Will Usual Cardiac Biomarkers Change After the Introduction of AI in Medicine

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Introduction

Cardiac biomarkers are critical in diagnosing heart-related conditions, serving as biochemical indicators of cardiac function and damage.

Artificial Intelligence (AI) has the potential to revolutionize medical diagnostics by improving speed, accuracy, and predictive capabilities.

What are Cardiac Biomarkers?

Key examples include:

Cardiac biomarkers are substances released into the blood when the heart is stressed or damaged.

- Troponin: A marker for heart muscle injury.

- BNP/NT-proBNP: Indicators of heart failure.

- CK-MB: A marker for myocardial infarction.

They play a vital role in diagnosing and monitoring cardiovascular diseases.

Current Challenges with Cardiac Biomarkers

Despite their utility, cardiac biomarkers have limitations:

- Time delays in their appearance post-cardiac event.

- Variability due to patient factors such as age, sex, and comorbidities.

- Sensitivity and specificity concerns in early detection of diseases.

Role of AI in Medicine

- Artificial Intelligence offers transformative potential in healthcare:
- Rapid data analysis and integration from multiple sources.
- Improved accuracy in diagnostics through machine learning models.
- Enhanced patient monitoring and predictive analytics.

How AI Can Enhance Biomarker Use

AI can address current biomarker limitations by:

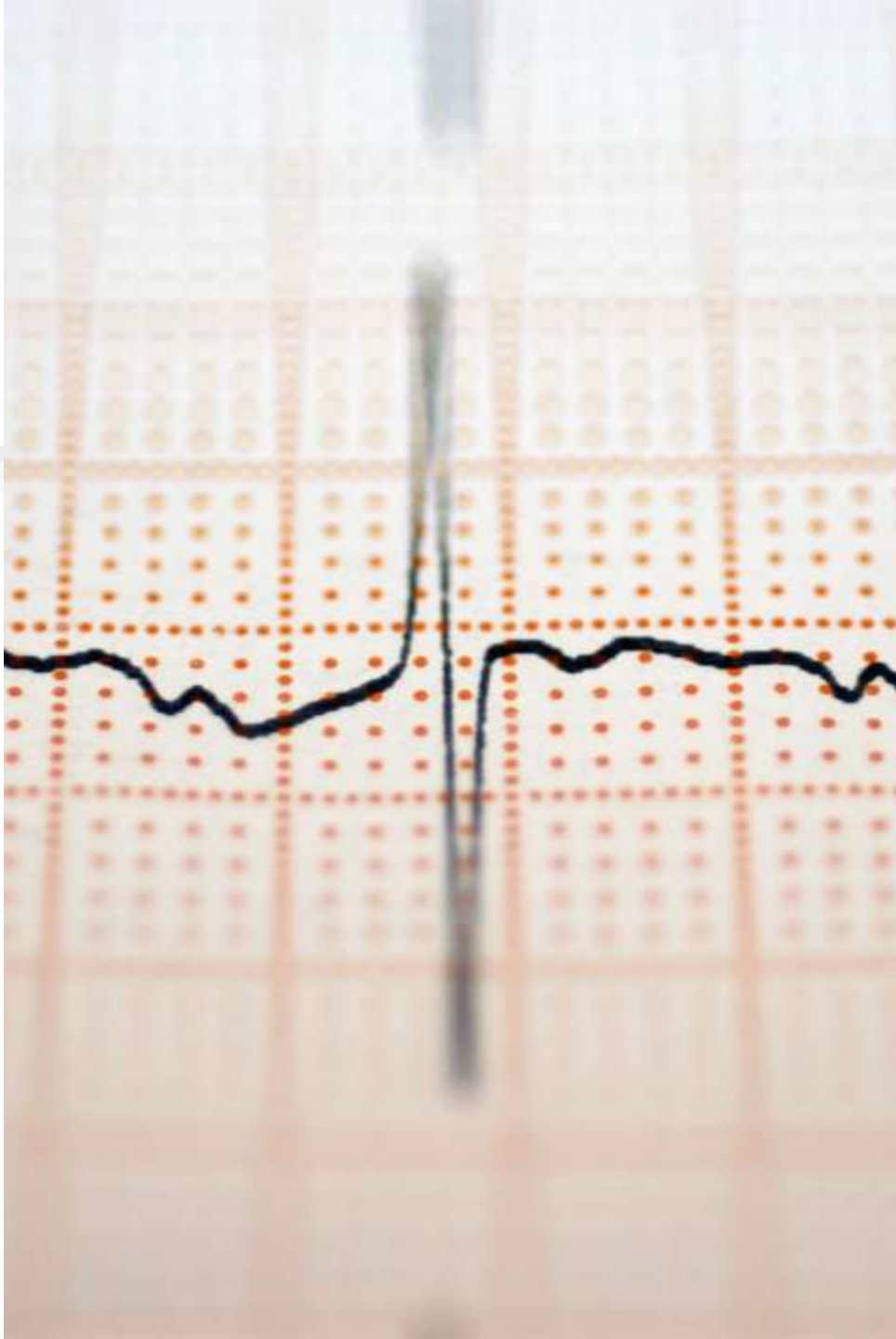
- Analyzing complex datasets to identify patterns missed by humans.

- Integrating biomarkers with imaging and clinical data for more robust diagnostics.

- Using predictive models to assess risk and disease progression.

AI in Cardiology: Current Applications

- AI applications in cardiology include:
- - Automated ECG and imaging analysis for arrhythmias and structural abnormalities.
- - Risk stratification models for conditions like heart failure.
- - Integration of biomarkers into AI-driven decision support tools.



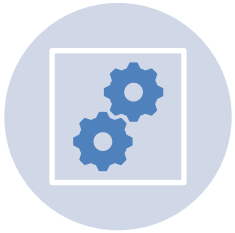
Trials

Çalışma	Cihaz ve AI algoritması	Sinyal analizi	AF algılaması
iREAD Çalışması William *ve ark.*	Akıllı telefon ve el tipi kardiyak ritim kaydedici kullanarak doktor tarafından yorumlanan EKG ile karşılaştırması	EKG	AF algılaması için %96,6 duyarlılık ve %94,1 özgüllük
HUAWEI Kalp Çalışması Guo ve ark.	Bileklik/kol saati tabanlı düzensiz ritm bildirim algoritması	PPG	PPG sinyallerinin pozitif tahmin değeri %91,6 (%95 CI %91,5–91,8)
Chen ve ark.	AF'yi tanımlayan AI algoritması ile etkinleştirilen akıllı bileklik cihazı ve doktorlar tarafından incelenen bileklik EKG'si	PPG ve EKG	Duyarlılık, özgüllük ve doğruluk PPG için sırasıyla %88.00, %96.41 ve %93.27 ve EKG için %87.33, %99.20 ve %94.76 idi.
Wasserlauf ve *ark.*	KardiaBand özellikli Apple Watch ile takılabilir kalp monitörü karşılaştırması	EKG	Bölüm duyarlılığı ve süre duyarlılığı için sırasıyla %97.5 ve %97.7
WATCH AF çalışması Dörr ve *ark*.	Elektrokardiyografi ile akıllı saat tabanlı algoritma	PPG	Duyarlılık %93,7 (%95 CI %89,8-96,4), özgüllük %98,2 (%95 GA %95,8-99,4) ve %96,1 doğruluk (%95 CI %94,0-97,5)
Apple Kalp Çalışması Perez ve ark.	Akıllı saat tabanlı düzensiz nabız bildirim algoritması ile EKG ile izleme karşılaştırması	İlk PPG, ardından eşzamanlı PPG ve EKG	Akıllı saat tabanlı algoritma, eşzamanlı izleme döneminde AF' yi gözlemlemek için 0,84 (%95 GA 0,76–0,92) pozitif bir tahmin değerine sahip

Potential Impact of AI on Traditional Biomarkers

AI could redefine the role of traditional biomarkers:

- Identify novel biomarkers with greater diagnostic value.



- Optimize the use of existing biomarkers by refining diagnostic thresholds.

- Combine multiple biomarkers into comprehensive diagnostic panels.

Emerging Biomarkers Identified via AI

AI has facilitated the discovery of biomarkers such as:

- MicroRNAs and exosomal markers linked to cardiac stress.

- Advanced imaging-derived biomarkers.

These biomarkers promise greater accuracy and predictive power.

Personalized Medicine and Biomarkers

- AI supports personalized medicine by:
- - Customizing biomarker thresholds based on patient-specific factors.
- - Integrating genetic and lifestyle data for a holistic view.
- This ensures more targeted and effective treatments.

Predictive Modeling and Biomarkers

- AI-powered predictive models:
- - Combine biomarkers with patient history to assess future risk.
- - Offer early warnings for potential cardiac events.
- - Enable proactive interventions and better resource allocation.

Challenges and Limitations of AI Integration

Challenges in implementing AI in biomarker analysis include:

- Data quality issues: Missing or inconsistent data.

- Ethical concerns: Bias in AI models, data privacy.

- Regulatory hurdles: Ensuring safety and efficacy of AI applications.

Case Studies

Real-world examples of AI in cardiology:

- AI tools improving diagnosis of myocardial infarction using troponin data.

- Enhanced heart failure management through AI-driven biomarker analysis.

These demonstrate AI's transformative potential and its current limitations.

AI vs. Traditional Biomarker Analysis

A comparison of traditional vs. AI-enhanced approaches:

- Traditional analysis relies on fixed thresholds and limited context.

- AI enables dynamic and context-aware interpretation.

This leads to improved diagnostic accuracy and better patient outcomes.

Future of Cardiac Biomarkers in AI Era

Predictions for the future include:

- A shift toward multi-biomarker panels integrated with AI.

- Increased emphasis on real-time monitoring and diagnostics.

- Discovery of new biomarkers with unprecedented specificity.

Implications for Clinical Practice

AI will reshape clinical workflows:

- Faster, more accurate diagnosis using AI-assisted tools.

- Clinicians focusing on interpretation and patient care.

- New training requirements for healthcare professionals.

Patient-Centric Outcomes

Patient benefits from AI include:

- Quicker and more accurate diagnoses.

- More personalized treatment plans.

- Improved long-term outcomes through proactive care.

Ethical and Regulatory Considerations

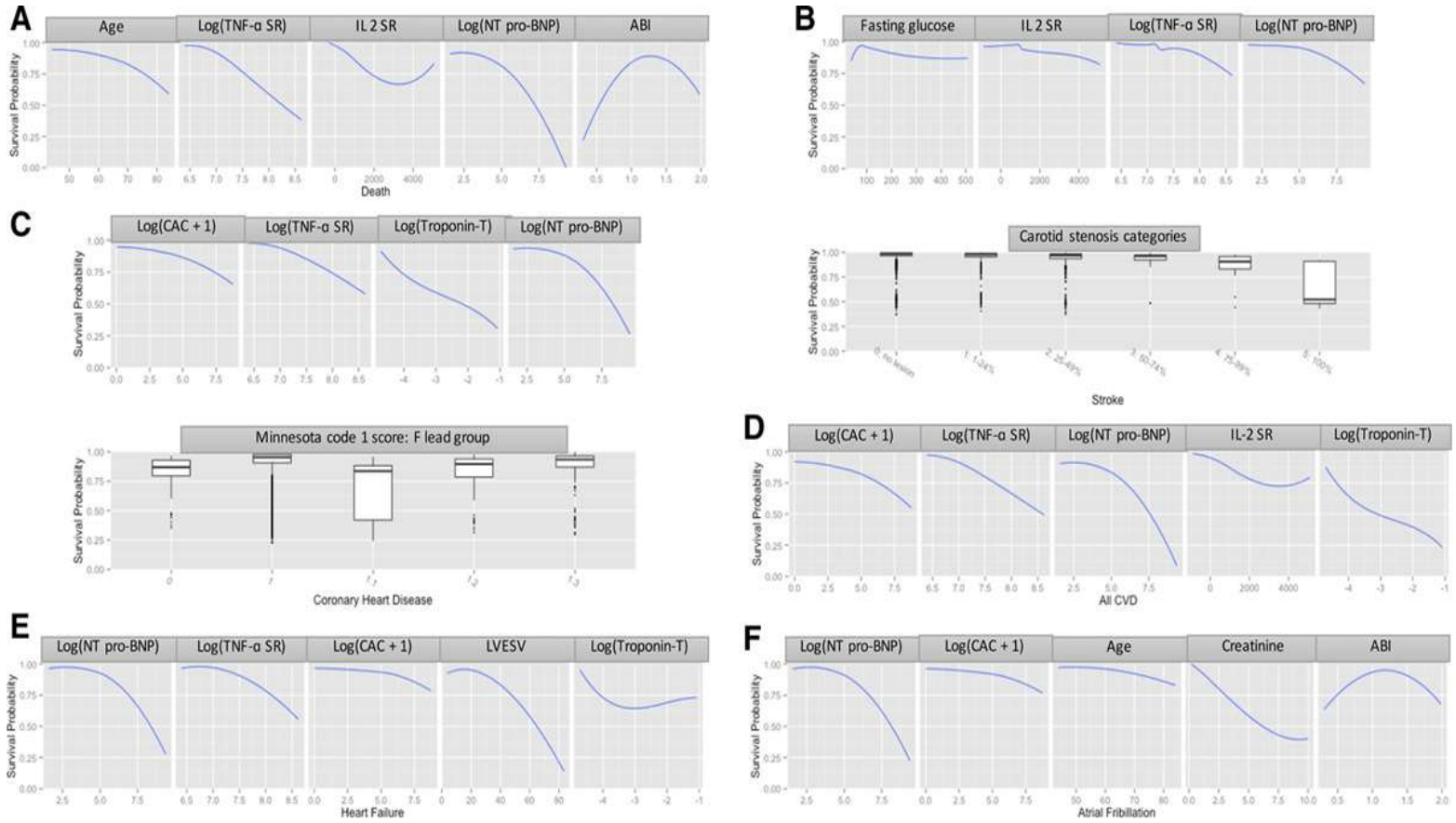
Key concerns in AI implementation:

- Ensuring equitable access to AI tools across diverse populations.

- Maintaining transparency in AI-driven decisions.

- Addressing regulatory standards for clinical safety and efficacy.

Trials



Bharath Ambale-Venkatesh. Circulation Research. Cardiovascular Event Prediction by Machine Learning, Volume: 121, Issue: 9, Pages: 1092-1101, DOI: (10.1161/CIRCRESAHA.117.311312)

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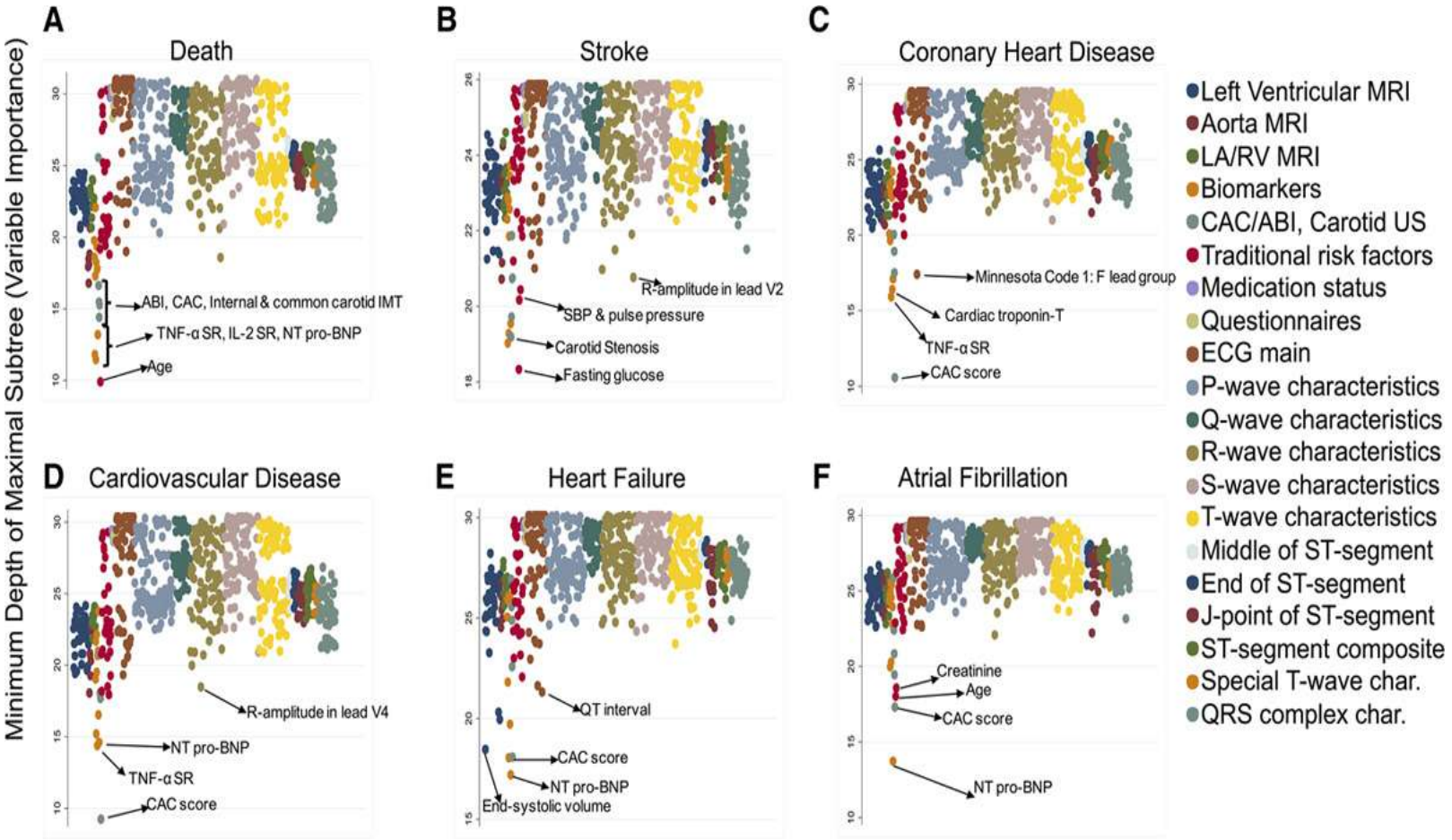

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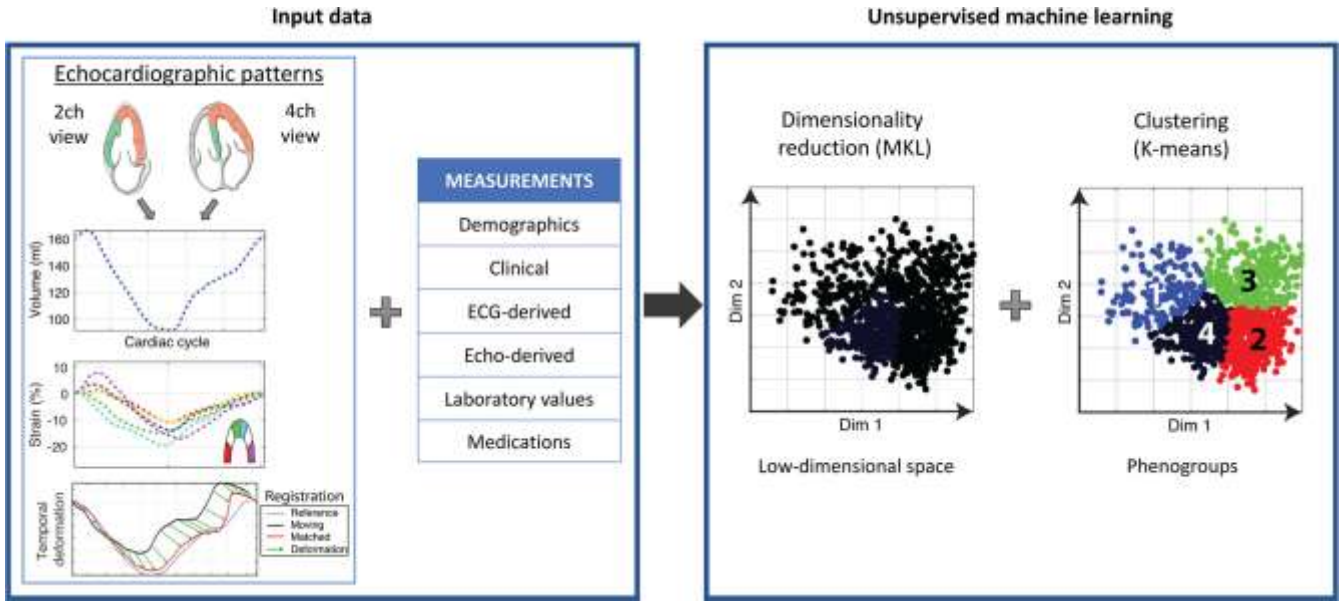
Machine learning-based phenogrouping in heart failure to identify responders to cardiac resynchronization therapy



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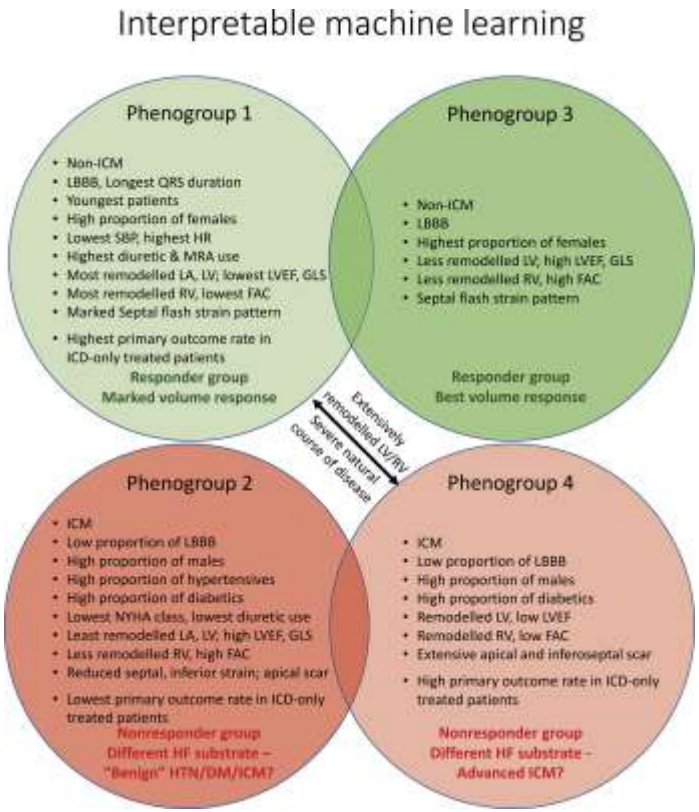

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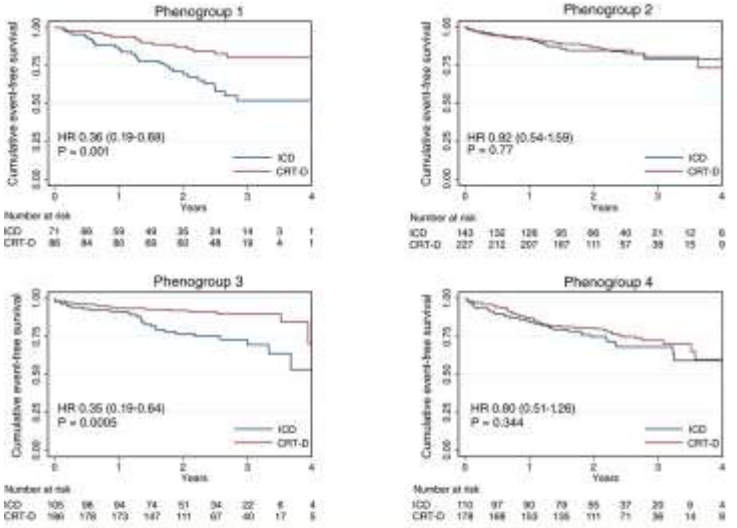
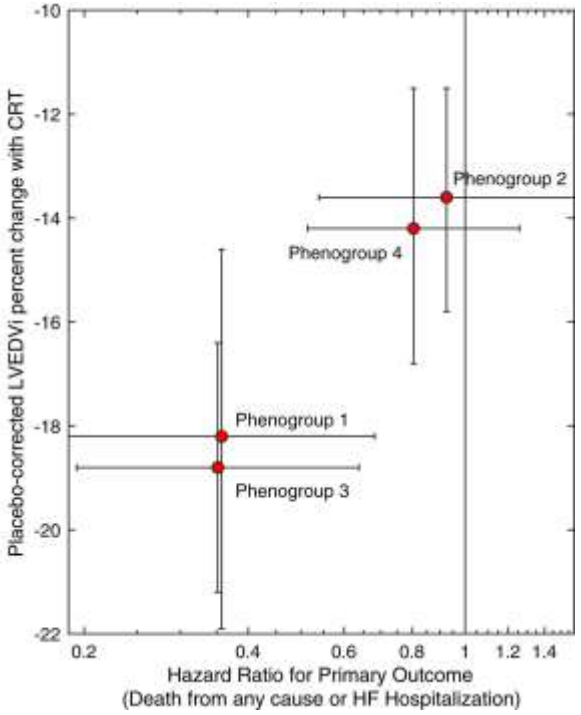


	Phenogroup 1 (N=157)	Phenogroup 2 (N=370)	Phenogroup 3 (N=291)	Phenogroup 4 (N=288)
Primary Outcome				
Participants with event, n (%)	41 (26.11%)	55 (14.86%)	45 (15.46%)	79 (27.43%)
Event rate per 100 person -years	11.9 (8.8 - 16.2)	7.4 (5.7 - 9.6)	7.2 (5.4 - 9.6)	12.8 (10.3 -16.0)



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Conclusion

AI is set to transform the role of cardiac biomarkers:

- Traditional biomarkers will remain important but may evolve.

- AI will enhance their utility and lead to the discovery of novel markers.

The integration of AI into cardiology promises improved diagnostics and outcomes.


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