

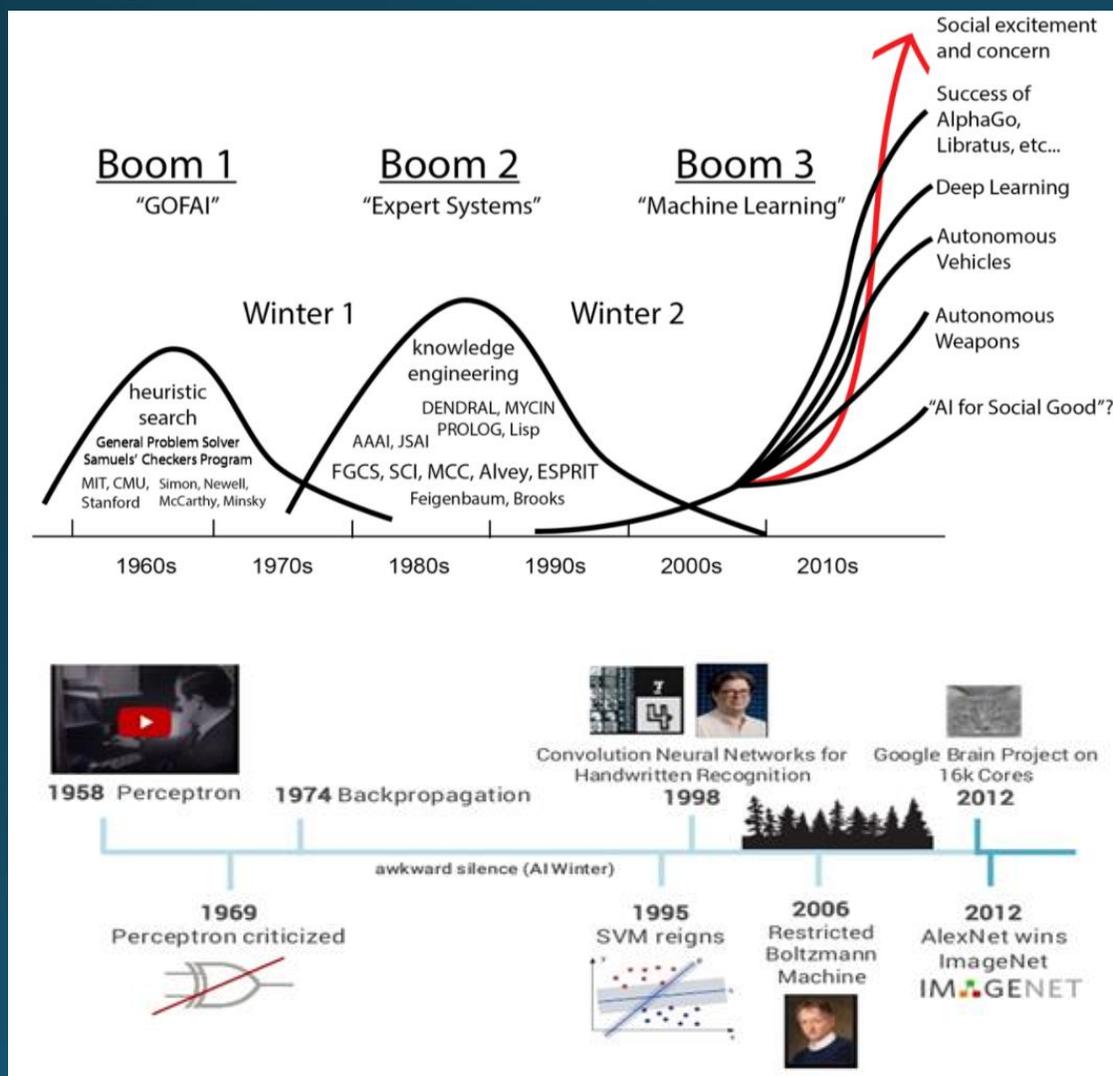
IA et prediction de la mort subite

Dr Laurent FIORINA

Liens d'intérêts

- Co-développeur de Cardiologs
- Directeur médical IA Philips

L'intelligence artificielle, une histoire à rebond



1842

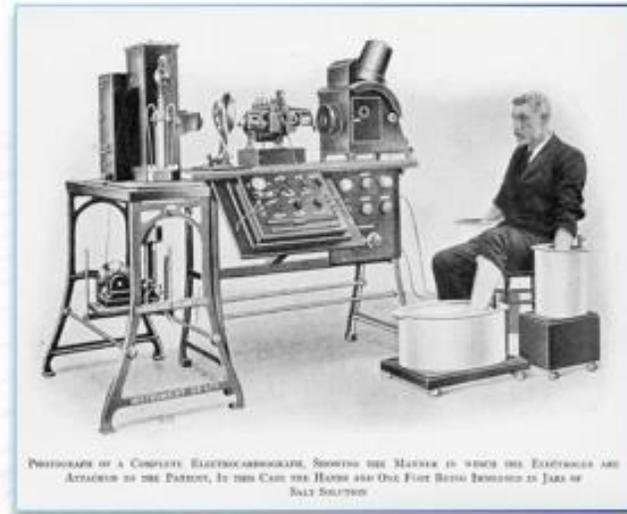
Carlo MATTEUCI
Potentiels électriques

1895

Willem EINTHOVEN
Galvanomètre à cordes,
Dénomination des ondes P, Q, R, S, T
Nobel 1924

1942

Goldberger
ECG 12D



Materre Alexandre, Histoire de l'électrocardiogramme : de la découverte de l'électrophysiologie à l'électrocardiographie moderne, thèse d'exercice, Limoges, Université de Limoges, 2016. Disponible sur <http://aurore.unilim.fr/ori-oai-search/notice/view/unilim-ori-107383>. Consulté le 3 mars 2022.

The democratic disruption of arrhythmia diagnostic

Rocky Mountain Medical Journal



Listen to "Dr. Fox-Detective"



Vol. 27—No. 3
35¢ Per Copy
\$2.50 Per Year

LUNG RESECTION
TWO CANCER PAINIS: CUTANEOUS — URINARY
EFFECTS OF ALTITUDE



aa

... in a prescription signifies "of each." Applied to Lilly products, this term alludes to uniformity of quality.

Of each product bearing the Lilly label are demanded the highest standards.

Of each prescription for a Lilly product, the physician may expect and will receive completely reliable medication.

Lilly

ELLI LILLY AND COMPANY • INDIANAPOLIS 6, INDIANA, U.S.A.

For Table of Contents, Turn to First Page



**DOCTOR,
WILL YOU MAKE
THIS NOSE TEST?**

SEE AT ONCE PHILIP MORRIS
ARE LESS IRRITATING

It is one thing to read published studies.* Quite another to have your own personal experience provide the proof! The PHILIP MORRIS nose test takes but a moment. Won't you try it?

HERE IS ALL YOU DO:



1...light up a PHILIP MORRIS
Take a pull — DON'T INHALE. Just *inhale* — let the smoke come through your nose. AND NOW...



2...light up your present brand
Do exactly the same thing — DON'T INHALE. Notice that bite, that sting? Quite a difference from PHILIP MORRIS!

With proof so conclusive, would it not be good practice to suggest PHILIP MORRIS to your patients who smoke?

PHILIP MORRIS
Philip Morris & Co., Ltd., Inc.
100 Park Avenue, New York 17, N. Y.

*Proc. Exp. Biol. and Med., 1954, 52, 243-245; N.Y. State Journ. Med., Vol. 55, 6-1-25, No. 11, 700-732; Lancet, Feb. 1955, Vol. XCV, Pt. 2, 148-154; Lancet, Jan. 1957, Vol. XXIV, Pt. 1, 39-40

for MARCH, 1950 305

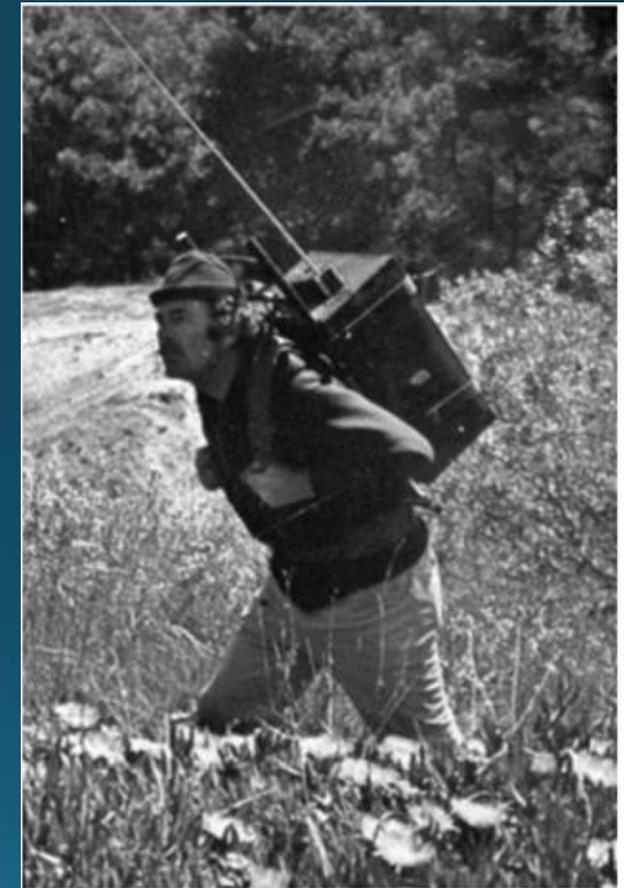
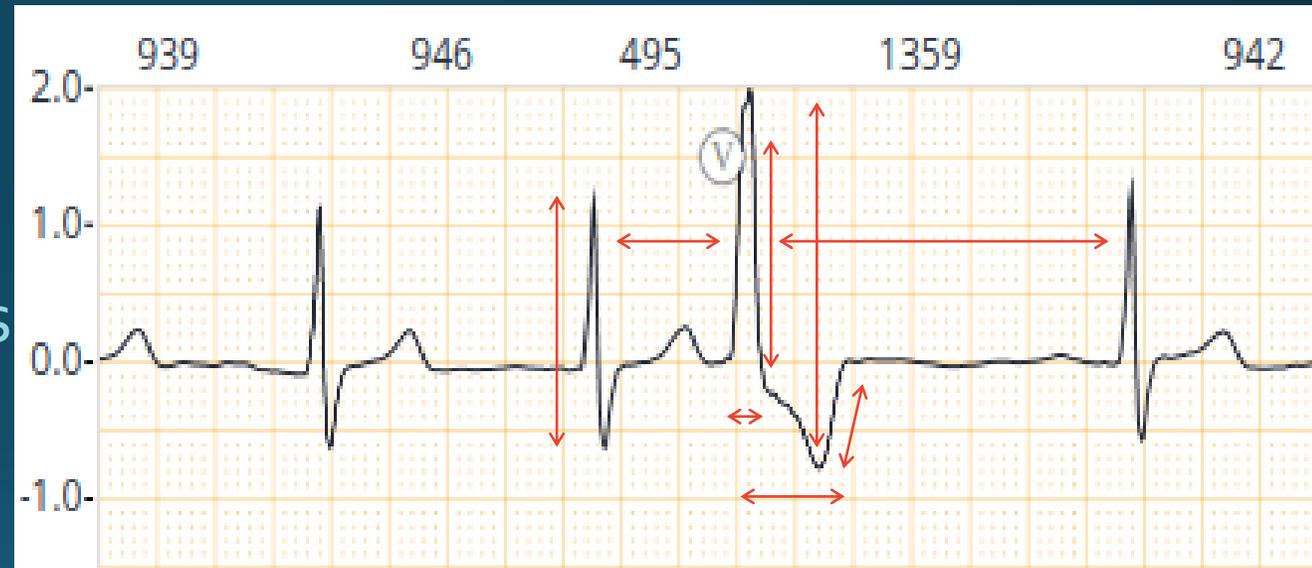


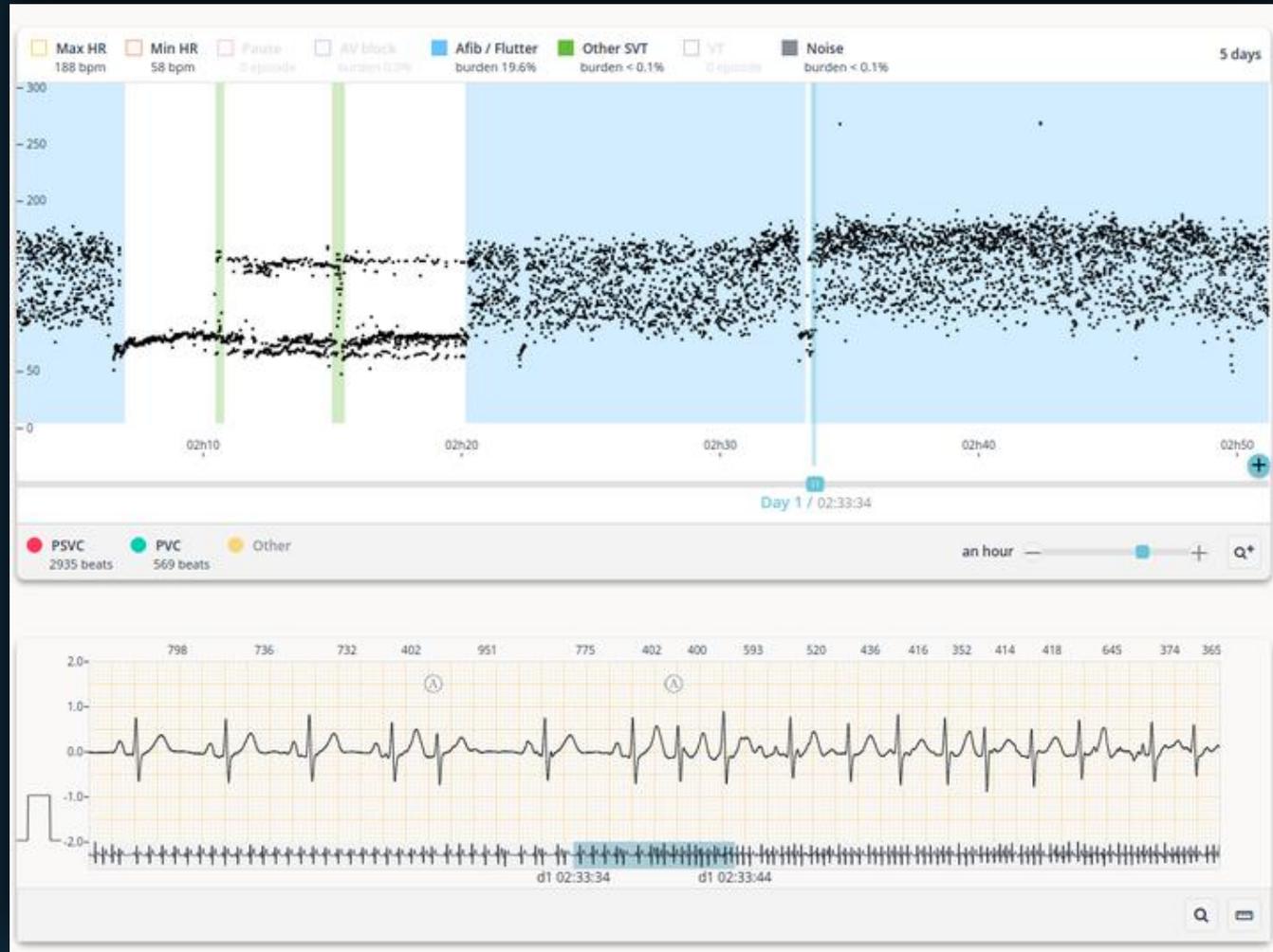
Figure 1. (A) Radiotransmitter in the form of an 85-pound backpack whose signal was carried a distance of one block.

Deep Learning

- **Détection des ECG automatique**
 - Apprentissage sur des milliers de paramètres
 - Besoin de beaucoup d'exemples (Cardiologs base de données de 200 millions d'ECG et 40 000 ans de signal ECG Holter)



Atrial Fibrillation

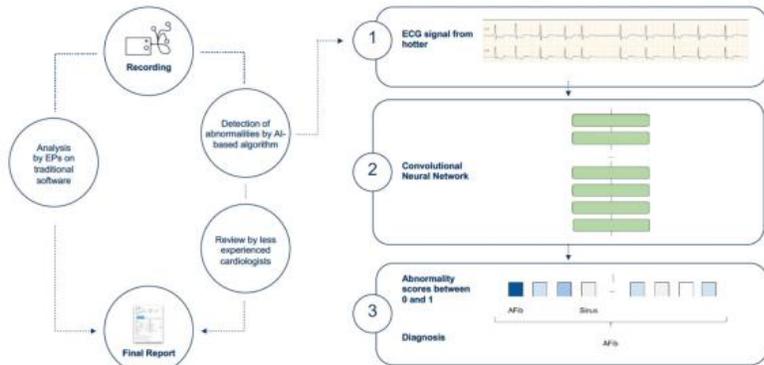


IA en pratique courante: n=1000 Holters sur 3 centres

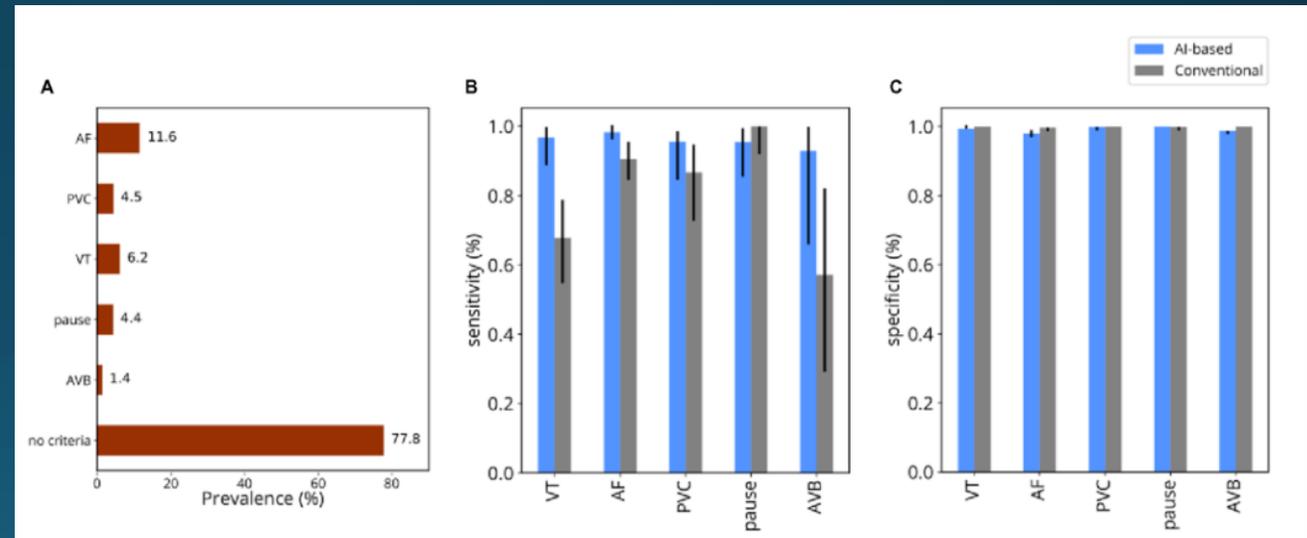
Evaluation of an Ambulatory ECG Analysis Platform Using Deep Neural Networks in Routine Clinical Practice

Laurent Fiorina, MD ; Carole Maupain, MD; Christophe Gardella, PhD ; Vladimir Manenti, MD ; Fiorella Salerno, MD; Pierre Socie, MD ; Jia Li, MSc; Christine Henry, MSc ; Audrey Plesse, MSc; Kumar Narayanan, MD, FHRS; Aurélie Bourmaud, MD ; Eloi Marijon, MD, PhD

Panel A



Panel B





Screening strategies for AF—Section 10.3

Review of an ECG (12-lead, single, or multiple leads) by a physician is recommended to provide a definite diagnosis of AF and commence appropriate management.

Population-based screening for AF using a prolonged non-invasive ECG-based approach should be considered in individuals aged ≥ 75 years, or ≥ 65 years with additional CHA₂DS₂-VA risk factors to ensure earlier detection of AF.

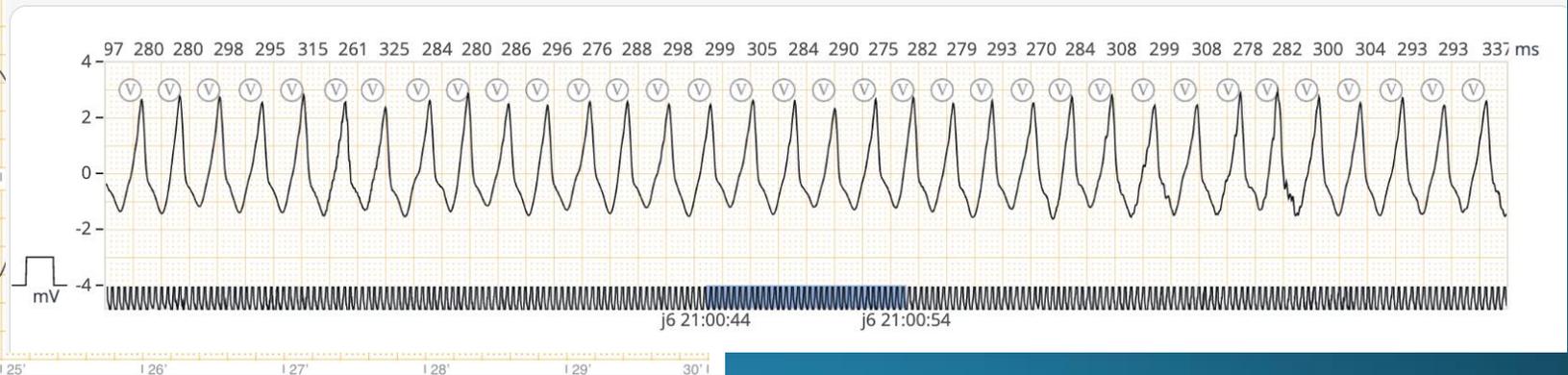
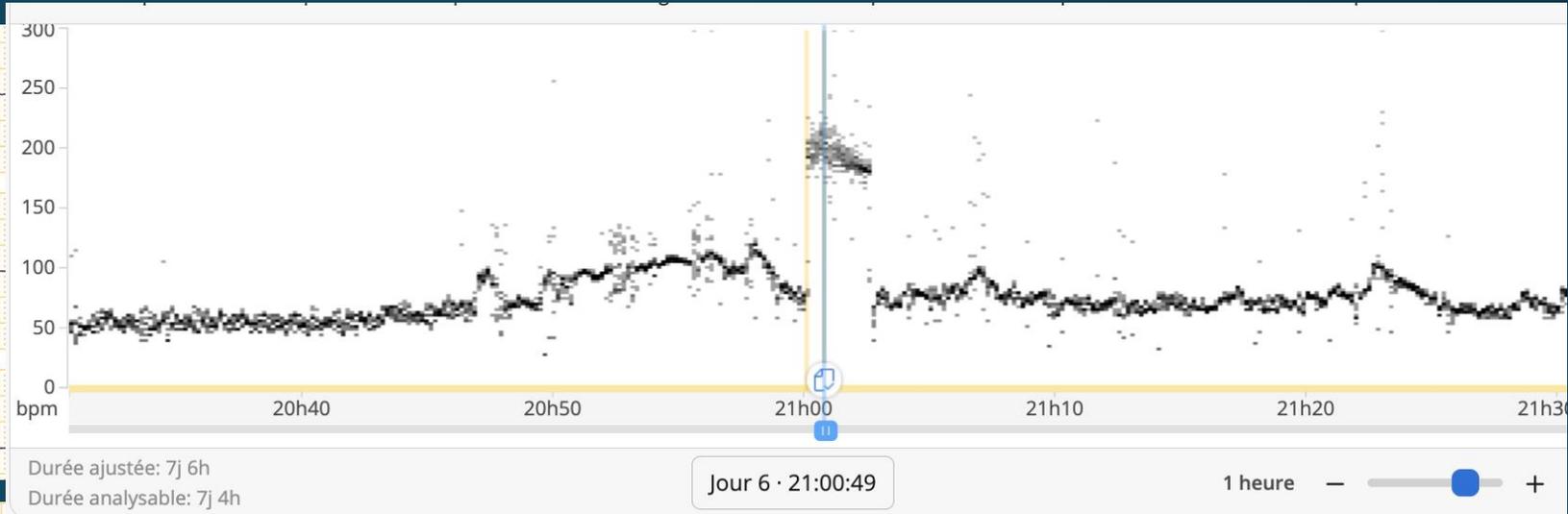
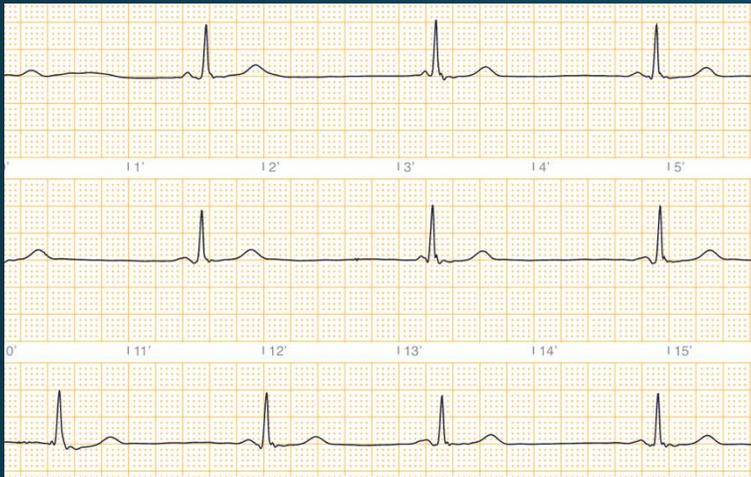
I	B
IIa	B



Tachogram = Periodic, opportunistic measurements
 5 confirmations = notify user
 Positive triggers frequent measurements
 Not confirmed = return to usual sampling

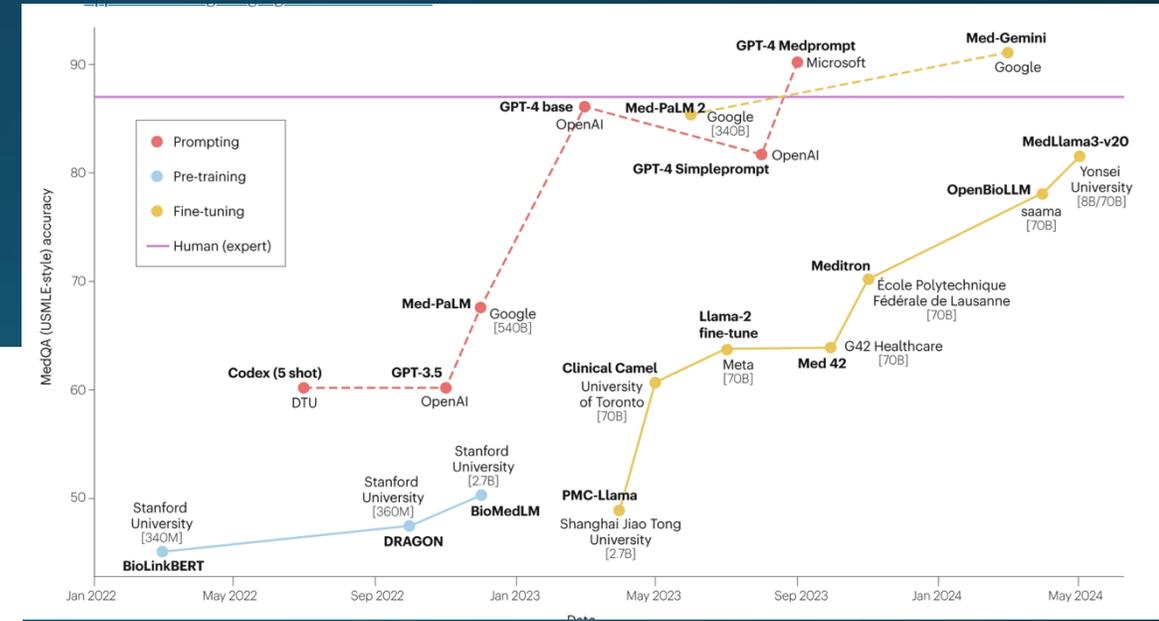
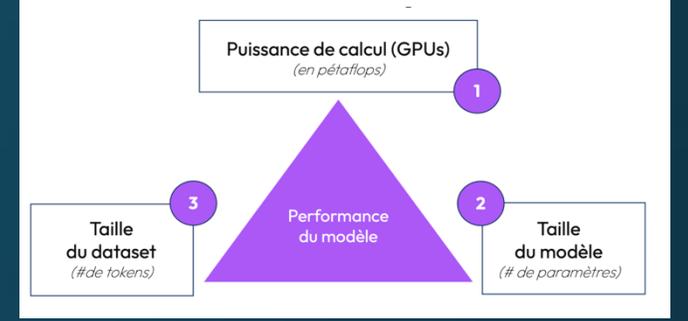
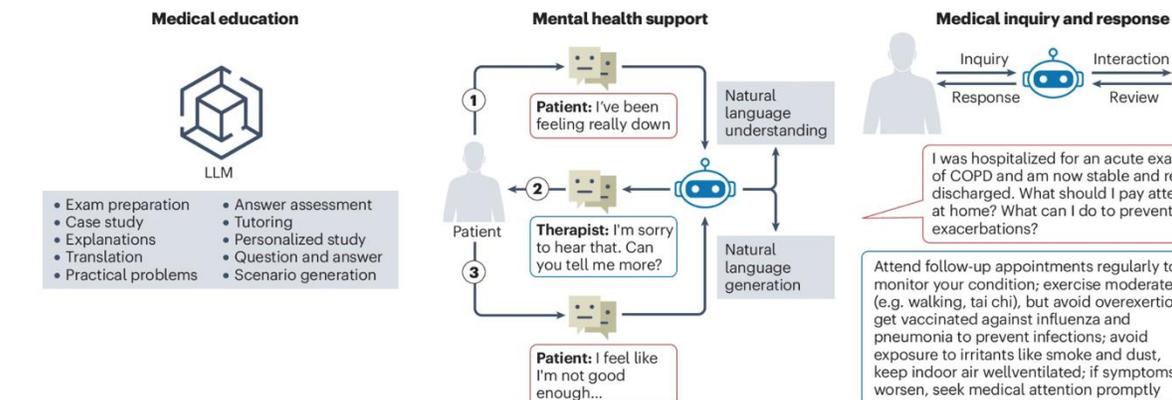
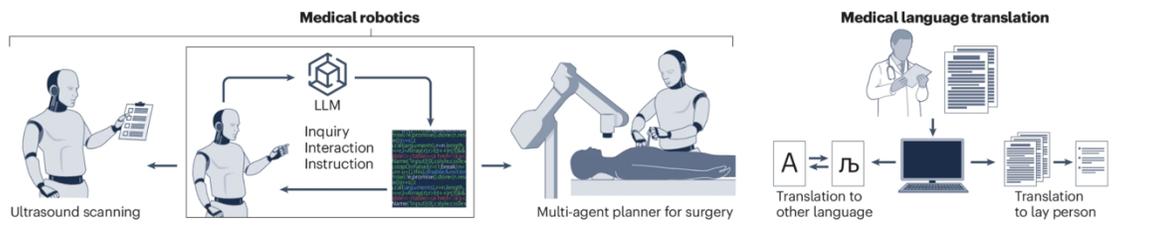
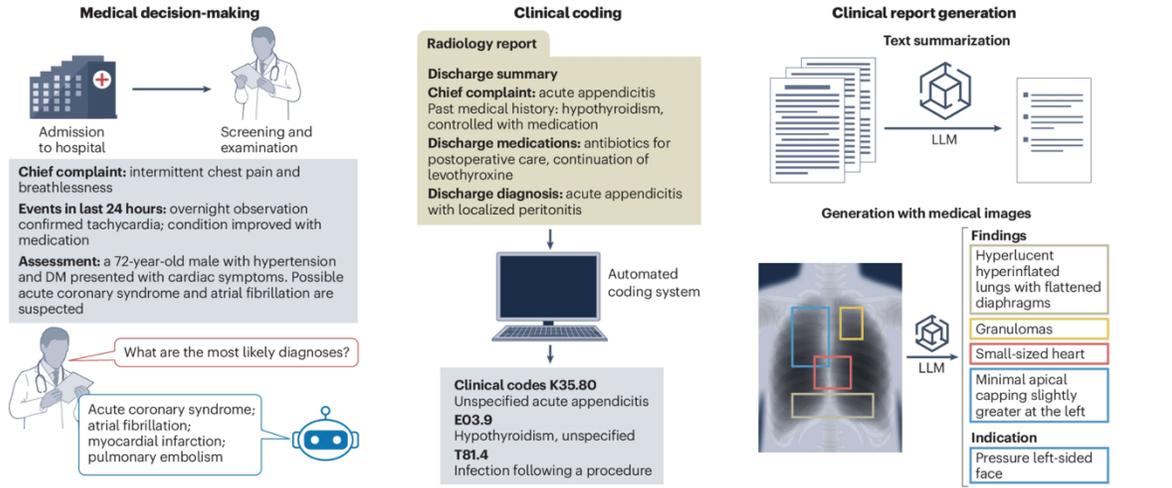


Homme de 50 ans FEVG 45%, lipothymie



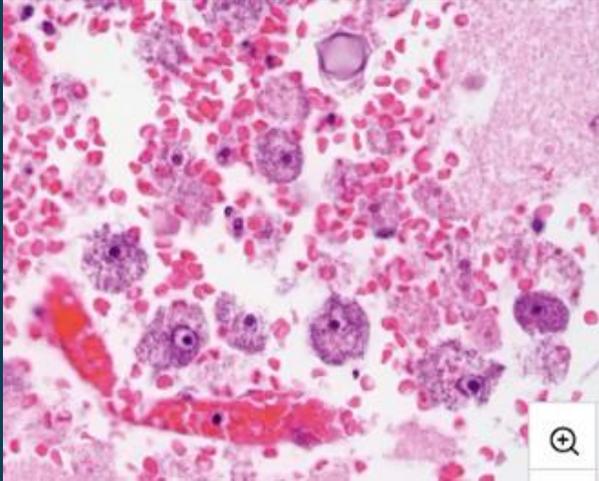
LLM pour l'aide au diagnostic

From: [Application of large language models in medicine](#)



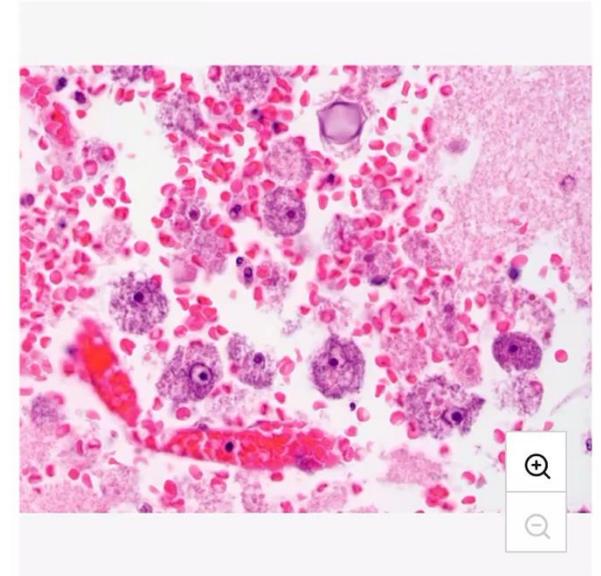
Liu, F., Zhou, H., Gu, B. *et al.* Application of large language models in medicine. *Nat Rev Bioeng* 3, 445–464 (2025). <https://doi.org/10.1038/s44222-025-00279->

NEJM Image challenge



- Granulomatous amebic encephalitis
- Gliomatosis cerebri
- Rabies
- Human polyomavirus 2
- Creutzfeldt-Jakob disease

21:22



f X in e b

An 82-year-old man presented to the emergency department with a 2-week history of generalized weakness and altered mental status. He was started on empiric treatment for meningitis, but he continued to have progressive neurologic decline with the development of seizures, and died 9 days later. Autopsy of the brain showed liquefactive necrosis. Microscopy is as shown. What is the diagnosis?



nejm.org



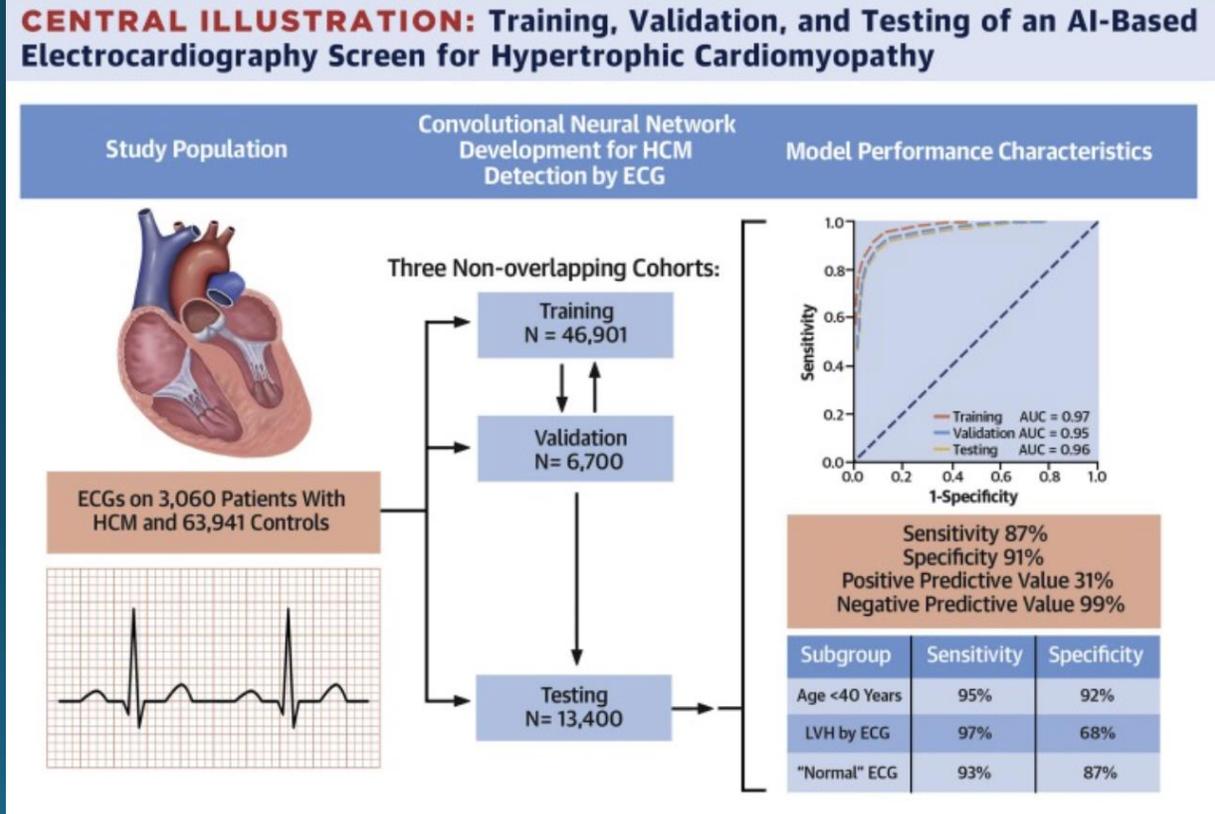
L'IA comme détecteur de trésor

- FEVG
- CMH
- Valvulopathies
- Canalopathies
- Dyskaliémie
- Glucose
- ...



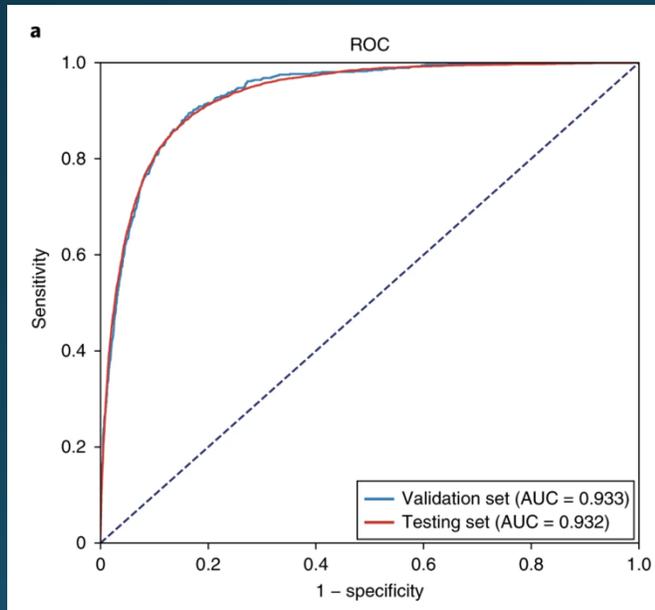
CMH

- N=13400, prev=4,6%: AUC= 0,96
- Si ECG « normal »: AUC= 0,95
- Si HVG sur ECG: AUC= 0,95



FEVG < 35% sur ECG 12D

- N=52000 rétrospective, prev=7,8% : AUC=0,93
- N=3874 prospective, prev=7% : AUC=0,91

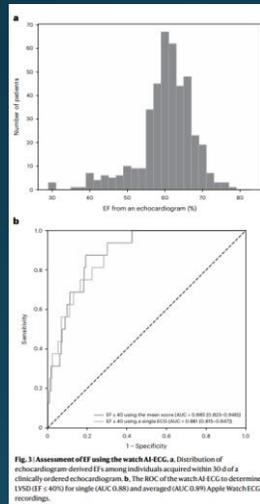


Sur Smartwatch! Ou Stethoscope!

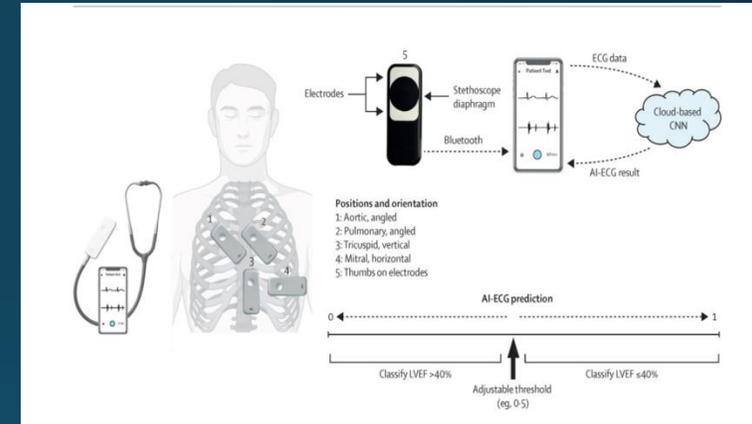
- N=421 « à domicile »
- FEVG < 40%
- AUC = 0,88



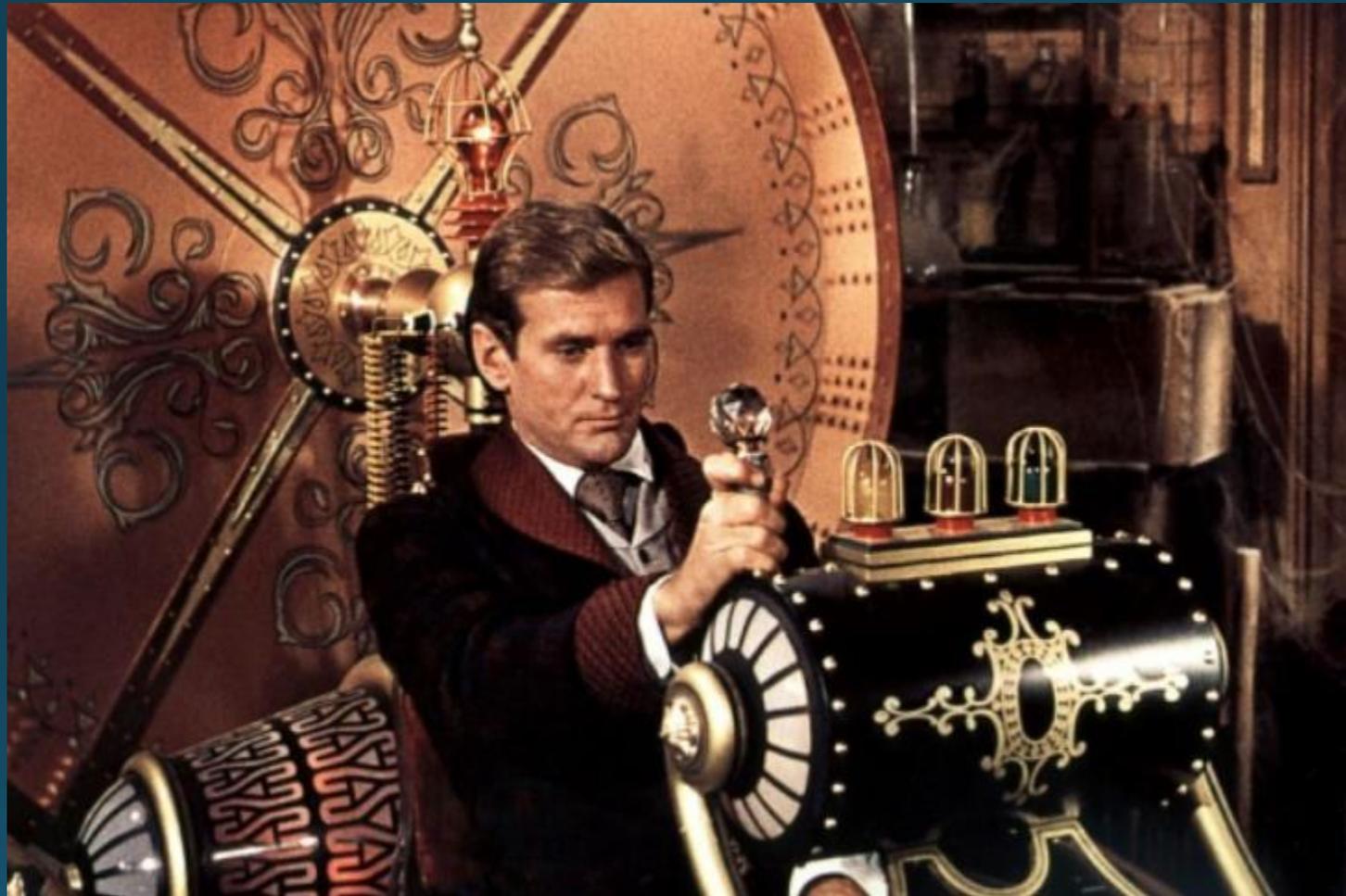
- N=1050
- FEVG < 40%
- AUC = 0,91



Attia ZI, Harmon DM, Dugan J, Manka L, Lopez-Jimenez F, Lerman A, et al. Prospective evaluation of smartwatch-enabled detection of left ventricular dysfunction. Nat Med. déc 2022;28(12):2497-503.



Bachtiger P, Petri CF, Scott FE, Park SR, Kelshiker MA, Sahemey HK, et al. Point-of-care screening for heart failure with reduced ejection fraction using artificial intelligence during ECG-enabled stethoscope examination in London, UK: a prospective, observational, multicentre study. The Lancet Digital Health. 1 févr 2022;4(2):e117-25.



»Death is sometimes a punishment, often a gift, and for many a favor. »

- Lown et Wolf

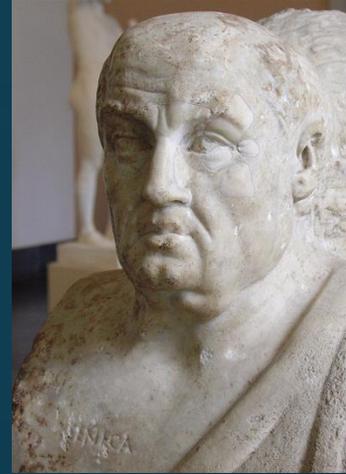


Table I The grading system for ventricular premature beats devised by Lown and Wolf

Grade	Observed
0	No VPB
1	Occasional, isolated VPB
2	Frequent VPB $> 1 \text{ min}^{-1}$ or $> 30 \text{ h}^{-1}$
3	Multiform VPB
4(a)	Repetitive VPB: couplets
4(b)	Repetitive VPB: salvos
5	Early VPB (note Class 5 previously included VT)

VPB, ventricular premature beats; VT, ventricular tachycardia.

Approaches to Sudden Death from Coronary Heart Disease

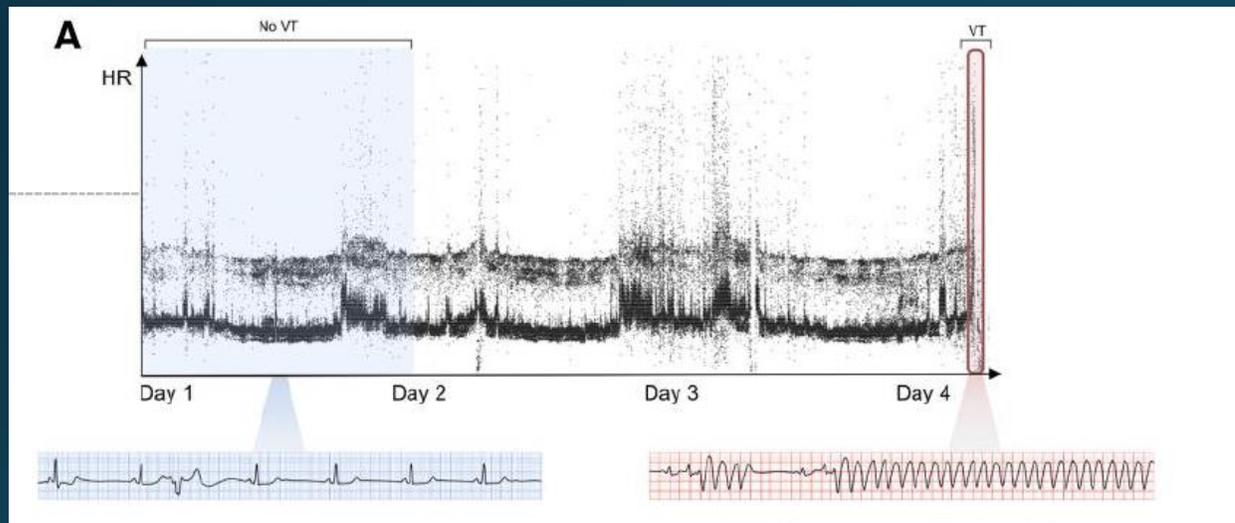
By BERNARD LOWN, M.D., AND MARSHALL WOLF, M.D.

N=220 post IDM

Circulation, Volume XLIV, July 1971

Near-term prediction of sustained ventricular arrhythmias applying artificial intelligence to single-lead ambulatory electrocardiogram

Laurent Fiorina ^{1,2,†}, Tanner Carbonati ^{3,†}, Kumar Narayanan ^{2,4}, Jia Li ³, Christine Henry ³, Jagmeet P. Singh ⁵, and Eloi Marijon ^{2,6,*}



Study population

14-day ambulatory ECG recordings from 247 254 patients collected across 6 countries (US, UK, France, Czech Republic, South Africa, and India)

The first 24 hours of each recording are used to predict the risk of sustained VT in the following 13 days

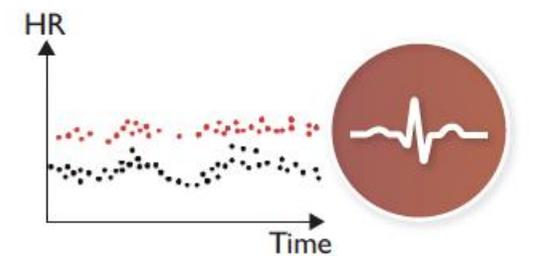
2019-01-01 2023-07-01 2024-01-01

Development
N = 183 177
(804 VT)

Internal validation
N = 43 580
(197 VT)

External validation
N = 20 497 (103 VT)

Deep learning-based model



Convolutional neural network

Convolutional neural network

Attention

Attention

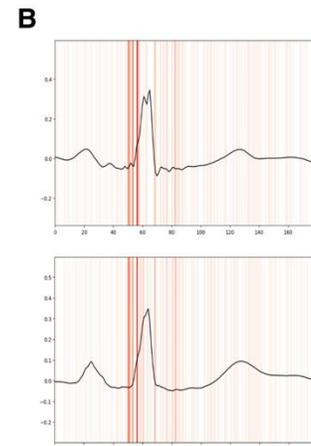
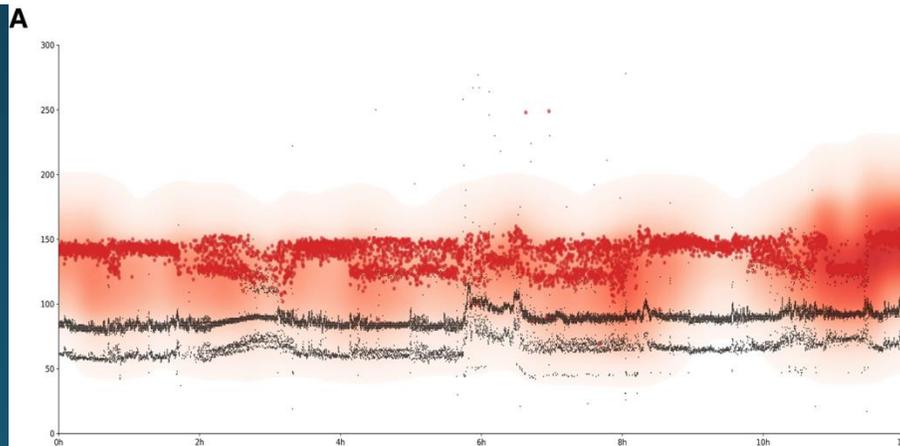
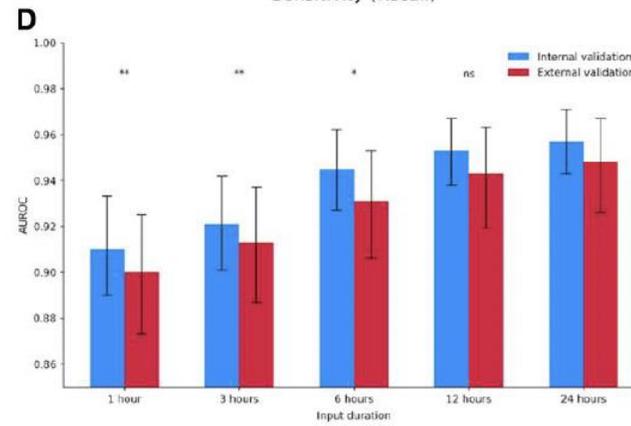
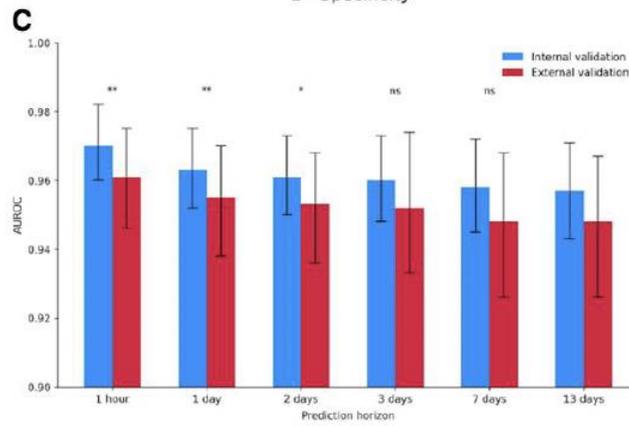
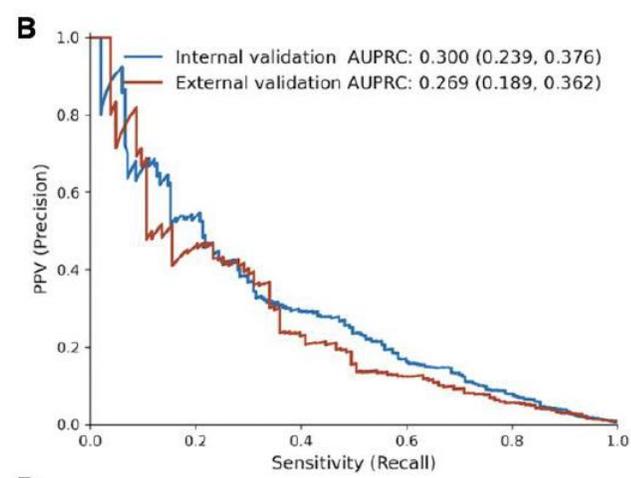
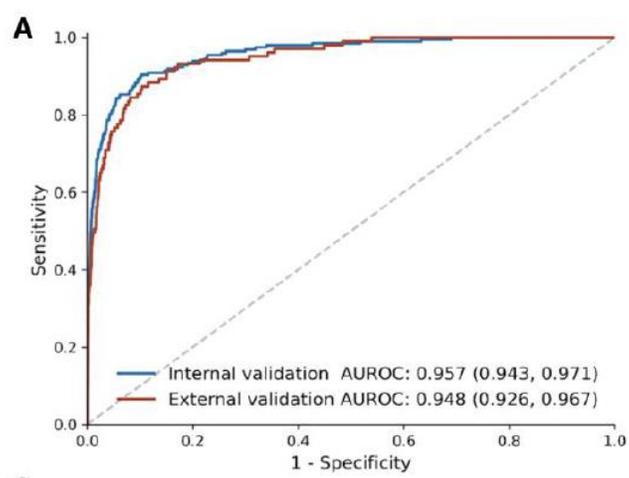
Embedding

Embedding

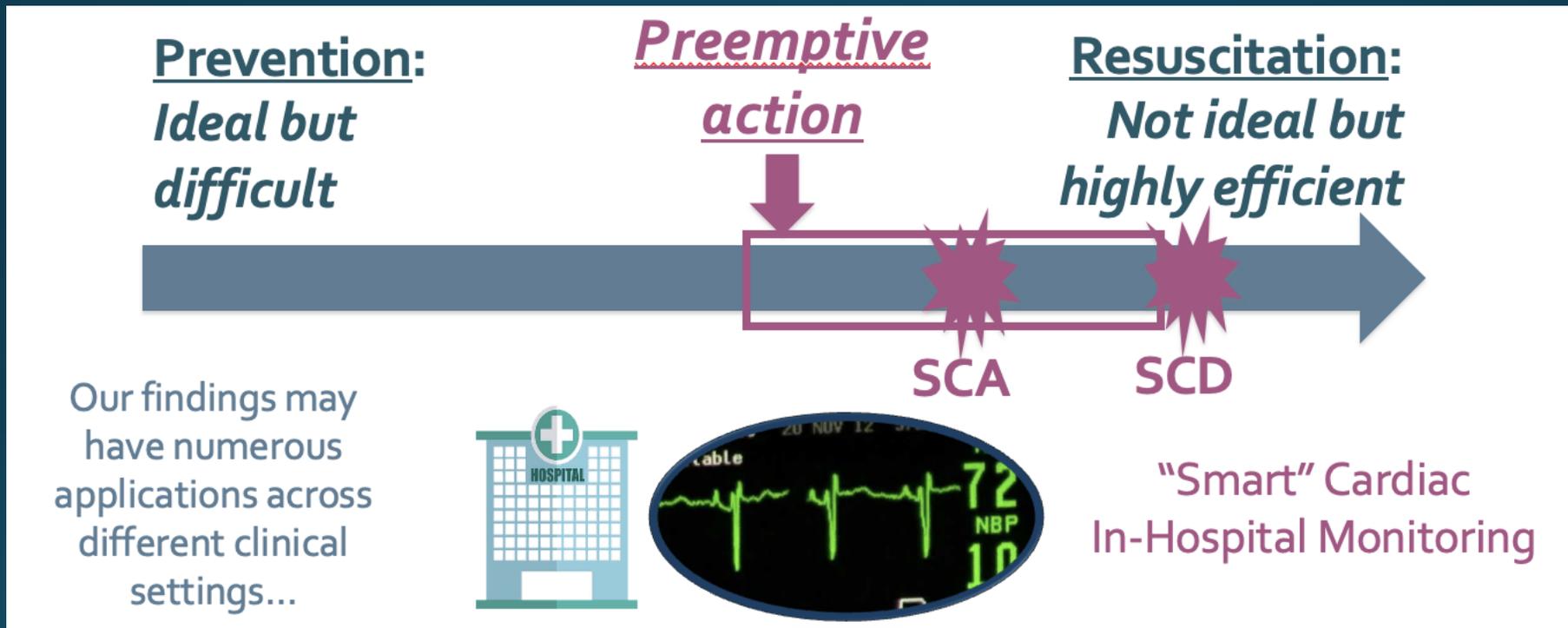
Fusion

Low risk

High risk

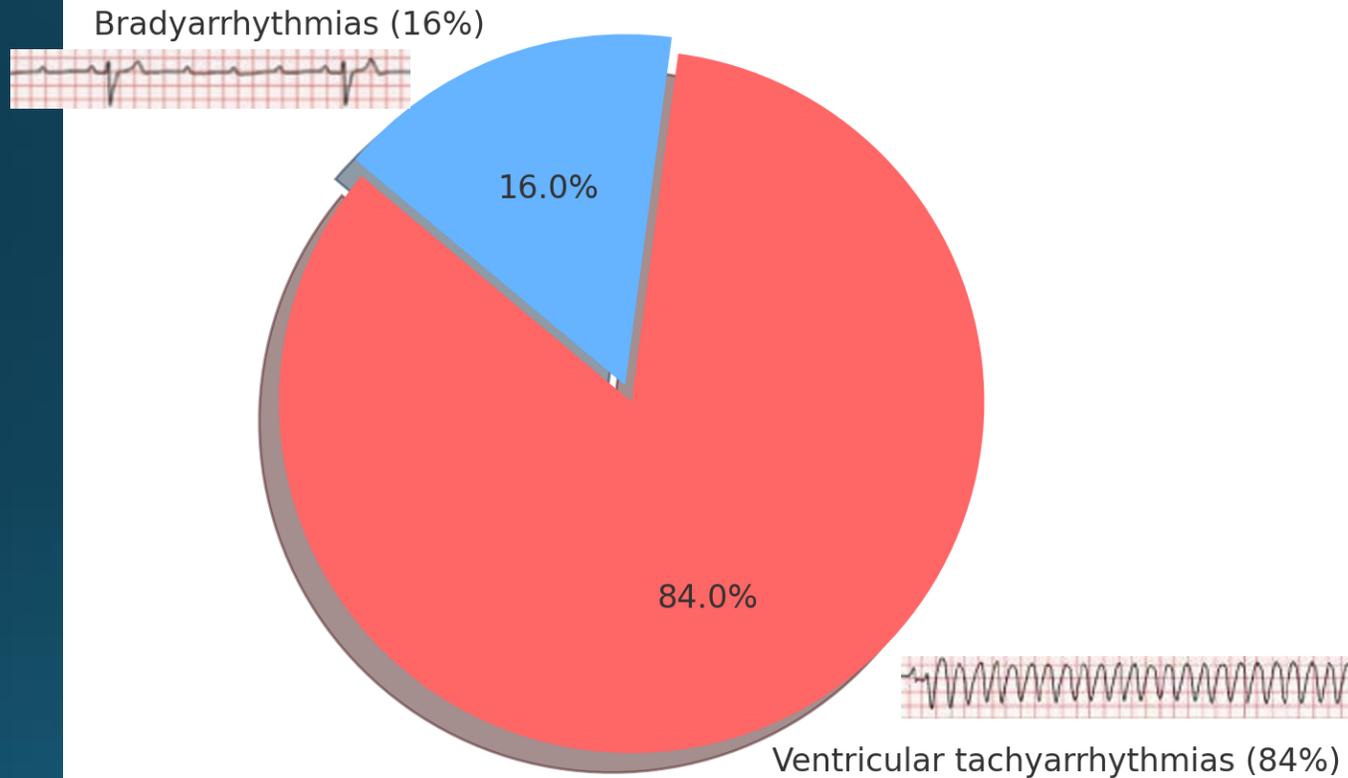


Perspectives



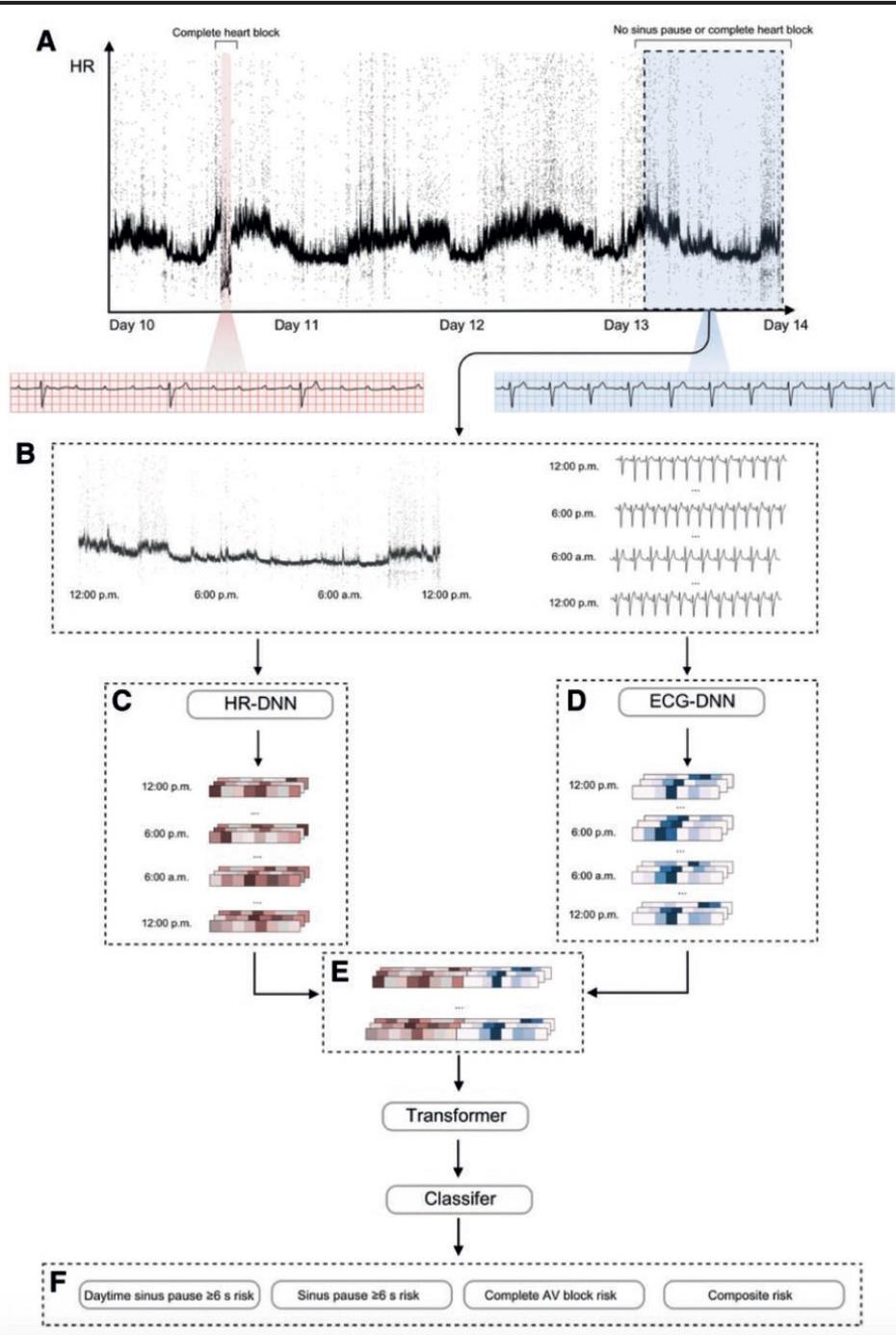
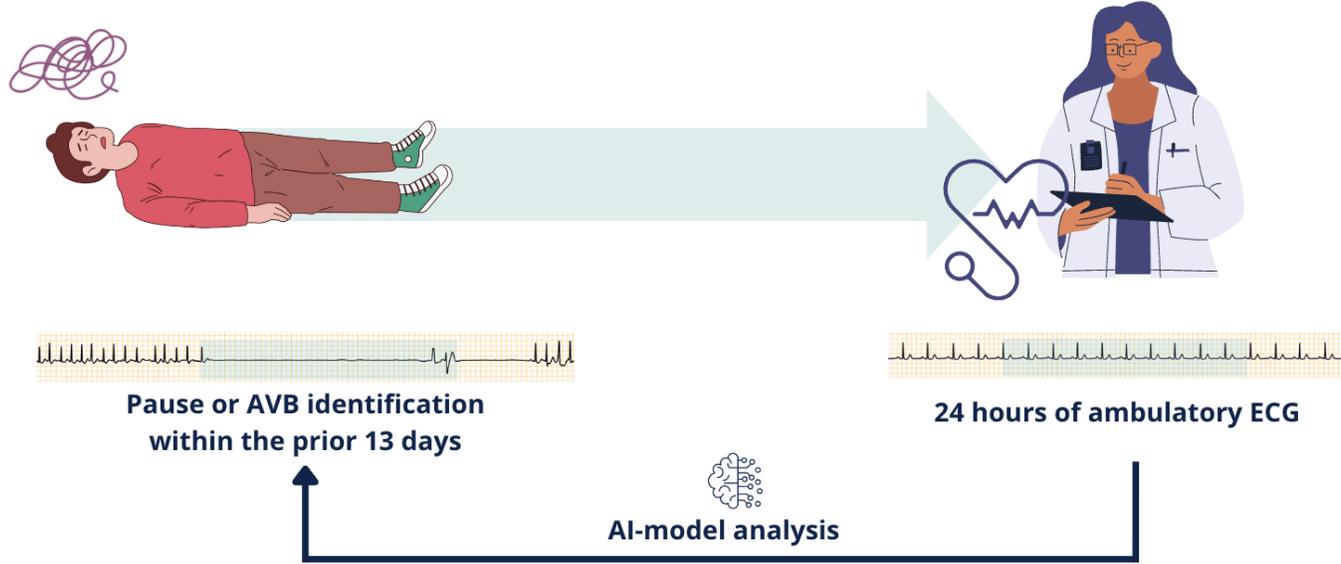
Au delà de la TV...

Terminal electrical events in sudden death (Holter studies)



Antonio Bayés de Luna, Philippe Coumel, Jean François Leclercq,
Ambulatory sudden cardiac death: Mechanisms of production of fatal arrhythmia on the basis of data from 157
cases, American Heart Journal, Volume 117, Issue 1, 1989,

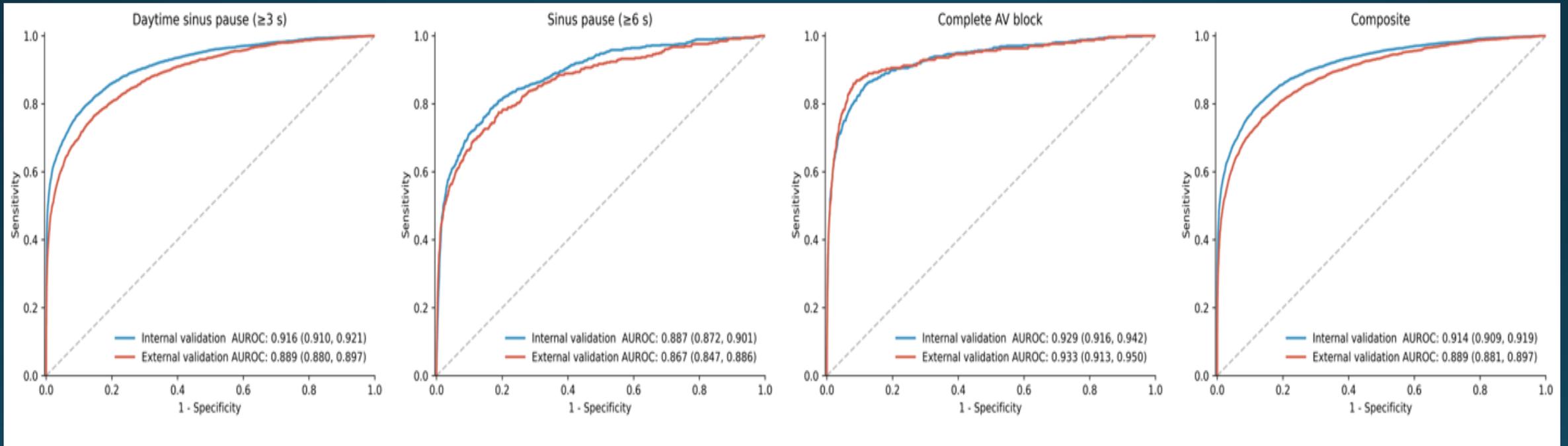
Back to the Future: Artificial intelligence-enabled single-lead ambulatory ECG can unmask conduction tissue disease



ORIGINAL ARTICLE

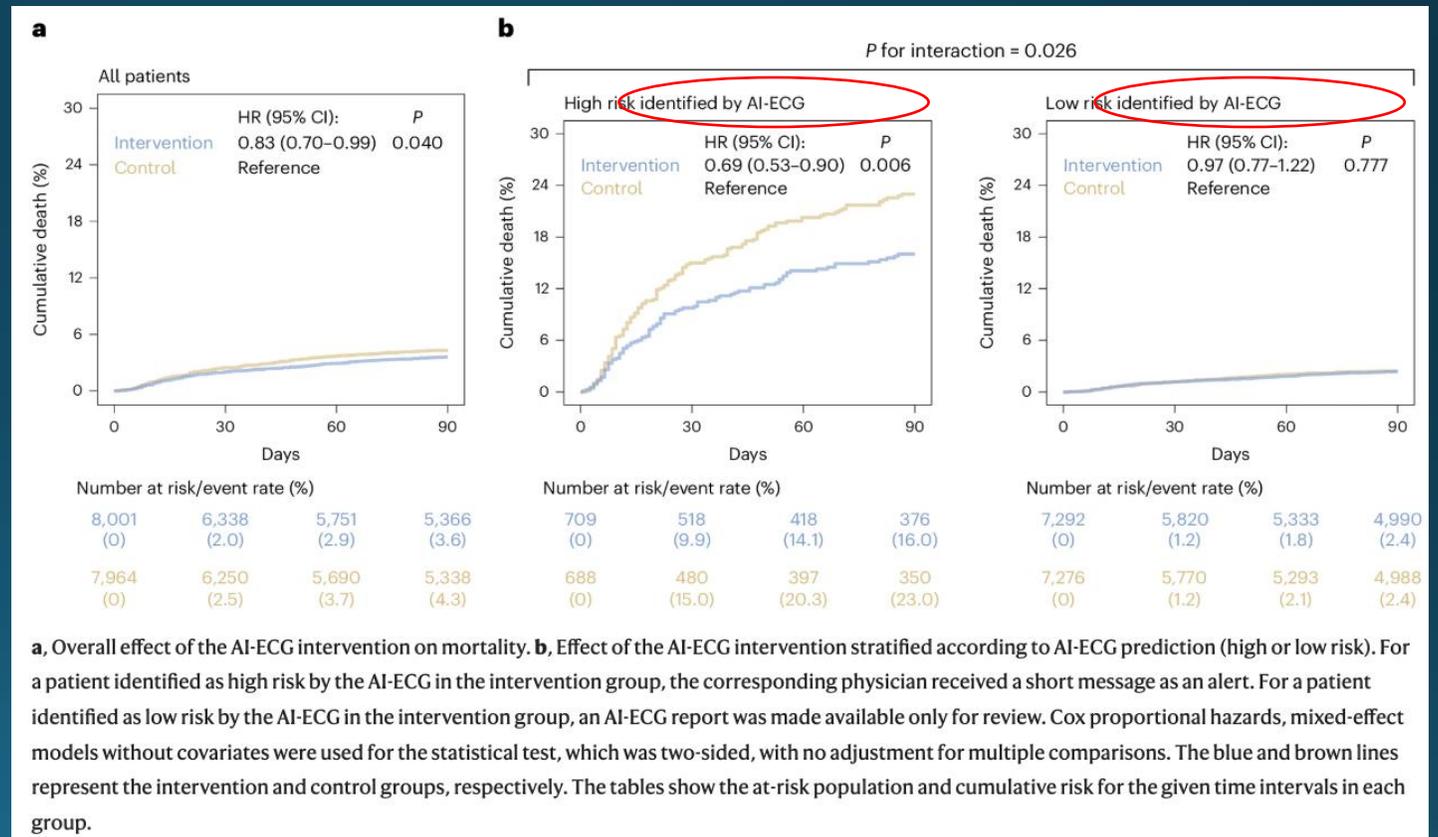
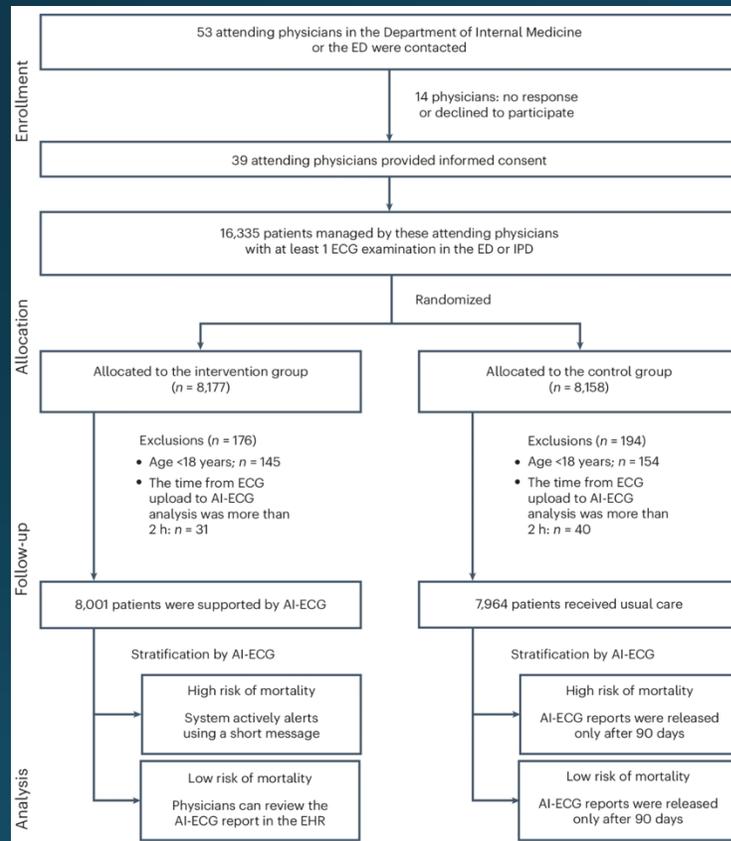
Deep Learning Can Unmask Conduction Tissue Disease From an Ambulatory ECG

Laurent Fiorina¹, MD*; Tanner Carbonati¹, BSc*; Baptiste Maille¹, MD; Kumar Narayanan¹, MD; Pauline Porquet¹, MSc; Christine Henry¹, MSc; Jagmeet P. Singh¹, MD, PhD; Eloi Marijon¹, MD, PhD; Jean-Claude Deharo¹, MD, PhD



1ere étude randomisée usage de l'IA et mortalité

- Model développé à partir d'une cohorte de 300 000 patients hospitalisés, 600 000 ECG: mortalité à 1 an et à 90 jours (AUC 0,83/ 0,90)



En résumé

- Diagnostic rapide et à grande échelle, avec une surveillance intensive
- Dépasser l'analyse experte traditionnelle



- Anticiper les événements futurs



- Prochainement... Études randomisées d'intervention et accès aux modèles d'IA

Talos le géant de bronze

