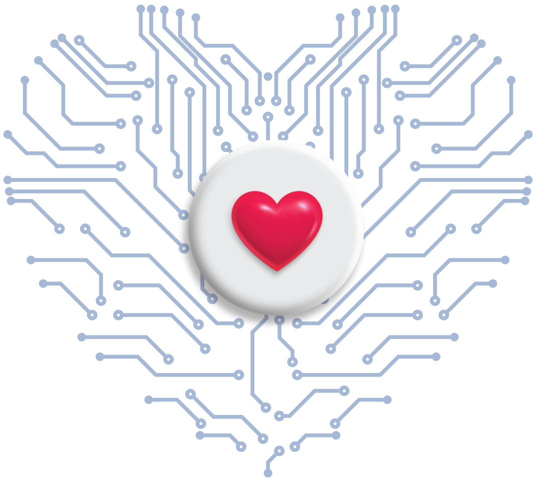
Materials and Methods:
A locally collected echocardiogram video dataset from Heshmat Hospital, Guilan, Iran, and two international public datasets, EchoNet-Dynamic (12,000 videos) and EchoNet-LVH (10,030 videos) were used. The local dataset included 500 echocardiographic videos, complete with masks for both left ventricle wall thickness and ejection fraction. EchoNet-Dynamic and EchoNet-LVH served as source domains, while our local dataset acted as the target domain. The proposed UDA based model applied a variational autoencoder architecture with three main modules: encoder, domain adaptation, and decoder. The encoder incorporates deep separable convolution layers, a dual attention layer, and max pooling to extract relevant features. The domain adaptation module employs a Wasserstein GAN (WGAN) to align the marginal and conditional distributions of the source and target domains. The decoder consists of a reconstruction component to ensure the generation of images similar to the inputs and a segmentation component that applied pixel shuffle to generate high-resolution outputs from lower-resolution features. Model effectiveness was assessed using Dice Coefficient Metrics. Implementation was carried out using TensorFlow on a workstation equipped with NVIDIA Tesla V100 GPUs to facilitate efficient processing and training.

Findings:
Our proposed model demonstrated significant improvements in cardiac structure segmentation compared to existing state-of-the-art UDA methods, achieving average Dice scores of 3.9% and 6.2% higher across two experimental settings using EchoNet-Dynamic and EchoNet-LVH as

source domains. The model successfully aligned features from the source and target domains, ensuring accurate segmentation of left ventricular wall thickness and ejection fraction. Evaluation metrics confirmed the model's robustness and generalizability across diverse echocardiographic data.

Conclusion:
By leveraging diverse datasets and a variational autoencoder architecture, we successfully improved the segmentation accuracy of key cardiac structures. The model achieved significant enhancements in averaged Dice scores compared to existing state-of-the-art methods, highlighting its potential to reduce operator dependency and variability in echocardiographic analysis, ultimately contributing to more accurate and consistent cardiac assessments in clinical practice.

Keywords:
Echocardiography, Unsupervised Domain Adaptation (UDA), Video Segmentation, Cardiac Structures, Ejection Fraction, Left Ventricle Thickness



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