AZERBAIJAN CARDIOLOGY FESTIVAL

13-14-15 DECEMBER, 2024
THE RITZ-CARLTON HOTEL, BAKU

What is New in Acute Myocardial Infarction Management in Era of Artificial Intelligence ?

Prof. Dr. Gani Bajraktari, PhD, FESC, FACC

Medical Faculty, University of Prishtina, Prishtina, Kosovo
Clinic of Cardiology, University Clinical Centre of Kosova, Prishtina, Kosovo
Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden

Kosovo Society of Cardiology

ALBANIAN ACADEMY OF SCIENCES

Declaration of interest:

No Conflict of Interest!

Prof. Dr. Gani Bajraktari, PhD, FESC, FACC

Medical Faculty, University of Prishtina, Prishtina, Kosovo
Clinic of Cardiology, University Clinical Centre of Kosova, Prishtina, Kosovo
Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden

Kosovo Society of Cardiology

ALBANIAN ACADEMY OF SCIENCES

Introduction

- Intelligence is a feature of humans (*Homo sapiens sapiens*), which distinguishes us in part from other species.
- In evolution, human intelligence, together with the socialization in groups, markedly enhanced by the development of gesturing and speech, allowed us to survive despite an overall weak physical constitution.
- Indeed, intelligent thinking allowed mankind to use and create tools and weapons, develop agriculture, and eventually, modern technology and medicine.
- For centuries, there was consensus that human-level intelligence can only arise from biological human brains yet rapid technological advances in the recent years have led to exponential growth in the number of intellectual tasks that now can be solved by computer-based artificial intelligence (AI), putting this long-held believe into question.

Introduction

ESC European Society of Cardiology

European Heart Journal (2024) **45**, 4291–4304
https://doi.org/10.1093/eurheartj/ehae465

STATE OF THE ART REVIEW
Digital health and innovation

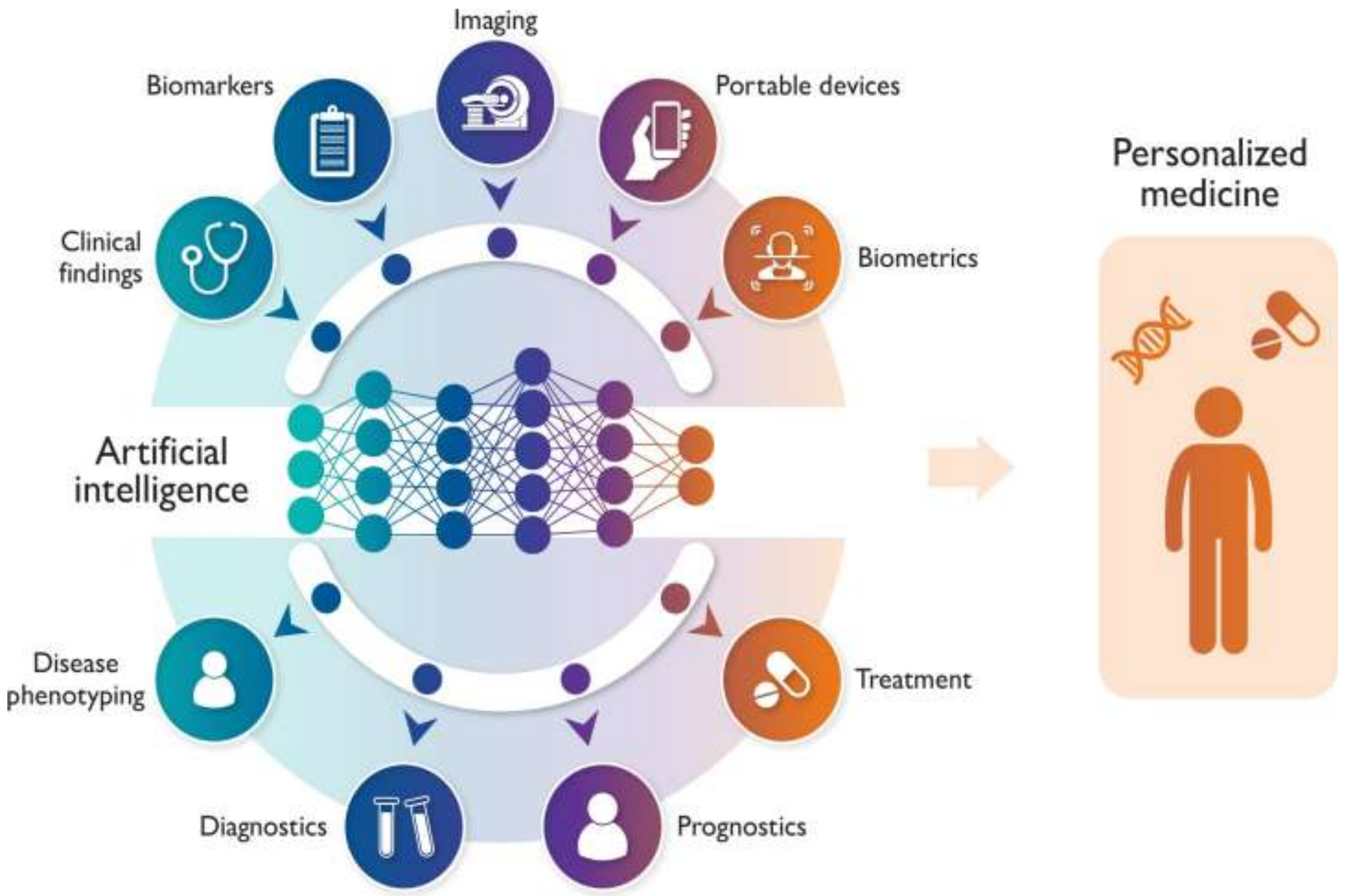
Artificial intelligence in cardiovascular medicine: clinical applications

Thomas F. Lüscher [1,2,3,4]*, Florian A. Wenzl [4,5,6,7], Fabrizio D'Ascenzo [8], Paul A. Friedman [9], and Charalambos Antoniades [10]

[1]Royal Brompton and Harefield Hospitals, London, UK; [2]National Heart and Lung Institute, Imperial College London, UK; [3]Cardiovascular Academic Group, King's College, London, UK; [4]Center for Molecular Cardiology, University of Zurich, Wagistrasse 12, 8952 Schlieren – Zurich, Switzerland; [5]National Disease Registration and Analysis Service, NHS, London, UK; [6]Department of Cardiovascular Sciences, University of Leicester, Leicester, UK; [7]Department of Clinical Sciences, Karolinska Institutet, Stockholm, Sweden; [8]Division of Cardiology, Cardiovascular and Thoracic Department, Città della Salute e della Scienza Hospital, Turin, Italy; [9]Department of Cardiovascular Medicine, Mayo Clinic and Mayo Foundation, Rochester, MN, USA; and [10]Acute Multidisciplinary Imaging and Interventional Centre, RDM Division of Cardiovascular Medicine, University of Oxford, Headley Way, Headington, Oxford OX39DU, UK

Received 18 March 2024; revised 7 June 2024; accepted 3 July 2024; online publish-ahead-of-print 19 August 2024

Graphical Abstract Clinical information including patient data, laboratory parameters, and results from clinical examination, ...



Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

Introduction

Table 1 **Glossary of keywords**

Keywords	Abbreviation	Brief explanation
Artificial intelligence	AI	AI is the technology that enables machines, in particular computer systems, to mimic human cognitive function. It integrates tasks like learning, reasoning, problem solving, perception, and understanding language, allowing computers to derive insights from data, make informed decisions, and solve complex problems.
Convolutional neural network	CNN	CNN represents a specialized architecture tailored for analysing visual imagery, within the broader category of DNN. They utilize convolutional layers that apply filtering operations to efficiently capture spatial patterns in the data. This makes CNN exceptionally skilled at tasks like image and video recognition, improving their ability to interpret intricate visual inputs.
Deep learning	DL	DL, a specialized area within ML, utilizes multi-layered neural networks to learn from vast datasets with little need for manual feature engineering. This approach is highly effective for complex tasks, including image and speech recognition, as it allows the networks to autonomously discern and analyse various data elements.
Deep neural network	DNN	DNN is a sophisticated DL structure in computational models, primarily designed to analyse and process complex data patterns similar to the human brain. This type of network utilizes multiple layers ('deep') of processing units to learn from vast amounts of data, enhancing its ability to make accurate predictions and decisions.
Large language model	LLM	LLM are advanced DL models, such as the Generative Pre-trained Transformer (GPT), trained on extensive text data. These models excel at generating human-like text and understanding natural language, allowing them to process and produce language effectively.
Machine learning	ML	ML, a branch of AI, focuses on creating algorithms and models that train computers to analyse data and make predictions. These algorithms are not explicitly programmed for each task; instead, they enhance their performance as they process more and more data, thereby enabling autonomous learning and decision-making.
Natural language processing	NLP	NLP is a field within AI aimed at enabling machines to understand, interpret, and respond to human languages in a way that is both meaningful and useful. This technology is crucial for developing applications such as language translation, sentiment analysis, and voice-activated systems. LLM is a type of DL algorithm designed to handle multiple NLP tasks.

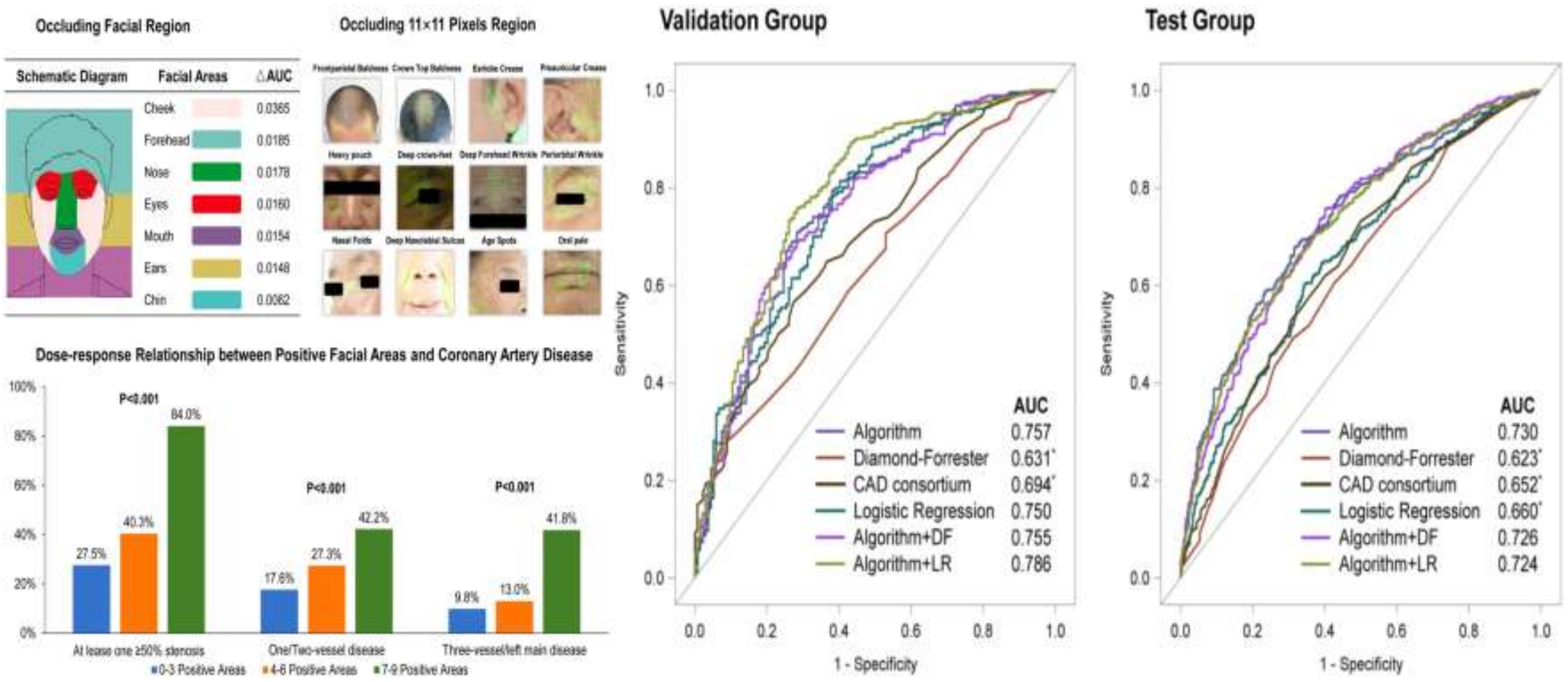
Introduction

Table 2 Data sources and analytical aspects

Data source	Common analytical approaches	Potential	Challenges
Imaging data	• Deep learning • Convolutional neural networks • Image enhancement algorithms	• High accuracy in image analysis • Rapid processing of visual data • Efficient pattern detection • Advanced feature extraction capabilities	• Requires extensive computational resources • Privacy issues with personal data
Voice recordings	• Deep learning	• Patient convenience • Continuous health monitoring • Early detection of cardiac disease • Real-time alerting systems	• Background noise
ECG readings	• Deep neural network • Support vector machines	• Patient convenience • Continuous health monitoring • Early detection of cardiac disease • Real-time alerting systems	• Prone to interference and noise
Text data	• Natural language processing	• Insight extraction from unstructured data • Health care efficiency	• Ambiguity and context dependence • Language and cultural variations
Tabular data (e.g. clinical characteristics)	• Tree-based learning algorithms • Neural networks	• Efficient handling of complex non-linear interactions • Efficient handling of high-dimensional data • Broad applicability	• Overfitting to training dataset

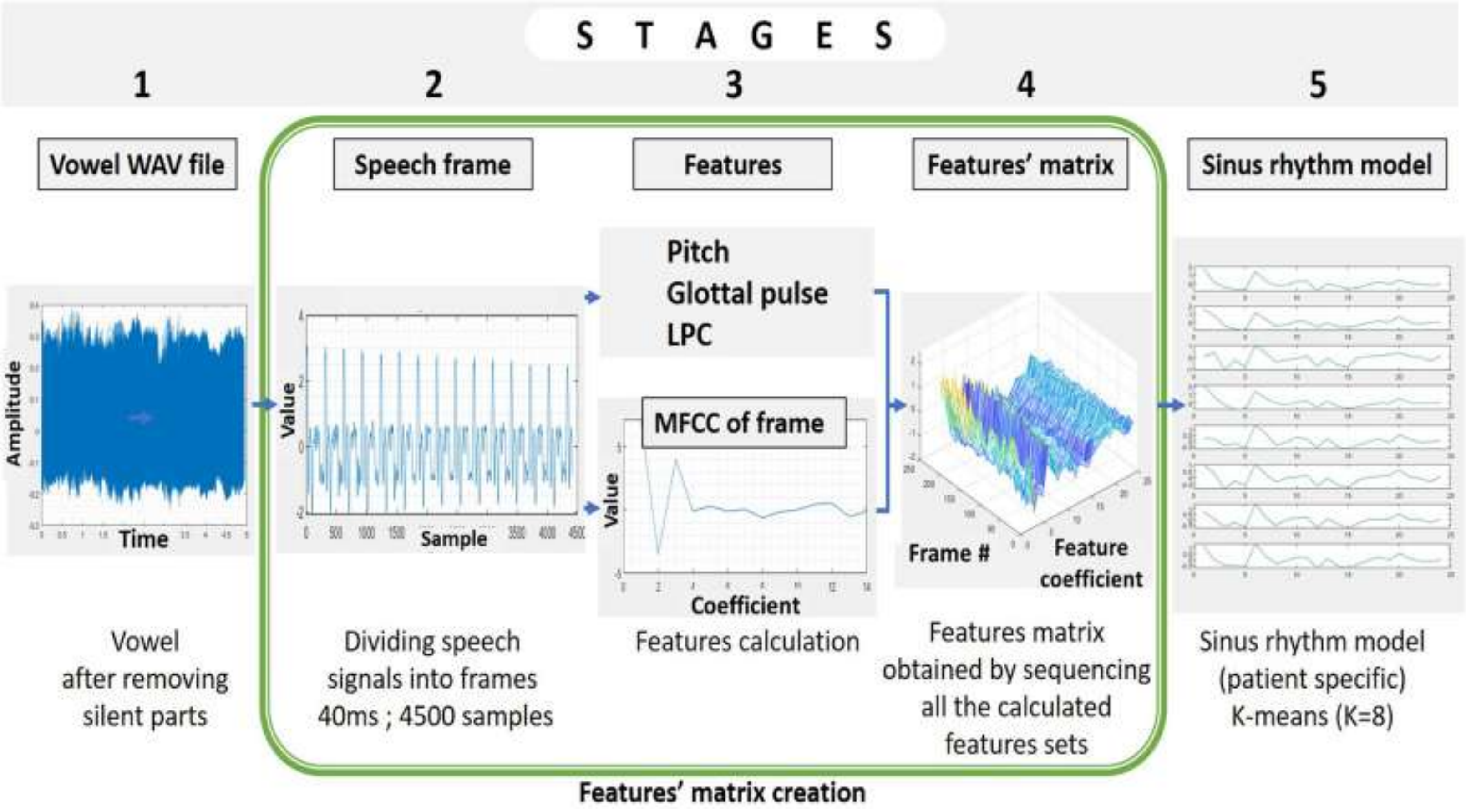
FACE RECOGNITION

Figure 1 Predicting outcomes based on a single facial photograph is feasible with clinically helpful accuracy. CAD, ...



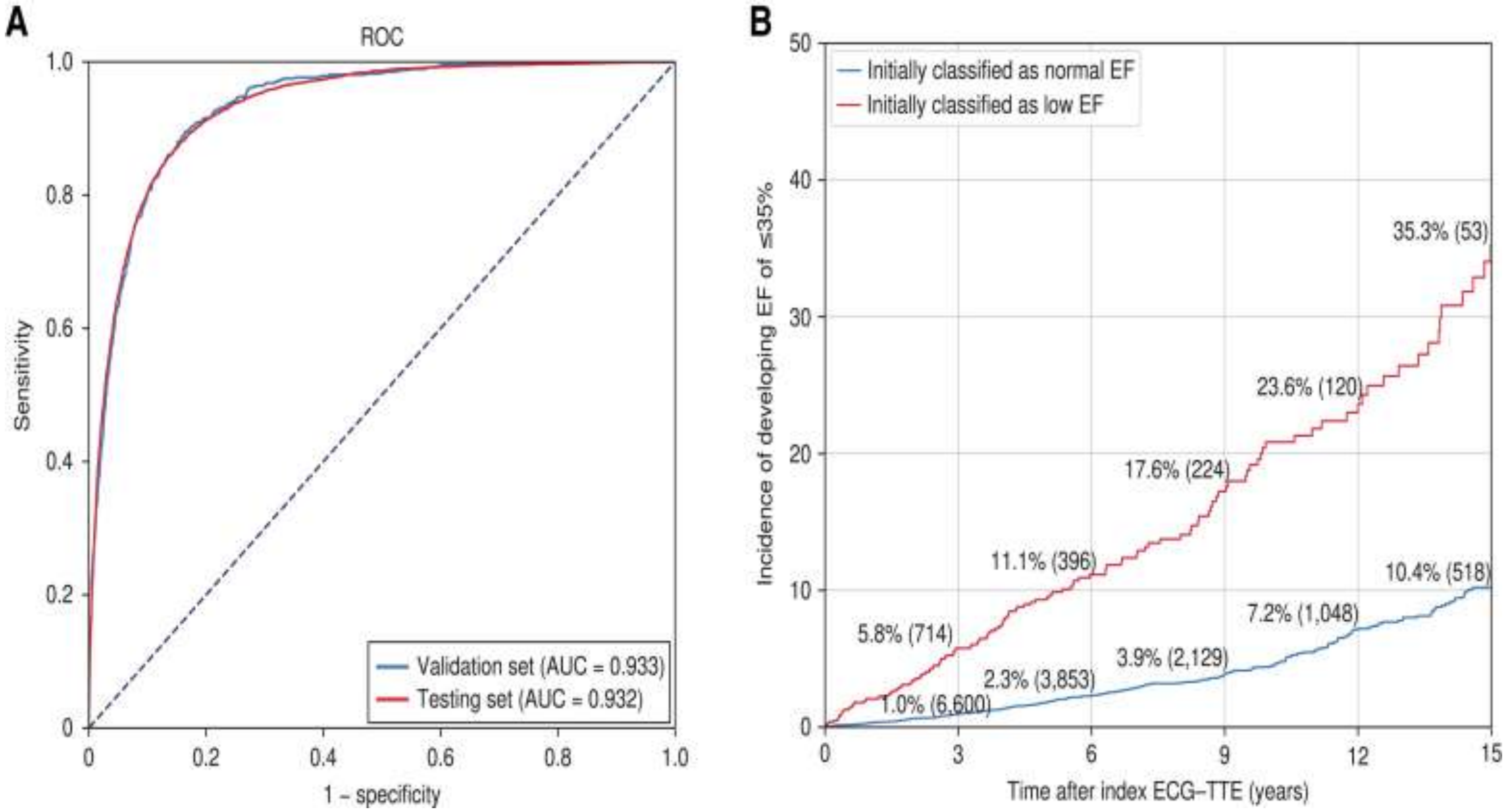
Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

Figure 2 Creation of the AI-enhanced 'sinus rhythm model' for voice-based recognition of atrial fibrillation. The ...



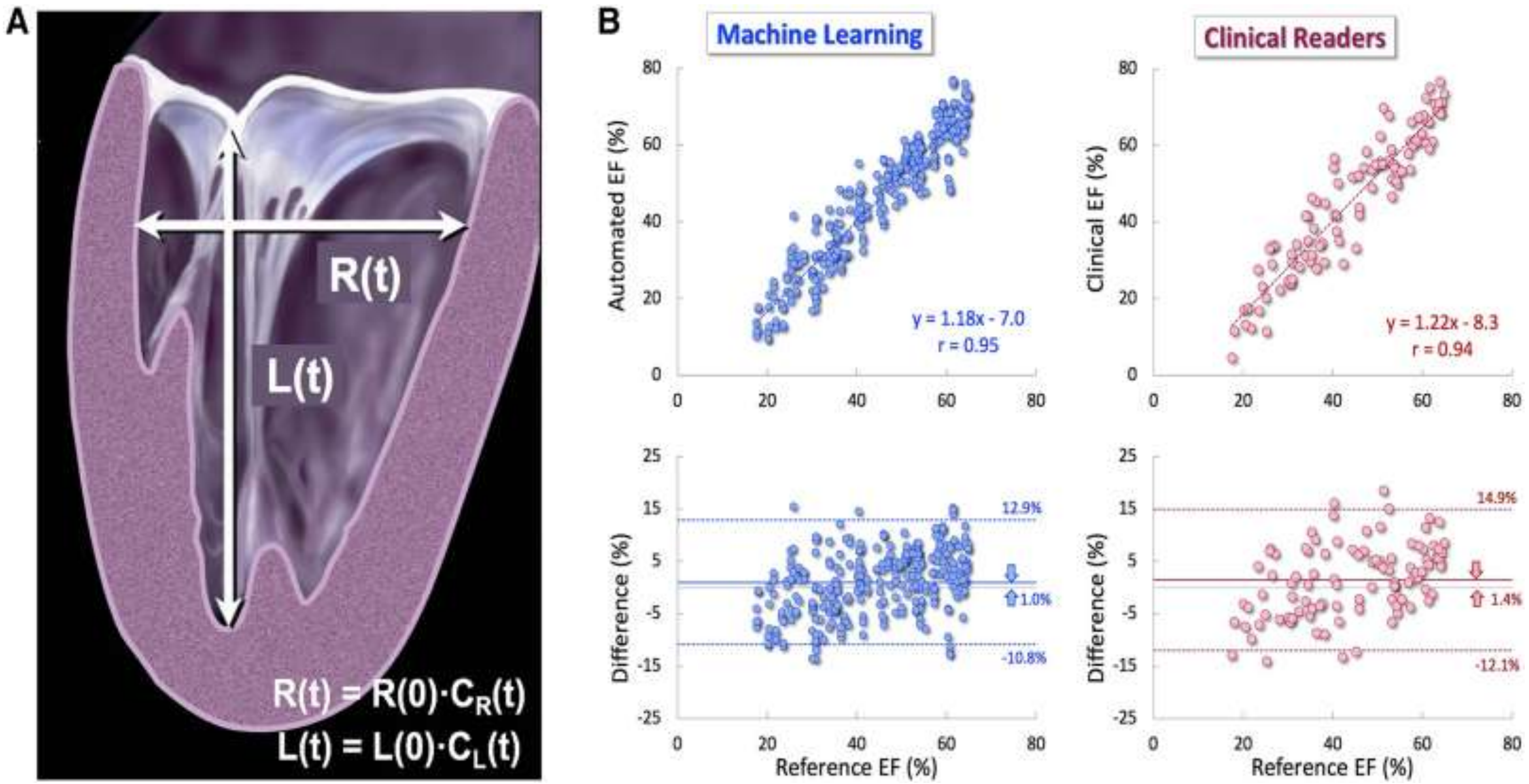
Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

Figure 3 AI/ML-enabled diagnosis of LV dysfunction based on ECG readings. (A) Area under the curve (AUC) of detection ...



Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

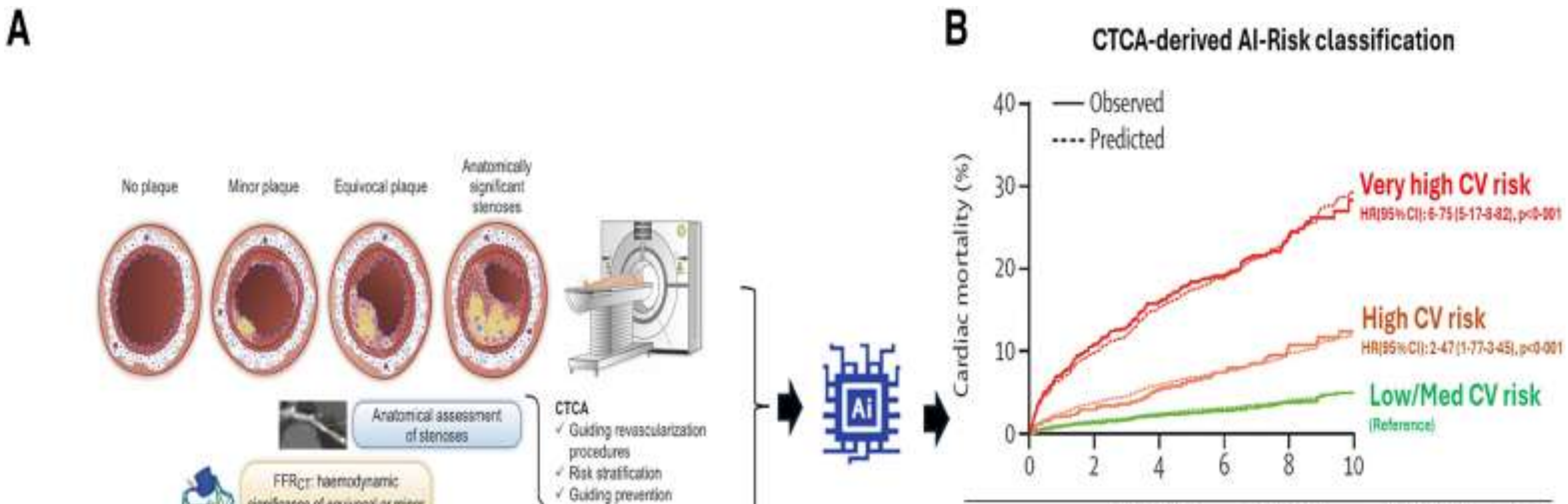
Figure 4 AI-enhanced calculation of LVEF from echocardiographic images. Schematic representation of the left ventricle ...



Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

ESC
European Society
of Cardiology

Figure 5 AI-based CTCA analysis. CTCA is increasingly becoming a ‘one-stop shop’ for evaluating patients with stable ...

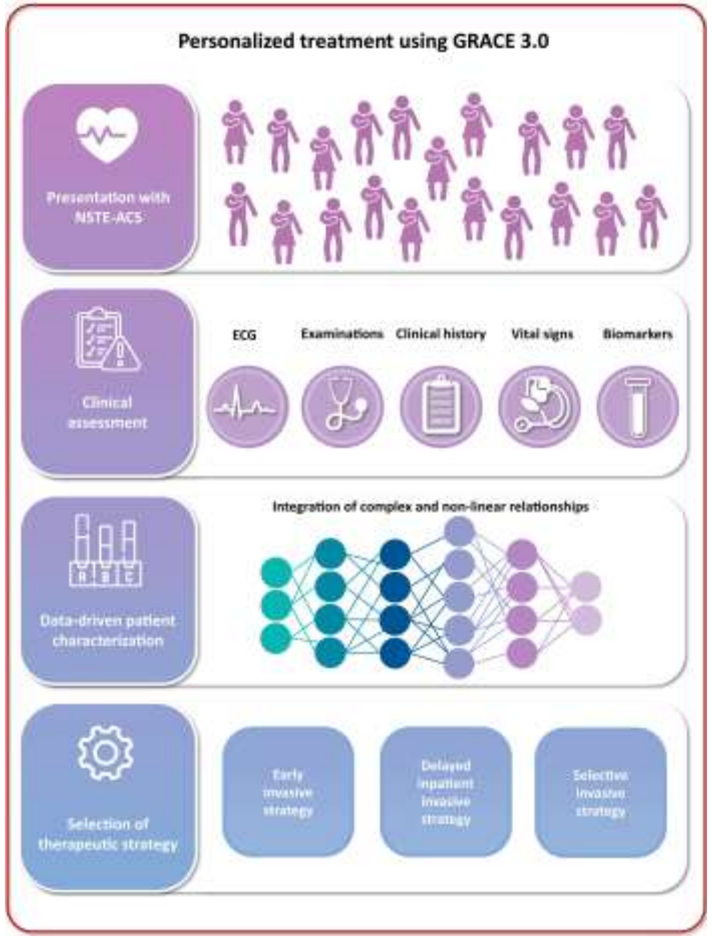


	FAI-Score LAD (AUC)	FAI-Score LCx (AUC)	FAI-Score RCA (AUC)	AI-Risk (AUC)
Cardiac Mortality				
All	0.838	0.854	0.806	0·844
No obstructive CAD	0.809	0.818	0.769	0·798
Obstructive CAD	0.793	0.801	0.763	0·778
MACE				
All	0.779	0.795	0.756	0·797
No obstructive CAD	0.740	0.756	0.727	0·745
Obstructive CAD	0.745	0.741	0.703	0·761

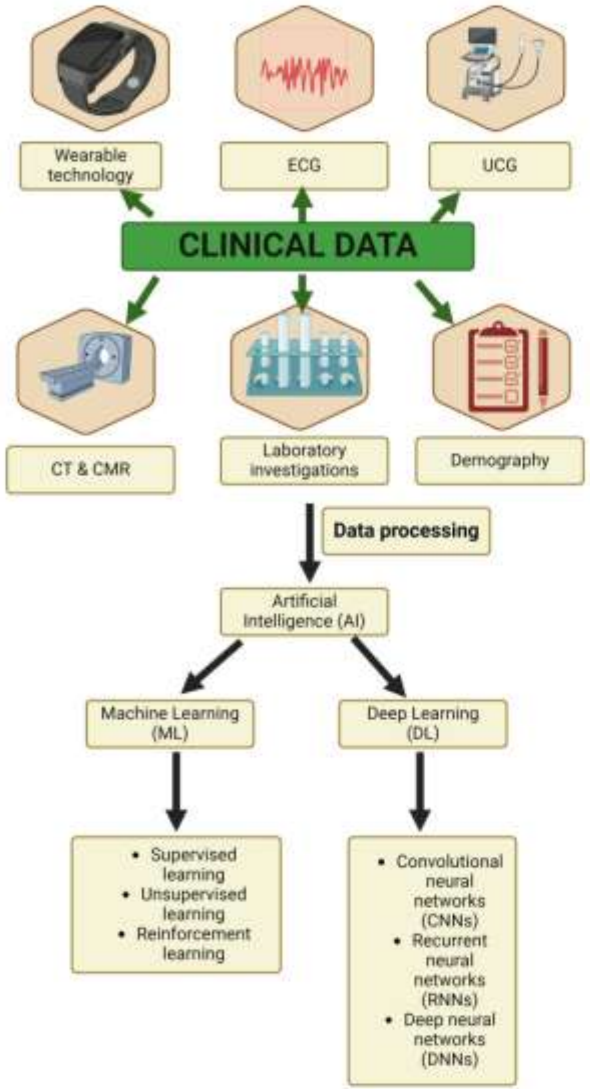
Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465

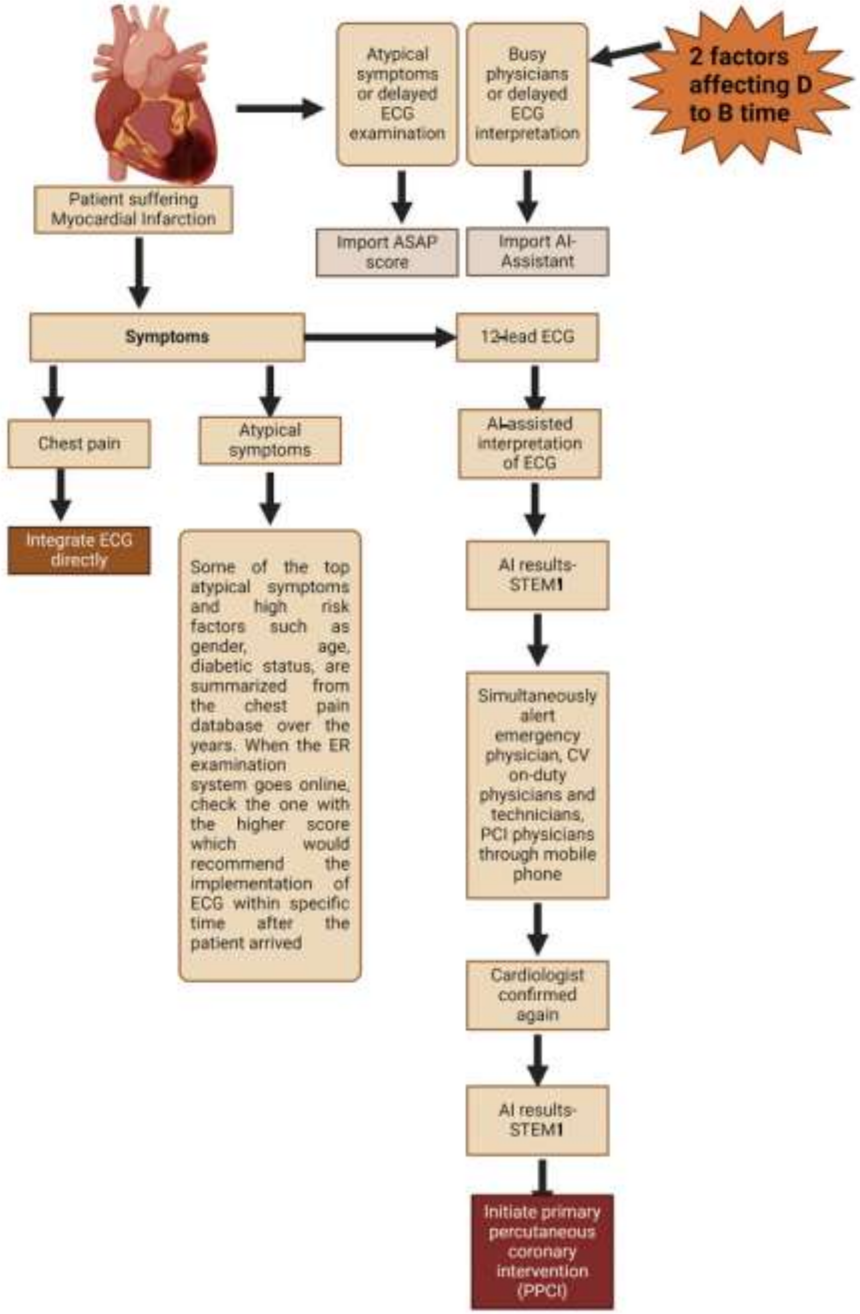
OXFORD
UNIVERSITY PRESS

Figure 6 Machine learning-based risk assessment for personalized care of patients with non-ST-elevation acute coronary ...

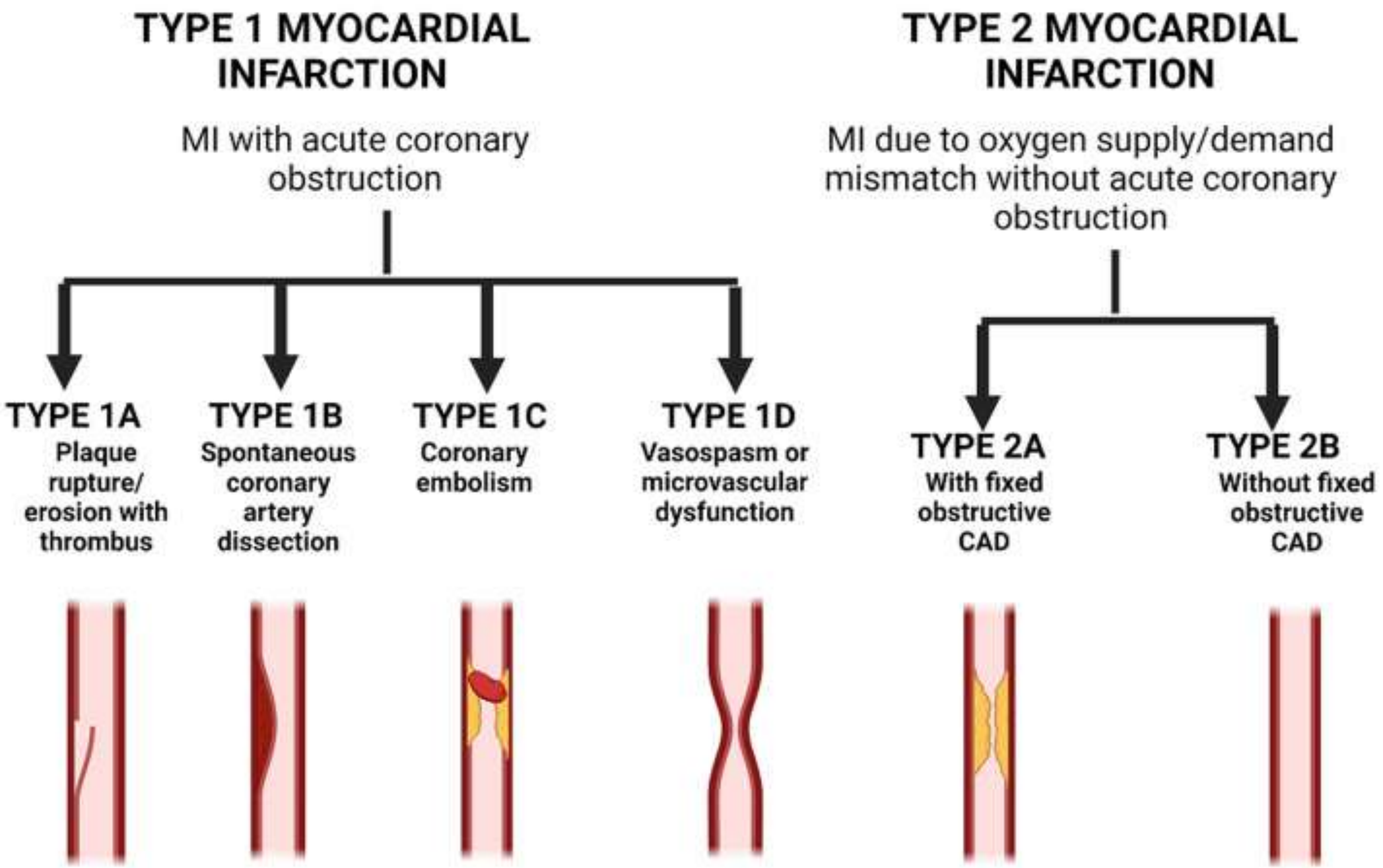


Eur Heart J, Volume 45, Issue 40, 21 October 2024, Pages 4291–4304, https://doi.org/10.1093/eurheartj/ehae465


Wearable technology
ECG
UCG
CLINICAL DATA
CT & CMR
Laboratory investigations
Demography
Data processing
Artificial Intelligence (AI)
Machine Learning (ML)
Deep Learning (DL)
• Supervised learning
• Unsupervised learning
• Reinforcement learning
• Convolutional neural networks (CNNs)
• Recurrent neural networks (RNNs)
• Deep neural networks (DNNs)



Patient suffering Myocardial Infarction
Atypical symptoms or delayed ECG examination
Busy physicians or delayed ECG interpretation
2 factors affecting D to B time
Import ASAP score
Import AI-Assistant
Symptoms
12-lead ECG
Chest pain
Atypical symptoms
AI-assisted interpretation of ECG
Integrate ECG directly
Some of the top atypical symptoms and high risk factors such as gender, age, diabetic status, are summarized from the chest pain database over the years. When the ER examination system goes online, check the one with the higher score which would recommend the implementation of ECG within specific time after the patient arrived
AI results-STEMI
Simultaneously alert emergency physician, CV on-duty physicians and technicians, PCI physicians through mobile phone
Cardiologist confirmed again
AI results-STEMI
Initiate primary percutaneous coronary intervention (PPCI)


TYPE 1 MYOCARDIAL INFARCTION
MI with acute coronary obstruction
TYPE 2 MYOCARDIAL INFARCTION
MI due to oxygen supply/demand mismatch without acute coronary obstruction
TYPE 1A
Plaque rupture/ erosion with thrombus
TYPE 1B
Spontaneous coronary artery dissection
TYPE 1C
Coronary embolism
TYPE 1D
Vasospasm or microvascular dysfunction
TYPE 2A
With fixed obstructive CAD
TYPE 2B
Without fixed obstructive CAD

nature medicine

Article

https://doi.org/10.1038/s41591-023-02325-4

Machine learning for diagnosis of myocardial infarction using cardiac troponin concentrations

Received: 4 October 2022

Accepted: 28 March 2023

Published online: 11 May 2023

Check for updates

Dimitrios Doudesis[1,2,32], Kuan Ken Lee[1,32], Jasper Boeddinghaus[1,3,32], Anda Bularga[1], Amy V. Ferry[1], Chris Tuck[1], Matthew T. H. Lowry[1], Pedro Lopez-Ayala[3], Thomas Nestelberger[3], Luca Koechlin[3,4], Miguel O. Bernabeu[2,5], Lis Neubeck[6], Atul Anand[1], Karen Schulz[7], Fred S. Apple[8], William Parsonage[9], Jaimi H. Greenslade[10,11,12], Louise Cullen[10,11,12], John W. Pickering[13,14], Martin P. Than[13], Alasdair Gray[15], Christian Mueller[3], Nicholas L. Mills[1,2] & CoDE-ACS Investigators*

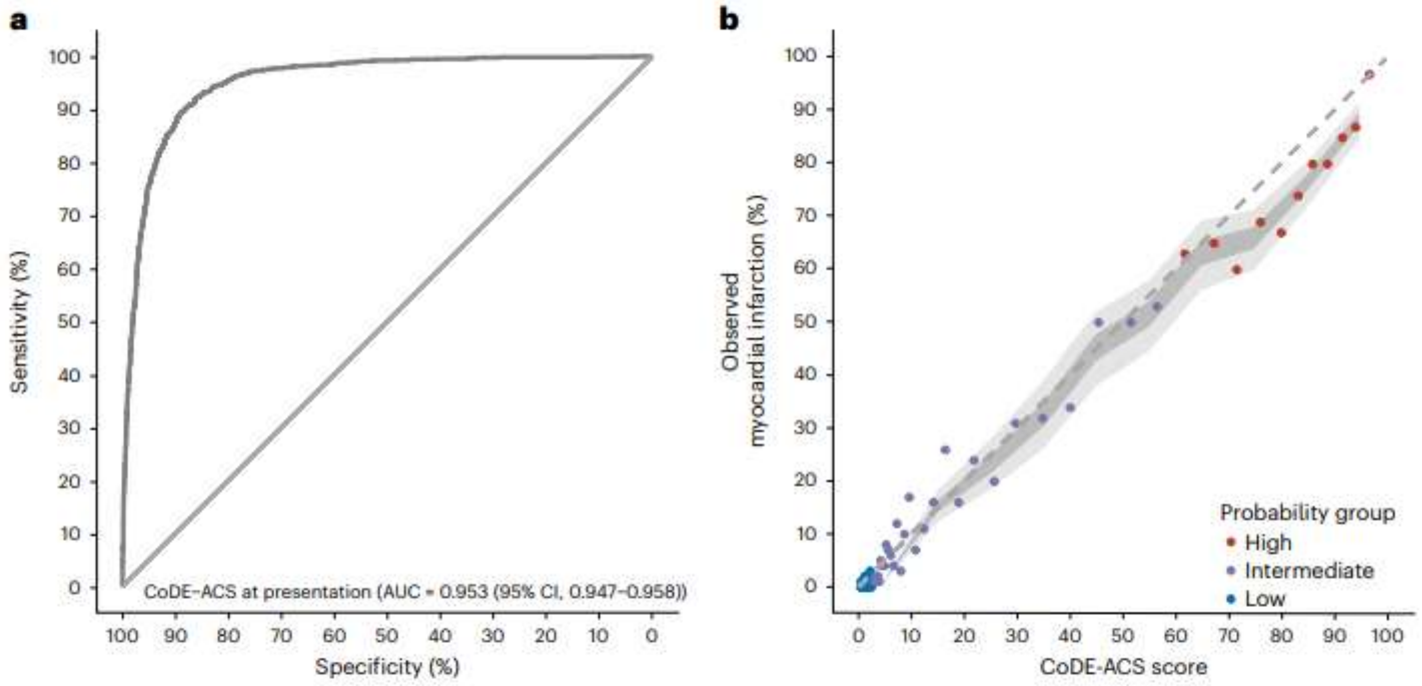


Fig. 2 | Diagnostic performance of the CoDE-ACS score in the external validation cohort using the presentation troponin concentration alone. **a**, Receiver-operating characteristic curve illustrating the discrimination of the CoDE-ACS for myocardial infarction. **b**, Calibration of the CoDE-ACS score with the observed proportion of patients with myocardial infarction. The dashed line represents perfect calibration. Each point represents 100 patients. Patients are grouped as low (<3), intermediate (3–60) or high probability (≥61) of myocardial infarction. The darker shaded area represents the 95% CI, while the lighter shaded area represents the 99% CI. AUC, area under curve.

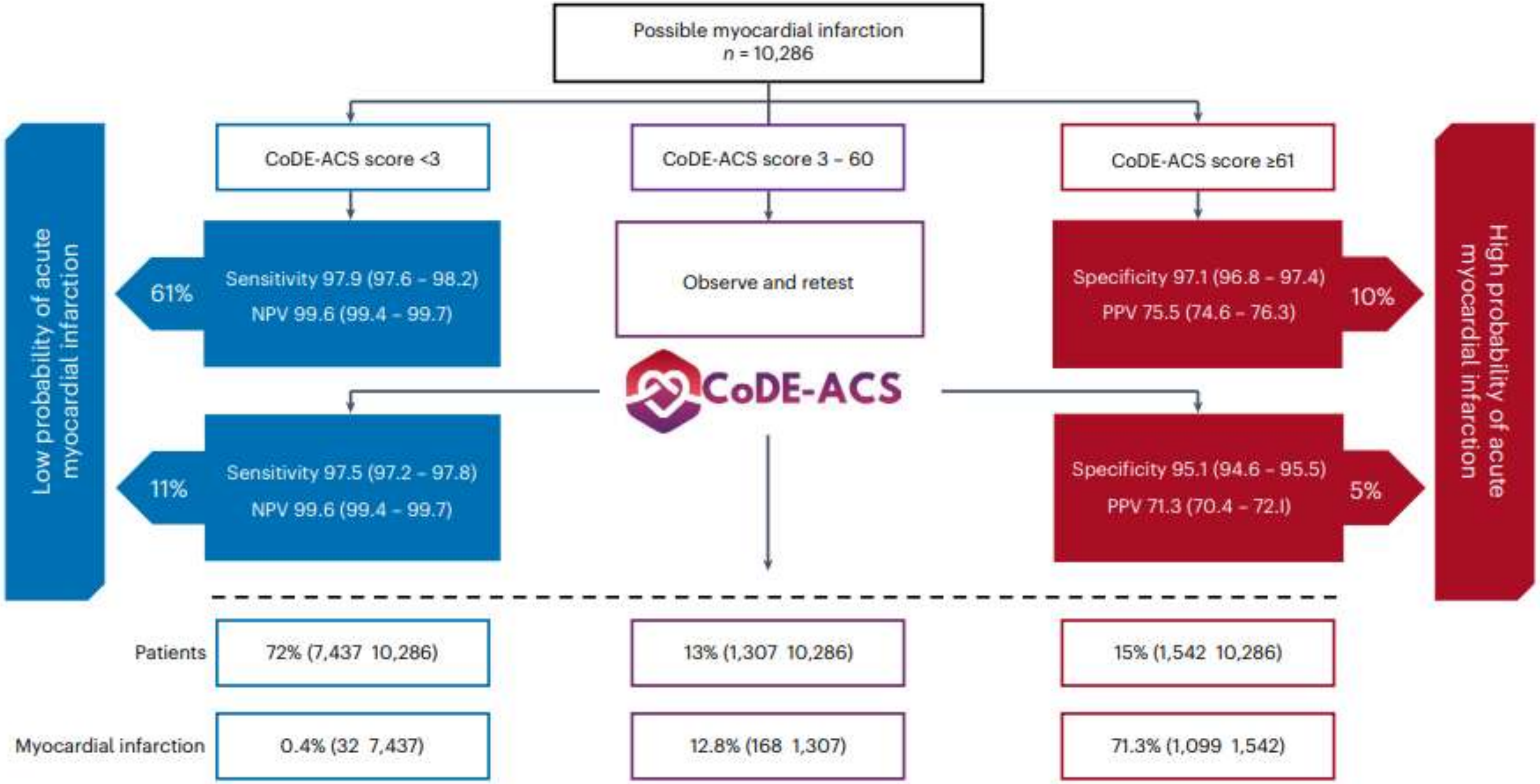
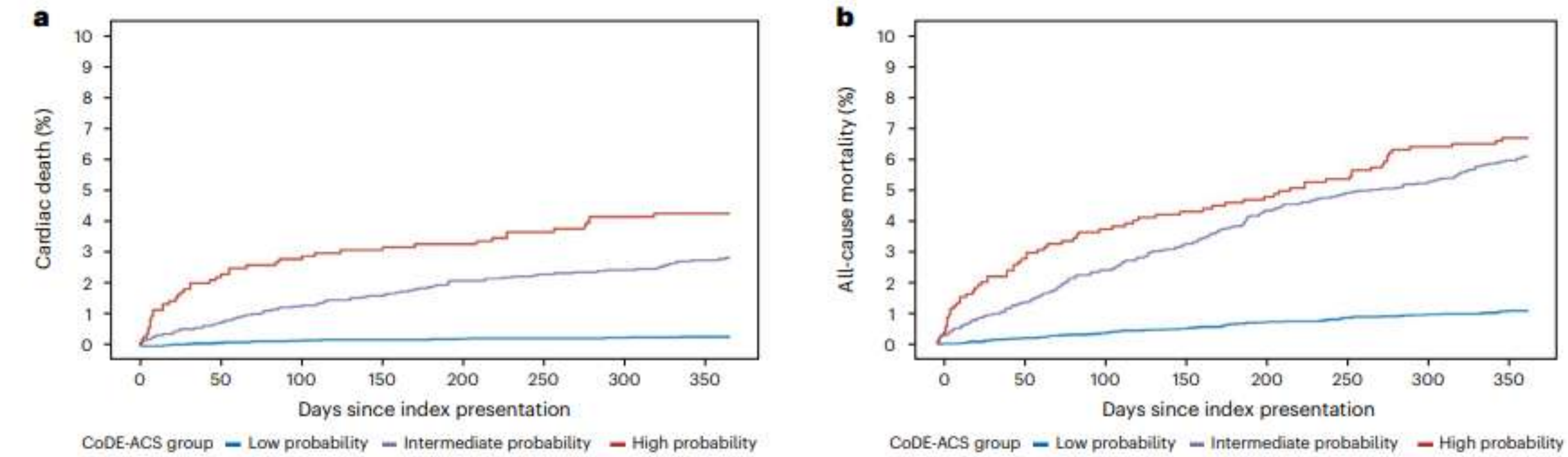


Fig. 3 | External validation of the performance of the CoDE-ACS pathway in 10,286 patients with possible myocardial infarction. Diagnostic performance of CoDE-ACS models in 10,286 patients from seven international cohorts. Sensitivity, negative predictive value (NPV), specificity and positive predictive value (PPV) with 95% CIs of the CoDE-ACS scores were used to identify patients as low probability (<3) or high probability (≥61) of myocardial infarction at presentation and after serial troponin testing if required.



a Number at risk

Low probability	6,265	6,254	6,244	6,234	6,221	6,214	6,206	6,199
Intermediate probability	2,969	2,931	2,900	2,876	2,844	2,826	2,815	2,794
High probability	1,052	1,025	1,014	1,008	1,003	996	985	982

b Number at risk

Low probability	6,265	6,254	6,244	6,234	6,221	6,214	6,206	6,199
Intermediate probability	2,969	2,931	2,900	2,876	2,844	2,826	2,815	2,794
High probability	1,052	1,025	1,014	1,008	1,003	996	985	982

Fig. 5 | Cumulative incidence of cardiac death and all-cause mortality as stratified by the CoDE-ACS score at presentation in the external validation cohort. **a**,**b**, Data for cardiac death (**a**) and all-cause mortality (**b**).

ESC European Society of Cardiology

European Heart Journal - Digital Health (2024) **5**, 123–133
https://doi.org/10.1093/ehjdh/ztad074

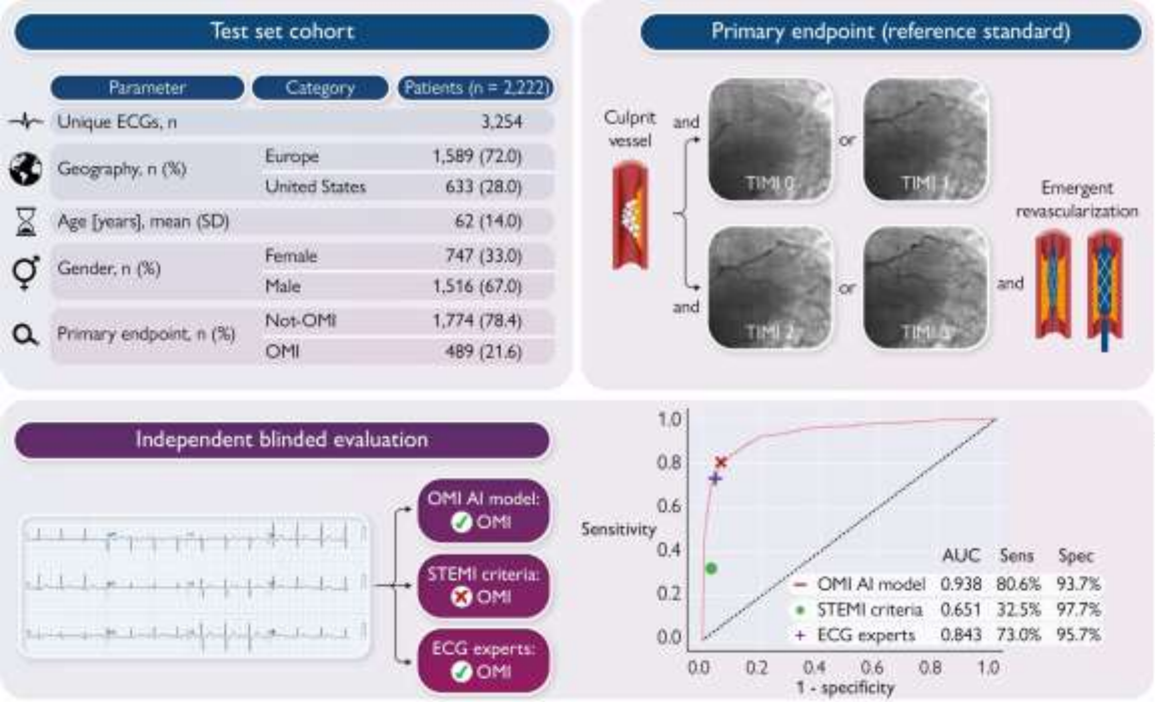
ORIGINAL ARTICLE

International evaluation of an artificial intelligence–powered electrocardiogram model detecting acute coronary occlusion myocardial infarction

Robert Herman [1,2,3,*], Harvey Pendell Meyers[4], Stephen W. Smith[5,6], Dario T. Bertolone[1,2], Attilio Leone[1,2], Konstantinos Bermpeis[1,2], Michele M. Viscusi[1,2], Marta Belmonte[1,2], Anthony Demolder[3], Vladimir Boza[3,7], Boris Vavrik[3], Viera Kresnakova[3,8], Andrej Iring[3], Michal Martonak[3], Jakub Bahyl[3], Timea Kisova[3,9], Dan Schelfaut [2], Marc Vanderheyden [2], Leor Perl [10], Emre K. Aslanger[11], Robert Hatala[12], Wojtek Wojakowski[13], Jozef Bartunek[2], and Emanuele Barbato [14]

[1]Department of Advanced Biomedical Sciences, University of Naples Federico II, C.so Umberto I, 40, 80138 Naples, Italy; [2]Cardiovascular Centre Aalst, OLV Hospital, Moorselbaan 164, Aalst 9300, Belgium; [3]Powerful Medical, Bratislavska 81/37, 931 01 Samorin, Slovakia; [4]Department of Emergency Medicine, Carolinas Medical Center, Charlotte, NC, USA; [5]Department of Emergency Medicine, University of Minnesota, Minneapolis, MN, USA; [6]Department of Emergency Medicine, Hennepin Healthcare, Minneapolis, MN, USA; [7]Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Bratislava, Slovakia; [8]Department of Cybernetics and Artificial Intelligence, Technical University of Kosice, Kosice, Slovakia; [9]Faculty of Medicine and Dentistry, Barts and The London School of Medicine and Dentistry, London, UK; [10]Department of Cardiology, Rabin Medical Center, Petah Tikvah, Israel; [11]Department of Cardiology, Basaksehir Cam and Sakura City Hospital, Istanbul, Turkey; [12]Department of Arrhythmia and Pacing, National Institute of Cardiovascular Diseases, Bratislava, Slovakia; [13]Department of Cardiology and Structural Heart Diseases, Medical University of Silesia, Katowice, Poland; and [14]Department of Clinical and Molecular Medicine, Faculty of Medicine and Psychology, Sapienza University of Rome, Rome, Italy

Received 14 September 2023; revised 13 October 2023; accepted 2 November 2023; online publish-ahead-of-print 28 November 2023



Key question

Can an artificial intelligence (AI) model detect an acutely occluded or obstructive culprit coronary artery [occlusion myocardial infarction (OMI)] lesion using only single-standard 12-lead electrocardiograms (ECGs)?

Key finding

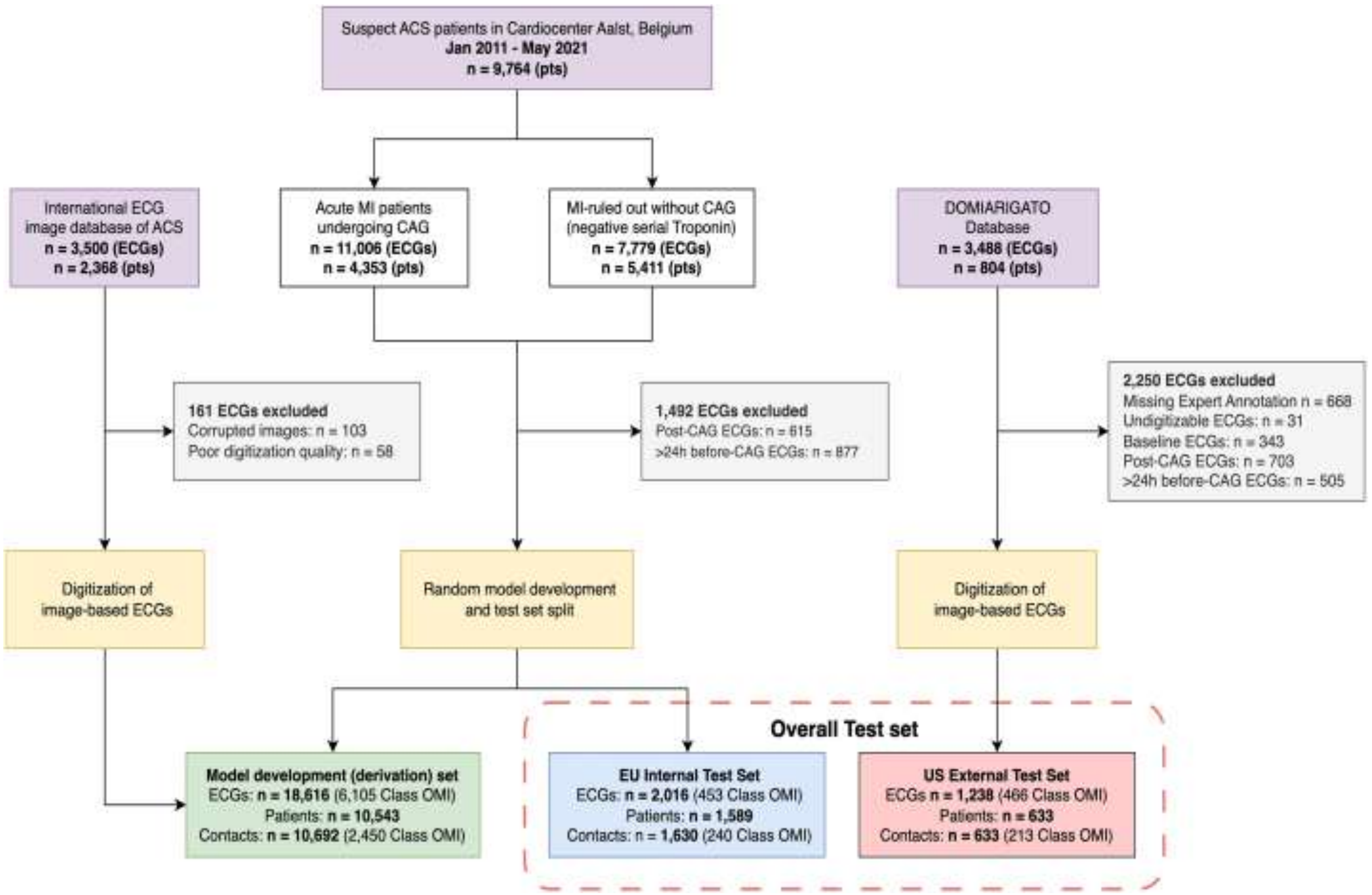
The occlusion myocardial infarction AI ECG model outperforms guideline-recommended ST-elevation myocardial infarction (STEMI) criteria in detecting angiographically confirmed OMI and remains robust in subgroup analysis.

Take home message

The OMI AI ECG model has the potential to improve acute coronary syndrome triage and clinical decision-making by enabling timely and accurate detection of OMI regardless of ST elevation. This automated deep learning approach demonstrated two times higher sensitivity in detecting angiographically confirmed OMI from single-standard 12-lead ECGs compared to the standard of care in geographically distinct cohorts.

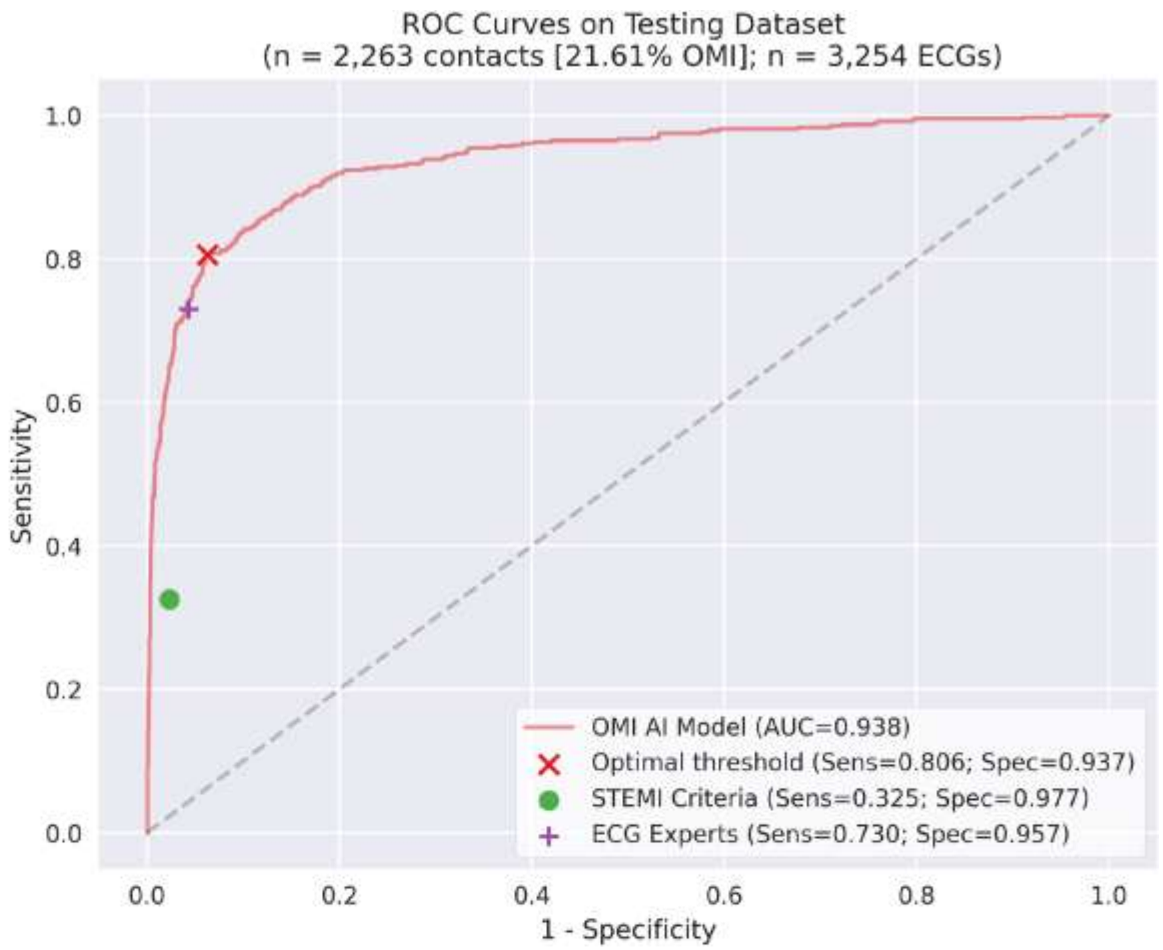
Eur Heart J Digit Health, Volume 5, Issue 2, March 2024, Pages 123–133, https://doi.org/10.1093/ehjdh/ztad074

Figure 1 A PRISMA flow chart showing data sources and study populations. Suspect acute coronary syndrome patients ...

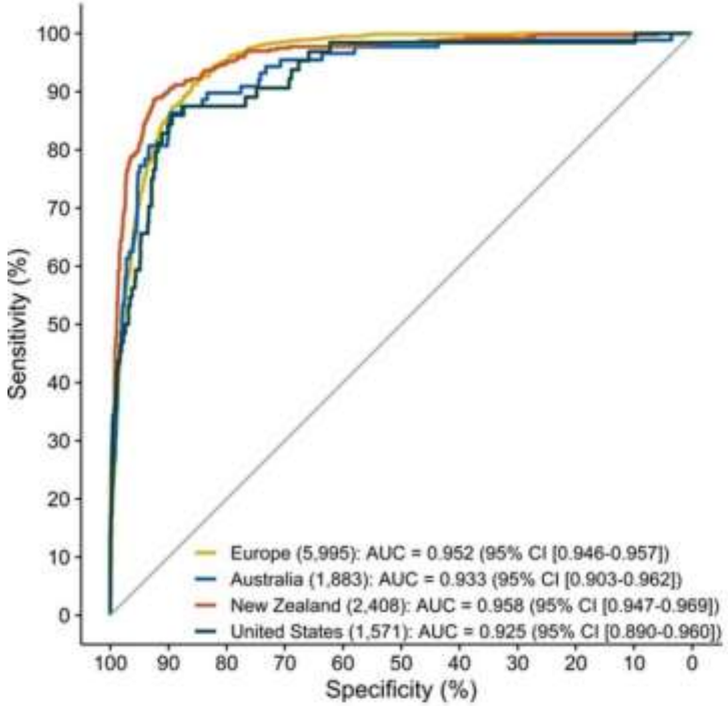


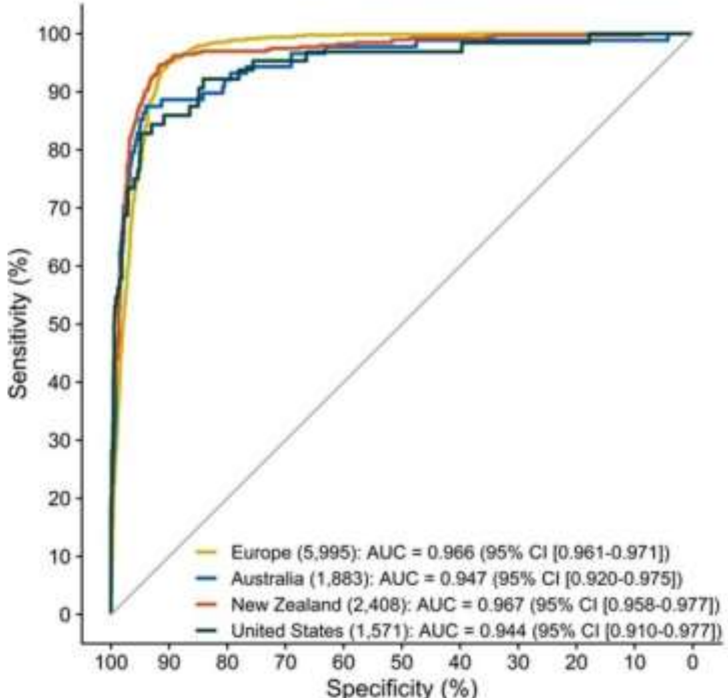
Eur Heart J Digit Health, Volume 5, Issue 2, March 2024, Pages 123–133, https://doi.org/10.1093/ehjdh/ztad074

Figure 2 Artificial intelligence model performance on the overall testing data set. The receiver operating ...



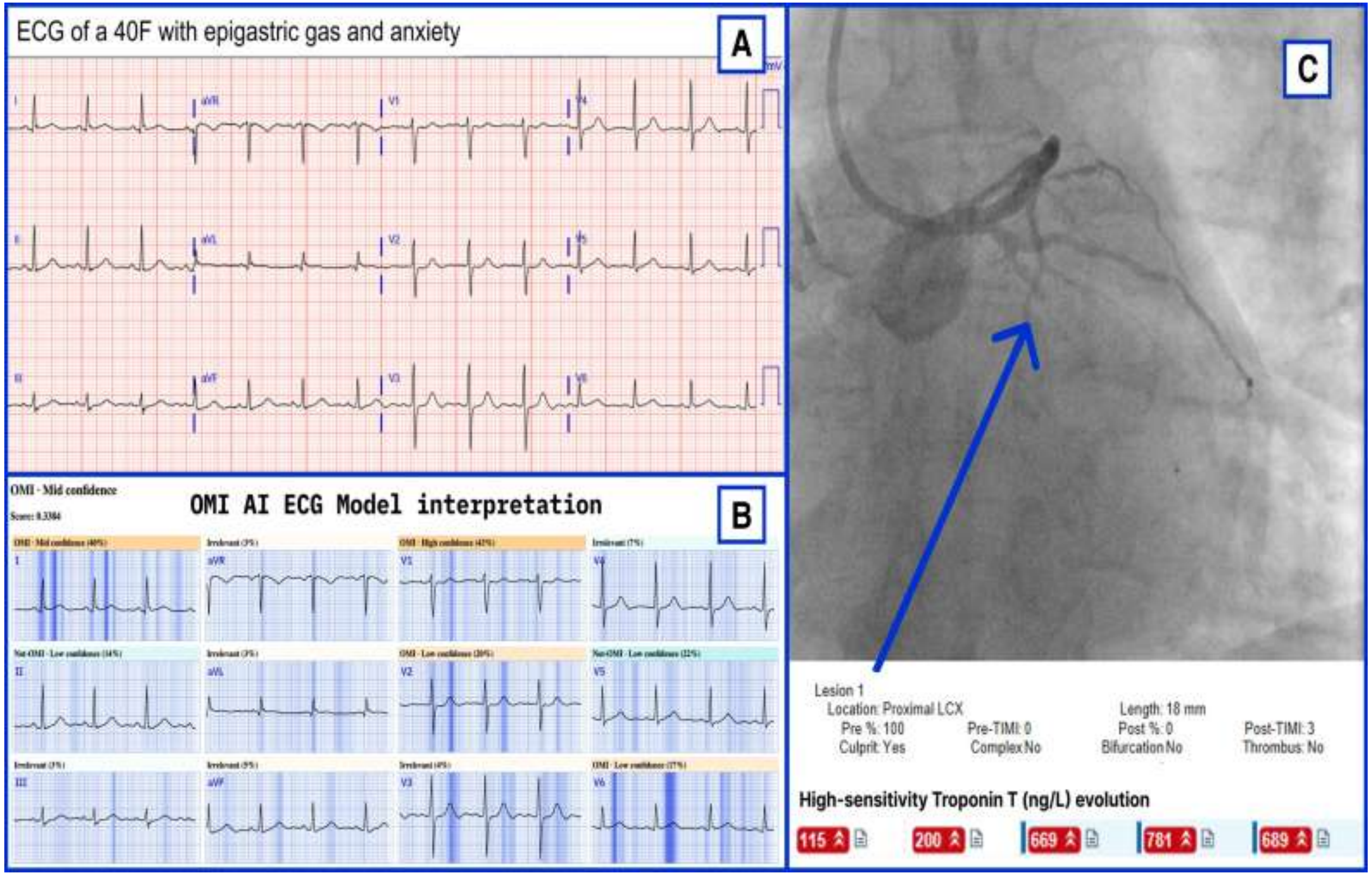
Eur Heart J Digit Health, Volume 5, Issue 2, March 2024, Pages 123–133, https://doi.org/10.1093/ehjdh/ztad074





- Receiver-operating-characteristic (ROC) curve illustrating discrimination of the CoDE-ACS for myocardial infarction.
- (**a**) Using the presentation cardiac troponin measurement.
- (**b**) Using the serial cardiac troponin measurement

Figure 4 A real-world demonstration of an occlusion myocardial infarction artificial intelligence true-positive ...



Eur Heart J Digit Health, Volume 5, Issue 2, March 2024, Pages 123–133, https://doi.org/10.1093/ehjdh/ztad074

CONCLUSIONS

- AI/ML algorithms provide information not accessible for the clinician, particularly in imaging and ECG analysis ('see what you can't see').
- This way, risk prediction is more precise as documented by the AI/ML-enabled GRACE 3.0 score, among others.
- AI/ML-enabled information is much faster. As a consequence, physicians will have better information and more time to discuss management options with their patients.
- AI/ML-provided information on diagnostics and guideline-based therapeutic options are provided comprehensively and timely.
- AI/ML cannot yet provide the same degree of empathy, personal interaction, and trust as good physicians.
- It is very likely that AI/ML will massively change the practice of medicine.
- It will make medicine more precise and faster.

Thank You !

Teşekkür ederim!

Faleminderit!