Cardiology in Motion: How Wearable Devices are Changing Patient Care

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2026 Clinical Cardiology for Primary Care

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EVMS
Eastern Virginia Medical School

DISCLOSURES

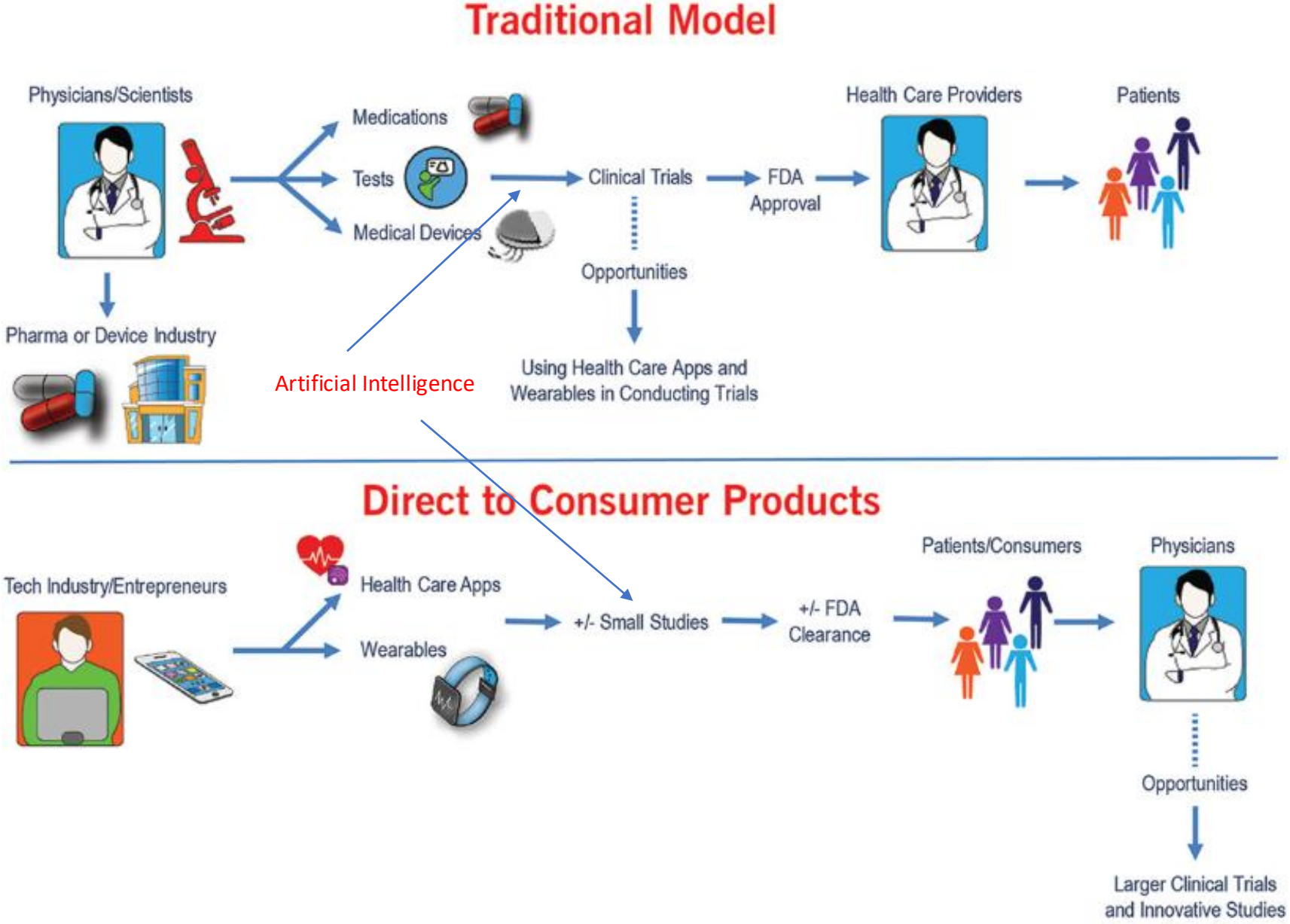
Consulting: Johnson and Johnson MedTech

Steering Committee and Consulting: Boston Scientific

Why This Matters in Your Clinic?

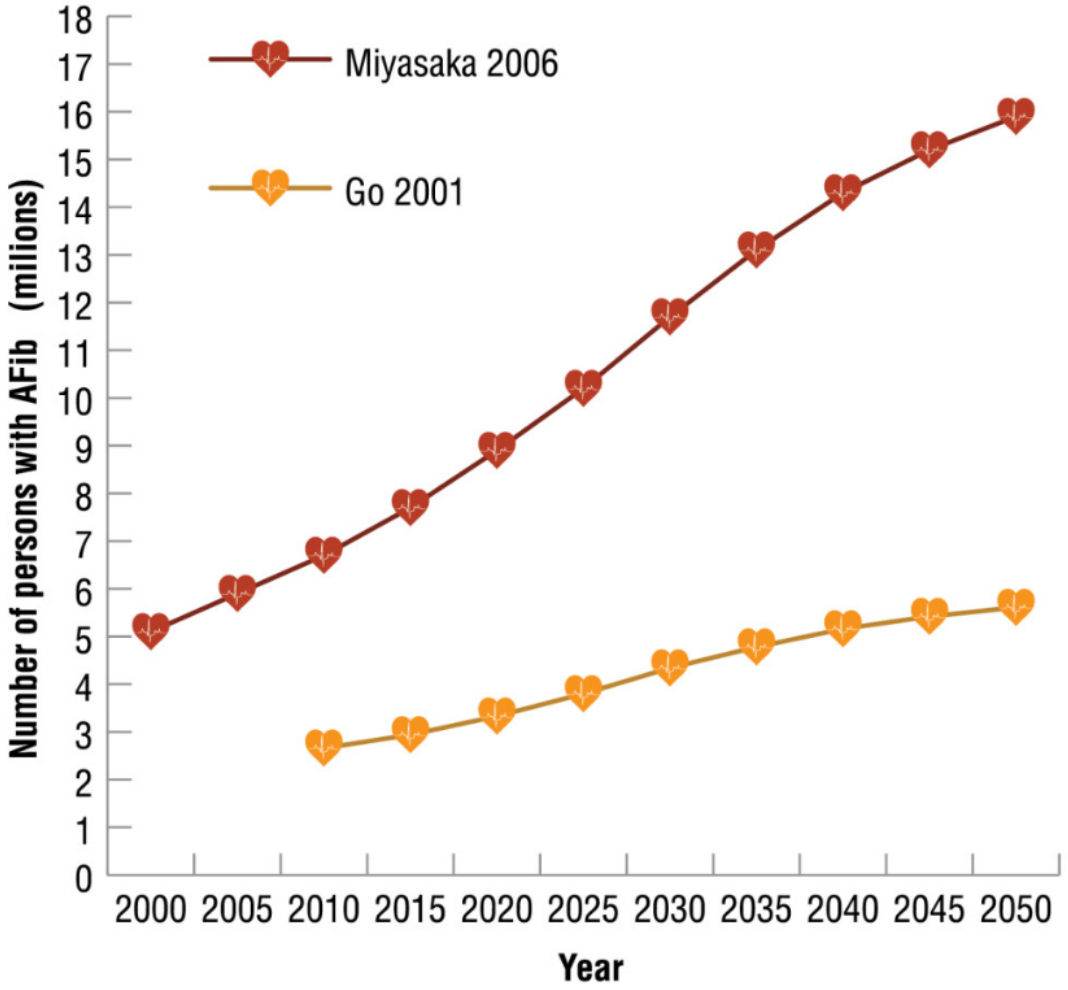
- Patients increasingly arrive with their own data
- Primary care is on the front lines of helping interpret it
- Allows for trends to be seen earlier and allows for earlier intervention

Medical Innovation in the Era of Digital Health



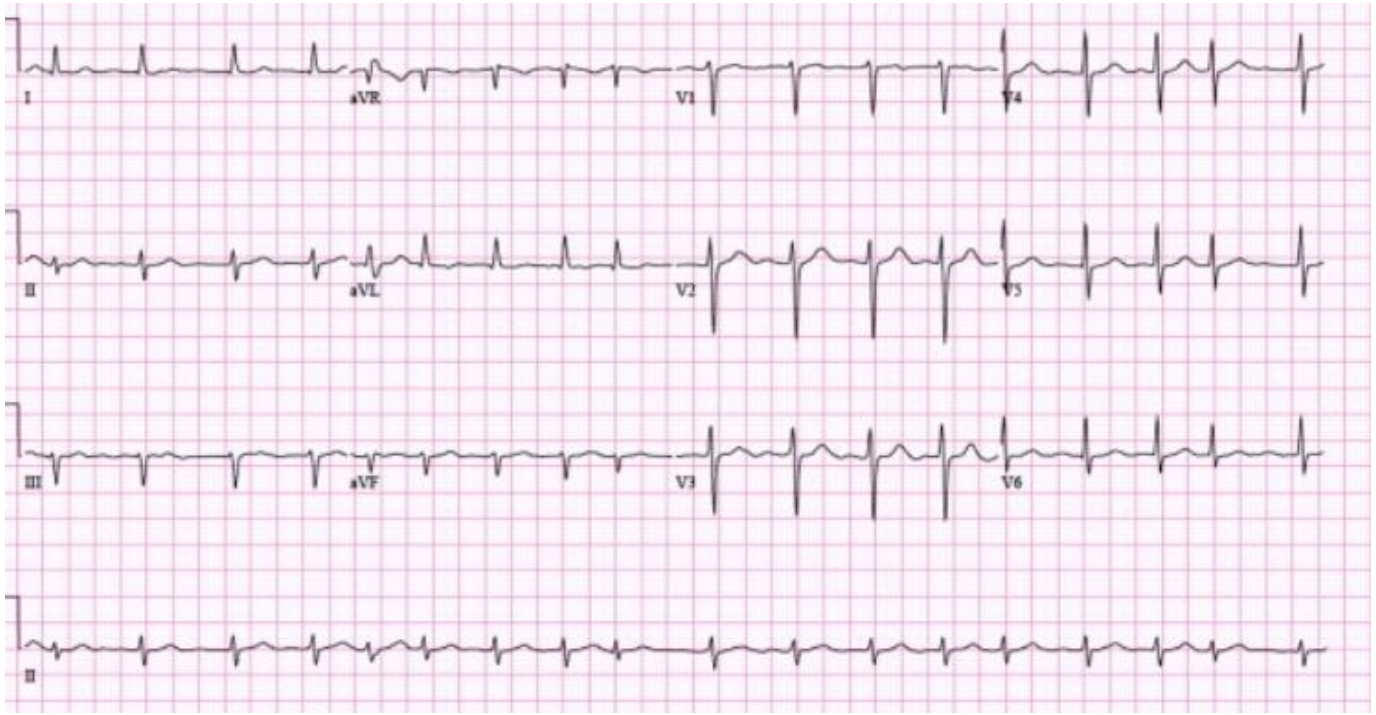
Tarakji, Chung *et al. Circ: EP 2020.*

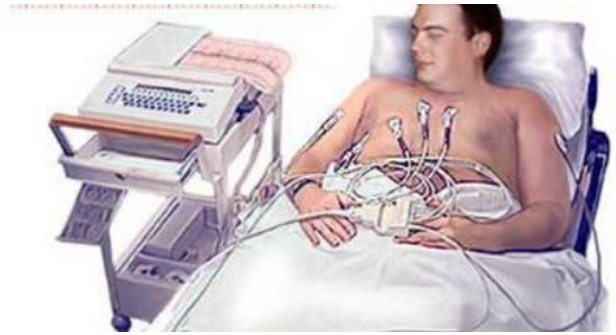
Atrial Fibrillation

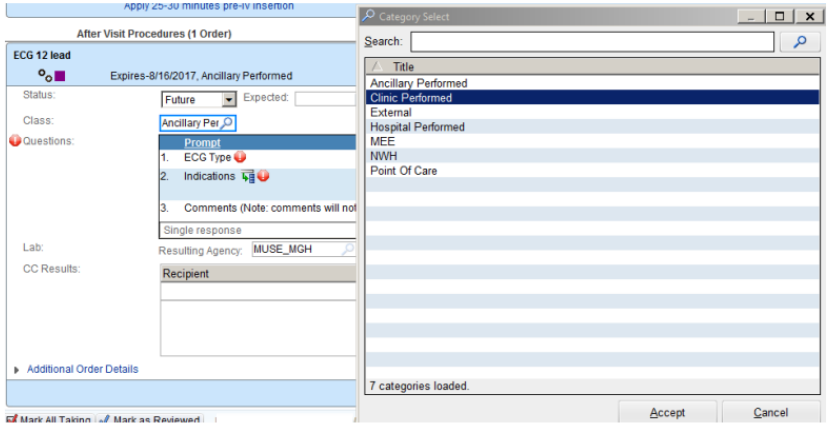


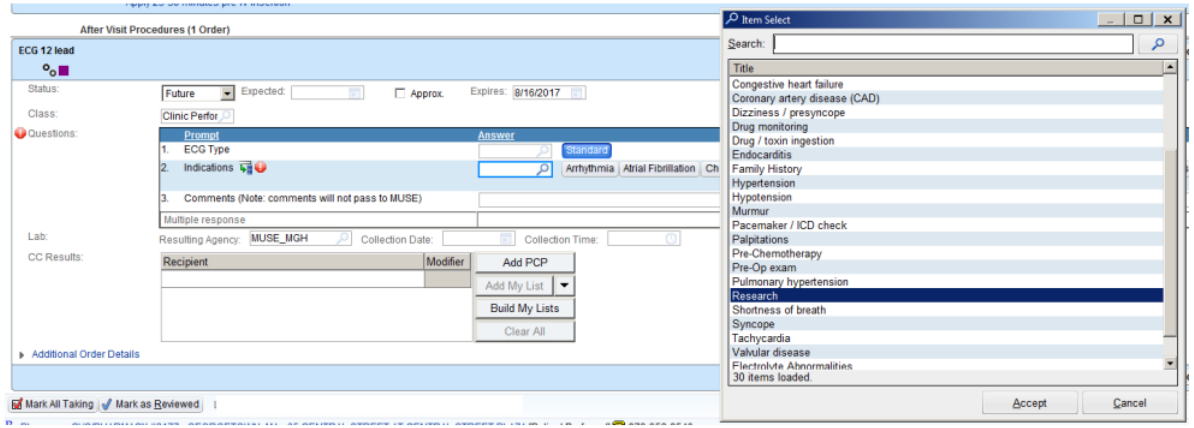
- Remains most common arrhythmia
- Difficult to detect unless symptomatic
- Expensive treatments
- Consequences if left untreated

The Gold Standard









US Preventative Task Force

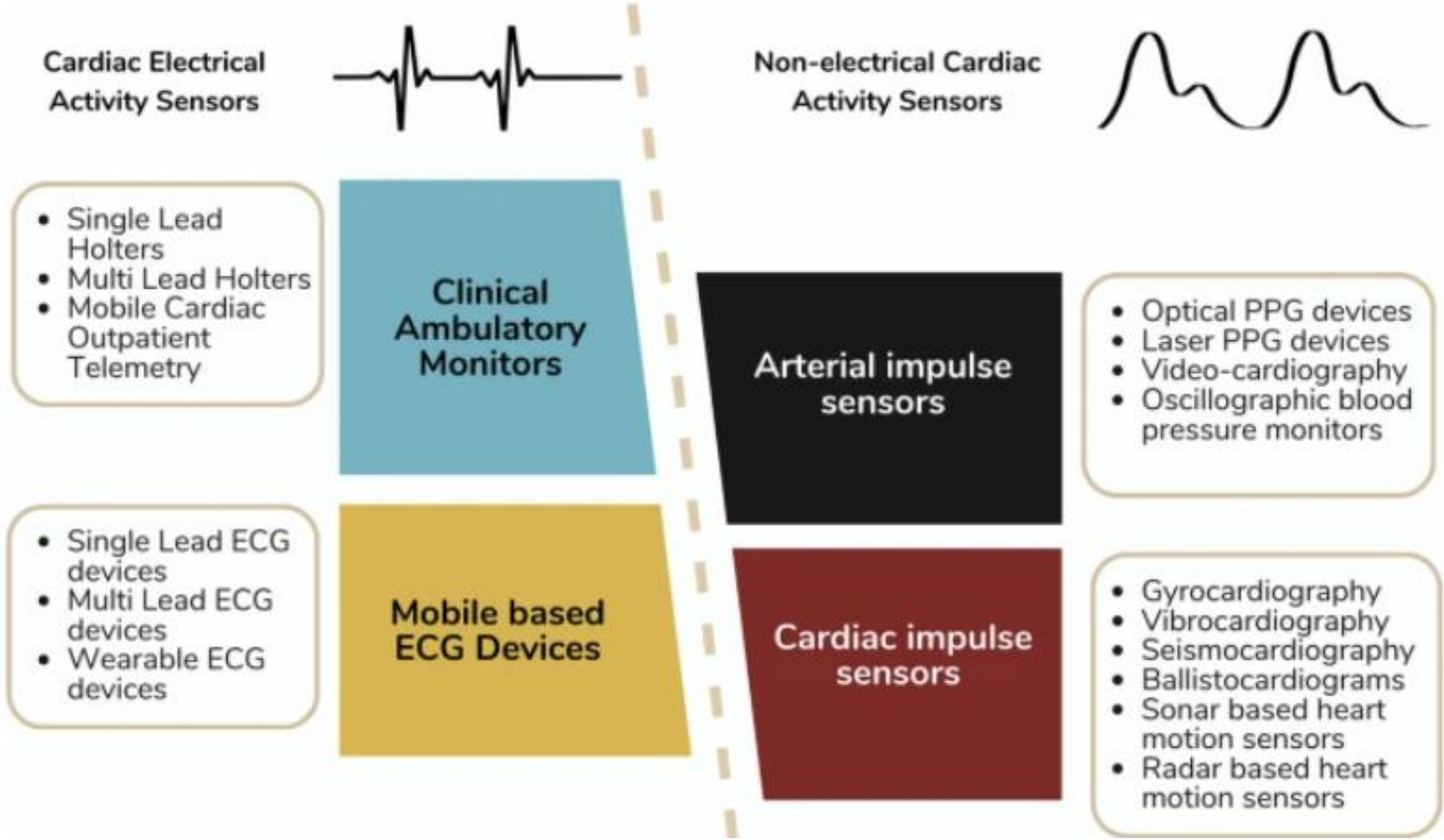
Recommendation Summary

Population	Recommendation	Grade
Asymptomatic adults 50 years or older	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for atrial fibrillation. See the Practice Considerations section for additional information regarding the I statement.	I

Research Needs and Gaps

More studies are needed that address the following.

- Randomized trials enrolling asymptomatic persons that directly compare screening with usual care and that assess both health outcomes and harms are needed to understand the balance of benefits and harms of screening for AF. It is important that screening trials enroll sufficient participants of both sexes and diverse racial and ethnic groups to enable assessment of whether the detection of AF or the benefits or harms of screening vary in different population groups.
- How to best optimize the accuracy of screening tests or strategies for AF.
- Understanding the risk of stroke associated with subclinical AF, or AF detected with use of consumer devices, how that risk varies with duration or burden of AF, and the potential benefit of anticoagulation therapy among persons with subclinical AF.



Sridhar et al Communications Medicine 2024

Types of Wearables

Consumer smartwatch

PPG + optional single-lead ECG. Worn continuously; opportunistic, always-on screening. e.g. Apple Watch.

Screening / awareness

Prescription ECG patch

Adhesive single-lead patch worn 7–14 days. Continuous diagnostic recording, analyzed after wear. e.g. Zio.

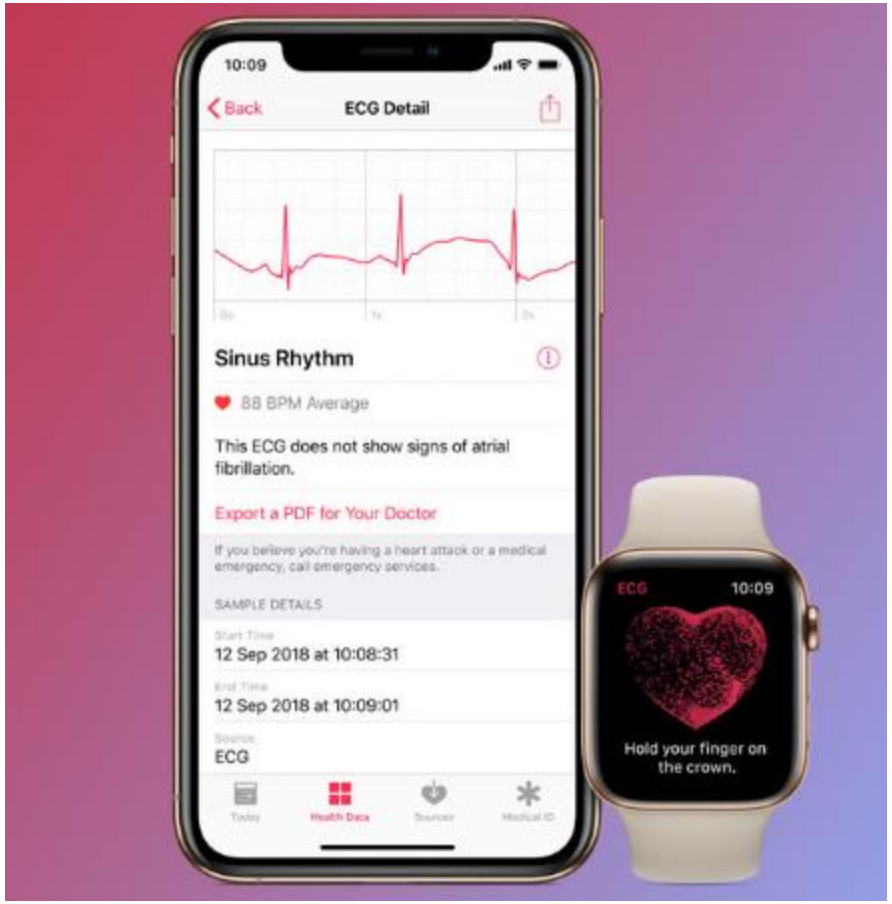
Diagnostic

Handheld ECG recorder

On-demand 30-sec single- or 6-lead ECG when symptoms occur. e.g. KardiaMobile.

Symptom capture

Apple Watch



- Introduced in 2014 by Tim Cook
- Uses PPG sensor to passively detect possible AF
- Added EKG feature in Series 4 using the crystals on the crown

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation

Marco V. Perez, M.D., Kenneth W. Mahaffey, M.D., Haley Hedlin, Ph.D., John S. Rumsfeld, M.D., Ph.D., Ariadna Garcia, M.S., Todd Ferris, M.D., Vidhya Balasubramanian, M.S., Andrea M. Russo, M.D., Amol Rajmane, M.D., Lauren Cheung, M.D., Grace Hung, M.S., Justin Lee, M.P.H., Peter Kowey, M.D., Nisha Talati, M.B.A., Divya Nag, Santosh E. Gummidipundi, M.S., Alexis Beatty, M.D., M.A.S., Mellanie True Hills, B.S., Sumbul Desai, M.D., Christopher B. Granger, M.D., Manisha Desai, Ph.D., and Mintu P. Turakhia, M.D., M.A.S., for the Apple Heart Study Investigators*

Perez et al. NEJM 2019

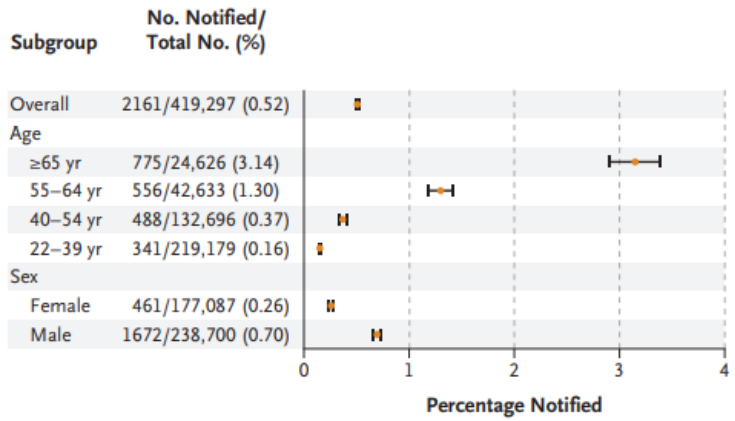


Figure 2. Irregular Pulse Notifications, According to Age and Sex.
Horizontal bars indicate 97.5% confidence intervals.

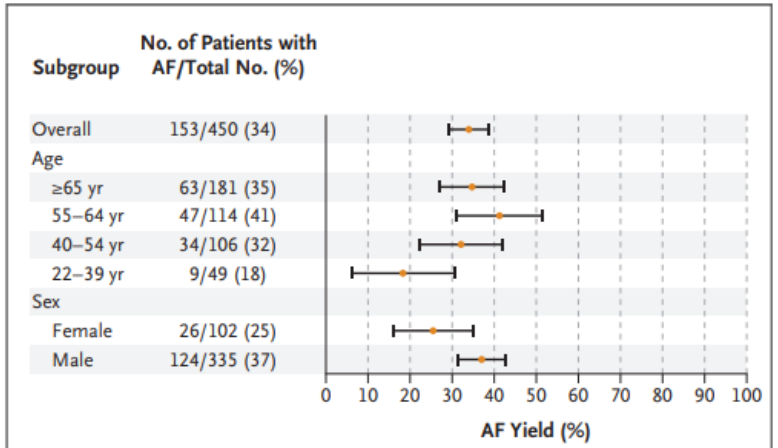


Figure 3. Yield of Atrial Fibrillation on ECG Patch Monitoring.
Horizontal bars indicate 97.5% confidence intervals.

Table 2. End-of-Study Survey.

Variable	Notification Subgroup (N=929)	Non-notification Subgroup (N=293,015)
New diagnosis — no. (%)		
Atrial fibrillation	404 (43)	3070 (1.0)
Stroke	7 (0.8)	321 (0.1)
TIA	12 (1.3)	498 (0.2)
Heart failure	30 (3.2)	648 (0.2)
Myocardial infarction	10 (1.1)	574 (0.2)
Major bleeding	7 (0.8)	842 (0.3)
Medication use — no. (%)*		
Warfarin	20 (2.2)	265 (0.1)
Direct oral anticoagulant	202 (22)	996 (0.3)
Aspirin	338 (36)	40,774 (14)

* This category refers to medication use since enrollment in the study, as reported by the participants.

Perez et al. NEJM 2019

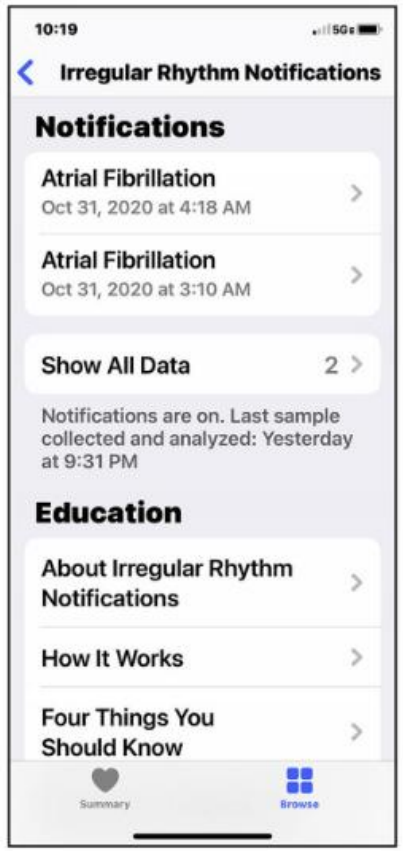
Smartwatch diagnosis of atrial fibrillation in patient with embolic stroke of unknown source: A case report

Divyang Patel, MD, Khaldoun G. Tarakji, MD, MPH, FHRS

From the Department of Cardiovascular Medicine, Heart and Vascular Institute, Cleveland Clinic Foundation, Cleveland, Ohio.

A

B



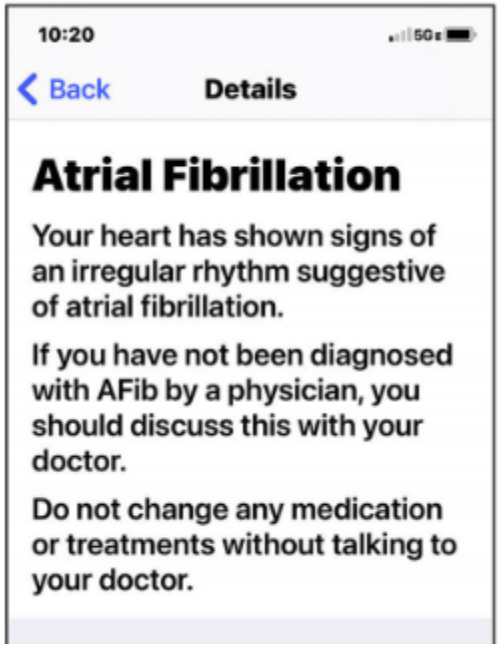


Figure 2 Electrocardiogram watch recording of atrial fibrillation as recorded by the patient.

Patel et al. *Cardiovascular Digital Health Journal* 2021

Atrial fibrillation future clinic. Novel platform to integrate smart device electrocardiogram into clinical practice

Cameron T. Lambert, MD,* Divyang Patel, MD,* Joseph M. Bumgarner, MD,† Mohamed Kanj, MD,* Daniel Cantillon, MD, FHRS,* Walid Saliba, MD,* Ayman Hussein, MD, FHRS,* Bryan Baranowski, MD,* Thomas Dresing, MD,* Mina K. Chung, MD, FHRS,* John Rickard, MD, MPH,* Niraj Varma, MD, PhD,* Thomas Callahan, MD, FHRS,* David Martin, MD,* Patrick Tchou, MD, FHRS,* Mandeep Bhargava, MD,* Kathy Wolski, MS,‡ Oussama Wazni, MD, FHRS,* Khaldoun G. Tarakji, MD, MPH, FHRS*

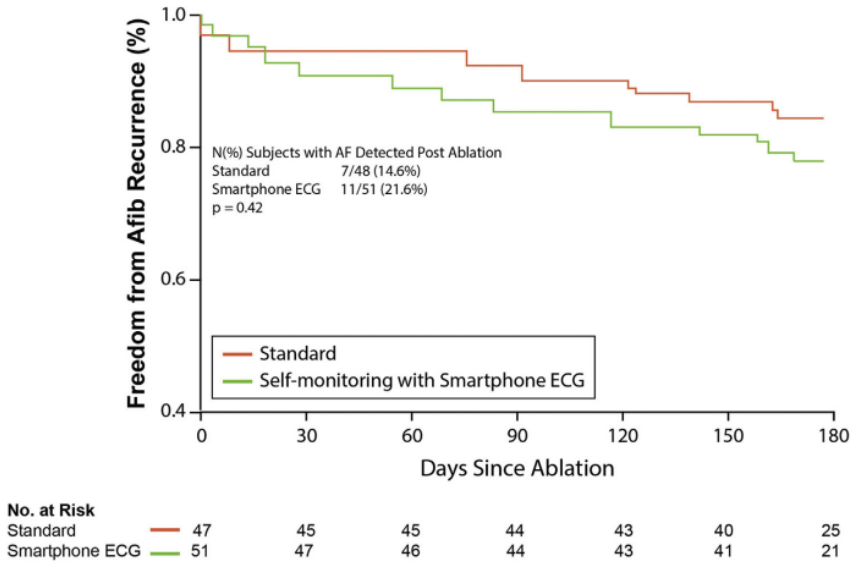


Table 2 Healthcare utilization and electrocardiogram or cardiac monitor use among the control and Kardia Mobile / Kardia Pro groups

	Control group n = 48	Smartphone ECG KM/KP group n = 51	*P* value
Healthcare utilization			
Outpatient clinic visits	2.2 ± 2.7	3.3 ± 5.8	.23
Phone encounters	2.9 ± 6.2	2.0 ± 2.7	.33
Emergency room visits	0.19 ± 0.5	0.16 ± 0.4	.74
Hospitalizations	0.17 ± 0.4	0.25 ± 0.7	.48
Cardioversions, n (%)	1 (2.1)	1 (2.1)	.99
Additional ECGs or cardiac rhythm monitors	13 (27.1%)	3 (5.9%)	.004
ECG	2 (4.2)	0	
Kardia Mobile	2 (4.2)	0	
Extended rhythm monitor (patch)	6 (12.5%)	2 (3.9)	
Ambulatory continuous telemetry	3 (6.3)	1 (2.0)	

ECG = electrocardiogram; KM / KP = Kardia Mobile / Kardia Pro.

Lambert, Patel et al. *Cardiovasc Digital Health* 2021

REACT-AF Trial

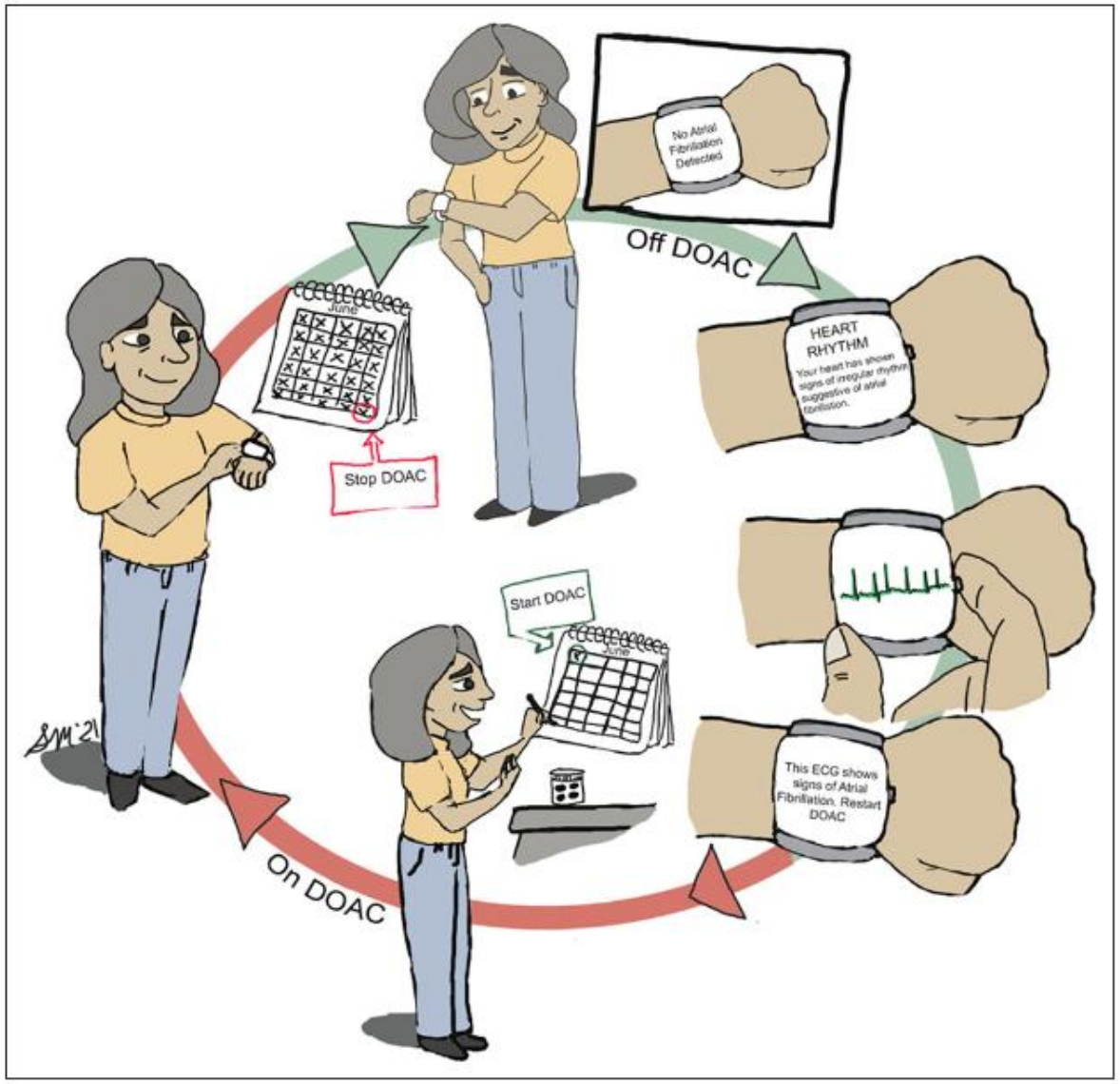
Circulation
Volume 143, Issue 23, 8 June 2021; Pages 2211-2213
https://doi.org/10.1161/CIRCULATIONAHA.121.053170

PERSPECTIVE

"Pill-in-Pocket" Anticoagulation for Atrial Fibrillation: Fiction, Fact, or Foolish?

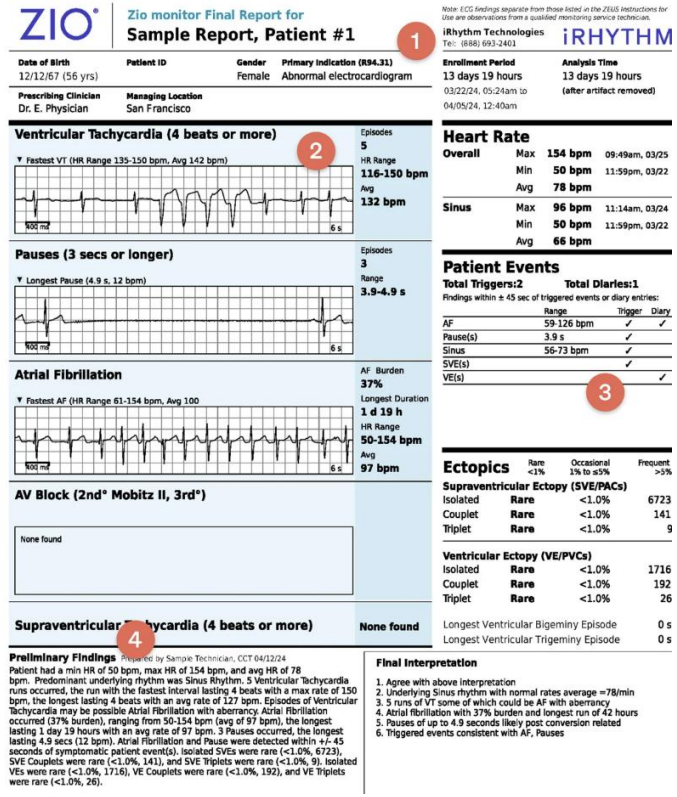
Rod Passman, MD, MSCE

- Randomized trial
- 100 US sites
- Enroll 5500 patients
  - Half on DOAC
  - Half smartwatch based anticoagulation



Passman et al. *Circulation* 2021

ECG Patch Continuous Monitoring



ZIO® Zio monitor Final Report for
Sample Report, Patient #1

Date of Birth	Patient ID	Gender	Primary Indication (R94.31)
12/12/67 (56 yrs)		Female	Abnormal electrocardiogram

Prescribing Clinician	Managing Location
Dr. E. Physician	San Francisco

Note: ECG findings separate from those listed in the ZEUS instructions for Use are observations from a qualified monitoring service technician.

iRhythm Technologies
Tel: (888) 693-2401

iRHYTHM

Enrollment Period	Analysis Time
13 days 19 hours 03/22/24, 05:24am to 04/05/24, 12:40am	13 days 19 hours (after artifact removed)

Ventricular Tachycardia (4 beats or more) — Episodes 5
▼ Fastest VT (HR Range 135-150 bpm, Avg 142 bpm)
HR Range 116-150 bpm
Avg 132 bpm

Pauses (3 secs or longer) — Episodes 3
▼ Longest Pause (4.9 s, 12 bpm)
Range 3.9-4.9 s

Atrial Fibrillation — AF Burden 37%
▼ Fastest AF (HR Range 61-154 bpm, Avg 100
Longest Duration 1 d 19 h
HR Range 50-154 bpm
Avg 97 bpm

AV Block (2nd° Mobitz II, 3rd°)
None found

Supraventricular Tachycardia (4 beats or more) — None found

Heart Rate

Overall	Max	154 bpm	09:49am, 03/25
	Min	50 bpm	11:59pm, 03/22
	Avg	78 bpm	
Sinus	Max	96 bpm	11:14am, 03/24
	Min	50 bpm	11:59pm, 03/22
	Avg	66 bpm	

Patient Events
Total Triggers:2 Total Diaries:1
Findings within ± 45 sec of triggered events or diary entries:

	Range	Trigger	Diary
AF	59-126 bpm	✓	✓
Pause(s)	3.9 s	✓	
Sinus	56-73 bpm	✓	
SVE(s)		✓	
VE(s)			✓

Ectopics

	Rare <1%	Occasional 1% to ≤5%	Frequent >5%
Supraventricular Ectopy (SVE/PACs)			
Isolated	Rare	<1.0%	6723
Couplet	Rare	<1.0%	141
Triplet	Rare	<1.0%	9
Ventricular Ectopy (VE/PVCs)			
Isolated	Rare	<1.0%	1716
Couplet	Rare	<1.0%	192
Triplet	Rare	<1.0%	26

Longest Ventricular Bigeminy Episode 0 s
Longest Ventricular Trigeminy Episode 0 s

Preliminary Findings Prepared by Sample Technician, CCT 04/12/24
Patient had a min HR of 50 bpm, max HR of 154 bpm, and avg HR of 78 bpm. Predominant underlying rhythm was Sinus Rhythm. 5 Ventricular Tachycardia runs occurred, the run with the fastest interval lasting 4 beats with a max rate of 150 bpm, the longest lasting 4 beats with an avg rate of 127 bpm. Episodes of Ventricular Tachycardia may be possible Atrial Fibrillation with aberrancy. Atrial Fibrillation occurred (37% burden), ranging from 50-154 bpm (avg of 97 bpm), the longest lasting 1 day 19 hours with an avg rate of 97 bpm. 3 Pauses occurred, the longest lasting 4.9 secs (12 bpm). Atrial Fibrillation and Pause were detected within +/- 45 seconds of symptomatic patient event(s). Isolated SVEs were rare (<1.0%, 6723), SVE Couplets were rare (<1.0%, 141), and SVE Triplets were rare (<1.0%, 9). Isolated VEs were rare (<1.0%, 1716), VE Couplets were rare (<1.0%, 192), and VE Triplets were rare (<1.0%, 26).

Final Interpretation
1. Agree with above interpretation
2. Underlying Sinus rhythm with normal rates average =78/min
3. 5 runs of VT some of which could be AF with aberrancy
4. Atrial fibrillation with 37% burden and longest run of 42 hours
5. Pauses of up to 4.9 seconds likely post conversion related
6. Triggered events consistent with AF, Pauses

Patient: Jane Doe
VitalConnect Holter

VitalConnect

Patient Summary
Date of Birth 09/28/1967 (53 yrs.) | Sex Female
Patient ID b008bf01ec06 | Pacemaker No
Primary Indication --

Clinician Summary
Analysis by -- | Institution vnv_v303
Referred by Dr. Wen | Interpreted by --

Report Summary
Recording Length 10h 8min 43sec (From 08/03/2021 To 08/03/2021) | Analysis Length 8h 54min 45sec
Date of Analysis 08/04/2021 | Noise Burden 12.2%

Heart Rate

Max	Min	Average
78bpm	44bpm	56bpm
08/03/2021 08:46:45 pm	08/03/2021 05:26:24 pm	

Ectopics
Premature Supraventricular Complexes
PSVC Count 8 (0.03%) | Isolated Count 8 (0.03%) | Couplets --
Premature Ventricular Complexes
PVC Count 10 (0.03%) | Isolated Count 8 (0.03%) | Morphologies 8
Couplets 1 (<0.01%) | Bigeminy -- | Trigeminy --

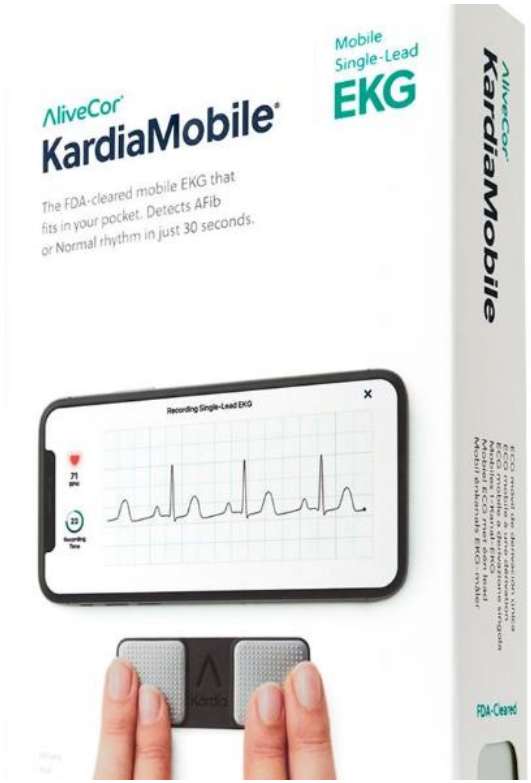
Patient Events Count --
Paced Beats Count --

	Burden	Longest Episode	Max HR
AFib / Flutter	--	--	--
Representative Strip: None			
Other SVT	Count --	Longest Episode --	Max HR --
Representative Strip: None			
Pause	Count --	Longest RR --	
Representative Strip: None			
AV Block	Type --		
Representative Strip: None			
VT	Count --	Longest Episode --	Max HR --
Representative Strip: None			

Technician Findings

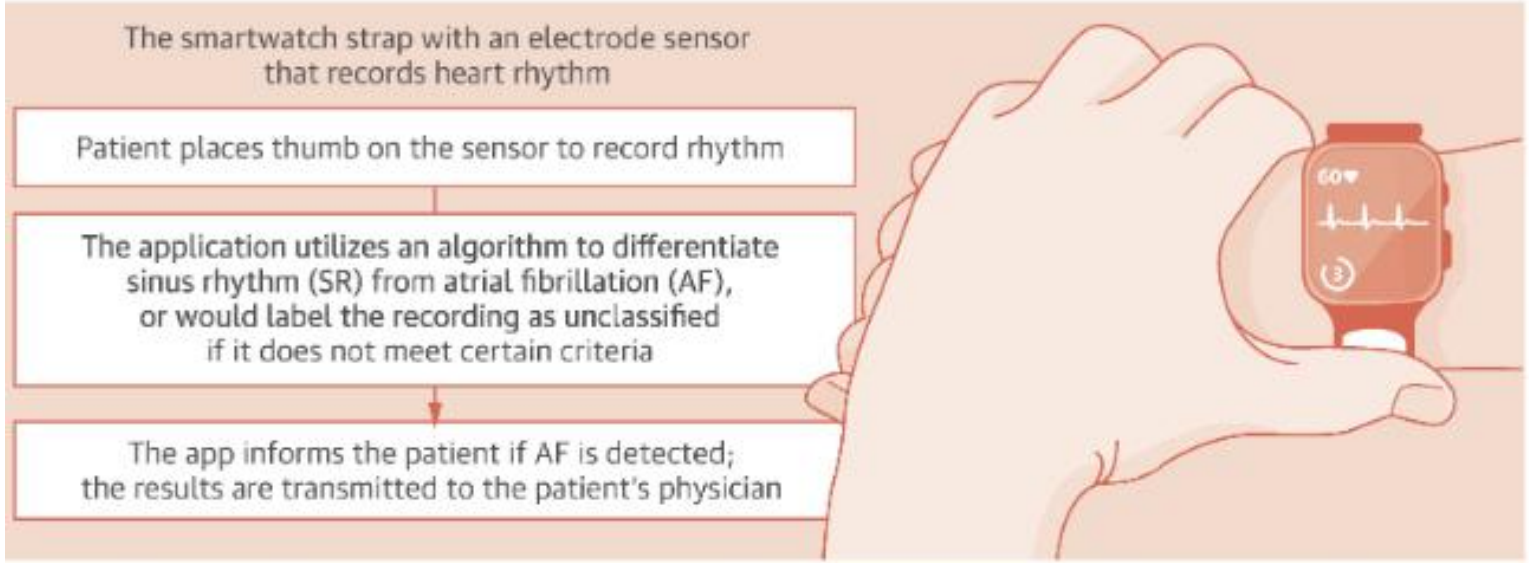
Physician Findings

Kardia-Mobile



- Founded in 2010 as first iPhone application
- Single lead EKG for the detection of atrial fibrillation
- Unlike other companies led the way in proving efficacy through trials
- Good for brief episodes and infrequent

Kardia detection



Method for interpreting the recording:	% of patients with interpretable results	Accuracy of AF diagnosis compared to 12 lead electrocardiogram
App algorithm only	66%	93% sensitivity; 84% specificity
Physician only	87%	99% sensitivity; 83% specificity
Recordings labeled as "unclassified" by the app algorithm when reviewed by physician	100%	100% sensitivity; 80% specificity

Bumgarner et al JACC 2018

Choosing the Right Tool

	Smartwatch	ECG Patch	Handheld
Signal	PPG (+ spot ECG)	Continuous ECG	Spot ECG
Wear time	Continuous, ongoing	7–14 days	On demand, 30 s
Best for	Opportunistic screening	Diagnostic yield	Symptom capture
Access	Consumer-owned	Prescription	Consumer-owned
Reviewed	Patient app / clinician	Report to clinician	PDF to clinician

Potential Pitfalls

- False positives and anxiety
- Single lead limitations
- Data Overload
- Equity
- Incidental findings

CONCLUSIONS

- Wearables are excellent at raising questions –they don’t answer them
- Match the tool to the question you’re asking
- Pre-test probability is everything!
- Meet patients where they are and set realistic expectations
- Questions drpatel1@sentara.com