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REVIEW ARTICLE

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AI and ML Digital Transformation on Cardio Applications in Healthcare for Outpatients' Safety

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ABSTRACT

The fields of machine learning (ML) and artificial intelligence (AI) are transforming outpatient cardiovascular care, enhancing patient safety, and expediting the provision of healthcare. Through the analysis of massive datasets, these technologies assist healthcare providers in making more informed decisions regarding diagnosis and treatment. For example, AI systems are able to predict the likelihood of cardiovascular events by analyzing patient data, including vital signs and medical history. Additionally, the accuracy of diagnosing conditions like cardiac rhythm irregularities and coronary artery disease is improved by the application of machine learning in image analysis. Wearables with AI capabilities can keep an eye on patients in real time and alert medical professionals to potential issues before they worsen. This AI and ML have the potential to greatly enhance healthcare, a number of problems still need to be handled, including data protection, legal compliance, and the requirement for seamless integration into existing systems.

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AI and ML in Cardiology

For the heart world, machine learning (ML) and artificial intelligence (AI) are like superpowers. Physicians' approaches to heart health are evolving, particularly for out- of-hospital patients. This paper explores the ways in which these technological tools are transforming cardiology, with an emphasis on care provided outside of hospital settings [1].

The intention here is to provide a comprehensive overview of the role of AI and ML in cardiology, including its advantages, disadvantages, and potential future developments. It is similar to giving your senses a whole new perspective on healthcare; it involves more than just visiting a doctor anymore—it involves interacting with intelligent, adaptable technology [2].

For clinical care treatments to be tested and evaluated iteratively, finding efficient quality improvement techniques is crucial to delivering high-quality, high-value care in a budget-constrained setting. However, unlike other medical disciplines, techniques for applying evidence-based medicine in the field of quality and safety improvement require their own evidence foundation [3].

By evaluating data from extended monitoring and f lagging only critical results for human review, machine learning (ML) application to the output of clinical grade ambulatory monitors (e.g., implantable loop recorders, Holter moniors, pacemakers/ defibrillators, etc.) and commercial heart ra te monitoring devices can expand the cardiologist's reach. It can also improve processes when used with natural language processing, producing reports (such electrocardiogram [EC G] interpretation) that are identical to those written by cardi ologists. Machine learning is being used in the EP lab to reduce noise in intracardiac tracings, making them easier to read as shown in the above figure 1. The digital transformation of our health-care system has seen a significant change in recent years as a result of political, medical, and technological advancements and reorganization.

In particular, the cardiovascular area has undergone tremendous transformation, resulting in new wide perspectives on optimal treatment techniques for patients today [4].

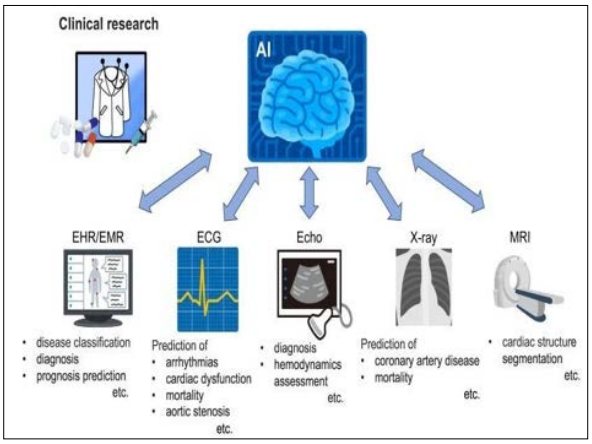

Figure 1: Clinical research in various AI fields Methods in Cardiology

AI and ML algorithms are being used in cardiology for a variety of purposes, including therapy planning, risk assessment, and diagnosis. The most popular techniques include:

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- **Supervised learning:** Boosting strategies, network analysis, regression analysis, and tree-based approaches are commonly used in cardiology to facilitate supervised learning.
- **Unsupervised learning:** Algorithms like as random survival forests are used to uncover hidden features in cardiovascular data and improve prediction models.
- **Natural language processing (NLP):** NLP techniques are used to retrieve relevant data from unstructured sources, such as electronic health records (EHRs) and encounter notes.

The below table shows the cardiovascular disease burden in India, and state highs & lows. Three-quarters of CVD- related deaths happen in lower-middle income countries, according to the World Health Organization, which classifies India among such countries.

Ischemia is characterized as a localized lack of blood flow (circulation) brought on by a blockage of the blood arteries feeding the area. An organ (such as the heart) is said to be ischemic if it is not receiving enough blood or oxygen. The term "ischemic heart disease" refers to cardiac issues brought on by restricted coronary arteries, which feed blood to the heart muscle. It is also known as coronary heart disease (CHD) or coronary artery disease.

Stroke in Indian states		Ischemic Heart Disease	
Huge Strain			
West Bengal	2512	Haryana	5765
Odhisa	2248	Andhra Pradesh	4668
Tripura	2220	Karnataka	4144
Less Strain			
Delhi	513	Mizoram	643
Sikkim	465	Sikkim	1456
Mizoram	445	Nagaland	1113

Written Work Review

The World Health Organization (WHO) sees guidelines as instruments to assist individuals in making decisions, emphasizing the concept of selecting from a variety of interventions or measures. A WHO guideline is any document created by the World Health Organization that includes recommendations for clinical practice or public health policy. A recommendation informs the intended end- user of the guideline about what he or she can or should do in certain scenarios to attain the best potential health outcomes, either individually or collectively. It provides a variety of strategies or measures designed to improve health and discuss how they affect resource allocation. Recommendations assist the user of the guideline in making informed decisions about whether to conduct specific interventions or clinical testing, or whether to execute broader public health initiatives, as well as where and when to do so. Recommendations also assist the user select and prioritize among a range of potential interventions [5].

With a greater emphasis on clinical practice, the U.S. Institte of Medicine (IOM) defines guidelines as "statements that include recommendations intended to optimize patient care, in formed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options" [6].

Essentially using the same terminology as NICE, the Italian National Center for Clinical Excellence (CNEC), which is in charge of the National Guidelines System (SNLG), emphasizes the significance of evidence based medicine as the corner stone of recommendations in guidelines [1].

The researchers also discovered that elderly persons were disproportionately affected by unfavorable events. Many individuals above the age of 85 experienced major (3.4%) and avoidable adverse events (6.2%).

Three ideas that affect primary care safety are included in this model in a broad sense [7].

a) The part that caregiven for patient health play

b) The part that patient-provider relationship plays

c) The function of the health and society systems.

In 2015, the incidence of out-of-hospital cardiac arrests (OHCA) in the United States was estimated to be around 347,322 cases

In 2020, the total number of deaths from heart attack in people aged 30 to 60 years in India was 19,120. The number of people aged 18 to 30 years who died from heart attacks in India was 2,456 in 2020, and 2,305 in 2019. This means that heart attack deaths in this age group increased 2019 to 2020 as shown in the below table.

Death due to cardiac arrest in India -Year wise approximatiely				
Year	2020	2019	2018	2017
below 14-18	212	157	160	186
18-30	2456	2305	2000	2047
30-45	8000	7745	7212	6665
45-60	11120	11052	10138	9153
60 and above	6248	6612	5753	5013

Emergency Actions for a Heart Attack to be taken unless the person is allergic to aspirin, those in the icinity should offer an aspirin tabletideally 300 milligramsto anyone experiencin g a sudden heart attack. This is a result of aspirin's ability to t hin blood vessels and enhance cardiac blood flow.

Cardiology utilization of AI/ML

Cardiology is using AI/ML algorithms in a number of domains, such as:

- **Imaging in medicine:** Machine learning algorithms are being trained to improve patient scan accuracy and more precisely identify cardiovascular problems. For example, Analytics 4 Life is developing an algorithm to detect coronary artery disease non-invasively through pattern recognition.
- **Threat Prediction:** By predicting the likelihood of cardiovascular events, AI/ML models are used for threat prediction, which helps guide treatment decisions. Weng et al. examined the predictive capacity of a machine learning method that automatically distinguishes between hypertrophic cardiomyopathy and the physiological hypertrophy that athletes experience using speckle-tracking echocardiography data.

- **ECG monitoring:** Deep learning algorithms are automatically detecting atrial fibrillation (AFib), the most common abnormal heart rhythm. Cardio logs, a Paris-based company, claims that artificial intelligence (AI) may be used to evaluate ECG data from various digital devices quite correctly.

Challenges and Limitations

Despite the exciting promise of AI/ML in cardiology, there are significant barriers to its wider adoption:

- **Ensuring Data Security and Privacy:** Using patient data in AI/ML models raises privacy and security concerns that must be addressed by strong regulations and data governance structures.
- **To Ensure Patient Safety and Responsibility:** when incorporating AI/ML into clinical practice, clear regulatory standards and frameworks are necessary.
- **Lack of Transparency:** Many AI/ML models are "black boxes," making it difficult for medical practitioners to understand how the algorithms generate recommendations and forecasts. This challenge is being addressed through the development of techniques such as explainable AI (XAI).
- **Fairness vs. Bias:** AI/ML models have the ability to exagg erate and reinforce preexisting biases in healthcare data, pot entially leading to inequitable treatment outcomes.It is vital to work to ensure the justice and equity of AI/ML algorithm s.

AI/ML's Strong Points in Cardiology

Using AI/ML in cardiology has a various strong points, such as shown in the below figure:

- **Enhanced Diagnostic Accuracy:** By examining vast volumes of patient data and medical imaging, artificial intelligence (AI) algorithms are more precise and effective than human specialists at identifying anomalies.
- **Better Risk Prediction:** By identifying trends in patient data, artificial intelligence (AI) and machine learning (ML) models can predict the likelihood of cardiovascular disease and guide preventative measures.
- **Personalized Care:** AI-based decision support systems can assist physicians in making decisions about individualized care by taking into account the distinct characteristics and preferences of each patient.
- **Reduced Healthcare Costs:** Artificial intelligence (AI) and machine learning (ML) have the potential to improve patient outcomes, save money for healthcare systems, and speed up clinical processes by eliminating unnecessary tests and procedures.

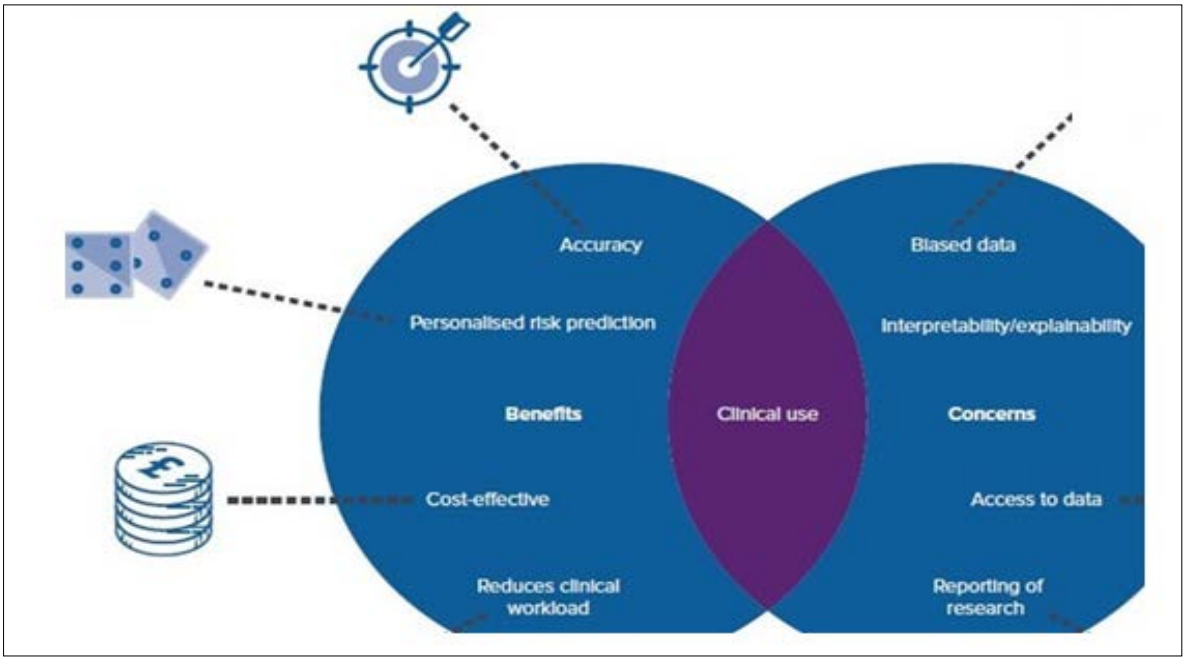

Figure 2: Strong Points of AI/ML Cardio Future Prospects

As AI/ML advances, the future of cardiology appears optimistic. Potential opportunities for expansion include:

- AI/ML algorithms can evaluate wearable technology data, such activity trackers and smartwatches, to monitor heart health and detect early signs of cardi ovascular disease.
- AI/ML can anticipate when ICDs and pacemakers need maintenance or replacement. This reduces the risk of device malfunction and improves patient saf ety.
- AI/ML systems can automatically evaluate medical images, such as cardiac MRI scans and echocardio grams, reducing physician burden and improving di agnosis speed and accuracy.

Conclusion

Cardiology is changing as a result of AI/ML, which opens u p new opportunities to improve patient safety and therapy. A I/ML can improve risk prediction, therapy customization, and diagnostic accuracy by leveraging large amounts of data and advanced algorithms. To ensure the safe and efficient use of AI/ML in clinical practice, hurdles like as bias, data privacy, and regulatory concerns must be addressed. Cardiology h as a promising future with the As AI/ML advances, the promise of improved patient outcomes and decreased healthcare e xpenses grows [8-22].

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