

7th Advances in Heart Failure 2024

10 e 11 de Outubro

FACULDADE DE MEDICINA DA UNIVERSIDADE DO PORTO

ORGANIZAÇÃO

U. PORTO

FM
UP

PATROCÍNIO CIENTÍFICO



PCO

NO
GET
DONE
EVENTS.

7th Advances in Heart Failure 2024

10 e 11 de Outubro

FACULDADE DE MEDICINA DA UNIVERSIDADE DO PORTO

Estratificação dinâmica do risco de WHF com ECG de ambulatório de derivação única implantado e deep learning



SÃO JOÃO

Serviço
de Cardiologia

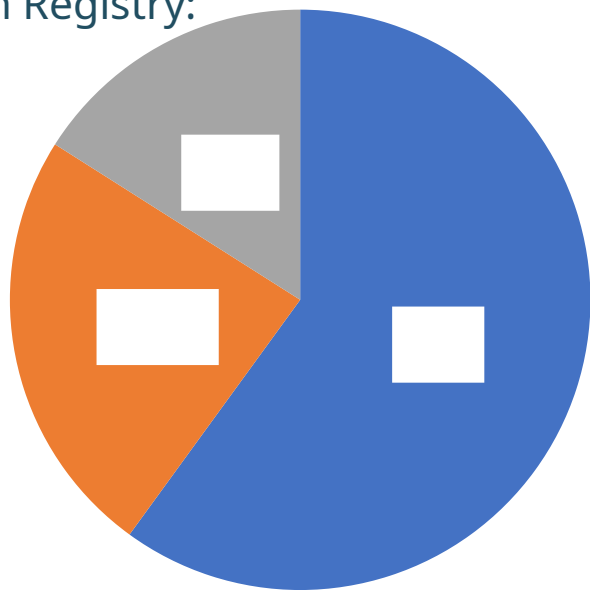
Estratificação dinâmica do risco de WHF com ECG de ambulatório de derivação única implantado e deep learning

- Worsening heart failure
- ECG de ambulatório de derivação única implantado
- Inteligência artificial
- Estratificação dinâmica do risco de WHF

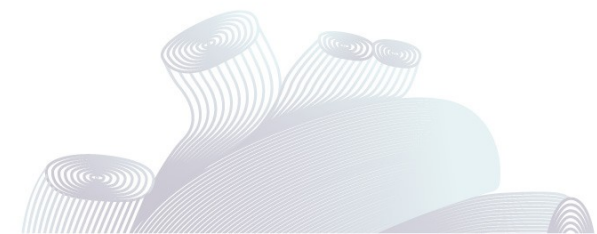
Worsening heart failure

Insuficiência cardíaca na Europa

- Incidência 5/1000 person-years adultos
- Prevalência 1-2% adultos (provavelmente subestimada)
 - 1% < 55 anos vs > 10% ≥ 70 anos
- ~1 internamento / ano após diagnóstico
- ESC Long-Term Registry:



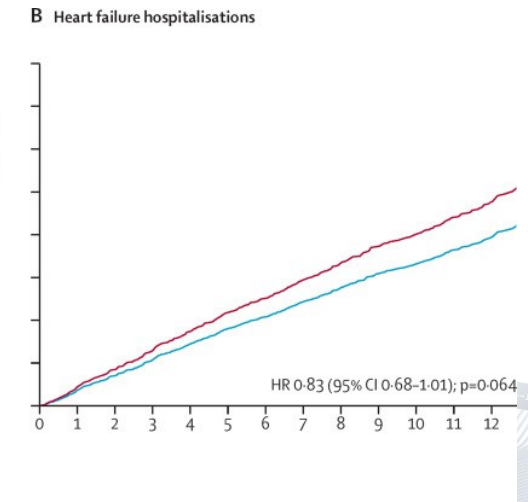
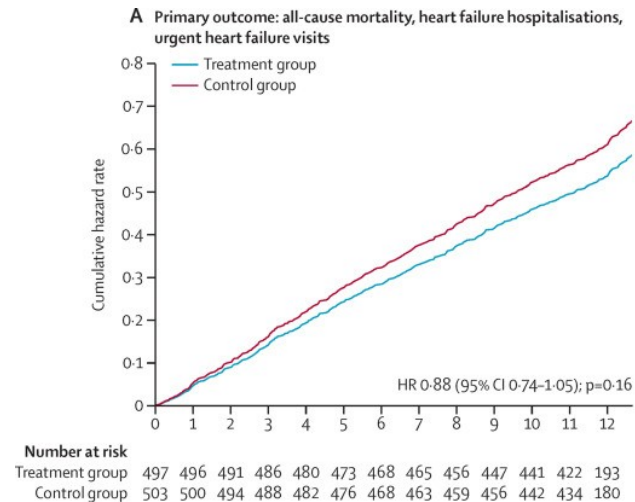
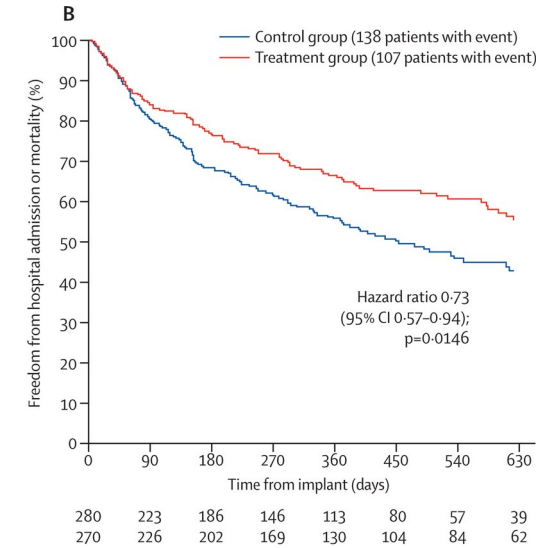
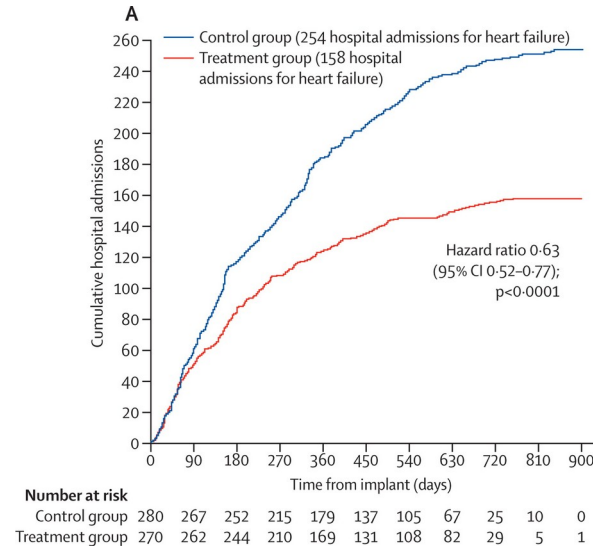
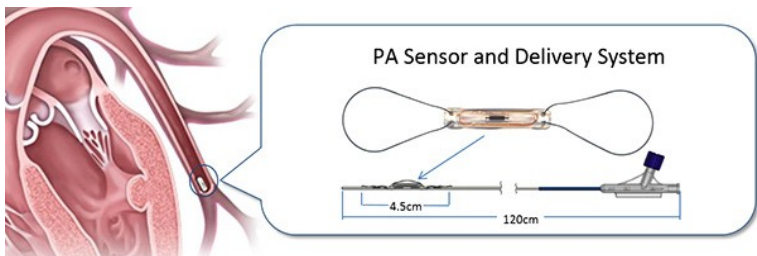
2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure



Worsening heart failure

Vigilância

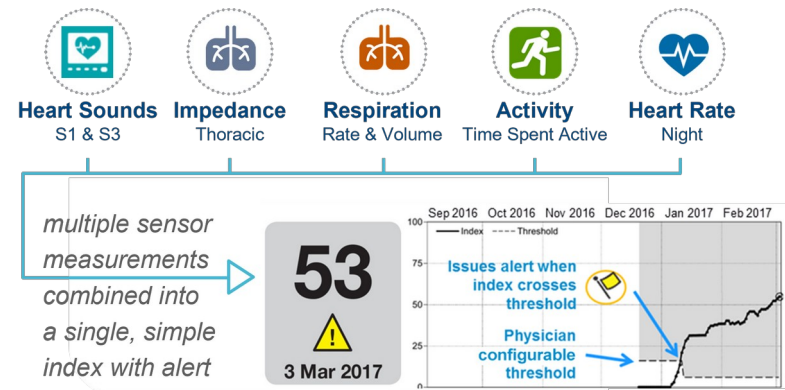
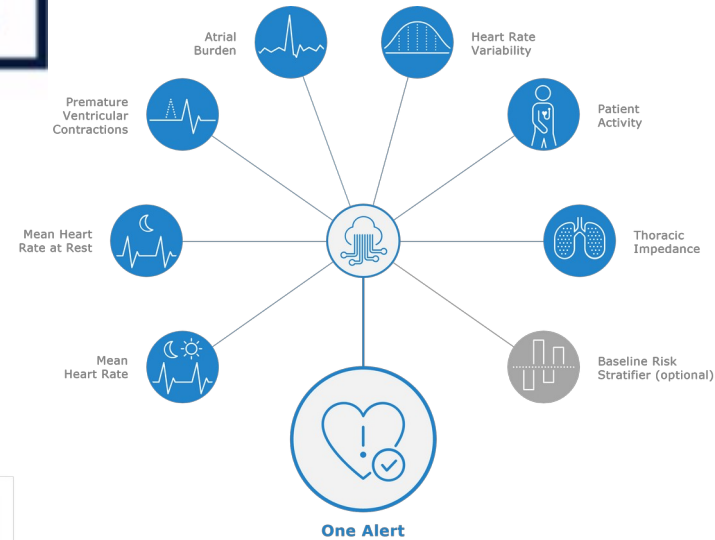
- Clínica
 - Sinais e sintomas
 - Pressão arterial
 - Peso diário
 - Adesão, sensibilidade...
- Pressão arterial pulmonar
 - CardioMEMS
 - CHAMPION-HF → GUIDE-HF



Worsening heart failure

Vigilância

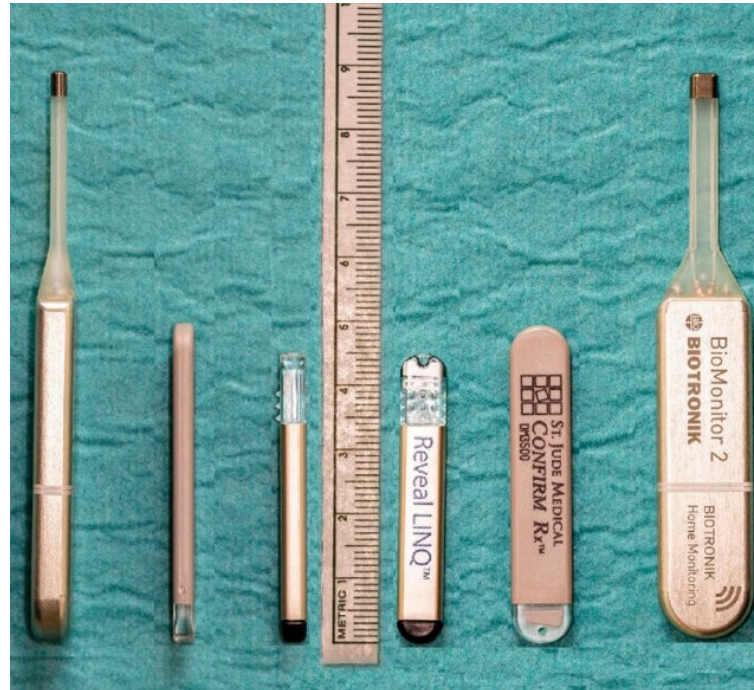
- Dispositivos cardíacos eletrônicos implantados
 - CorVue (Abbott – impedância torácica)
 - TriageHF (Medtronic)
 - HeartInsight (Biotronik)
 - HeartLogic (Boston Scientific)
- Doentes sem dispositivo?



ECG de ambulatório de derivação única implantado

Registador de eventos implantáveis (*Implantable Loop Recorder*)

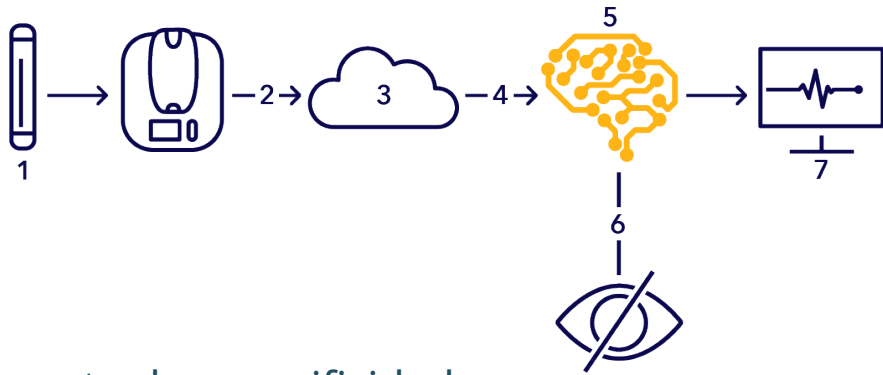
- Indicações atuais:
 - Síncope inexplicada
 - AVC criptogénico
 - Palpitações
 - Fibrilhação auricular



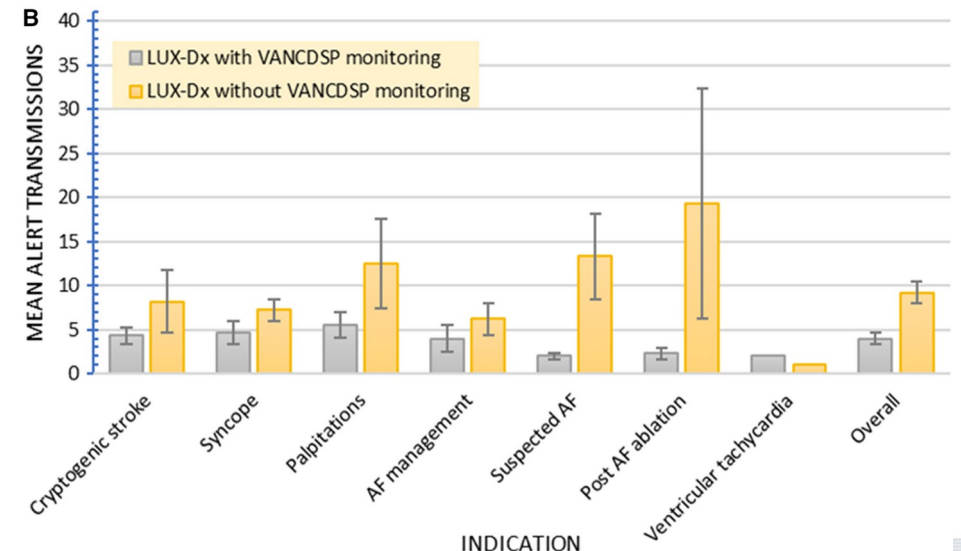
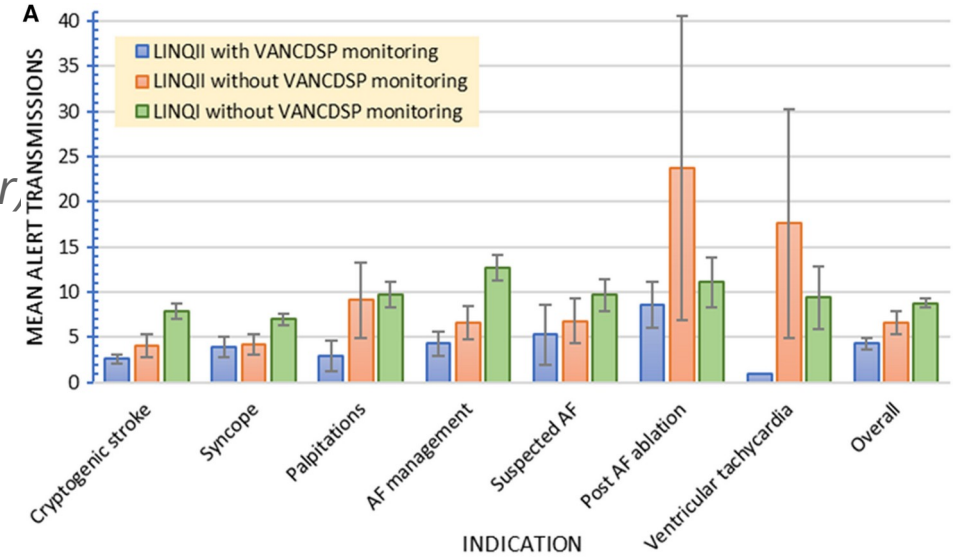
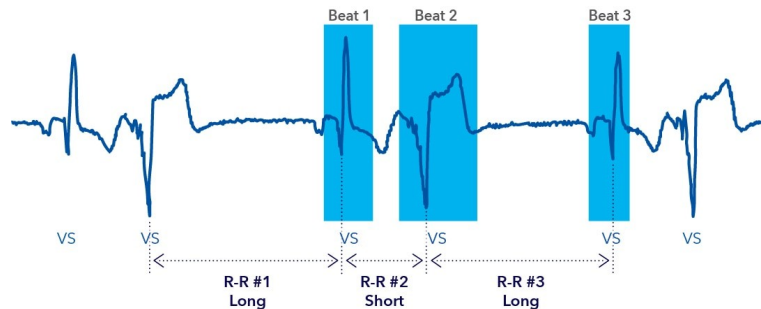
ECG de ambulatório de derivação única implantado

Registador de eventos implantáveis (*Implantable Loop Recorder*,

- Inteligência artificial

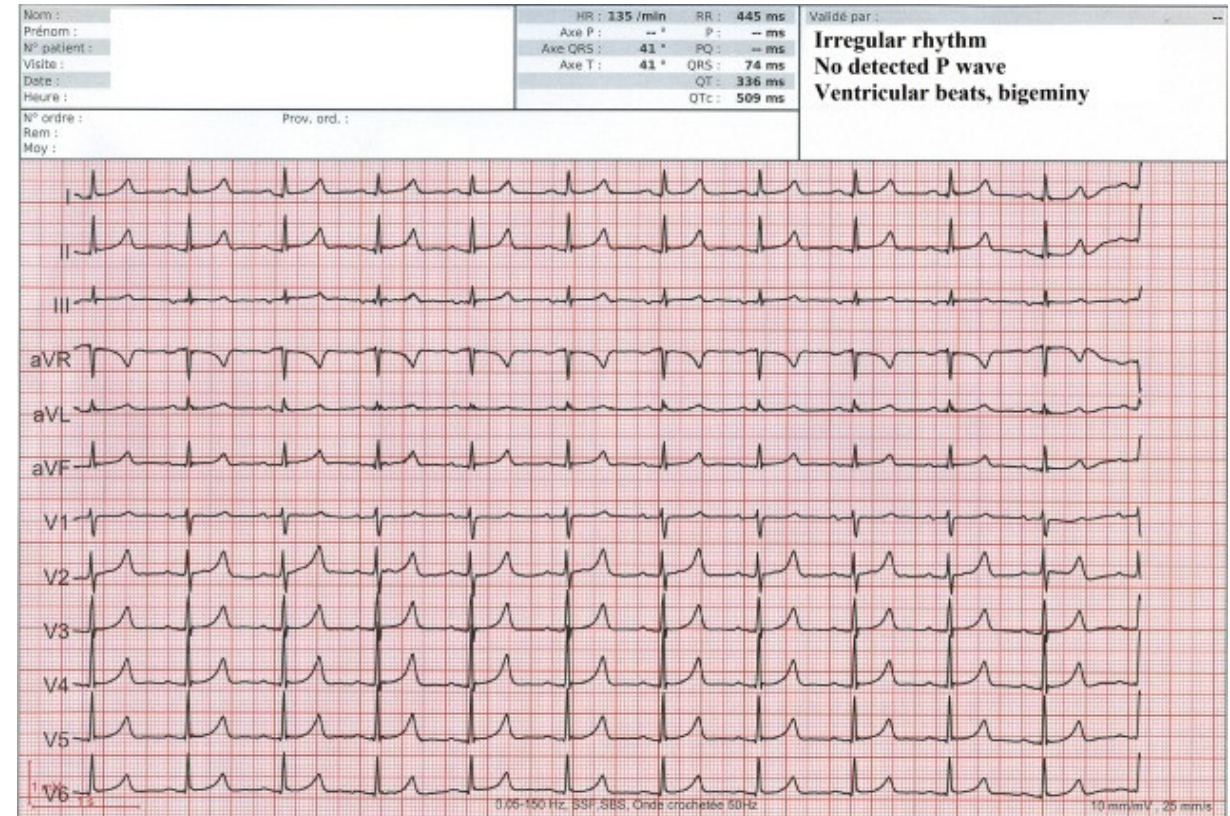
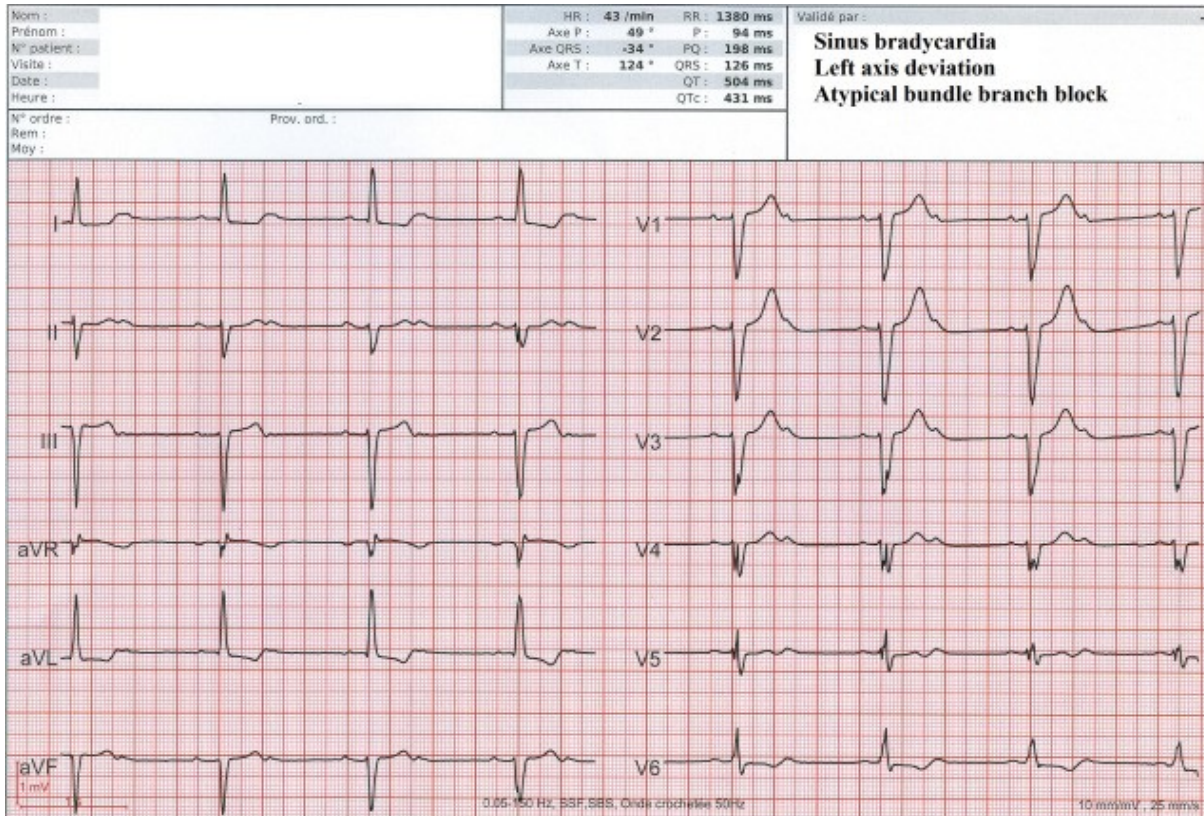


- Aumento da especificidade
- Novas capacidades (contador EVs)

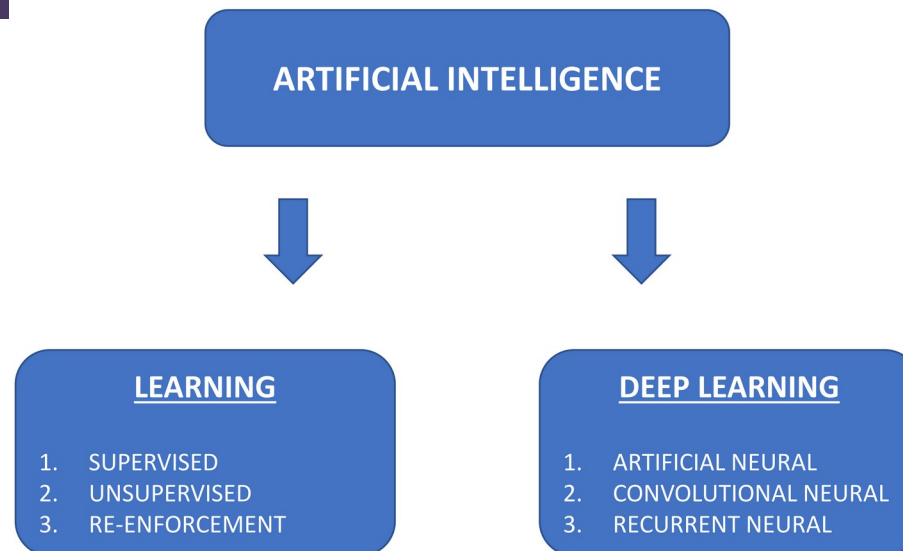


Inteligência artificial

ECG 12 derivações



Inteligência artificial

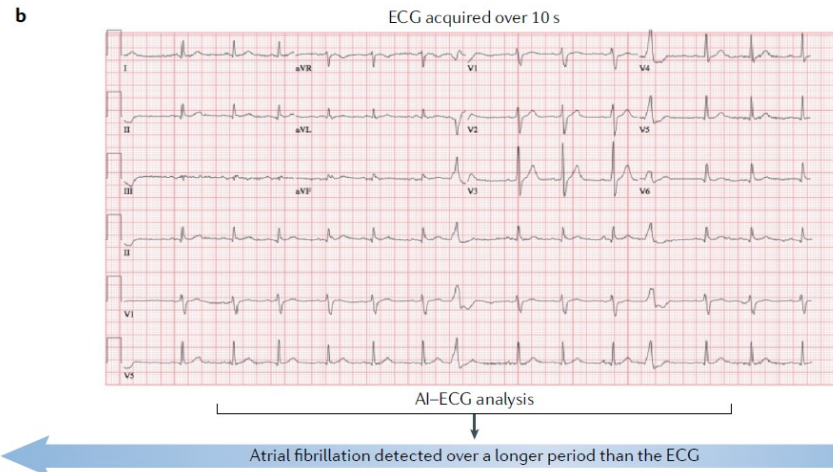
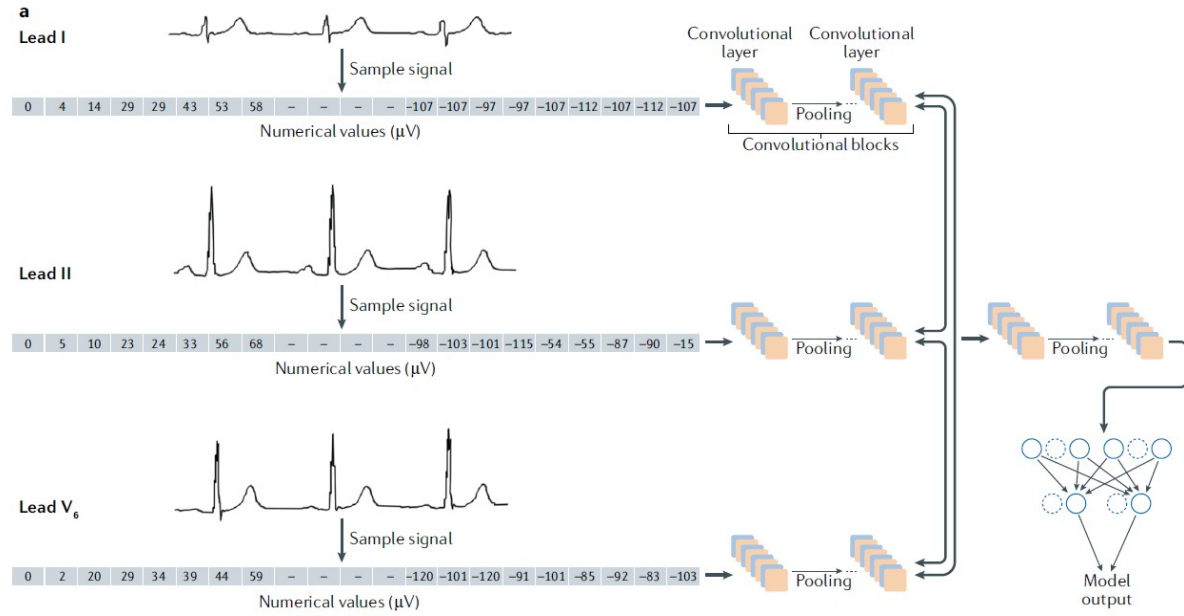


TYPE OF AI	DESCRIPTION
SUPERVISED	Usage of a previously labelled database to predict outcomes of future events.
UNSUPERVISED	Identification of previously un-categorised database to predict peculiar relation between the dataset.
RE-ENFORCEMENT	Interaction of a machine with its environment using sensors, camera and GPS. It is typically used for robotic interventions.
ARTIFICIAL NEURAL	Computing system that analyses and processes information in a similar way compared to the human brain [7].
CONVOLUTIONAL NEURAL	Performs analyses of visual images [8].
RECURRENT NEURAL	Functions by developing connections between nodes from a directed graph along a dynamic temporal sequence [9].

Inteligência artificial

ECG 12 derivações

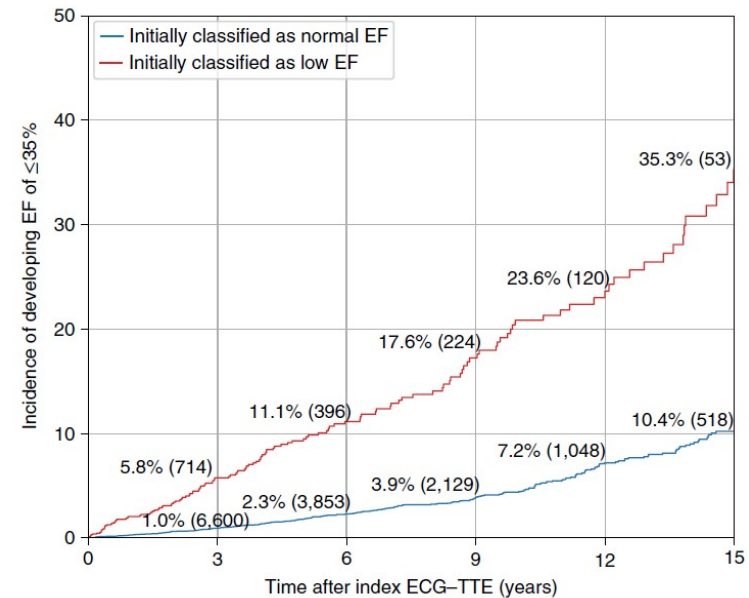
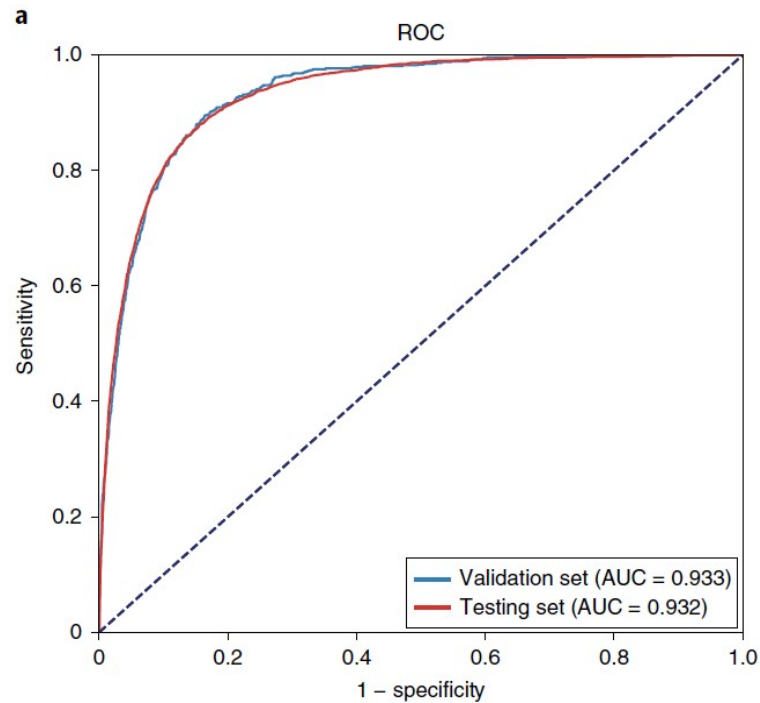
- Fibrilhação auricular silenciosa
- Estenose aórtica
- Miocardiopatia hipertrófica
- Hiperkaliemia
- ...



Inteligência artificial

ECG 12 derivações

- Disfunção ventricular esquerda



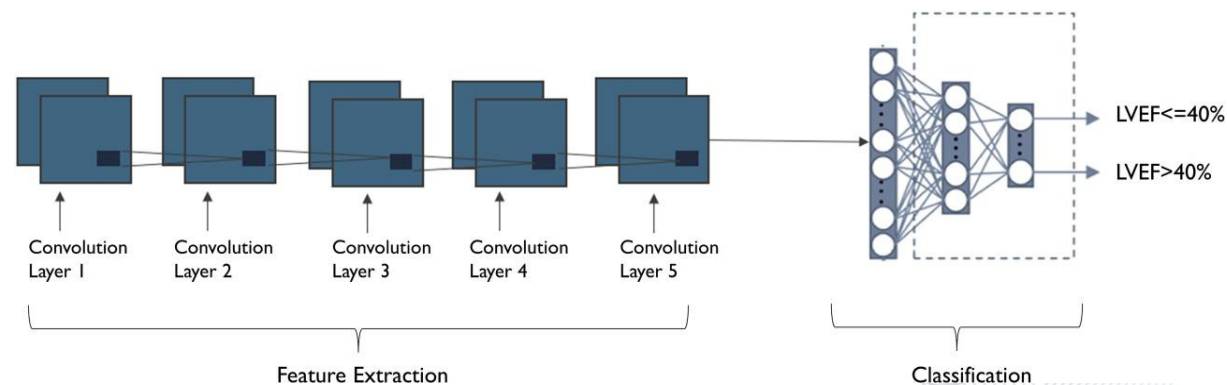
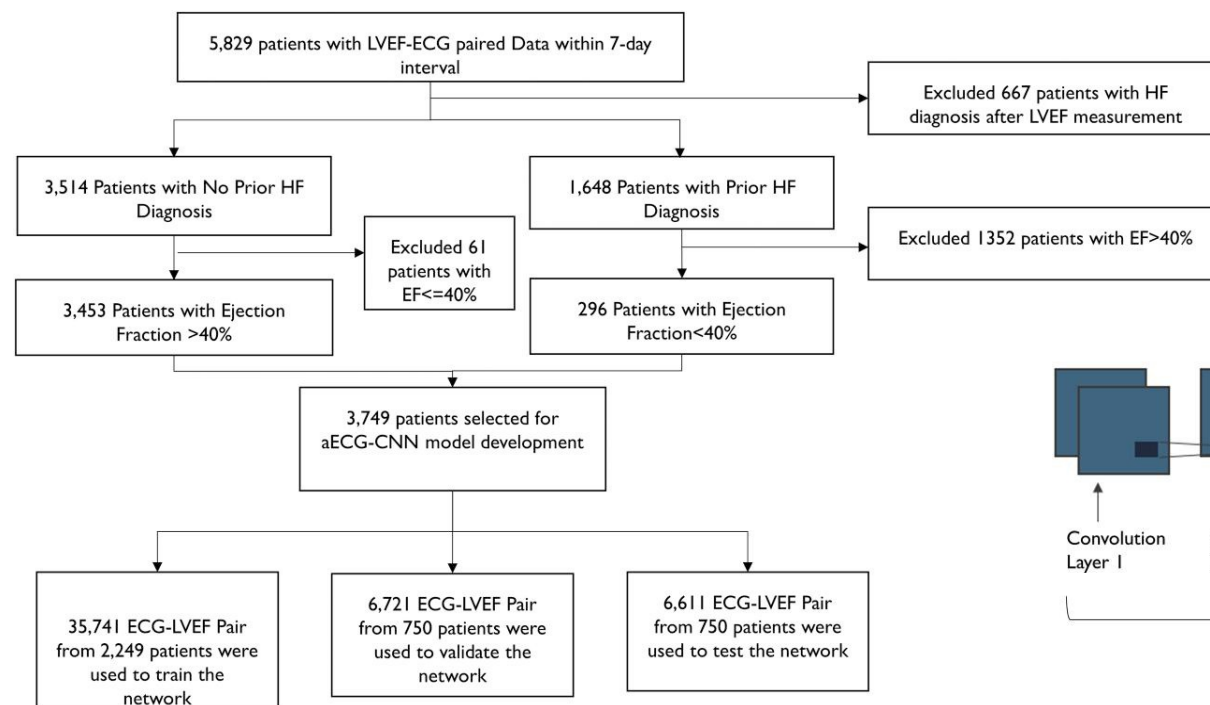
Estratificação dinâmica do risco de WHF

ECG de ambulatório de derivação única implantado

- Probabilidade de disfunção VE

Dynamic risk stratification of worsening heart failure using a deep learning-enabled implanted ambulatory single-lead electrocardiogram

James Philip Howard ¹*, Neethu Vasudevan², Shantanu Sarkar², Sean Landman², Jodi Koehler², and Daniel Keene¹



Estratificação dinâmica do risco de WHF

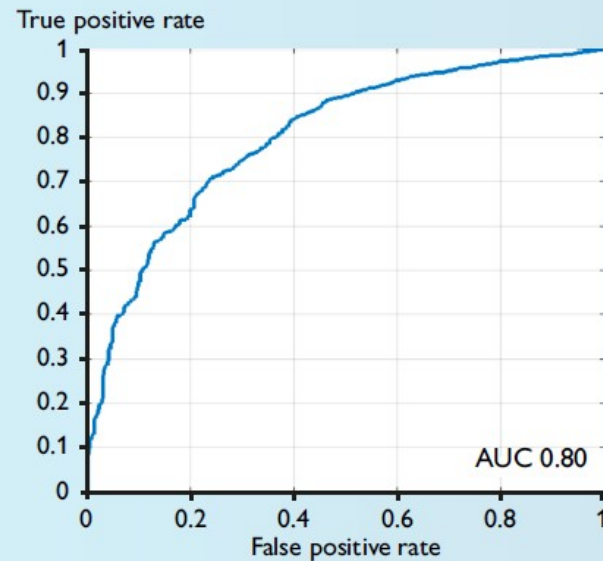
ECG de ambulatório de derivação única implantado

- Probabilidade de disfunção VE
 - Precisão: 75%
 - Sensibilidade: 70%
 - Especificidade: 76%



2,247 Patients

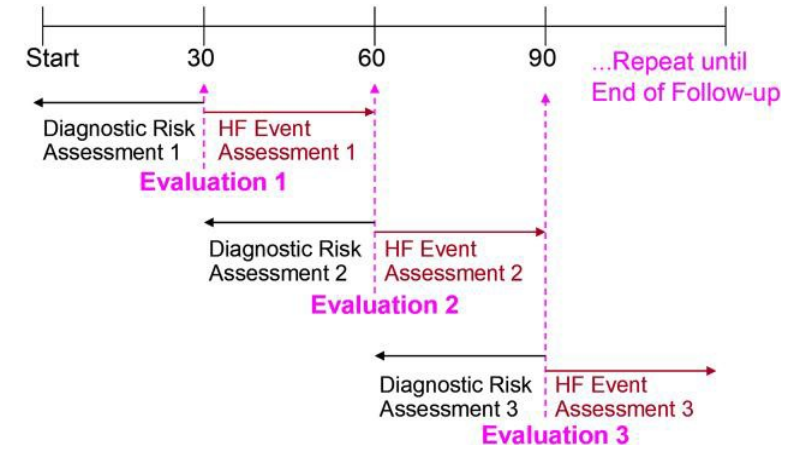
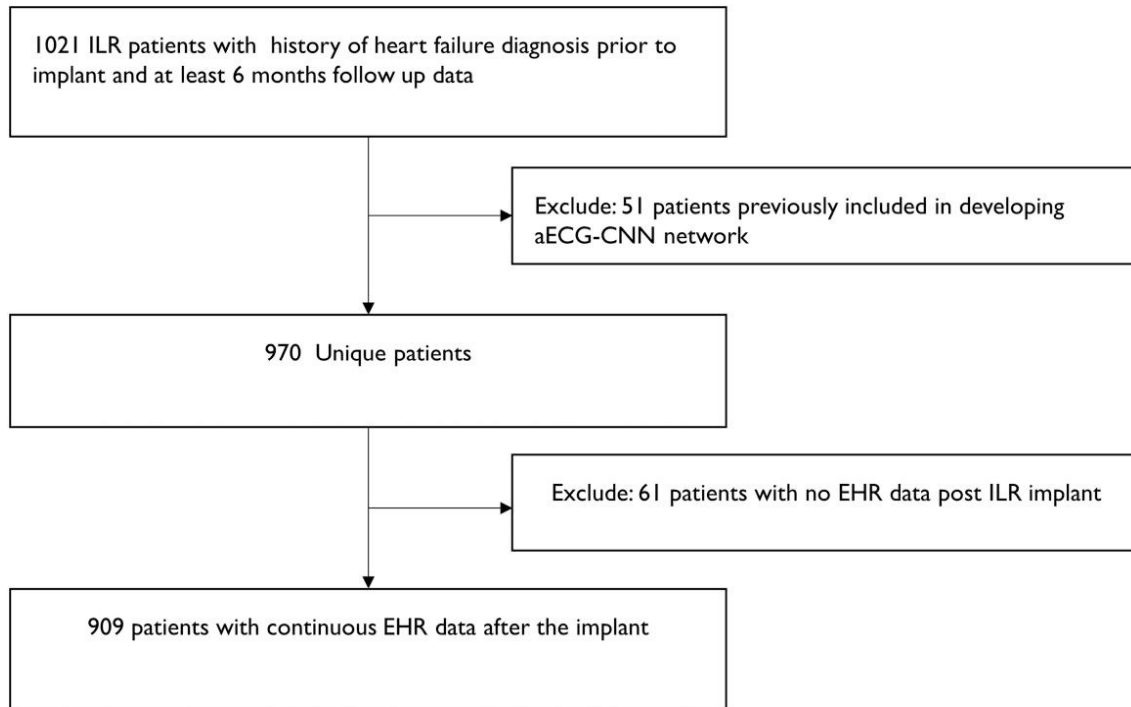
AI can identify left ventricular impairment
using implantable loop recorder ECGs



Estratificação dinâmica do risco de WHF

ECG de ambulatório de derivação única implantado

- Risco de descompensação de IC



Risk assessment

High risk

Low risk

Utilized features

Pmax7

Pmax15

Pmean15

Pmax30

Feature set

Defined as **large fluctuations** and **sustained fluctuations** in predicted LVEF.

Large fluctuations = $(P_{max7} - P_{max30} \geq 0.1)$ AND $(P_{max15} - P_{mean15} \geq 0.05)$

Sustained fluctuations = $(P_{max7} - P_{max15} \geq 0.08)$ for ≥ 6 Days OR $(P_{max7} - P_{max30})$ for ≥ 5 Days

Above conditions not met.

Description

The peak probability of LVEF $\leq 40\%$ within the 7-day running average.

The peak probability of LVEF $\leq 40\%$ within the 15-day running average.

The mean probability of LVEF $\leq 40\%$ within the 15-day running average.

The peak probability of LVEF $\leq 40\%$ within the 30-day running average.

Estratificação dinâmica do risco de WHF

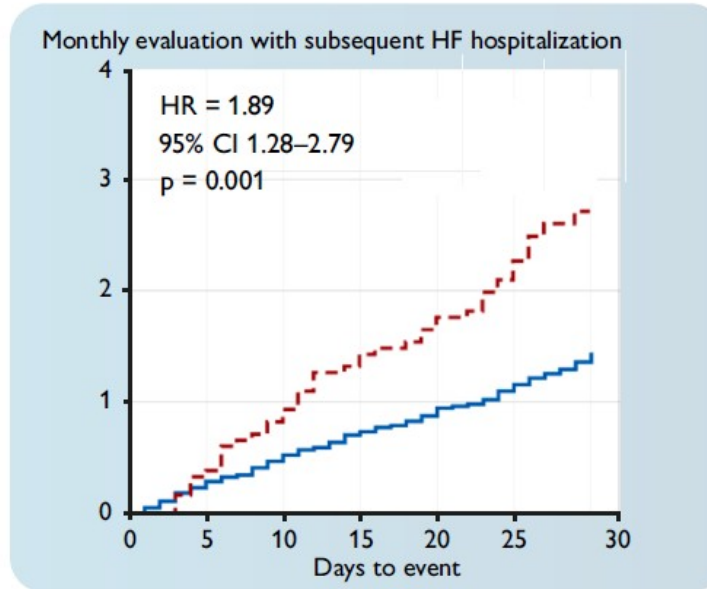
ECG de ambulatório de derivação única implantado

- Risco de descompensação de IC

Diagnostic parameter	Number of evaluations (%)	Number of HF events (% of evaluations)	Hazard ratio (95% CI)	P-value
Risk group based on aECG-CNN				
Low	10 637 (85.3)	152 (1.4)	Reference	0.001
High	1830 (14.7)	49 (2.7)	1.89 (1.28–2.79)	

 **35,741 ECGs**

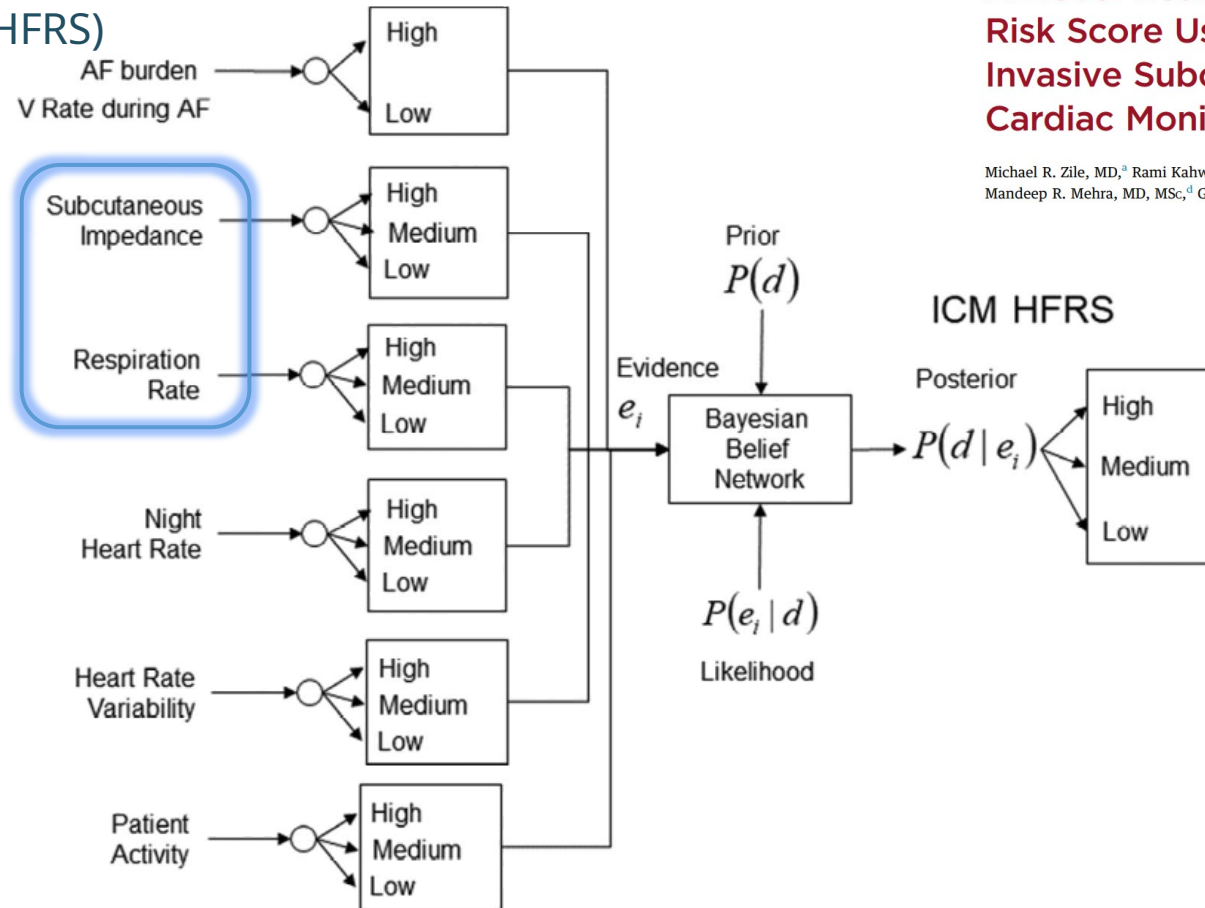
This can identify patients at increased risk of heart failure hospitalization



Estratificação dinâmica do risco de WHF

ECG de ambulatório de derivação única implantado

- Heart failure risk score (HFRS)



JACC: HEART FAILURE
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ORIGINAL RESEARCH

ICD / CRT AND STRUCTURAL INTERVENTIONS IN HF

A Novel Heart Failure Diagnostic Risk Score Using a Minimally Invasive Subcutaneous Insertable Cardiac Monitor

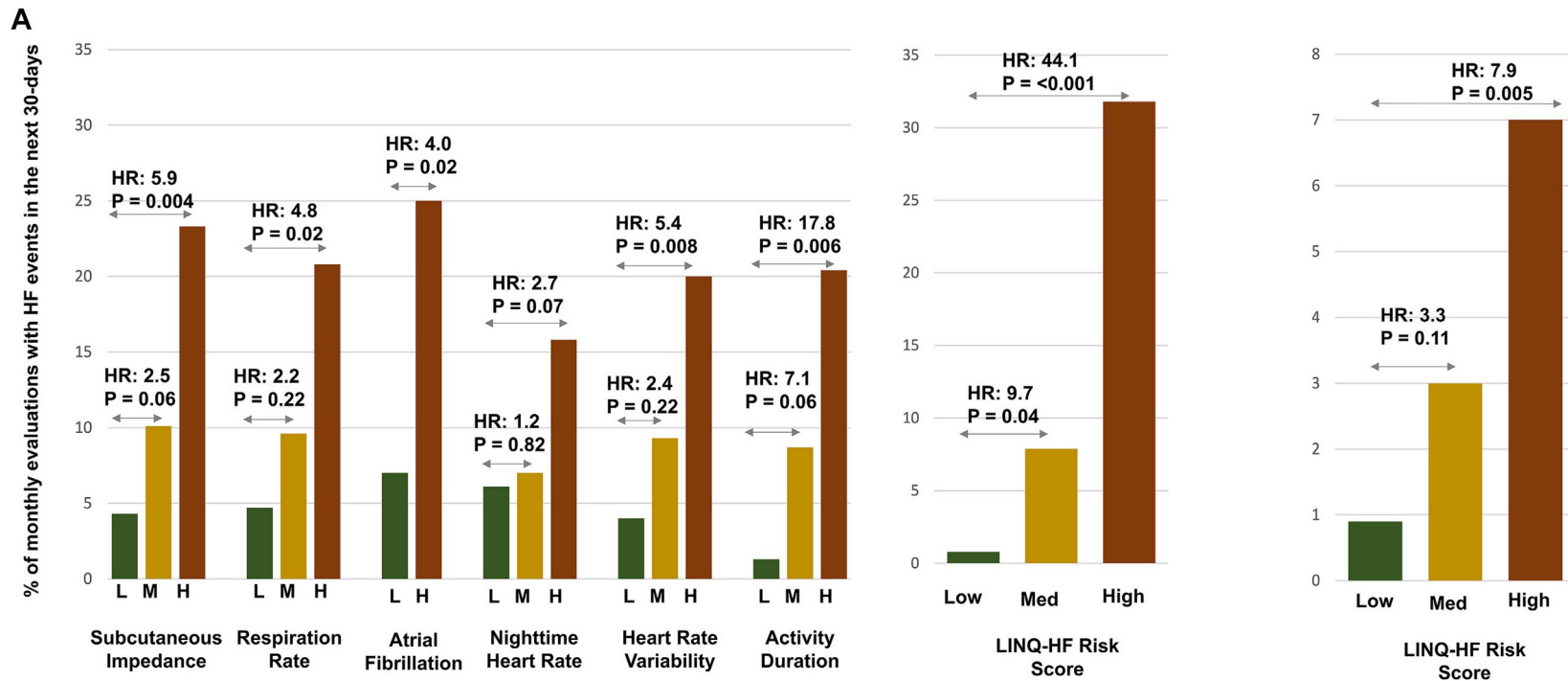
Michael R. Zile, MD,^a Rami Kahwash, MD,^b Shantanu Sarkar, PhD,^c Jodi Koehler, MS,^c Todd Zielinski, PhD,^c Mandeep R. Mehra, MD, MSc,^d Gregg C. Fonarow, MD,^e Sanjeev Gulati, MD,^f Javed Butler, MD^g



Estratificação dinâmica do risco de WHF

ECG de ambulatório de derivação única implantado

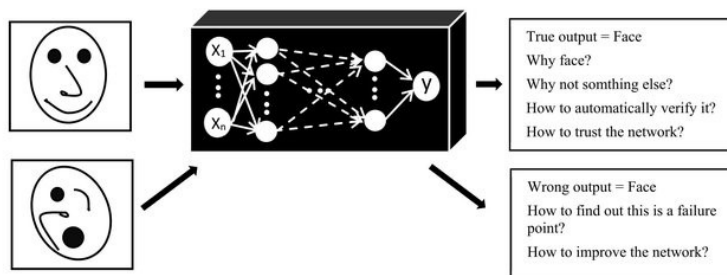
- Heart failure risk score (HFRS)



Estratificação dinâmica do risco de WHF

Riscos

- Generalização
 - Populações
 - Qualidade dos dados
- Black-box



Estratificação dinâmica do risco de WHF

Futuro

- Outcomes clínicos
 - ALLEVIATE-HF (NCT04452149)
 - Reveal LINQ com RAMware investigacional
 - Mortalidade CV, eventos IC, alt. KCCQ, alt. teste 6 minutos de marcha
- Custo-efetividade
- Modelos híbridos
- Wearables
- Regulamentação
 - Cibersegurança

