



PLATFORM OF LABORATORIES FOR ADVANCES IN CARDIAC EXPERIENCE

ROMA
Centro Congressi
di Confindustria
Auditorium
della Tecnica

9^a Edizione
30 Settembre
1 Ottobre
2022

CONNECTED HEALTH

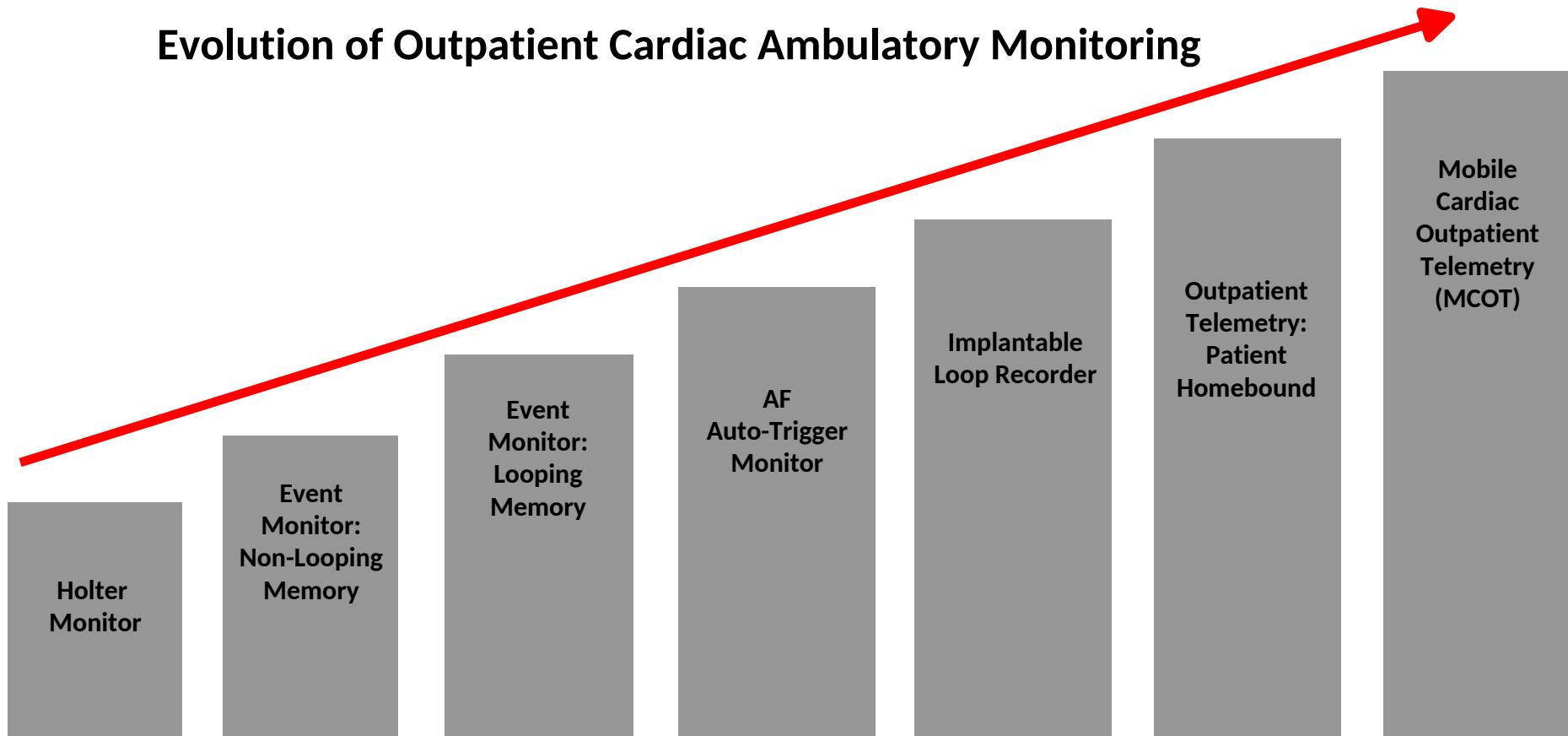
WEARABLE DEVICES IN ARITMOLOGIA: FRIENDS OR FOE?. ECG ED ALTRI PARAMETRI A PORTATA DI MANO.

MARCO REBECCHI
ARITMOLOGIA CLINICA ED INTERVENTISTICA
POLICLINICO CASILINO
ROMA

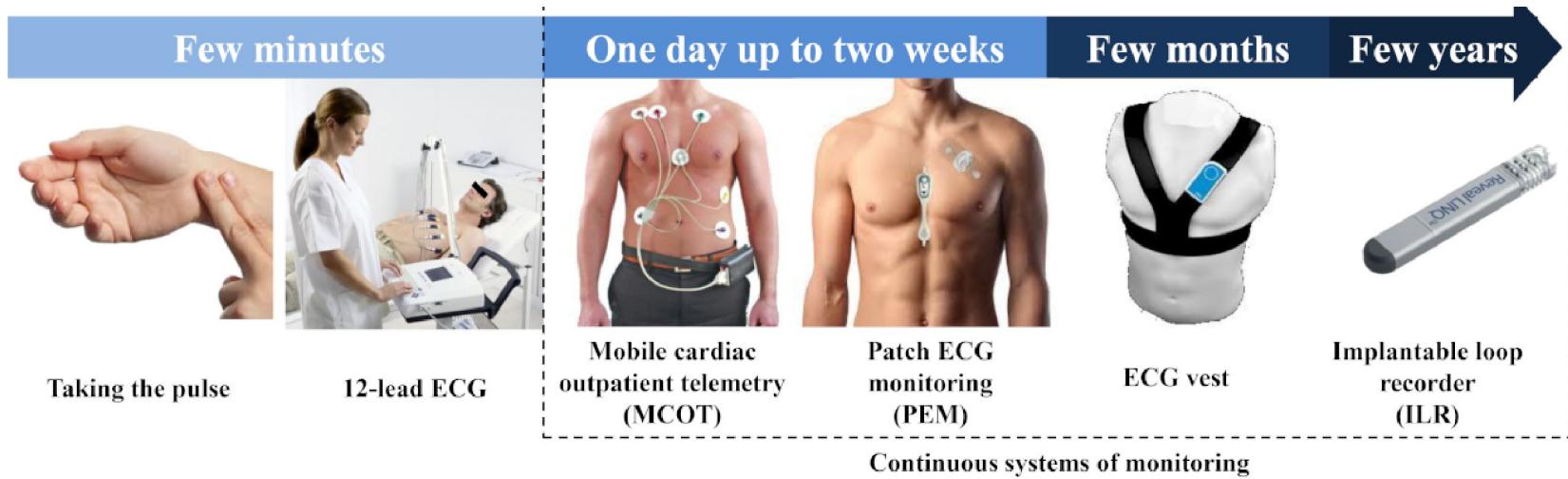


THE EVOLUTION OF OUTPATIENT AMBULATORY CARDIAC MONITORING

Evolution of Outpatient Cardiac Ambulatory Monitoring



heart rhythm monitoring



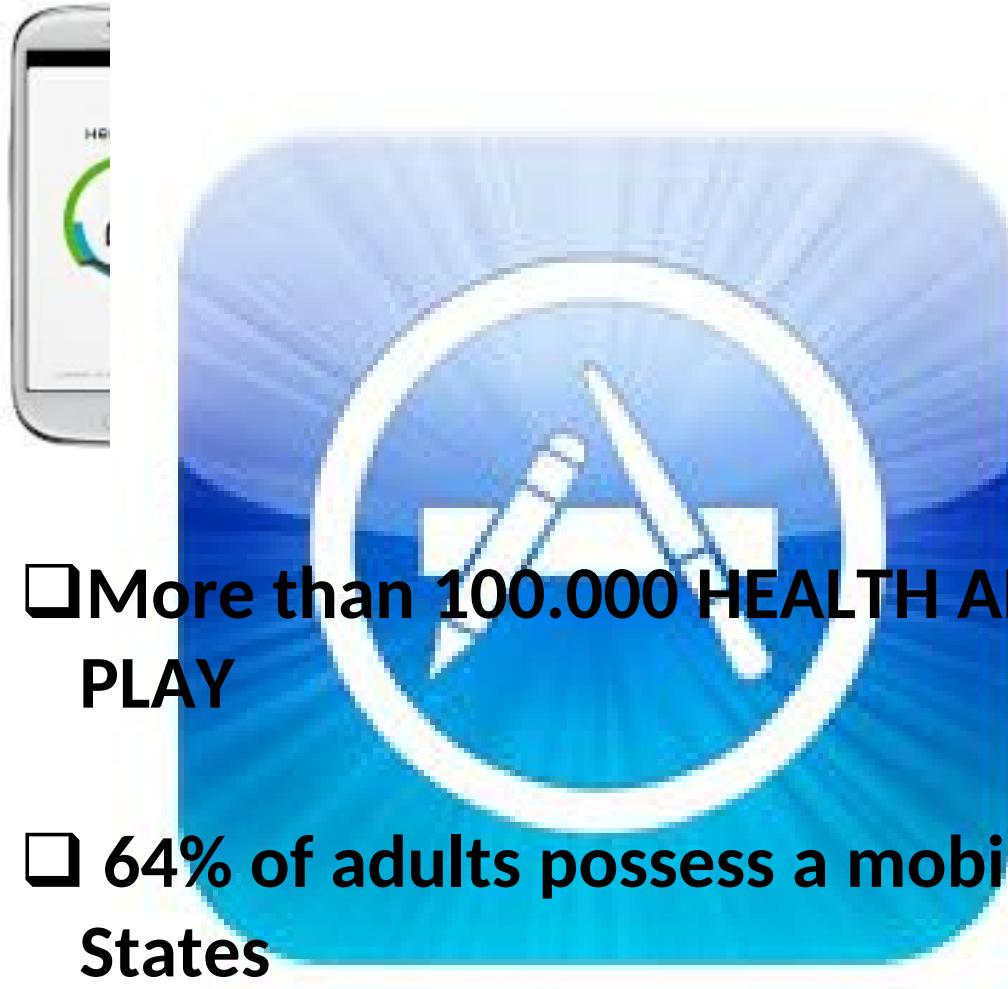
E-Health e m-Health: La sfida della gestione digitale della salute (il presente ed il futuro)



Col termine **e-Health** facciamo riferimento all'utilizzo delle tecnologie informatiche e di telecomunicazione in ambito sanitario.



L'**m-Health** può esserne definita una sottocategoria perché riguarda i servizi che sono effettuati attraverso l'uso di apparecchi mobili e wireless come smartphone e tablet.



- More than 100.000 HEALTH APPS on ITUNES and GOOGLE PLAY
- 64% of adults possess a mobile phone in the United States
- 62% of mobile phone owners use their phones to access health information

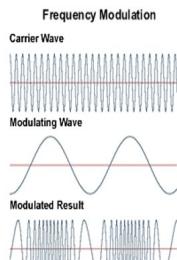
App Store

Google play

m-Health ECG Monitoring

- ❖ **handheld electrocardiograph (ECG) recorders (External Sensors).** the handheld ECG recorder is also based primarily on
 - a mobile phone
 - mobile phone app interface.
 - an additional external component, an ECG sensor unit, is required for the app to function adequately.
- ❖ mobile phone-based on **photoplethysmography (PPG and internal sensor)**

Smartphone as 1-lead ECG with automated interpretation (KARDIA MOBILE-ALIVE COR)



- 30 sec to 5 min recordings
- 300 Hz sampling rate
- Electrical impulses modulate in frequency a sinusoidal ultrasound, digitizes by the smartphone's microphone

CE marked and FDA Class II cleared

iOS or Android

FDA-cleared algorithm:

- **Normal Detector (HR between 50 and 100 BPM)**
- **Interference Detector (recording is unreadable)**
- **AF Detector based on criteria of p-wave absence and R-R interval irregularity. (In 204 pts, Se 98%, Sp 97%) [Lau JK et al, Int J Cardiol 2013].**



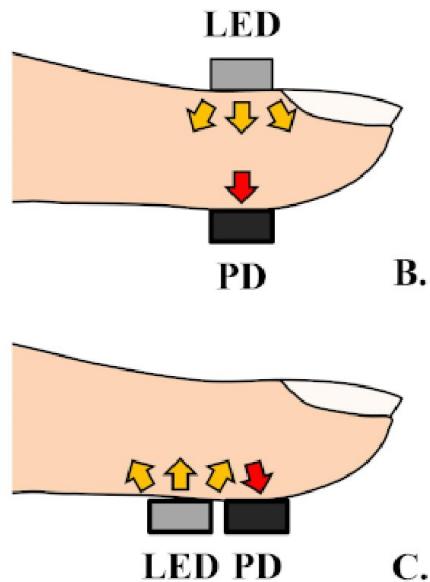
Potential limitations of mobile ECG (m-ECG) devices

- Esperienza del paziente che lo utilizza (mal posizionamento delle dita sui sensori)
- Limitazioni tecniche
 - TYPICAL THUMB CONTACT
 - WITH PRACTICE
 - ELECTRODES
- Affidabilità degli algoritmi di analisi
- Necessità di una connessione per l'interpretazione
- Costi del dispositivo e del servizio addebitati al cliente

Photoplethysmography

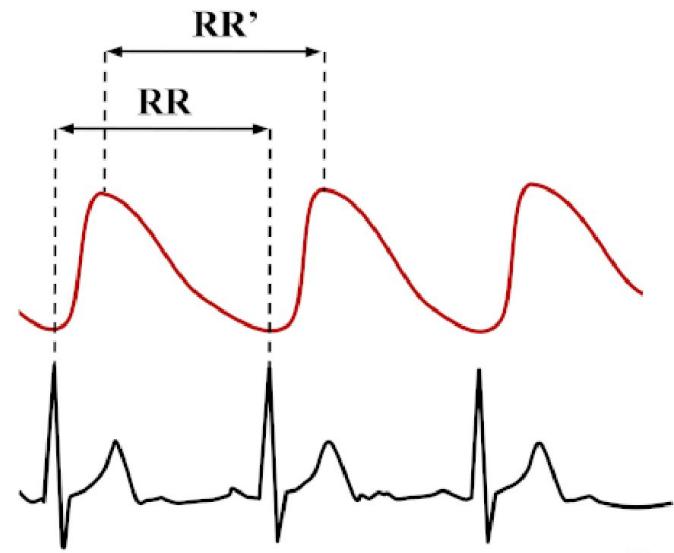


A.



B.

C.



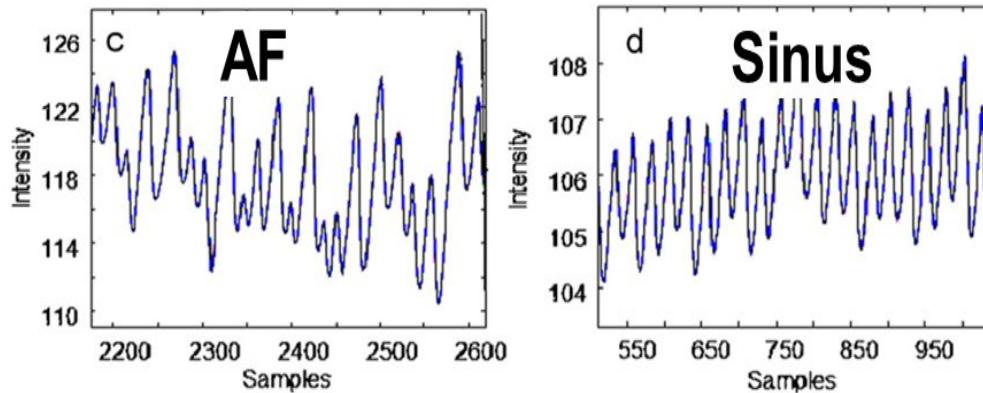
D.

Smartphone-based apps using internal sensors



Camera pulsometry (m-PPG)

- **76 pts with persistent AF**
- **2 min before and after cardioversion using an iPhone 4S camera**
- **Se 96.1%, Sp 97.5% in distinguishing pulse recordings during AF from those in sinus rhythm.**



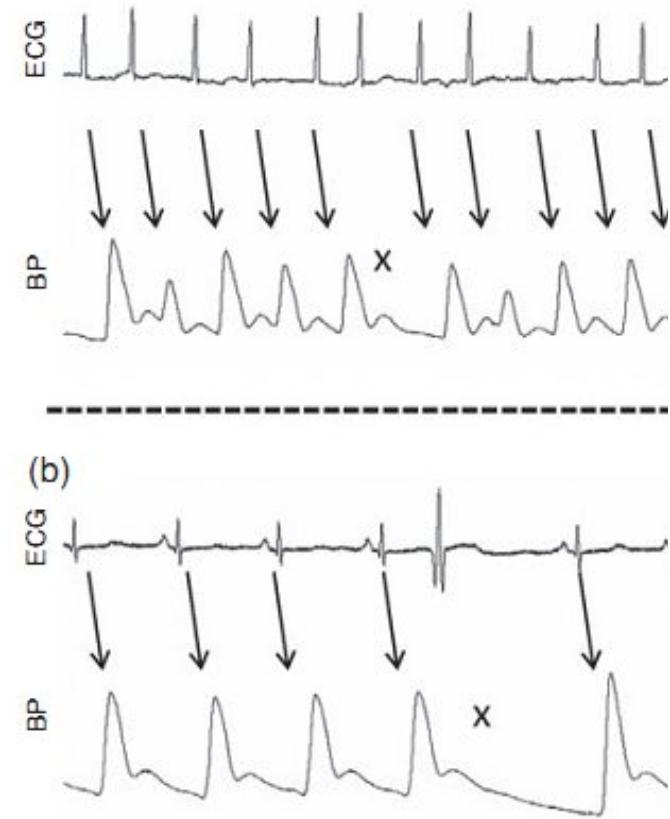
[McManus D et al, Heart Rhythm 2013]

98 pts with AF (91 pre and post successful cardioversion), 15 with PACs and 15 with PVCs: Se 97%, Sp 93.5% [McManus D et al, J CV Electrophys 2015]

Limitations of m-PPG

Camera pulsometry limitations

- Artefatti di movimento
- Luce ambientale
- Riscaldamento della fotocamera
- Sudorazione
- Dita fredde
- aritmie



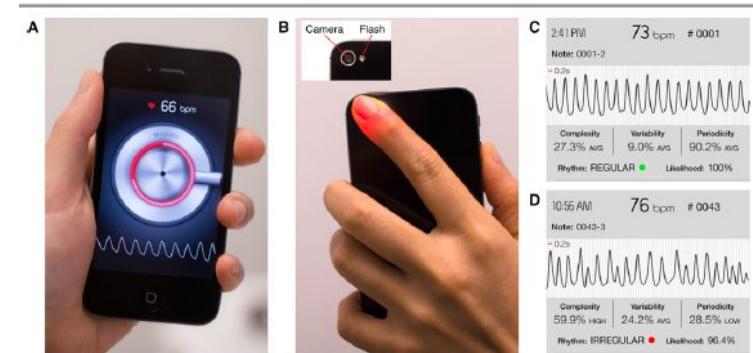
[Bruining N et al. Eur J Prev Cardiol 2014]

Finger m-PPG CardioRhythm application

Diagnostic Performance of a Smartphone-Based Photoplethysmographic Application for Atrial Fibrillation Screening in a Primary Care Setting

Pak-Hei Chan, MBBS;* Chun-Ka Wong, MBBS;* Yukkee C. Poh, PhD; Louise Pun, BA; Wangie Wan-Chiu Leung, MBBS; Yu-Fai Wong, MBBS; Michelle Man-Ying Wong, MBBS; Ming-Zher Poh, PhD;† Daniel Wai-Sing Chu, MBBS;† Chung-Wah Siu, MD†

- **1013 outgoing patients** aged ≥ 65 years (mean age 68 ± 12 yo, 47% male)
- **30 sec iECG (Alivecor)**
- **m-PPG, iPhone4, Cardio Rhythm app, 17 sec acquisition x 3 times**
- **12-leads ECG within 15 min if Irregular Alert by iECG or by m-PPG**



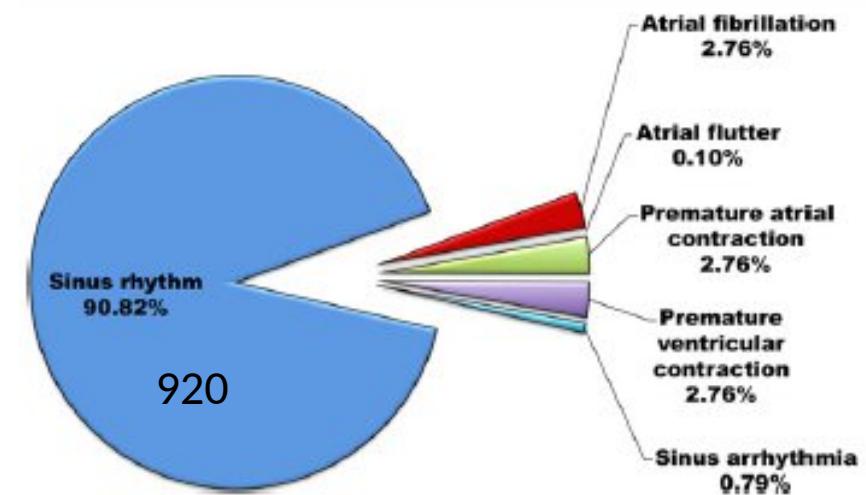
RESULTS

28 AF, 5 Newly diagnosed

Se 92.9%

m-PPG vs 12-leads ECG

Sp 97.7



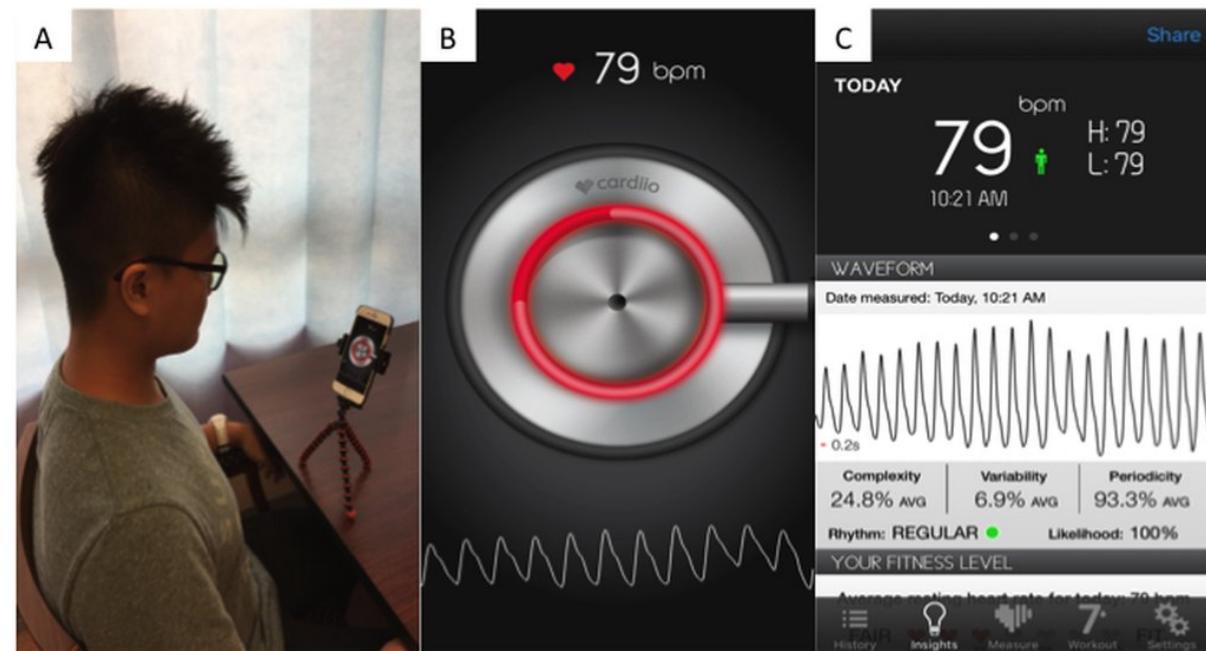
Facial m-PPG CardioRhythm application

the CardiioRhythm app was used to analyze facial PPG signals in

217 patients recorded using the front camera of an iPhone 6S without physical contact

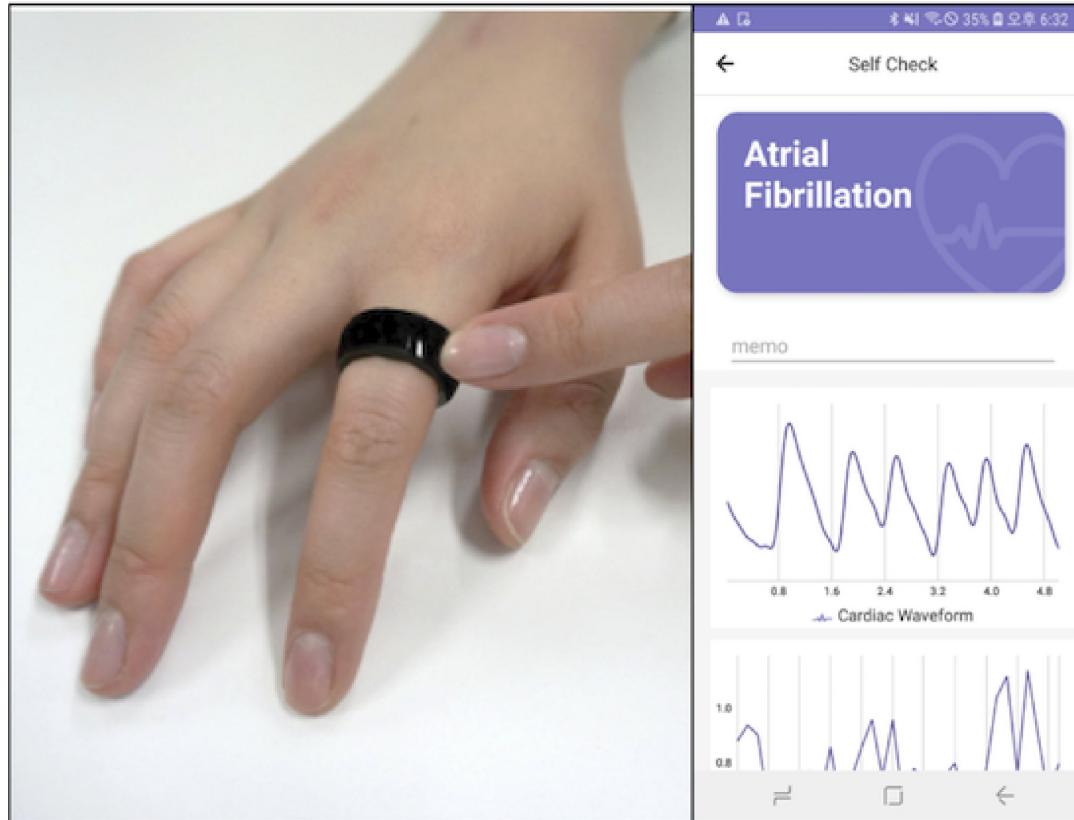
Overall, 3 successive 20-second recordings were acquired per patient. Pulse irregularity in 1 or more PPG readings or 3 uninterpretable PPG readings were considered a positive AF screening result.

SE 94.7%
SP 95.8%.

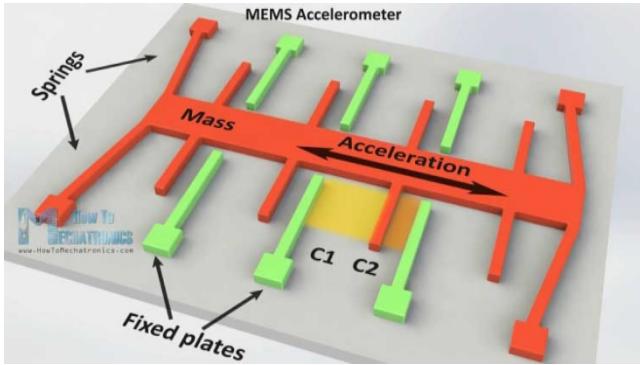


Detection of Atrial Fibrillation Using a Ring-Type Wearable Device (CardioTracker) and Deep Learning Analysis of Photoplethysmography Signals: Prospective Observational Proof-of-Concept Study

Soonil Kwon^{1*}, MD; Joonki Hong^{2*}, MSc; Eue-Keun Choi¹, MD, PhD; Byunghwan Lee³, MSc; Changhyun Baik³, MSc; Euijae Lee¹, MD; Eui-Rim Jeong⁴, PhD; Bon-Kwon Koo¹, MD, PhD; Seil Oh¹, MD, PhD, FHRS, FESC; Yung Yi², PhD

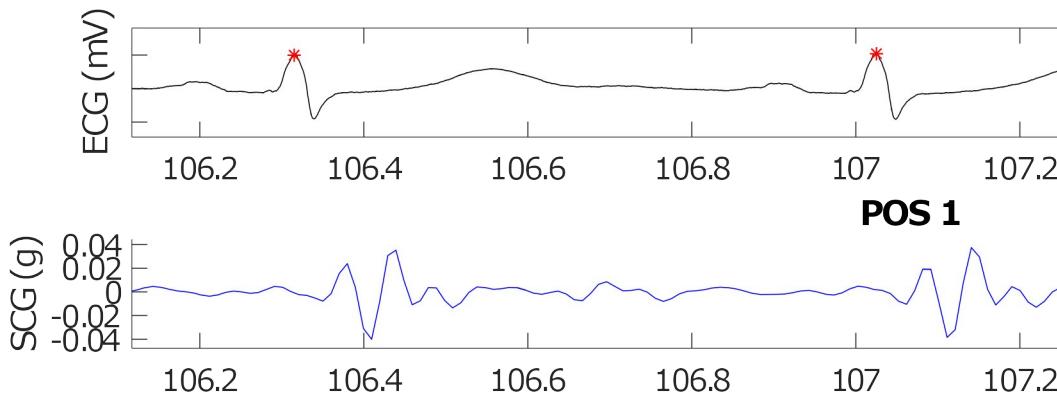


Mobile seismocardiography (m-SCG)



MEMS (Micro-Electro Mechanical System)
accelerometers and gyroscopes

Pz in posizione supina, porta lo smartphone al torace
Un accelerometro all'interno dello smartphone e' sensibile
Ai movimenti di apertura della valvola aortica.
Le variazioni atipiche della ritmicità di tale movimento
possono favorire la diagnosi di FA



- 16 pts in AF and 23 controls
- Supine position, 5 minutes acquisition
- Sony Xperia Z and SUMM app (Android), 200 Hz
- Se 93.8%, Sp 100%

[Landreani et al. IEEE EHB 2017]

[Lahdenoja O et al. IEEE J Biomed Health Inf 2017]

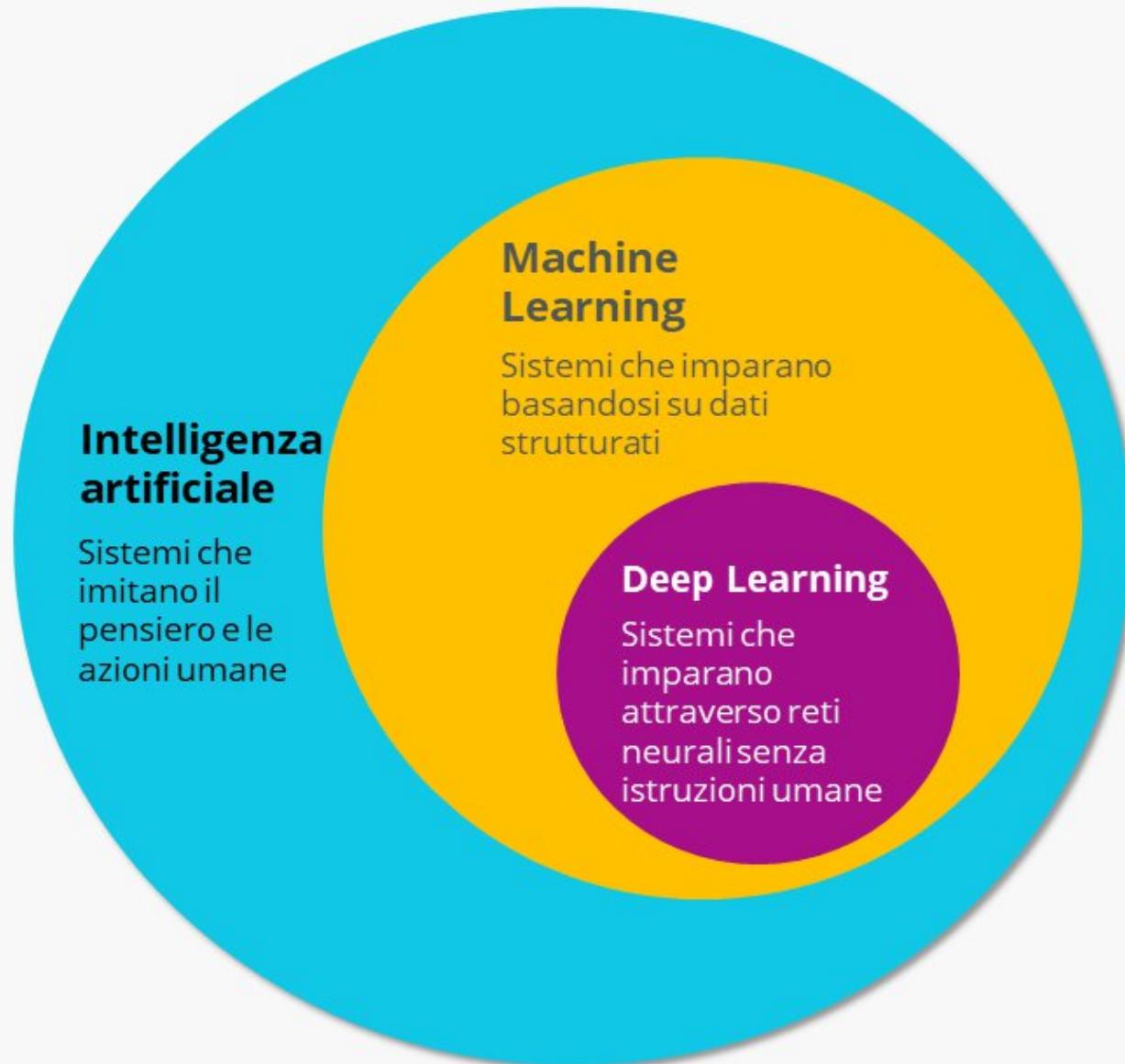
INTELLIGENZA ARTIFICIALE



L'intelligenza artificiale è un insieme di tecnologie differenti che interagiscono per consentire alle macchine di percepire, comprendere, agire e apprendere con livelli di intelligenza simili a quelli umani. Ecco perché sembra che le definizioni di intelligenza artificiale siano tutte diverse: l'intelligenza artificiale, infatti, non è una sola cosa.

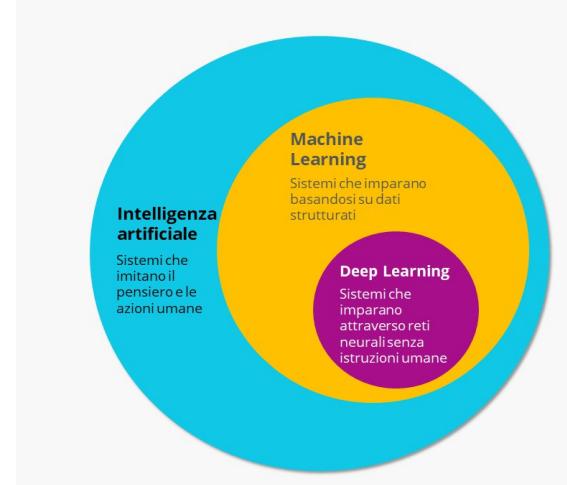
Secondo una ricerca di Frost & Sullivan's, il mercato dell'**AI in sanità** arriverà a **6 miliardi di dollari nel 2022, con un tasso annuo di crescita del 68%**, generando un risparmio di oltre **150 miliardi di dollari**.

Global Market Insights calcola che fino al 2025 si assisterà a una crescita annua del 41,7%.



Machine Learning

- Machine learning: I **Machine Learning** è la tecnologia storicamente più antica e più semplice.
- Utilizza un algoritmo che il sistema adatta, solo dopo aver ricevuto un feedback umano. Un presupposto per l'utilizzo della tecnologia è l'esistenza di dati strutturati. Il sistema viene prima alimentato con dati strutturati e categorizzati e quindi capisce come classificare i nuovi dati a seconda del tipo. In base alla classificazione, il sistema esegue poi le attività programmate. Ad esempio è in grado di riconoscere un cane o un gatto in una foto e di spostare i file nelle cartelle corrispondenti.
- Dopo una fase iniziale di applicazione, l'algoritmo è ottimizzato dal feedback umano, che indica al sistema le classificazioni errate e le categorizzazioni corrette.



Deep Learning

- Nel caso del **Deep Learning** i dati strutturati non sono necessari. Il sistema funziona nelle reti neurali multistrato, che combinano diversi algoritmi e sono modellate sul cervello umano. Ciò consente al sistema di elaborare anche dati non strutturati.

Article

Artificial Intelligence-Enabled ECG Algorithm Based on Improved Residual Network for Wearable ECG

Hongqiang Li ^{1,*}, Zhixuan An ¹, Shasha Zuo ², Wei Zhu ², Zhen Zhang ³, Shanshan Zhang ^{1,4}, Cheng Zhang ¹, Wenchao Song ¹, Quanhua Mao ¹, Yuxin Mu ¹, Enbang Li ⁵ and Juan Daniel Prades García ⁶

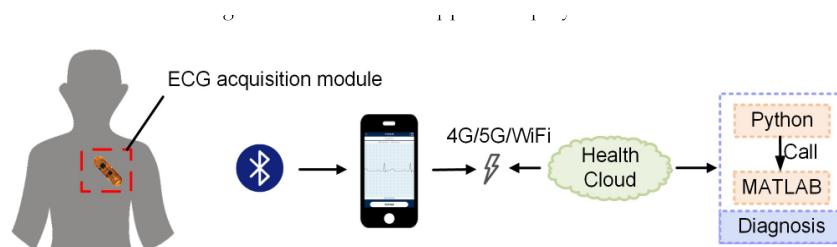


Figure 1. Schematic of overall system structure.

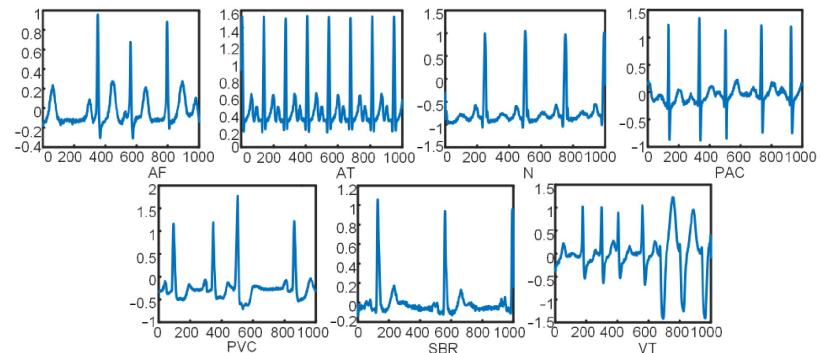
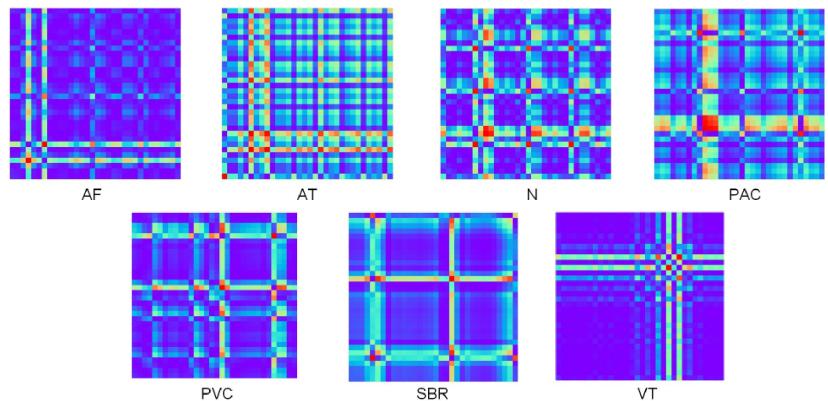


Figure 4. Seven types of original ECG data.



STANDARD ECG

APPLE WATCH



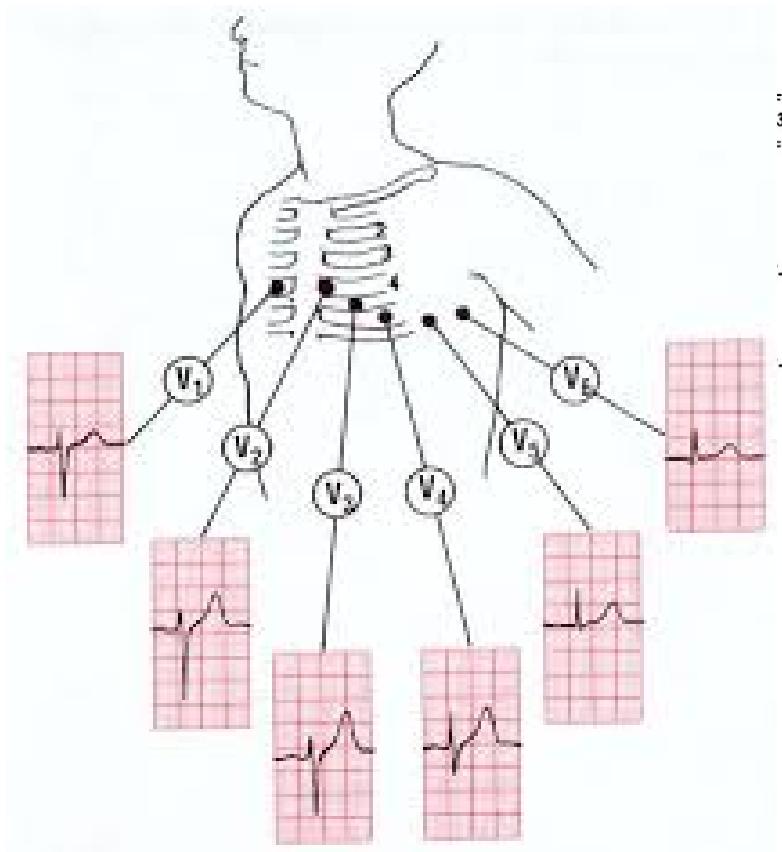
Can the Apple Watch replace a standard 12-lead ECG?

Can the Apple Watch complement the execution of a standard ECG

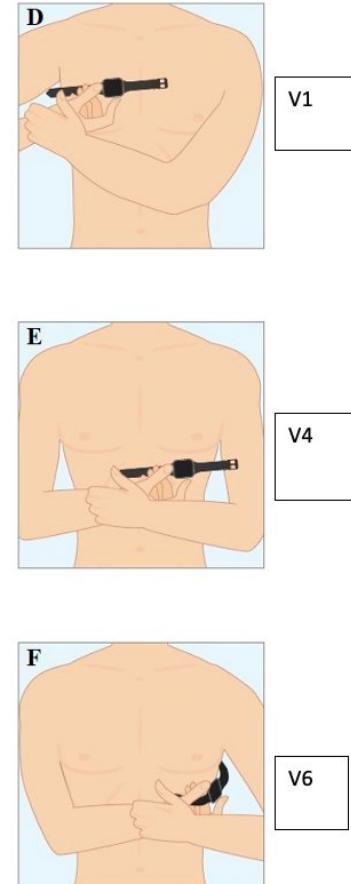
aVR | I | II | III | aVF | III | GS | BS | interiore



STANDARD ECG



APPLE WATCH



ECONOMICS
IDEAS
VALUES
CARDIO
INNOVATION 2022
SUDDEN CARDIAC DEATH PREVENTION
VALVE HEART DISEASE
CAD
GENETIC
SPORT
SIGNAL PROCESSING
TELEHEALTH
TRANSLATIONAL MEDICINE
INNOVATION & COMMUNICATION
TECHNOLOGY
HEALTH CARE
HEART FAILURE
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MATERIALS
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PROJECT
PRODUCT
PROCESS
PRECISE
DIGITAL
RESEARCH
PRESENCE

STANDARD ECG

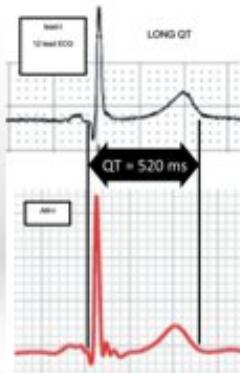
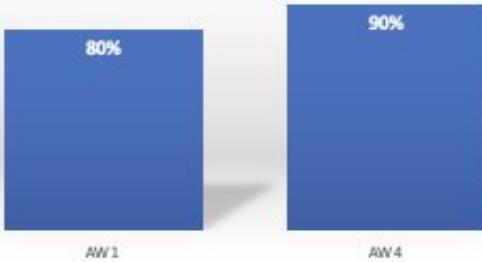
APPLE WATCH



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h: A New Era of
ential Diagnosis of
2019, 19, 4377; doi:10.3390/s19204377
ut, Marcus Wiemer and Sven Kaese

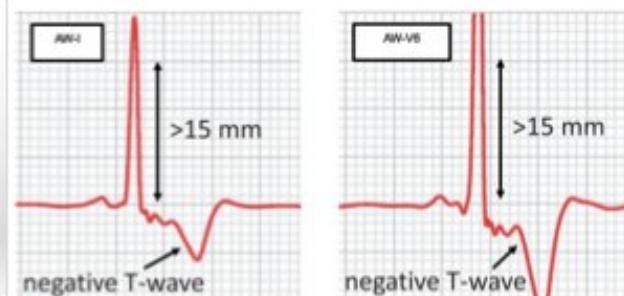


Long QTS

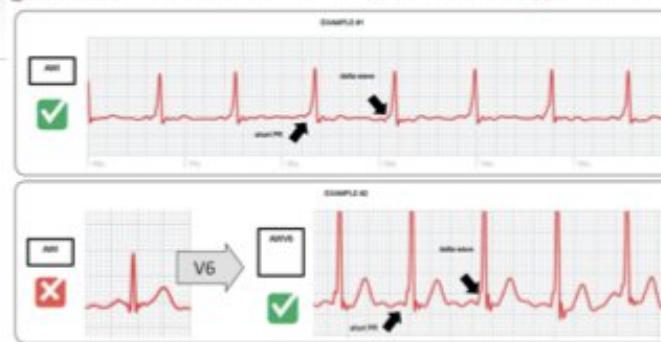
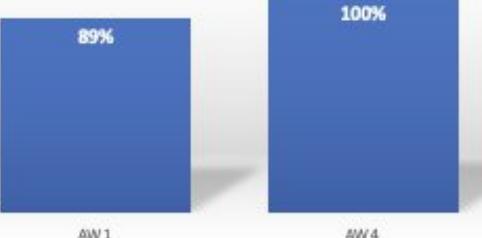


**Equilibrated and optimal Sensivity
of AW1 and AW4**

Hypertrophic CM



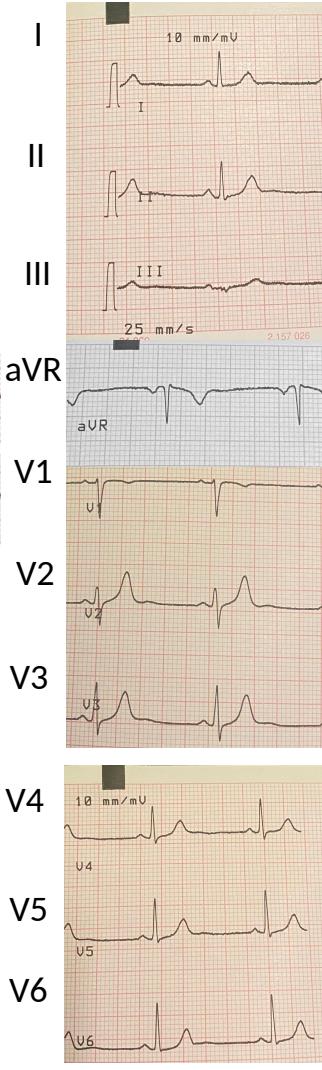
WPW



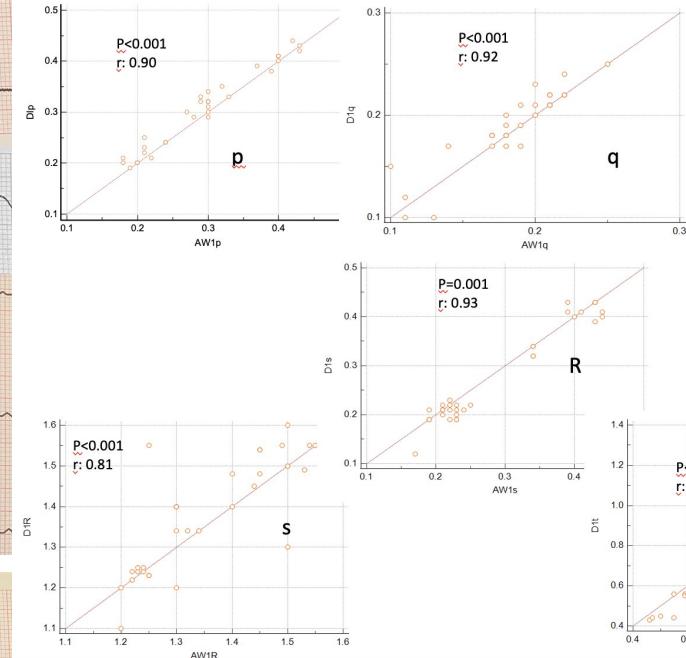
Patients (N)	32
Age (MD±SD)	42±11
Hypertension N(%)	13 (40.6%)
Dyslipidemia N(%)	12 (37.5%)
Valvular heart disease N(%)	1 (3.1%)
CAD N(%)	6 (18.7%)
Atrial Fibrillation N(%)	6 (18.7%)
Paroxysmal N(%)	3 (9.3%)
Persistent N(%)	2 (6.2%)
Permanent N(%)	1 (3.1%)
Ectopic Ventricular beats N(%)	2 (6.2%)
RBB	1 (3.1%)
LBB	1 (3.1%)
WPW	1 (3.1%)
AVNRT	1 (3.1%)

Our Experience on 32 pts Monitored with AW





D1 Derivation



D1

"Apri una nuova finestra"?



Sei impazzito? Si muore di freddo!

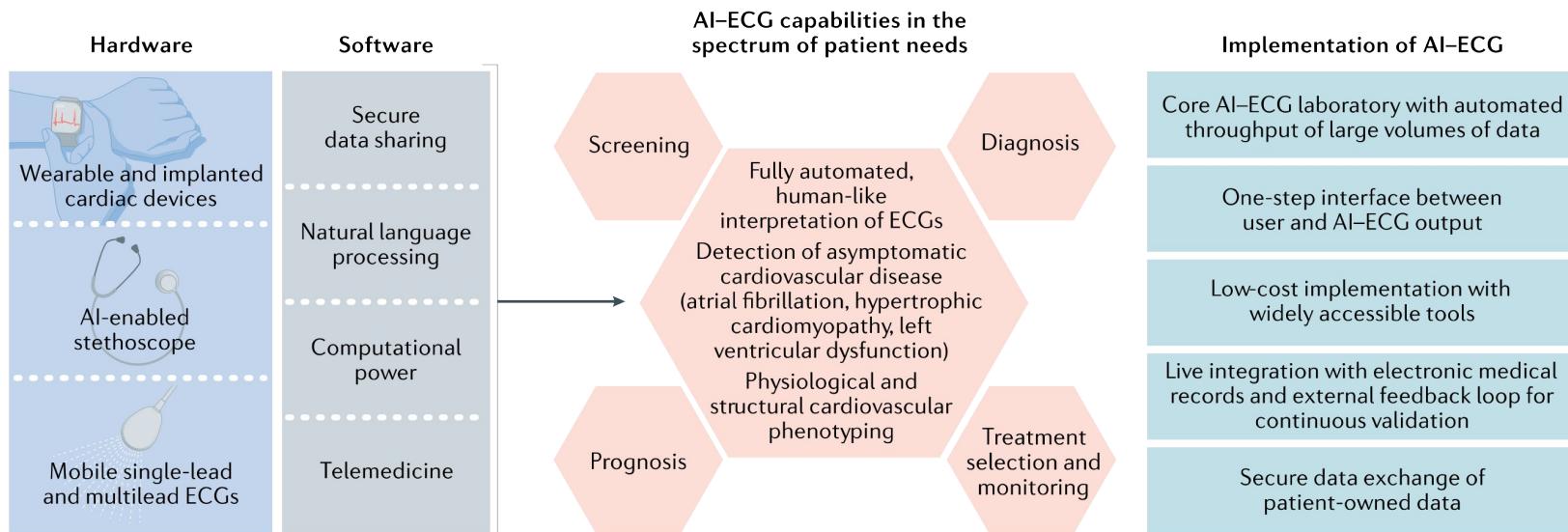
Watch4,1 — The waveform is similar to a Lead I ECG. For more information, see Instructions for Use.

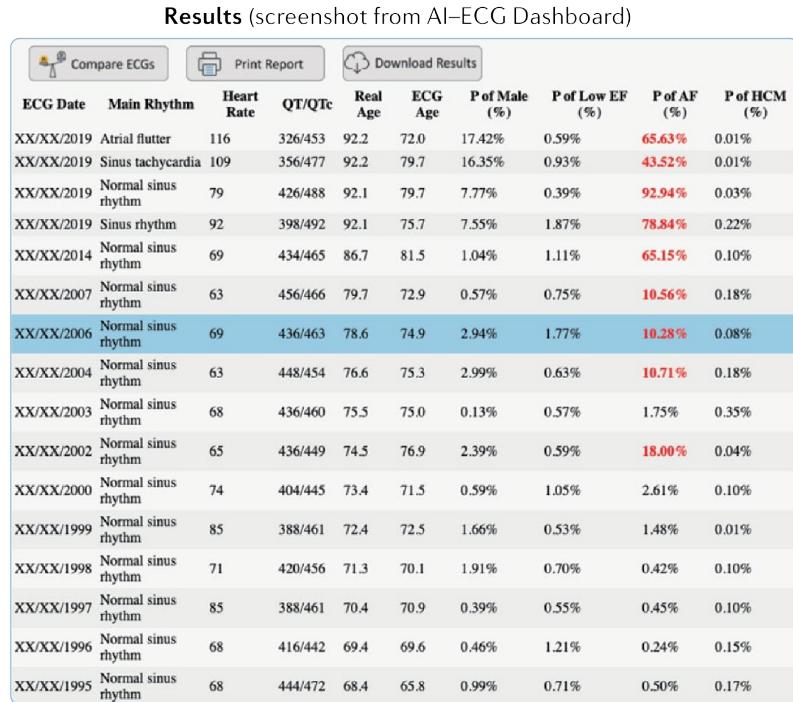
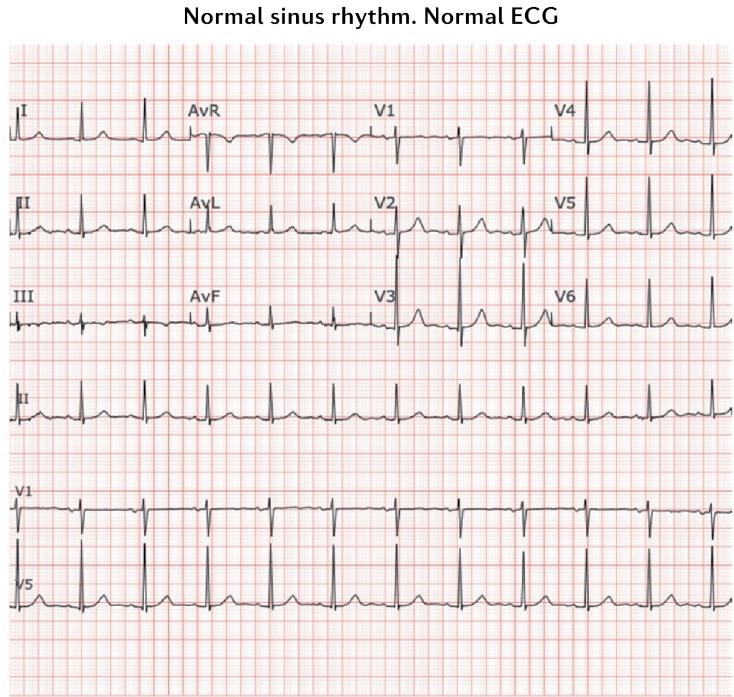
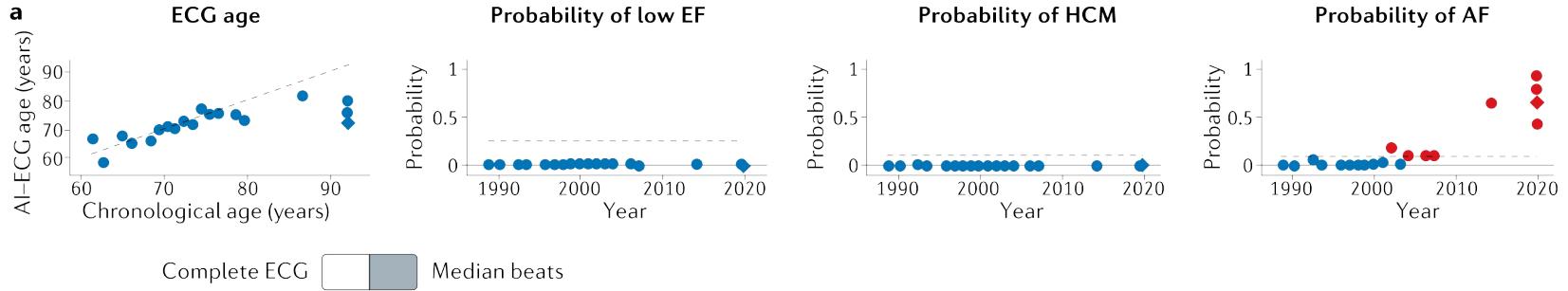
REVIEWS

 Check for updates

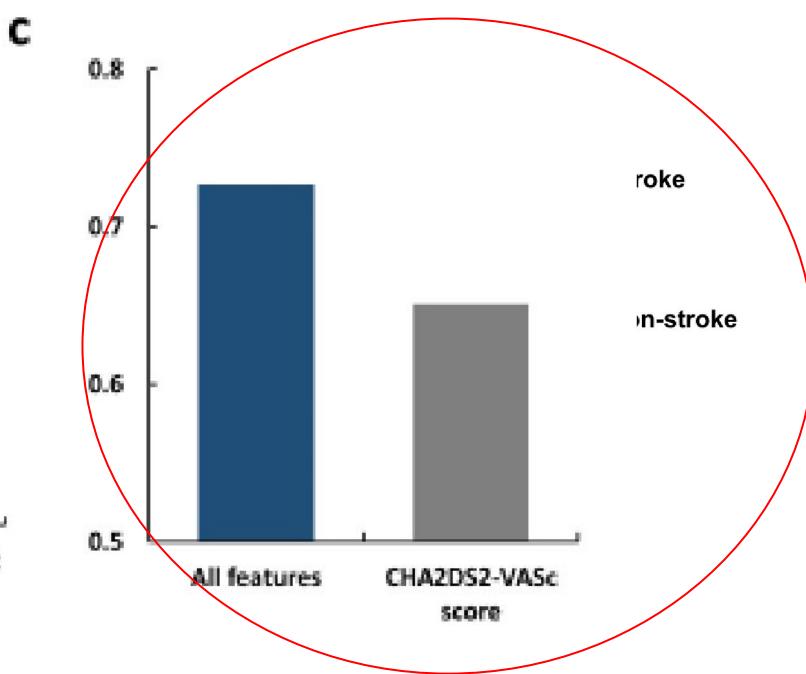
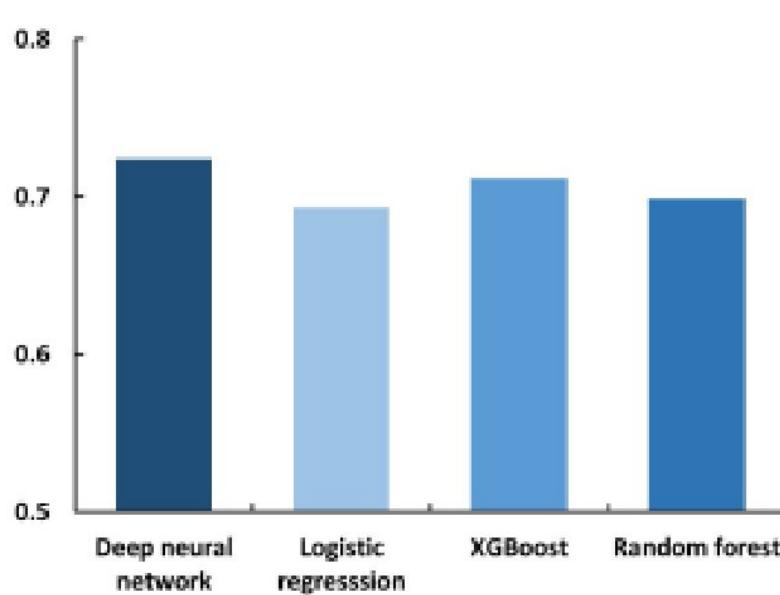
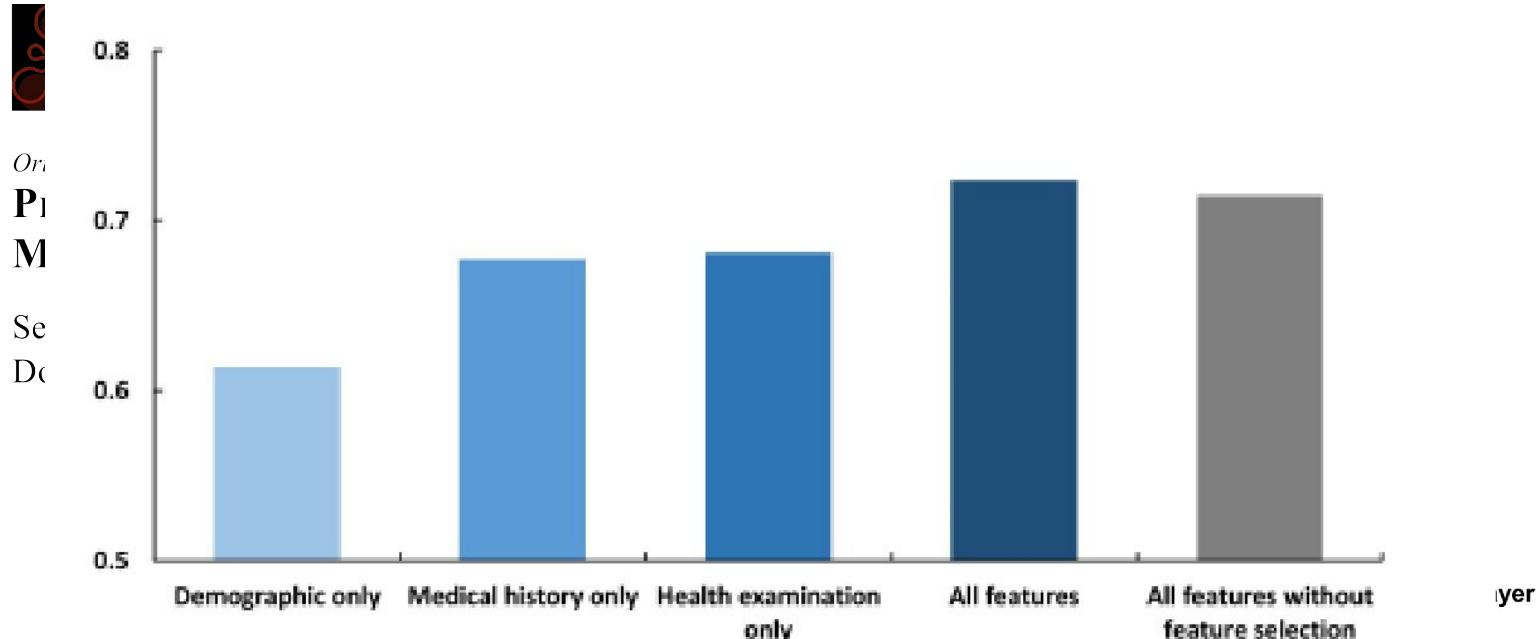
Artificial intelligence-enhanced electrocardiography in cardiovascular disease management

Konstantinos C. Siontis, Peter A. Noseworthy, Zachi I. Attia  and Paul A. Friedman  





Pts whith ESUS that presented an elevated risk of cardioembolic stroke (Afib) several years before The first stroke





I computer sono
inutili. Sanno dare
soltanto risposte.

(Pablo Picasso)

FRASIMANIA

Il vero pericolo non è che i computer
inizino a pensare come gli uomini,
ma che gli uomini inizino a
pensare come i computer.

(Sydney J. Harris)