AF screening and wearable devices: S-patch Ex Solution

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Agenda

- AF screening guidelines
- Subclinical AF (SCAF) and risk of stroke/HF
- Various modalities for AF screening
- Major trials on AF screening
- Wearable devices: S-patch Ex Solution

ESC 2020 and KHRS 2021 AF Guidelines
: Screening for AF

Recommendations for screening to detect AF

Recommendation	Class[a]	Level[b]
Opportunistic screening for AF by pulse taking or ECG rhythm strip is recommended in patients ≥65 years of age.[188,211,223,225]	I	B
It is recommended to interrogate pacemakers and implantable cardioverter defibrillators on a regular basis for AHRE.[c224,226]	I	B
Systematic ECG screening should be considered to detect AF in individuals aged ≥75 years, or those at high risk of stroke.[212,224,227]	IIa	B

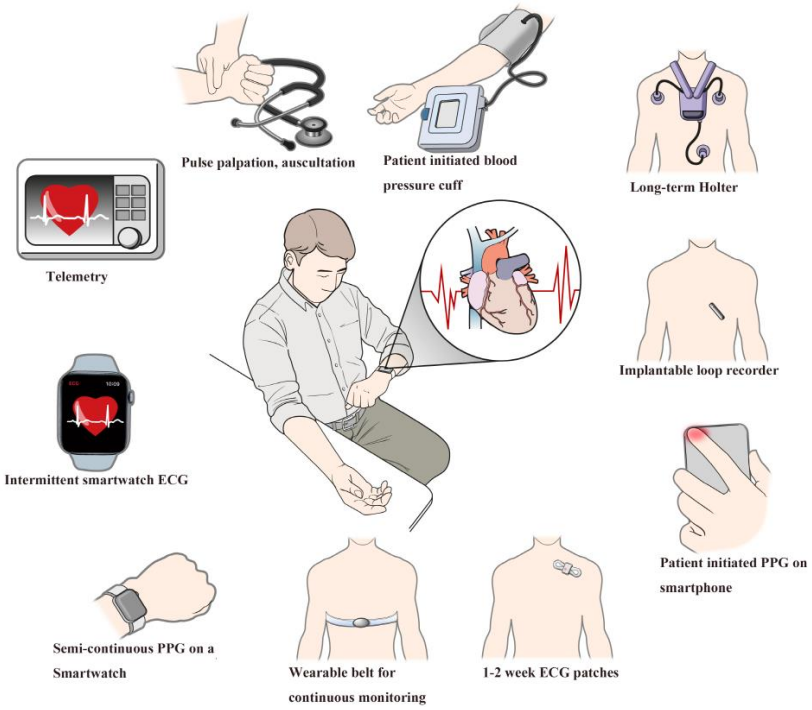
Table 5 Sensitivity and specificity of various AF screening tools considering the 12-lead ECG as the gold standard[173]

	Sensitivity	Specificity
Pulse taking[203]	87 - 97%	70 - 81%
Automated BP monitors[204–207]	93 - 100%	86 - 92%
Single lead ECG[208–211]	94 - 98%	76 - 95%
Smartphone apps[188,189,191,195,212,213]	91.5 - 98.5%	91.4 - 100%
Watches[196,198,213,214]	97 - 99%	83 - 94%

AF = atrial fibrillation; BP = blood pressure; ECG = electrocardiogram.

2021 대한부정맥학회 심방세동의 선별검사 및 무증상 심방세동의 관리 지침

Abbreviated title: 무증상 심방세동의 선별검사 및 관리 지침



2020 ESC AF guidelines, Eur Heart J 2020

2021 *대한부정맥학회 무증상 심방세동의 선별검사 및 관리 지침. 대한내과학회지*

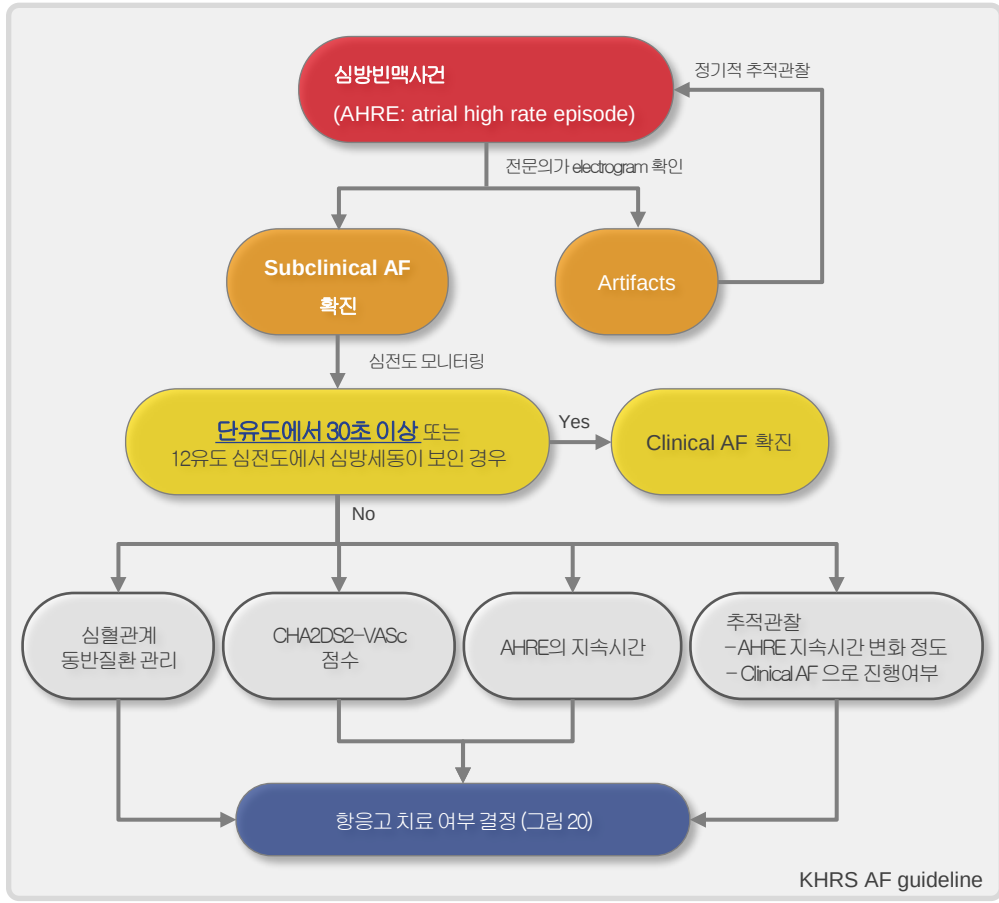
2021 KHRS AF guideline

[심방세동 진단의 권고 사항]

권고 사항	권고 등급	근거 수준
심방세동 진단에는 심전도 기록이 필요함 표준 12유도 심전도 혹은 단일 유도 심전도에서 30초 이상의 심방세동 심전도 소견(분명한 P파가 관찰되지 않으면서 RR 간격이 불규칙적임)을 보임	I	B

[심방빈맥사건 / 잠복성심방세동 관리에 관한 권고 사항]

권고 사항	권고 등급	근거 수준
심방빈맥사건 / 잠복성심방세동이 발견된 환자에서는 심전도, 위험인자/동반질환 평가, CHA_2DS_2-VASc 점수 계산을 통해 심혈관계의 면밀한 평가를 권장한다. 환자를 추적관찰(원격모니터링 선호)하여, 임상적 심방세동으로 진행여부, 심방빈맥사건/잠복성심방세동의 양 변화(특히 24시간 이상 증가여부), 및 기저질환의 변화를 평가하도록 권장된다.	I	B



심장내 전기장치로 발견된 심방빈맥사건 / 잠복성 심방세동의 진단과 관리 방법

Screening for AF: is it suitable?
: WHO criteria

Criteria		Suitability
Important health problem with an accepted treatment	+	2%, 5-fold stroke, 3-fold mortality
Facilities for diagnosis and treatment	+	From primary clinic to tertiary hospital
Latent and symptomatic stage	+	Subclinical AF → Clinical AF
Natural history is understood	±	Subclinical -> Paroxysmal -> Persistent Increase Stroke, heart failure, mortality
Agreed policy on whom to treat	+	Global guidelines, CHA_2DS_2-VASc score
Cost of finding the condition is economically balanced with overall health benefits of treatment	±	Cost-effective detection tools Stroke <70% reduction with NOAC
Case-finding is a continuous process	+	Consistent new AF incidence rate
Screening test is suitable and acceptable to the population	+	Non-invasive tests (ECG, wearables etc..)

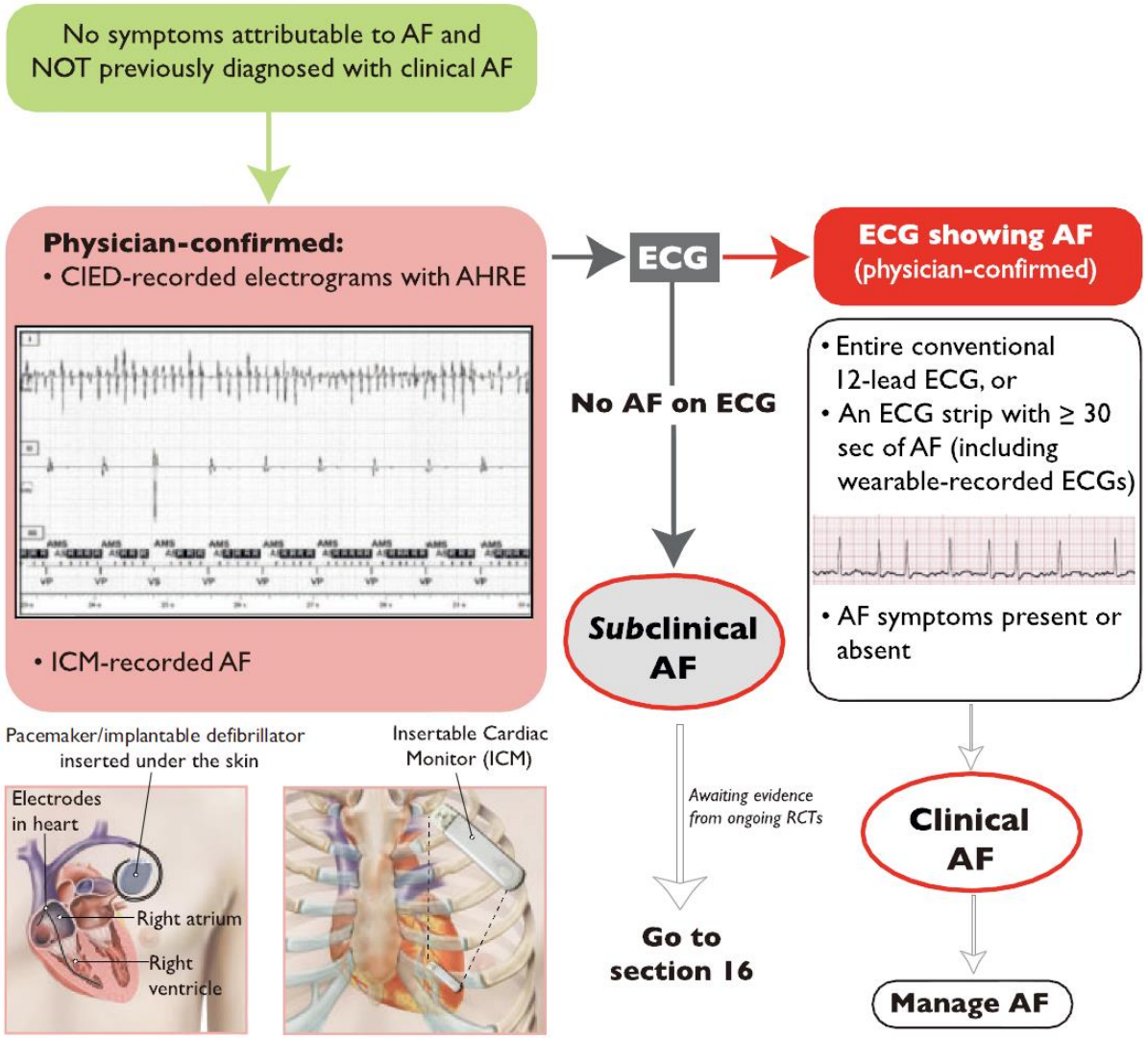
+ = suitable; ± = uncertain.

Chen NY. Arrhythm Electrophysiol Rev 2018;7(1): 39-42.

AF screening, Why now?

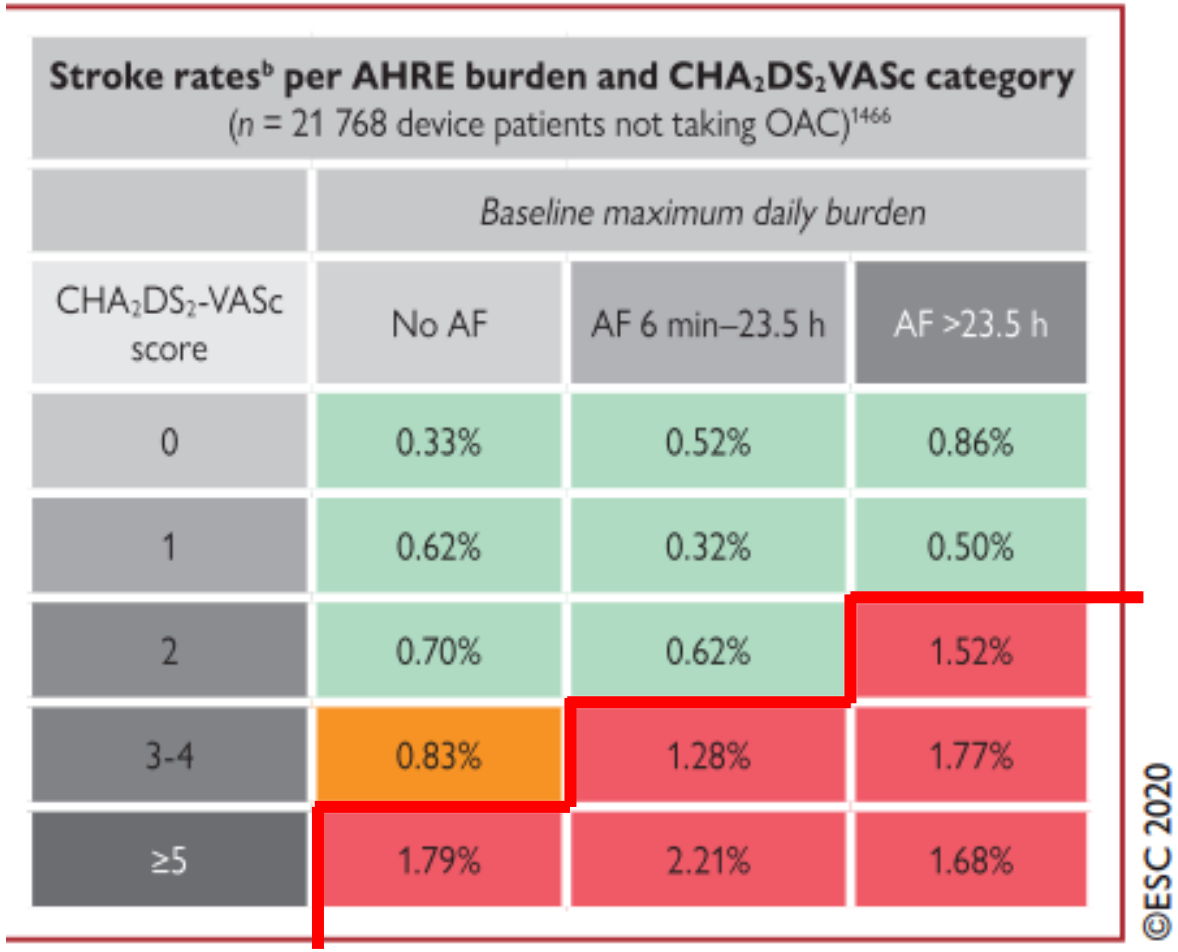
- Aging population; AF –stroke a major problem
- "**Subclinical**" AF is associated with stroke
- Adverse effects of AF beyond stroke
- Many new **screening technologies** have shown promise.
- **NOAC**s have made treatment easier
- Early work suggests a large number of AF patients can be identified.

Subclinical AF
: detected by CIED → detected by wearable devices



- Subclinical AF (SCAF)
  - Asymptomatic
  - Short duration (minutes to hours)
  - Usually detected by monitoring devices
- Clinical AF
  - Symptomatic or asymptomatic
  - Documented on ECG

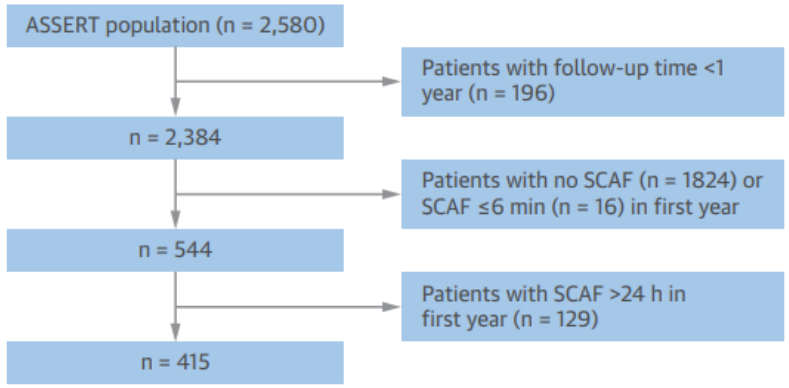
SCAF (AHRE) and risk of stroke

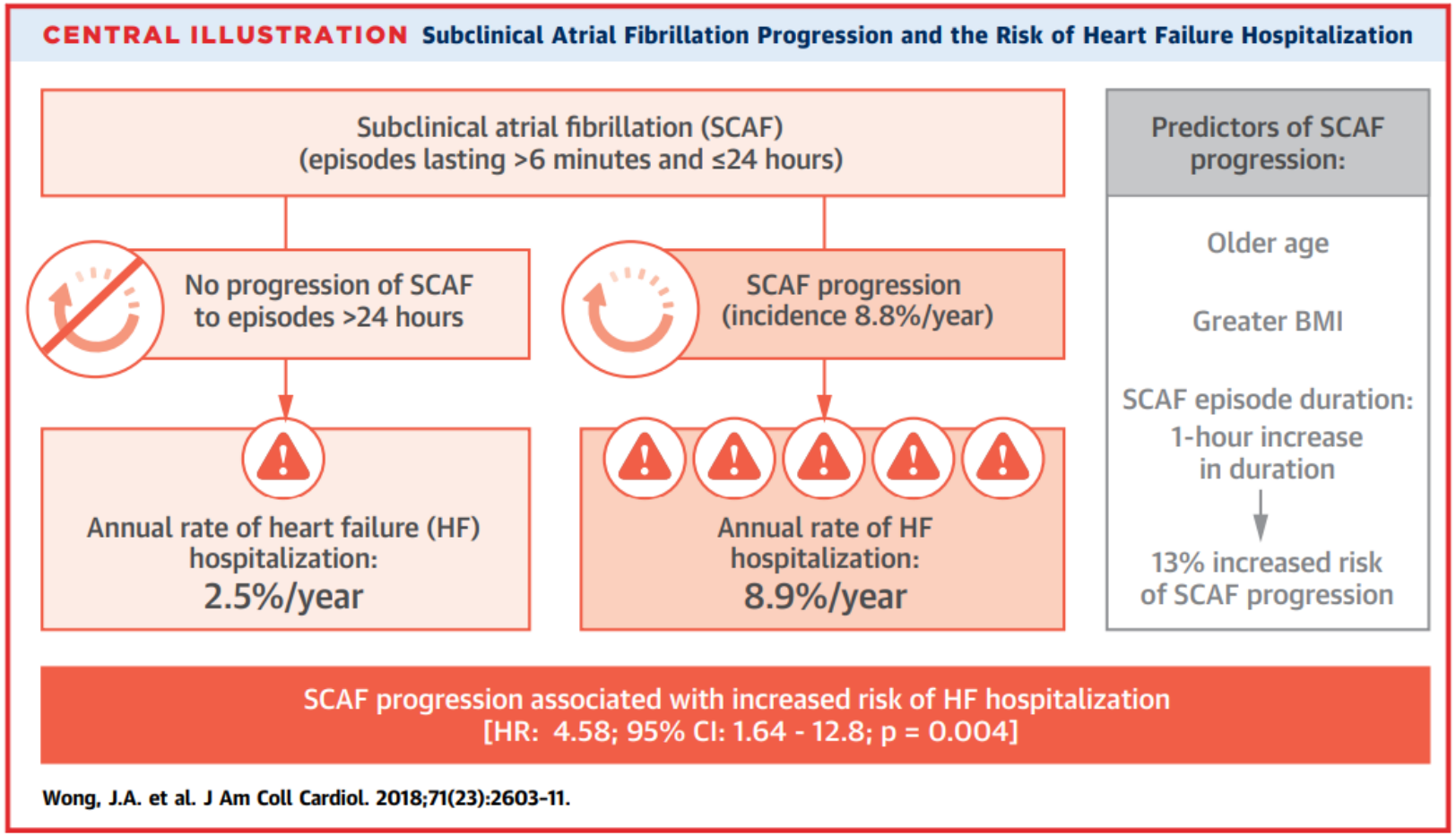


Stroke rates[b] per AHRE burden and CHA_2DS_2VASc category
(*n* = 21 768 device patients not taking OAC)[1466]

	Baseline maximum daily burden		
CHA_2DS_2-VASc score	No AF	AF 6 min–23.5 h	AF >23.5 h
0	0.33%	0.52%	0.86%
1	0.62%	0.32%	0.50%
2	0.70%	0.62%	1.52%
3-4	0.83%	1.28%	1.77%
≥5	1.79%	2.21%	1.68%

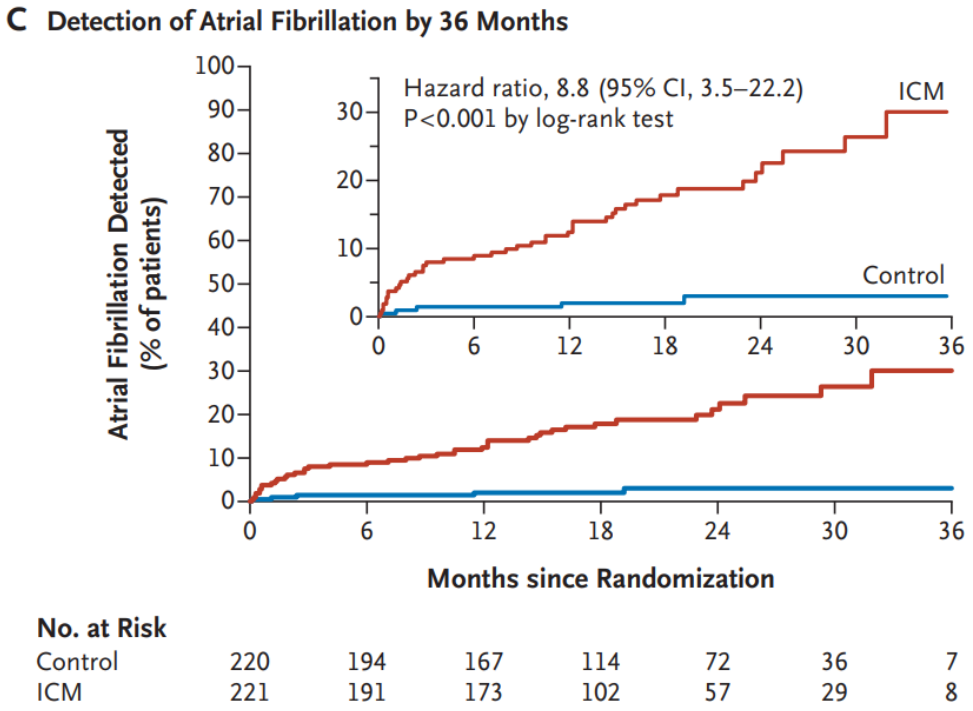
SCAF progression and HF





Wong J.A. et al. J Am Coll Cardiol. 2018;71(23):2603–11.

AF detection with ILR
:Embolic Stroke of Undetermined Source (ESUS)



Research Group	Total Patients Included	Rate of AF Detection	Monitoring Duration	Time to Detection
CRYSTAL AF (2014)	221	8.9% at 6 months 12.4% at 12 months 30.0% at 36 months	Minimum 6 months	Median 84 days
SURPRISE (2014)	85	16.1%	569 days	Mean 109 days
Cotter et al (2013)	51	25.5%	Mean 229 days	Median 48 days
Ritter et al (2013)	60	16.7%	1 year	Mean 64 days

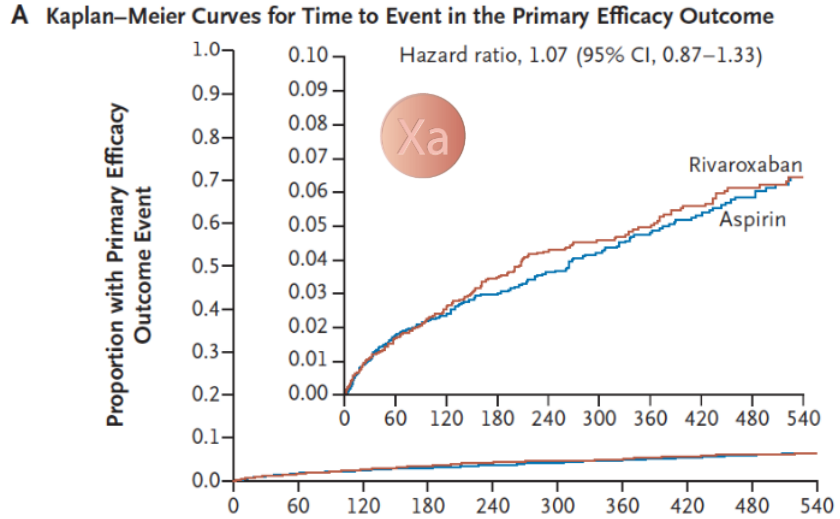
- ILR (221) vs standard of care (12-lead ECG) (220)
- >30sec AF: 6month 8.9% vs 1.4% / 12months: 12.4% vs 2.0%

- AF detection rate of 16.1 ~ 30% with ILR in patients with cryptogenic stroke
- Time to detection : median 50 – 100days

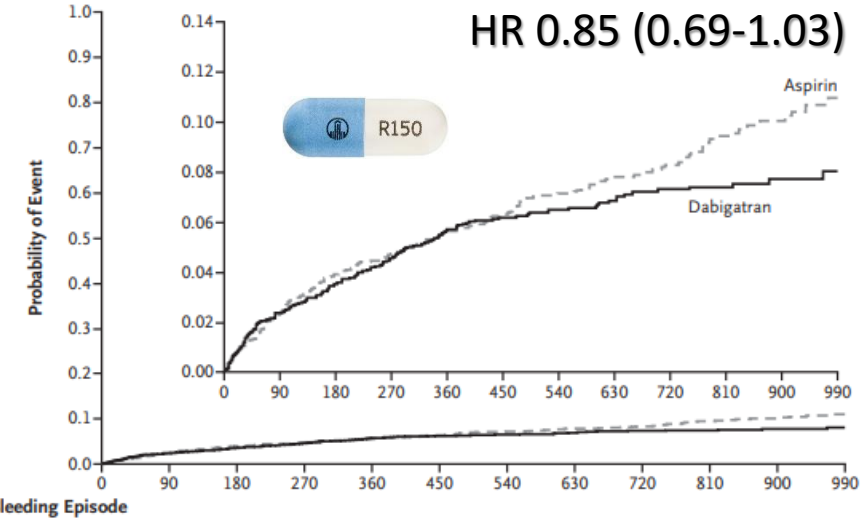
Sanna T et al. N Engl J Med 2014;370:2478-86
Brambatti M et al. Circulation. 2014 May 27;129(21):2094-9.

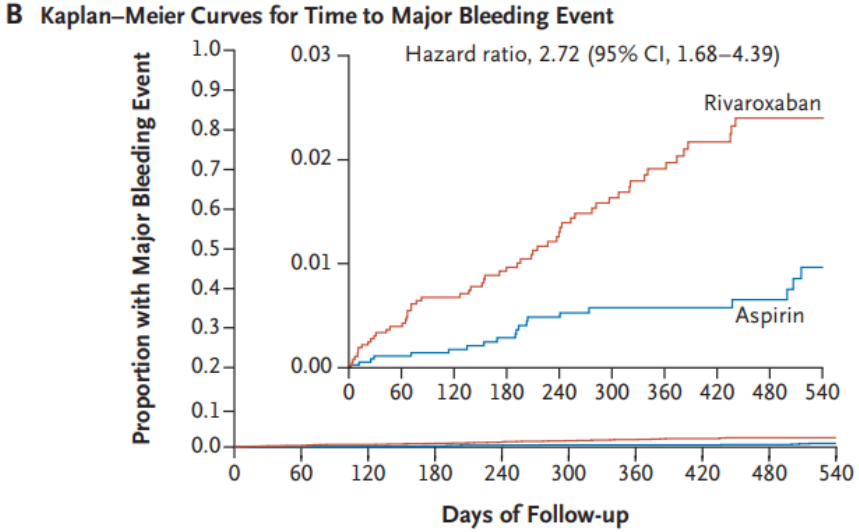
Empirical OAC in ESUS?

: NAVIGATE ESUS (Rivaroxaban) & RE-SPECT ESUS (Dabigatran) trial

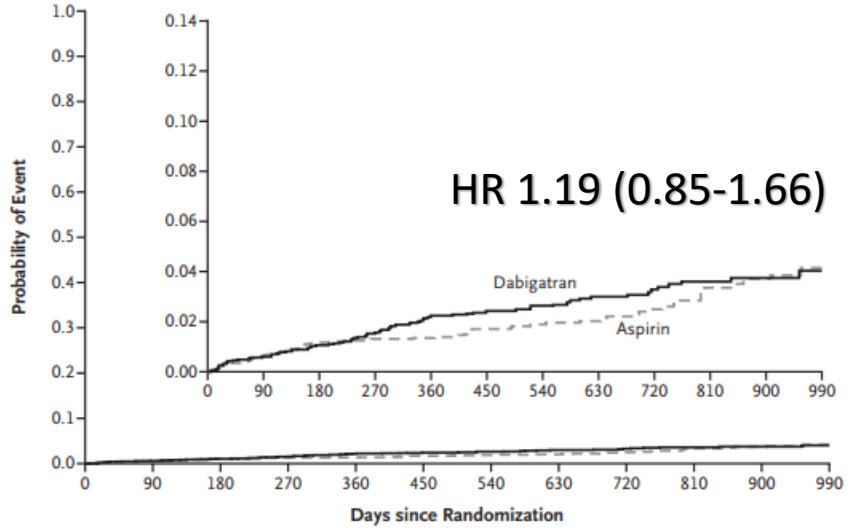


Recurrent stroke





Major bleeding



Hart RG et al. N Engl J Med 20187;378:2191-2201 / Diener HC et al. N Engl J Med 2019;380:1906-1917

Detection of Subclinical AF

- Subclinical AF is associated with increased risk of stroke
- SCAF aggravates HF? maybe (maybe burden is the key)
- Empirical OAC in ESUS is not effective treatment strategy at all.
- Detecting Subclinical AF and accurate AF burden has remained an important Issue.

Guidelines for AF screening

Organization	Population	Recommendation	Grade
AHA/ASA	≥65	Active screening in primary care setting by pulse assessment followed by ECG as indicated	IIa, LOE B
USPSTF (2018)	≥65	Evidence insufficient to assess benefits and harms of ECG screening	Insufficient evidence
UK NSC		Population screening for AF should not be offered	
ESC/EHRA/EACTS (2020) KHRS (2021)	≥65	Opportunistic screening by pulse assessment or ECG rhythm strip	I
	≥75 or at high risk of stroke	Systematic ECG screening should be considered	IIa, LOE B

Guidelines for AF screening in 2022 (USPSTF) : Age 65 → 50

Clinical Review & Education

JAMA | US Preventive Services Task Force | RECOMMENDATION STATEMENT

Screening for Atrial Fibrillation
US Preventive Services Task Force Recommendation Statement

US Preventive Services Task Force

Summary of Recommendation

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.	I

The USPSTF did this to be inclusive of all potential evidence on screening for AF. Lowering the inclusion age was not intended to dilute the evidence in older adults in any way, nor did it. Some

Benefits and Risks of Screening

표 6. 심방세동 선별검사의 잠재적인 이점과 위험성

심방세동 선별검사	
위험성	**이 점**
• 비정상 결과에 의한 불안감 발생 • 심전도 오판독으로 인한 과잉 진단 및 과잉 치료 • 비정상 결과로 인해 발생하는 침습적 검사 및 치료 증가	**예방효과** • 항응고제 사용에 의한 뇌경색/색전증의 예방 • 심방세동 증상 발생 예방 **예방/회복 효과** • 전기/구조적 심방 리모델링의 회복 • 심방세동 관련 혈역학적 장애의 회복 • 빈맥 유발성 심근증 예방 및 회복 **예방/감소 효과** • 심방세동에 의한 입원률, 사망률의 감소 **감소 효과** • 심방세동과 밀접하게 연관된 컨디션/질환의 빠른 발견 및 치료로 인한 예후 향상

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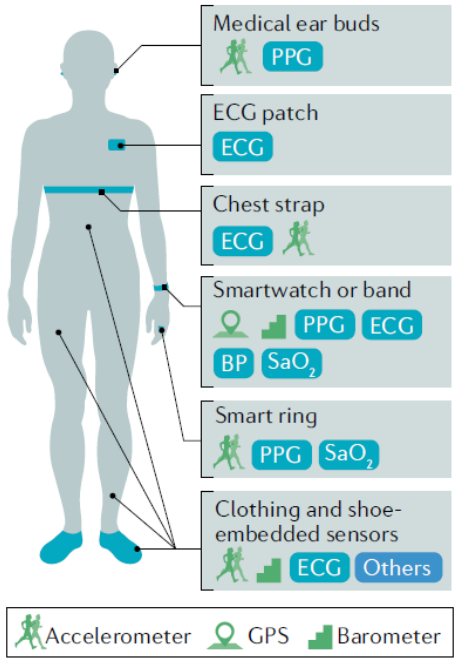
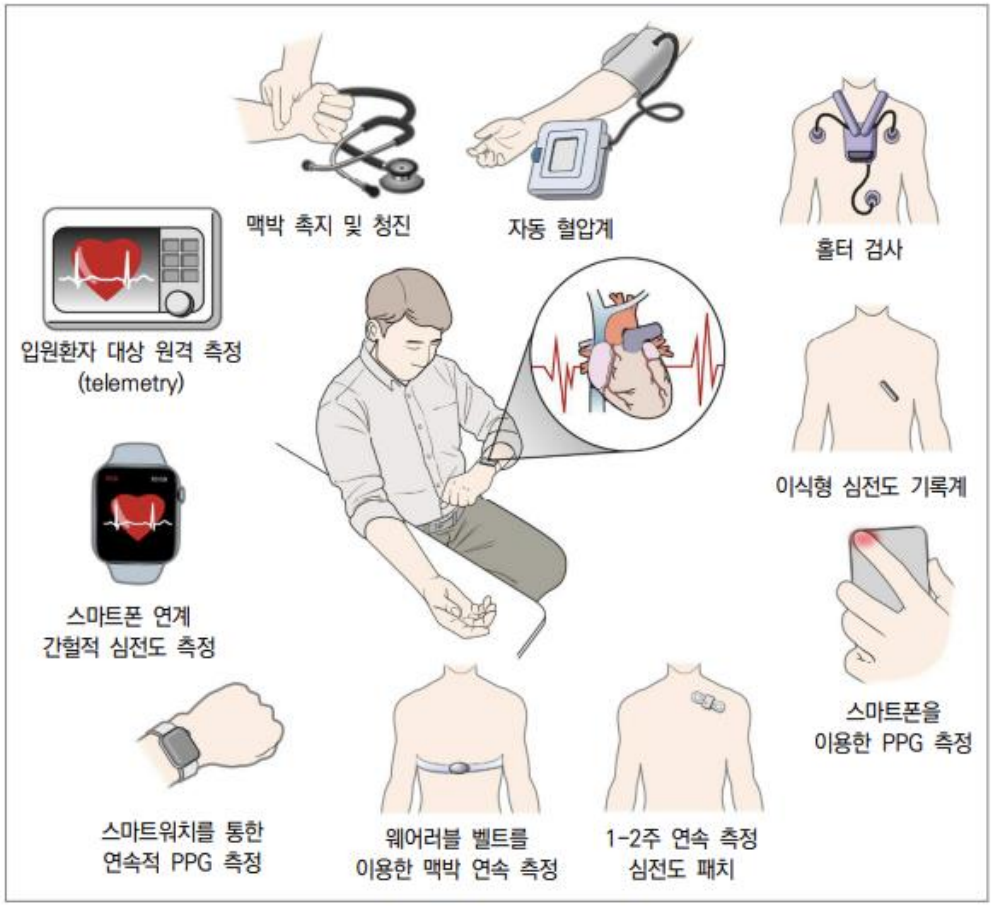
Various smart wearable devices…



Sensors	Measurements	Clinical applications
Activity		
Accelerometer	Step count, impact force, speed, sedentary time, exercise	• Risk assessment in healthy individuals and those with established CVD • Physical activity behavioural interventions in primary and secondary prevention • Cardiac telerehabilitation • Heart failure management
Barometer	Stair count	
GPS	Distance traveled	
	Calories burned estimated from multiple measurements	
Biometric		
PPG	HR, HRR, HRV, cuff-less BP, SaO_2, cardiac output, stroke volume, pulse-based rhythm detection, sleep and its stages	• Risk prediction in healthy individuals and those with established CVD • Hypertension screening and management • Cardiac telerehabilitation • Arrhythmia screening and diagnosis • Acute coronary syndrome diagnosis • Diagnosis of electrolyte abnormalities such as hyperkalaemia • Long QTc diagnosis • Heart failure management • Medication titration such as β-blockers
ECG	Single-lead and multi-lead ECG, continuous or as-needed ECG monitoring, interval measurements such as QTc, arrhythmia detection and electrolyte abnormality changes	
Oscillometry	Wrist cuff BP	
Other		
Biochemical sensors	Invasive for continuous blood glucose and electrolyte monitoring Non-invasive for sweat and saliva electrolytes and hydration status	• Identifying electrolyte abnormalities • Continuous blood glucose monitoring • Heart failure management
Biomechanical sensors such as ballistocardiograms, seismocardiograms and dielectric sensors	Cardiac output, stroke volume, lung fluid volume, body vibrations, weight	



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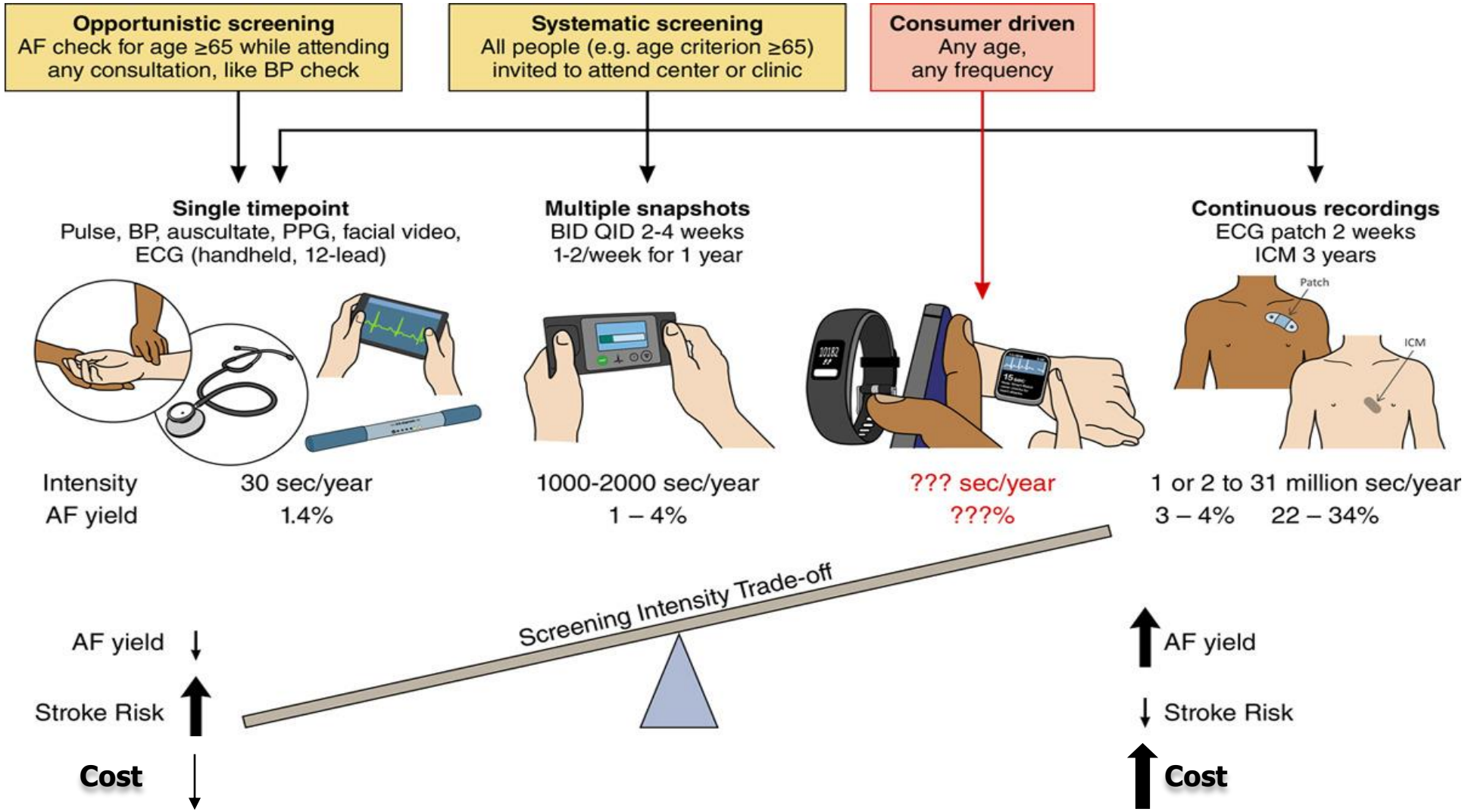
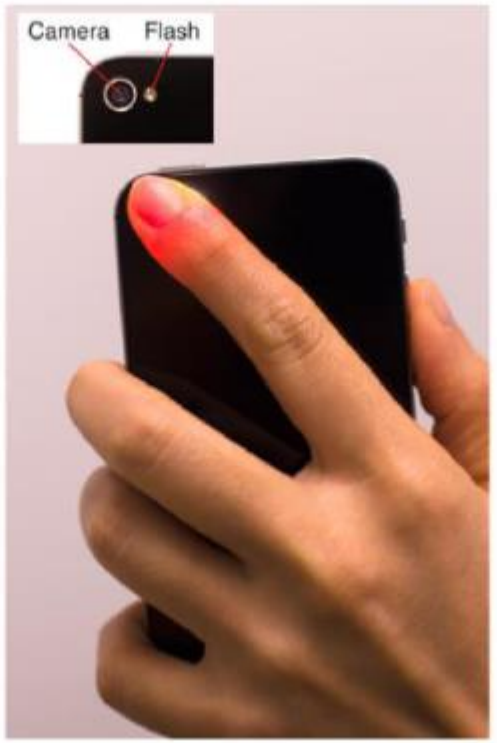
Bayoumy K et al. Nat Rev Cardiol 2021;18:581-99

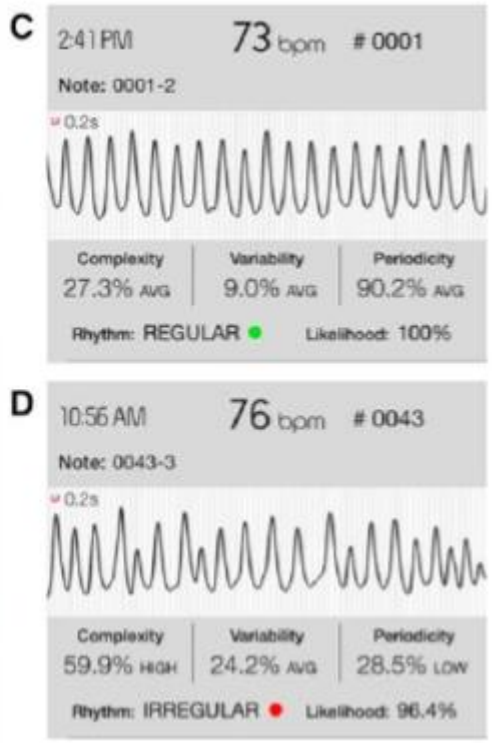
Different Modalities for AF screening
: AF yield, Stroke risk, and Cost-Effectiveness



Benjamin EJ et al. Circulation. 2021 Jan 26;143(4):372-388

Non-ECG method
: Photoplethysmography (PPG)

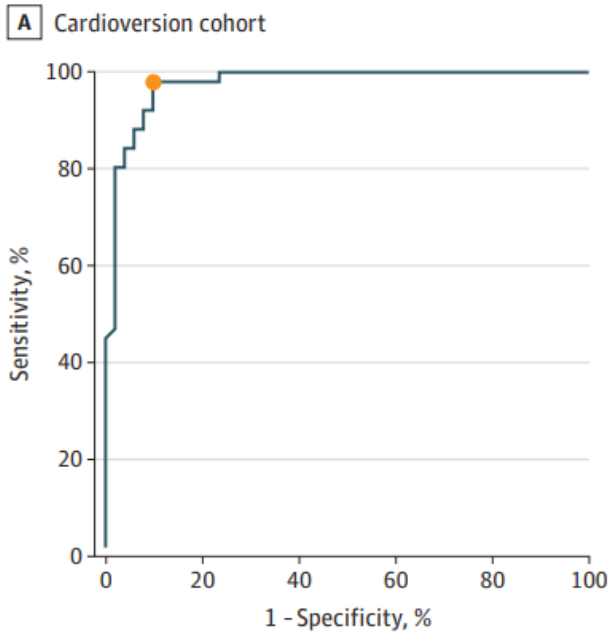


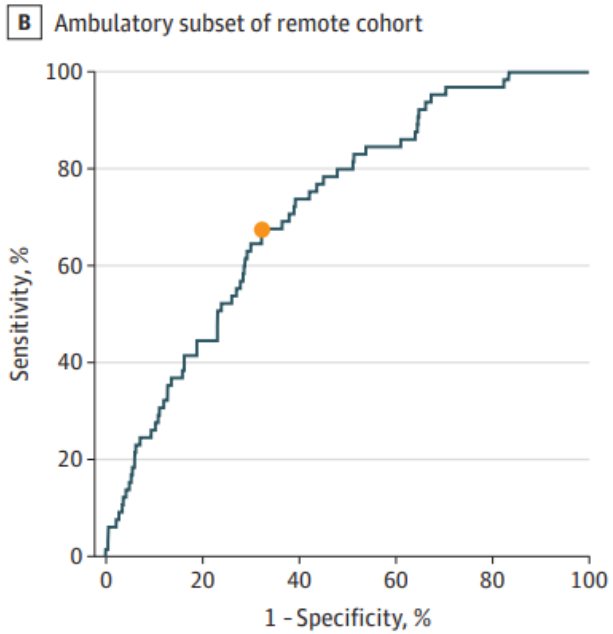


- Utilizes an infrared light to measure the volumetric variations of blood circulation.
- The popularity of the PPG technology as an alternative heart rate monitoring technique has recently increased, mainly due to the simplicity of its operation, the wearing comfort ability for its users, and its cost effectiveness.
- Very susceptible to Motion Artifacts caused by hand movements.

Chan PH et al. J Am Heart Assoc. 2016;5:e003428

Is PPG feasible for detecting AF?
: Apple watch with deep learning algorithm (ambulatory cohort)





	%				
Cohort	Sensitivity	Specificity	PPV	NPV	AUC
Cardioversion cohort (sedentary)	98.0	90.2	90.9	97.8	0.97
Subset of remote cohort (ambulatory)	67.7	67.6	7.9	98.1	0.72

- Total of 9750 participant, 347 with AF. 51 patients undergoing cardioversion.
- Smartwatch PPG with DNN can detect AF but with some loss of accuracy (**very poor PPV**).

Tison G et al. JAMA Cardiol 2018 May 1;3(5):409-416

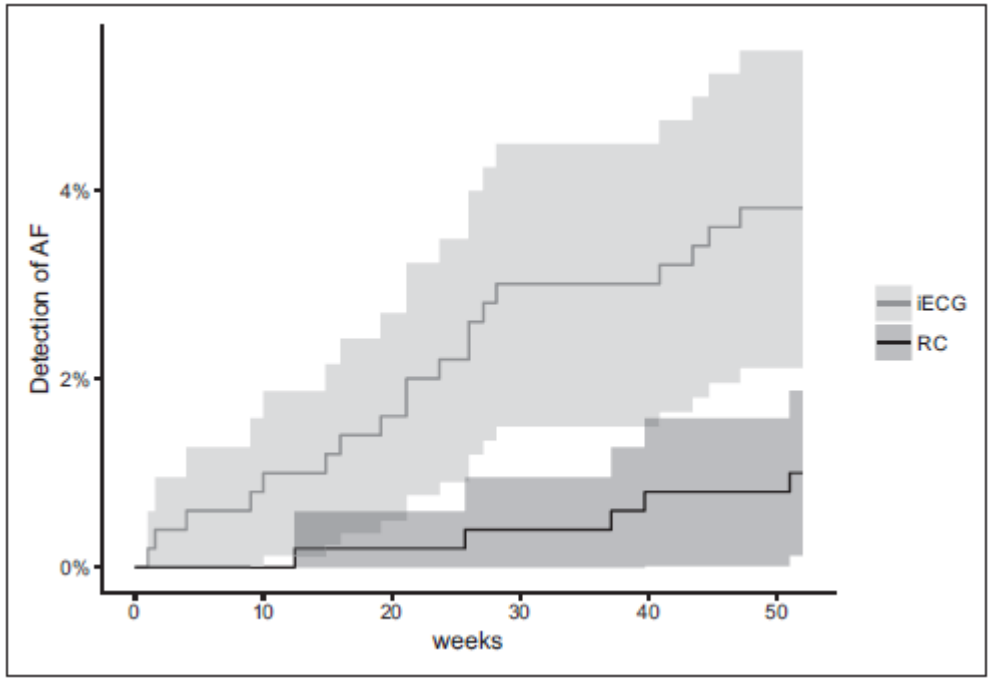
Confirmation of AF : 12 lead ECG or single lead ECG >30s

Recommendations for diagnosis of AF

Recommendations	Class[a]	Level[b]
ECG documentation is required to establish the diagnosis of AF. • A standard 12-lead ECG recording or a single-lead ECG tracing of ≥30 s showing heart rhythm with no discernible repeating P waves and irregular RR intervals (when atrioventricular conduction is not impaired) is diagnostic of clinical AF.[6]	I	B

2020 ESC AF guidelines, Eur Heart J 2020

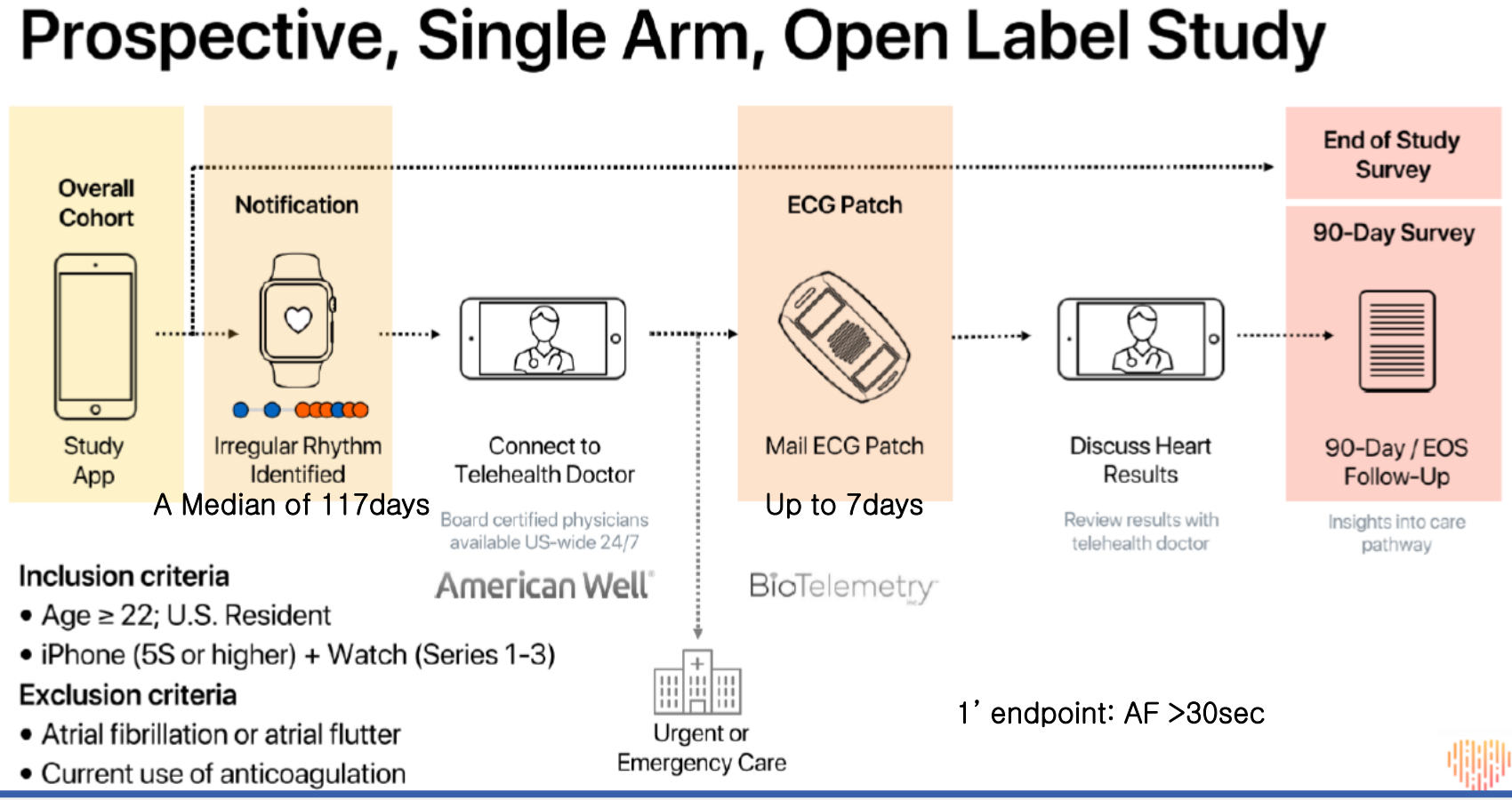
Intermittent single lead ECG (twice weekly for 1yr)
: The Rehearse-AF study



- 5846 participants with no AF, >65yo & CHA2DS2-VASc ≥2, 1272 volunteered → 1004 enrolled → 500 study (Alivecor) vs. 501 control (routine care)
- Twice-weekly Alivecor ECG for 12 month → 74% completed without missing
- Age was not related to compliance.
- AF detection 19 vs 5 (HR 3.9 [1.4-10.4] p=0.007), but no difference in outcome.

Halcox J et al. Circulation. 2017;136:1784–1794

PPG + Continuous single-lead ECG
: Apple Heart Study - design

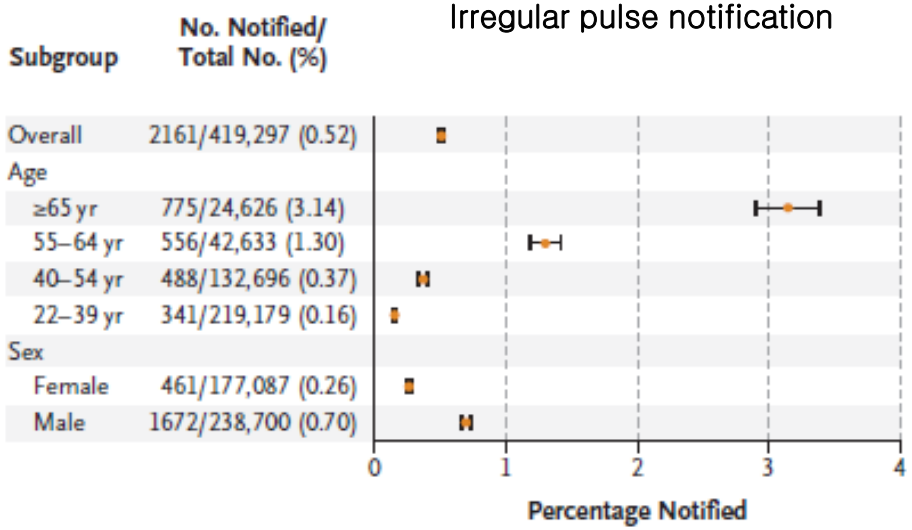


- 419,297 participants. A Median of 117 days of monitoring.
- Irregular pulse notification in 2161 (0.52%). → 450 applied & returned ECG patches.
- AF diagnosed in 34% overall, 35% in >65yo, 57% contacted health care providers.

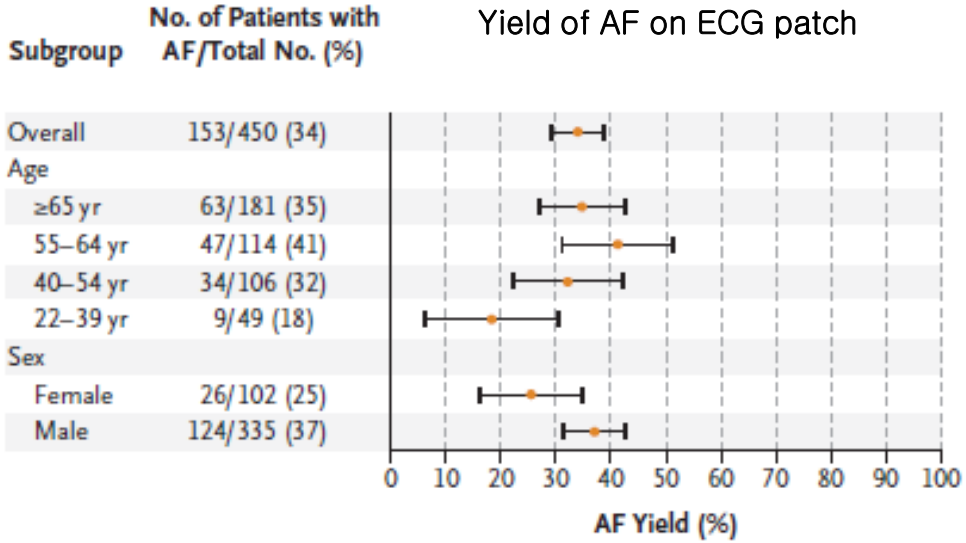
Perez MV et al. N Engl J Med. 2019 Nov 14;381(20):1909-1917

PPG + Continuous single-lead ECG
: Apple Heart Study - results

Irregular pulse notification



Yield of AF on ECG patch

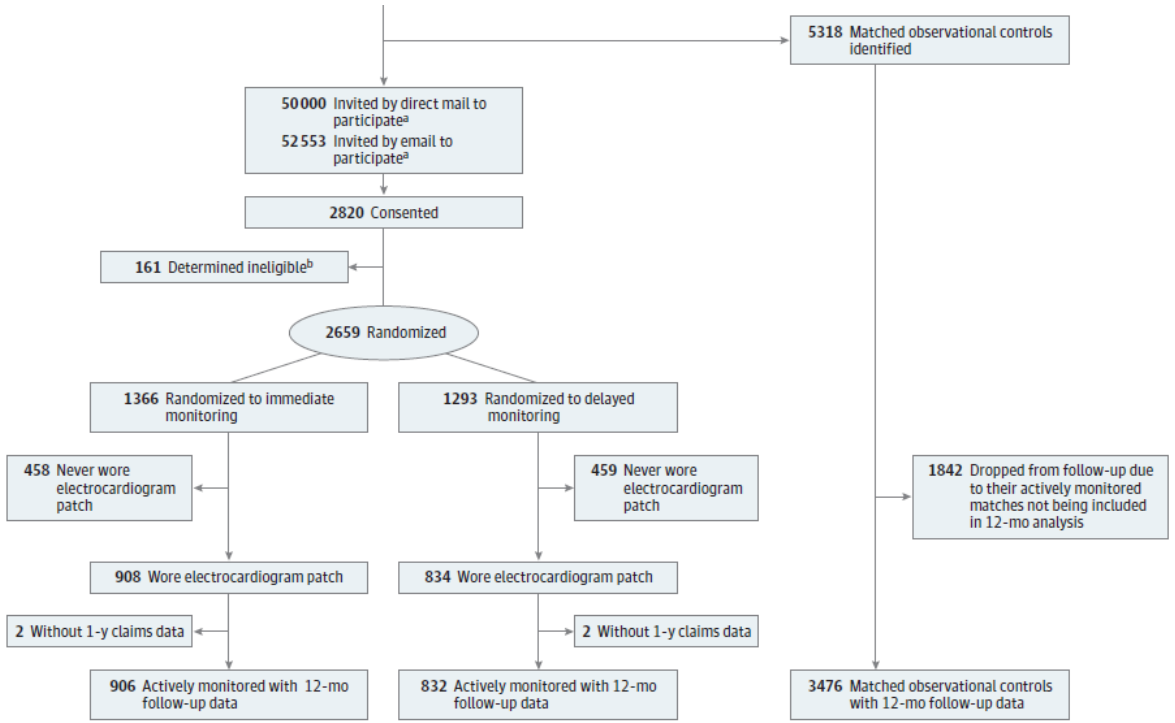


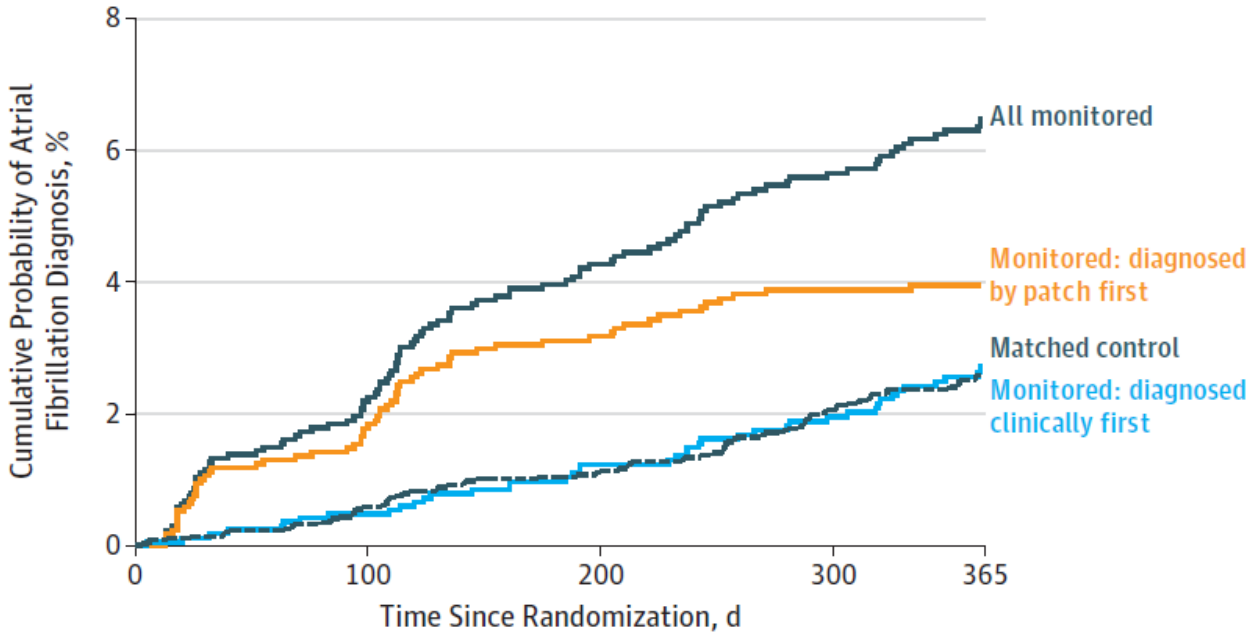
Variable	Notification Subgroup (N=929)	Non-notification Subgroup (N=293,015)
New diagnosis — no. (%)		
Atrial fibrillation	404 (43)	3070 (1.0)
Stroke	7 (0.8)	321 (0.1)
TIA	12 (1.3)	498 (0.2)
Heart failure	30 (3.2)	648 (0.2)
Myocardial infarction	10 (1.1)	574 (0.2)
Major bleeding	7 (0.8)	842 (0.3)
Medication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

- The probability of receiving an irregular pulse notification was low. (0.52%), but 84% of notification were concordant with AF.
- 34% had AF on ECG patch among the notification group.
- This siteless pragmatic study can be done with user-owned devices. (Funded by Apple).

Perez MV et al. N Engl J Med. 2019 Nov 14;381(20):1909-1917

Continuous ECG monitoring Patch
: The mSToPS trial (iRhythm Zio^{XT} Patch)



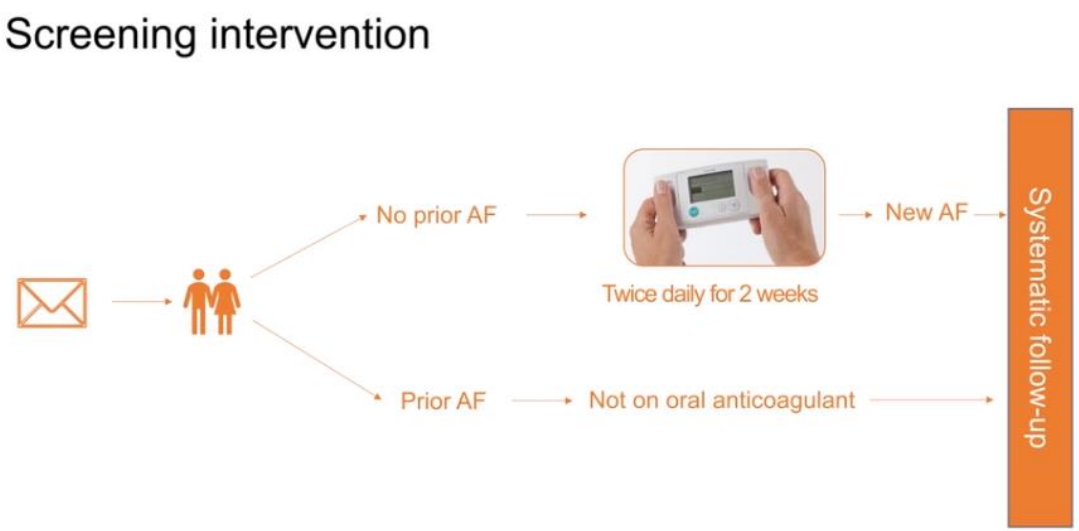


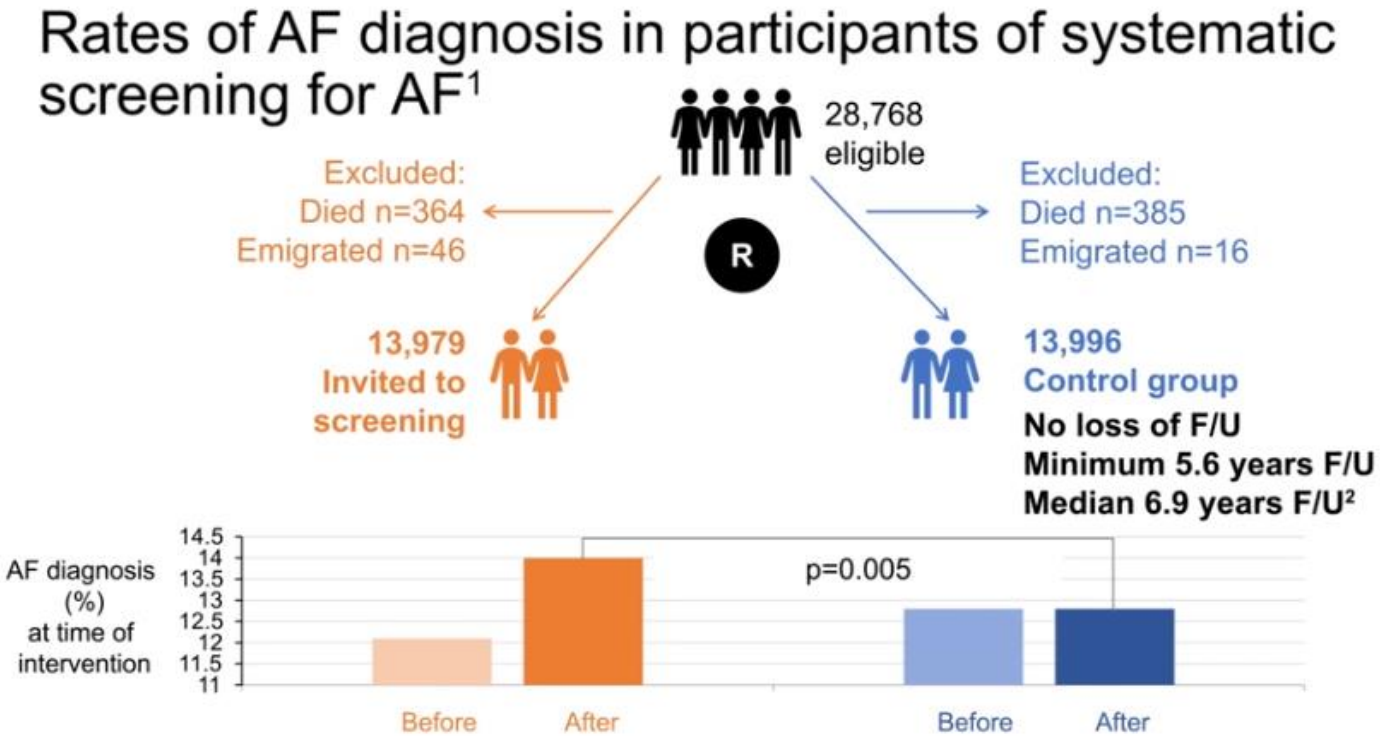
- AF detection: 3.9% vs 0.9% at first 4 months
- AF related therapeutic interventions (No/100pyrs): 5.7 vs 3.7 (OAC), 0.8 vs 0.3 (AAD), 0.3 vs 0.1 (RFA)
- Medical visit (No/100pyrs): 1.3 vs 1.4 (ED visit), 2.78 vs 2.84 (primary care visits)

Steinhubl S et al. JAMA 2018;320:146-155

Clinical outcomes in systematic screening for AF
: STROKESTOP trial (Intermittent single lead ECG)

- ✓ All living residents aged 75 or 76 years in Stockholm or Halland (in Sweden)
- ✓ No exclusion criteria

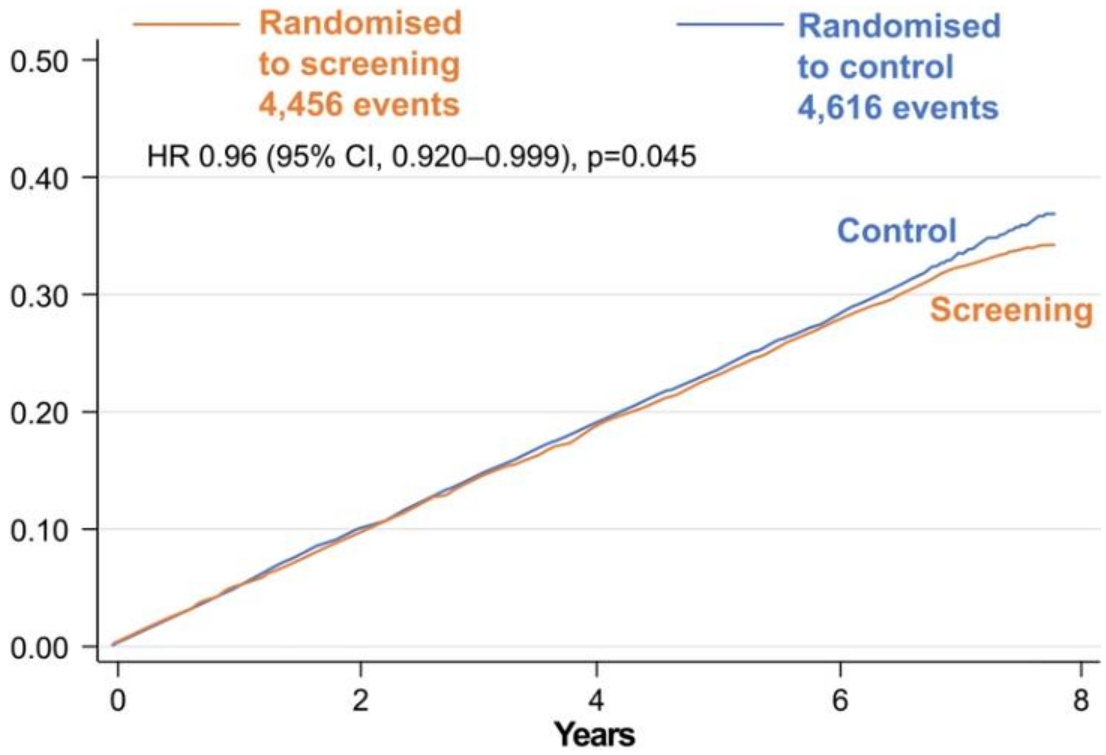


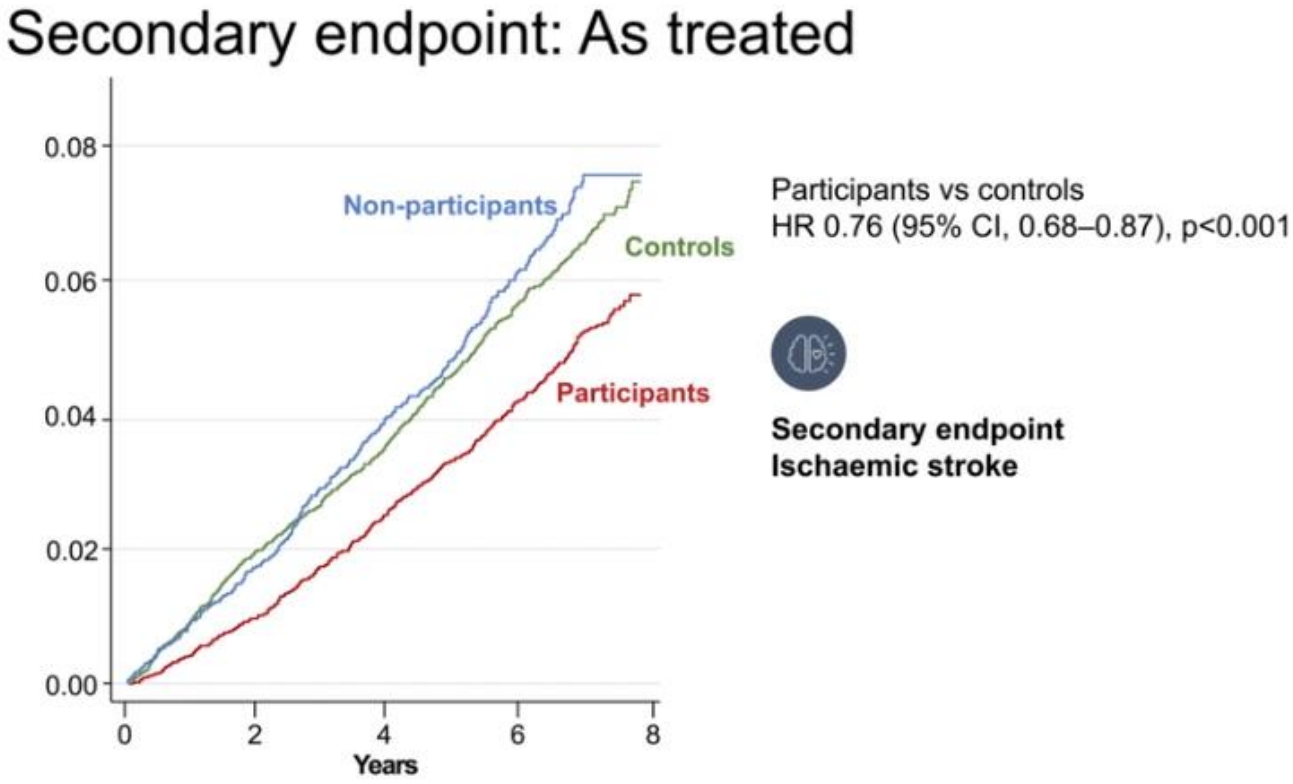


Svennberg E et al. Lancet 2021;398:1498-1506

Clinical outcomes in systematic screening for AF
: STROKESTOP trial (Intermittent single lead ECG)

- ✓ Mean : 76yo, women 54.6%, CHA_2DS_2-VASc 3.5
- ✓ Primary endpoint : all cause death + stroke + SE + hospitalization for bleeding

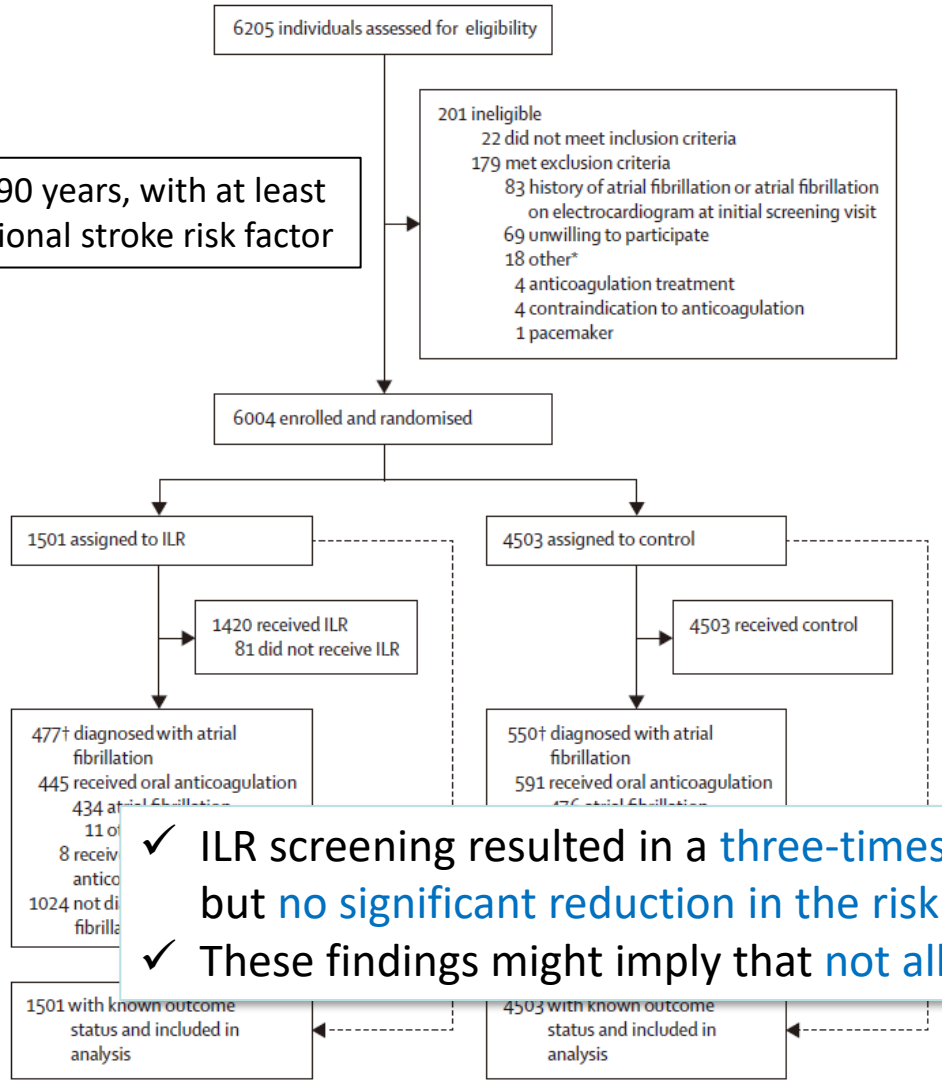


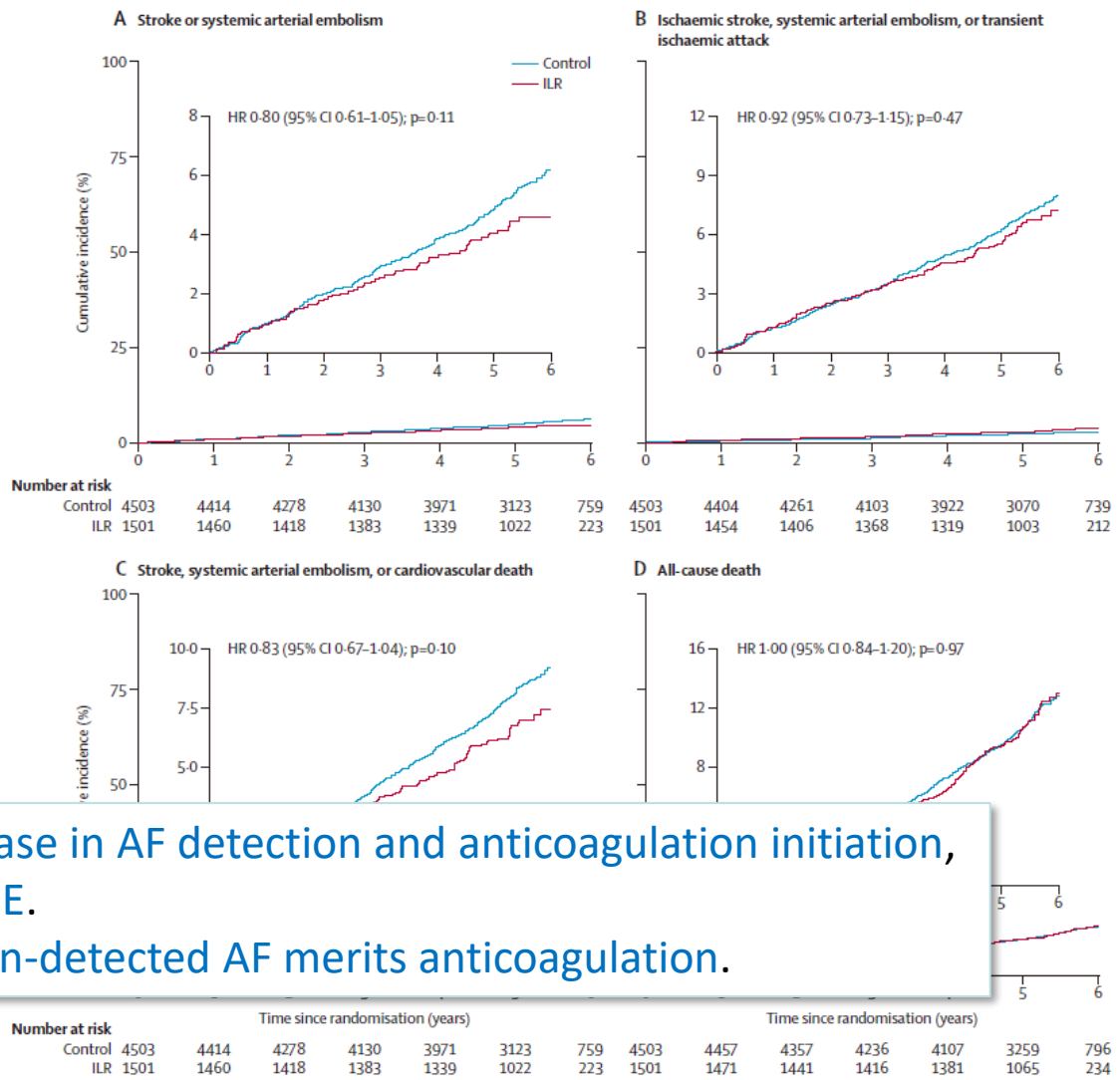


Svennberg E et al. Lancet 2021;398:1498-1506

Implantable Loop Recorder
: The LOOP Study

Aged 70–90 years, with at least one additional stroke risk factor



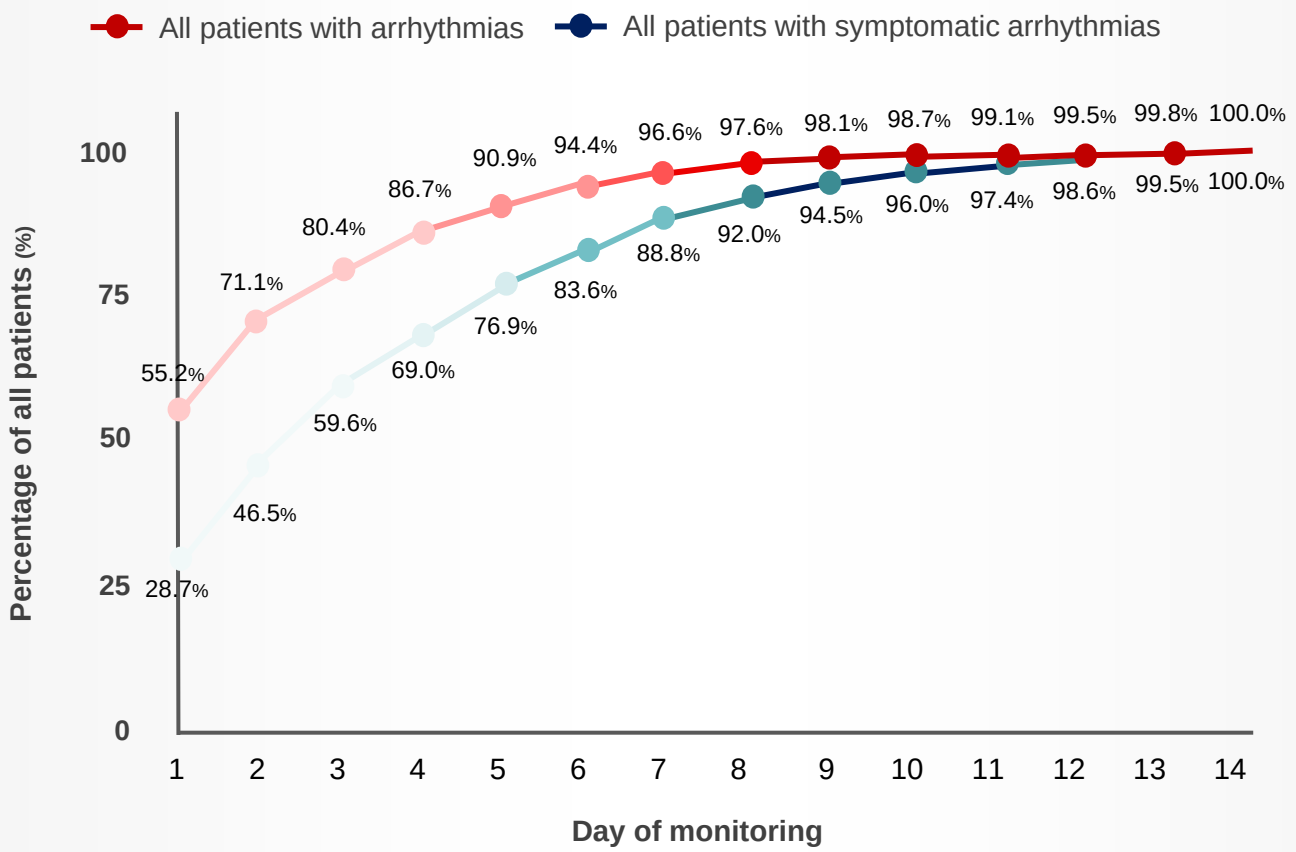


- ✓ ILR screening resulted in a three-times increase in AF detection and anticoagulation initiation, but no significant reduction in the risk of S/SE.
- ✓ These findings might imply that not all screen-detected AF merits anticoagulation.

Svendsen JH et al. Lancet 2021;398:1507-1516

Arrhythmia detection yield over time

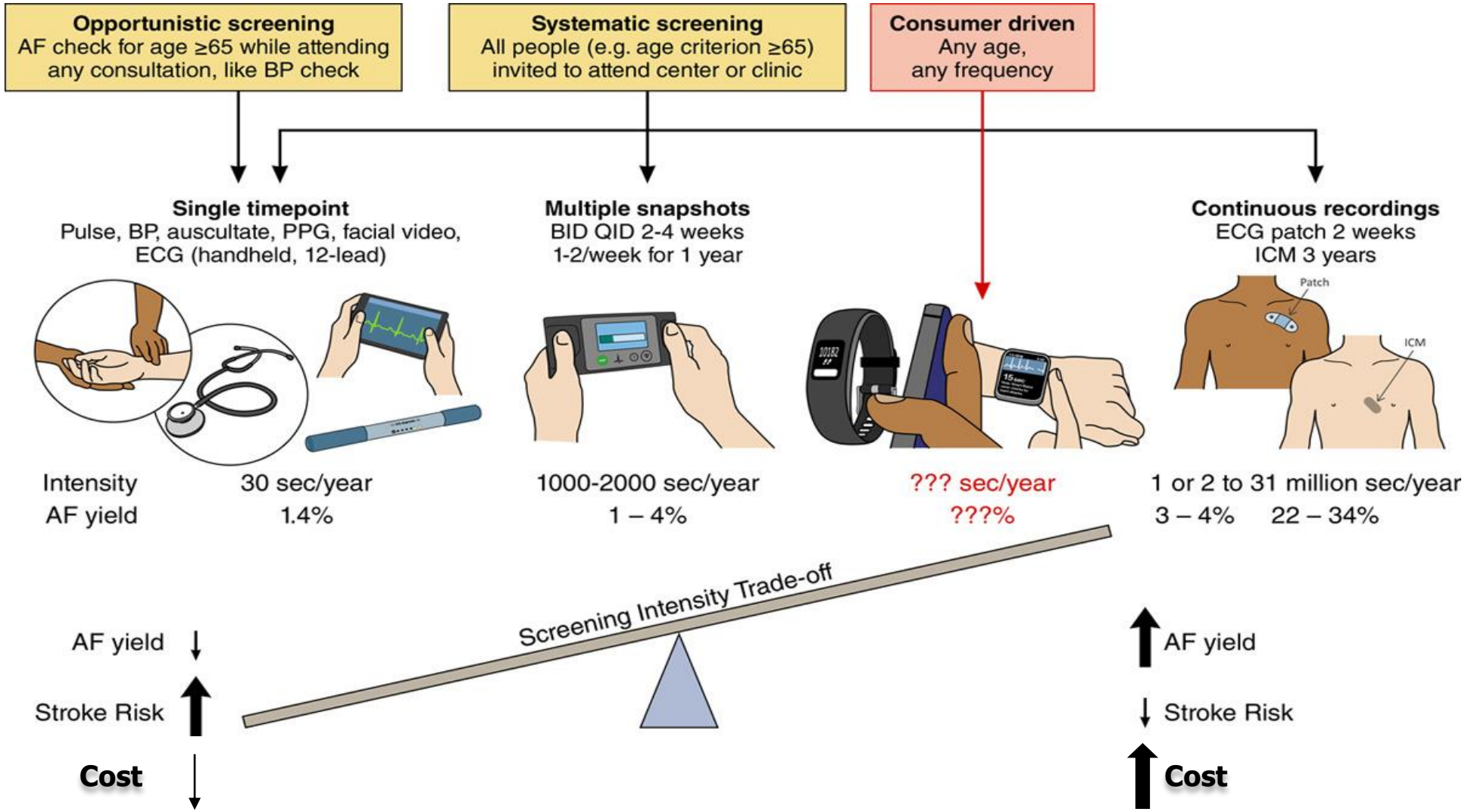
Cumulative yield of arrhythmia detection over time



Among patients with arrhythmias, regardless of symptoms, **90% had arrhythmia identified by the fifth day of monitoring; only 71% did so in the first 2 days of monitoring.** The trends were similar for symptom-triggered arrhythmias, with a 90% yield by 8 days of monitoring.

MP Turakhia, et al. Am J Cardiol 2013;112:520-524.

Different Modalities for AF screening
: AF yield, Stroke risk, and Cost-Effectiveness

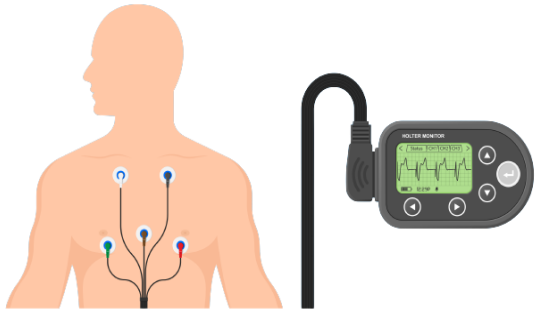


Benjamin EJ et al. Circulation. 2021 Jan 26;143(4):372-388

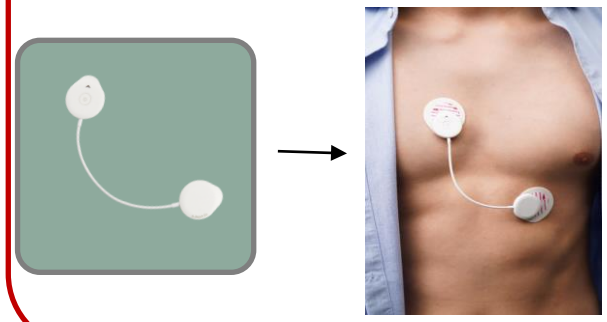
Modalities for ambulatory cardiac continuous monitoring

Ambulatory cardiac monitoring devices

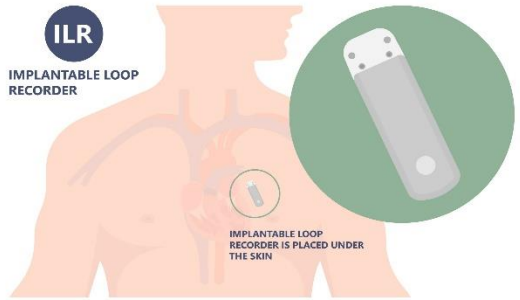
Standard holter recorder



Patch ECG



Implantable loop recorder



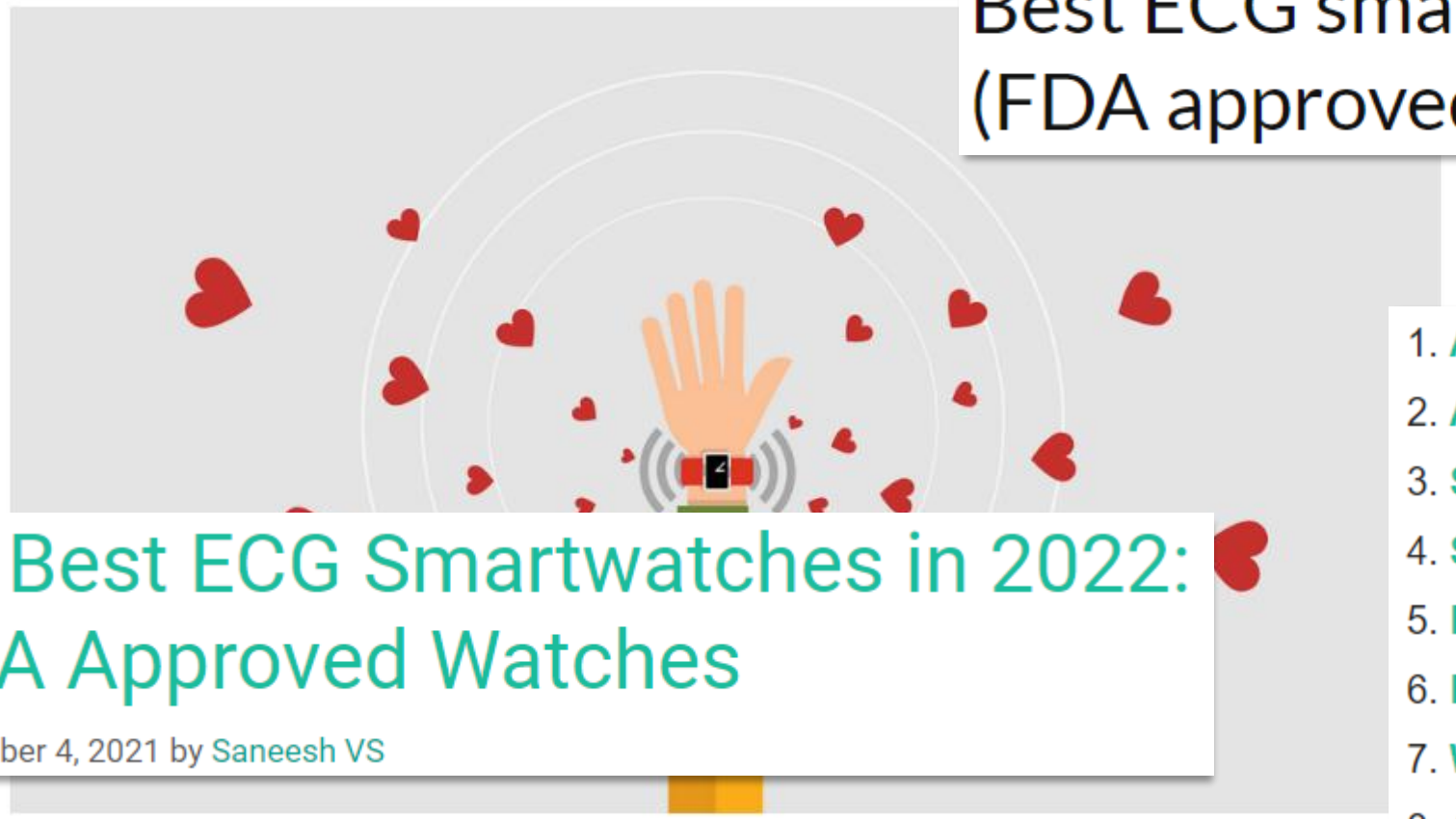
Duration of recording	<1 min	24-48 hr	3-7 days	1-4 weeks	≤36 months
Types of recorder	External event Recorder	Standard Holter Recorder			Implantable loop Recorder
	Smartphone-based recorder	Mobile cardiac Telemetry	Patch ECG	Patch ECG	
			Mobile cardiac Telemetry	External loop Recorder	
			Event loop recorder	Mobile cardiac Telemetry	

Steinberg, et al. Ann Noninvasive Electrocardiol. 2017;22:e12447.

ECG Smartwatches (Consumer driven screening)

8 Best ECG Smartwatches & Devices Of 2022

by John Rayes / January 12, 2022



Best ECG smartwatches for 2022 (FDA approved/cleared)

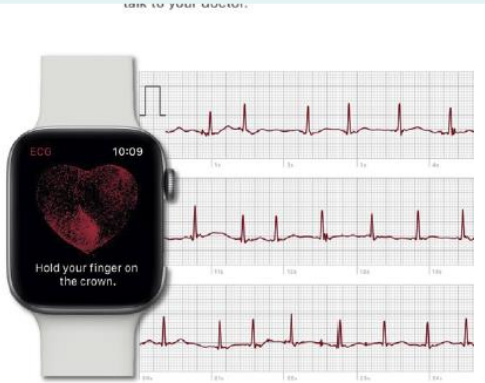
1. Apple Watch Series 7
2. Apple Watch Series 6
3. Samsung Galaxy Watch 4
4. Samsung Galaxy Watch 3
5. Fitbit Sense
6. Fitbit Charge 5
7. WithingsScan Watch
8. Apple Watch Series 5

10 Best ECG Smartwatches in 2022: FDA Approved Watches

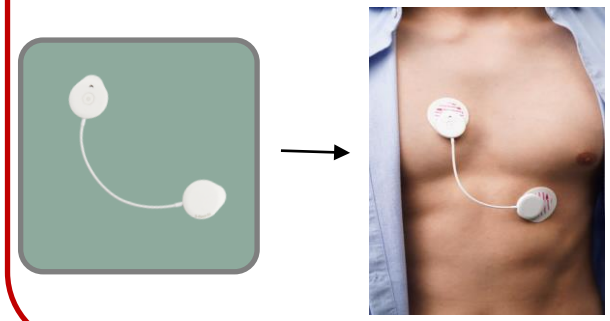
November 4, 2021 by Saneesh VS

Smartwatch ECG (consumer-driven, snapshot) vs. Continuous monitoring

Smartwatch ECG (snapshot)



ECG Patch (24hr to 2wks)



ILR (3yrs)

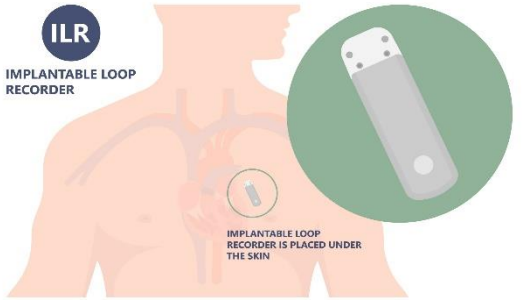


Table 1 Overview of similarities and differences between out-of-hospital ECG recording systems

Variable	Smartwatch ECG	Ambulatory ECG	Short-term Holter recording	Long-term Holter recording	Implantable loop recorder
Palpitations <1 min	−	−	−/+	++	+++
Palpitations >1 min	+++	++	−/+	+	+++
Syncope	−	−	−/+	++	+++
Asymptomatic AF	+*	+	−/+	++	+++
Patient participation required	+++	+++	+	++	-
Costs	$$ - $$$	$$	$	$$	$$$$$

AF = atrial fibrillation; ECG = electrocardiographic.
- means less suitable while +++ means very suitable. $ means low cost while $$$$$ means very high cost.
*Efficacy of asymptomatic AF detection is higher when combined with a photoplethysmography alert.

Strik M et al. Heart Rhythm 2021;18:1524-32

국내 Wearable ECG Devices

Product Name	S-Patch Ex	mobiCARE-MC200M	mobiCARE-MC200M7	HiCardi plus	AT-Patch ATP-C120	AT-Patch ATP-C130	Cardea Solo	MEMO Patch2	Kardia Mobile 6L	CART-I plus	Hativ
Picture											
Company	Wellysis	Seers Technology		MEZOO	AT-Sense	AT-Sense	Dreamtech	Huinno	AliveCor	Skylabs	VUNO
Approval Date	2021.04.26	2021.10.01		2022.02.09	2019.08.12	2019.08.14	2020.09.28	2021.04.22	2021.07.09	2021.12.20	2022.10.05
Size (mm) 길이x너비x 두께	186*30*6.0	285*48*12.3	285*48*15	6.0*4.0*1.0	93*50.6*8.3	84*48.8*8.5	140*75*14.8	142*46*13	90*30*7	반지 형태	100*30*8
Weight	9g	19g	21g	18g	13g	13g	25g	35g	24g	3.6g~5.2g	38g
Continuous monitoring period	Battery 100 hours	Battery 120 hours	Battery 216 hours	72 Hours (충전)	264 hours (11 days)	14 days	168 hours (7 days) (8 days)	14 days	Event Monitoring	48 hours	Event Monitoring
Water Resistance	IP55	IP44	IP44	IP67	IP44	IP57	IPX7	IP25	NA	IP58	IP22
Type of Use	Reusable	Reusable	Reusable	Reusable	Single-Use	Single-Use	Single-Use	Reusable	Reusable	Reusable	Reusable

Patch ECG vs Conventional Holter

	Wearable ECG Device	Conventional Holter
제품 외관		
편의성	컴팩트한 사이즈 및 전극수 최소화로 사용자 편의성 높음	사이즈가 크고 전극수가 많음 사용자 편의성 낮음
무게	9g~35g	120g 이상
데이터 저장 방식	Mobile App, 내장 메모리, Cloud	Memory(32Mb)
소프트웨어	제품 가격 내 포함	소프트웨어 별도 구매
검사 기간	48시간 이상 장기 심전도 검사가능	48시간 이내 검사만 가능
분석 보조 서비스	분석 보조 가능	병원 내 자체 심전도 분석

S-Patch Ex Solution

S-Patch EX Solution

환자

의료진

환자에게 S-Patch 부착

스마트폰 블루투스로
S-Patch Ex 앱과 연동

(스마트폰 없이도 검사 가능)

Cloud

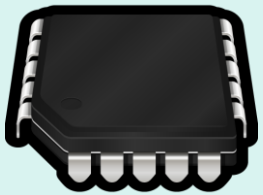
검사가 종료 시 클라우드
서버로 심전도 데이터
자동 업로드

AI가 1차 분석한 심전도 데이터

최종 레포트
해당 의사 컨펌

Why S-Patch Ex?

내장 메모리



- 블루투스 끊기는 구간에서도 데이터 손실이 없음
- 256MB의 내장 메모리 장착
- 블루투스 기능 업데이트 (5.1버전)

증상추가 가능

- 스마트폰이 없어도 패치에서 증상 기록 및 저장 가능
- Reset 기능 추가

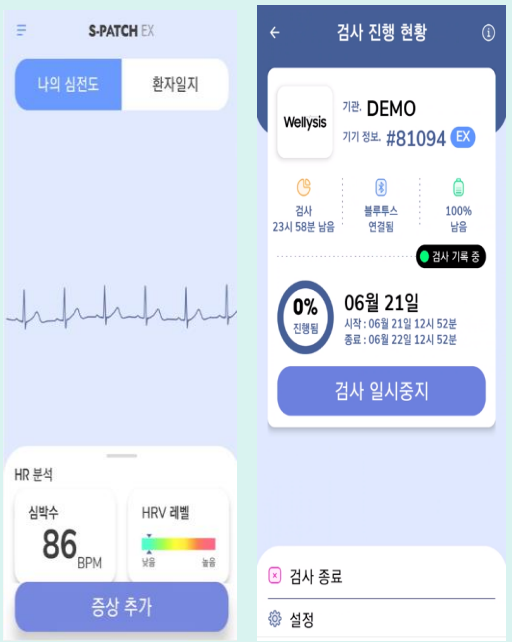
분석 보조 서비스

- 분석 보조 서비스 제공

▼

심전도 판독 전문 인력이 부족한 병원에서도 사용이 가능

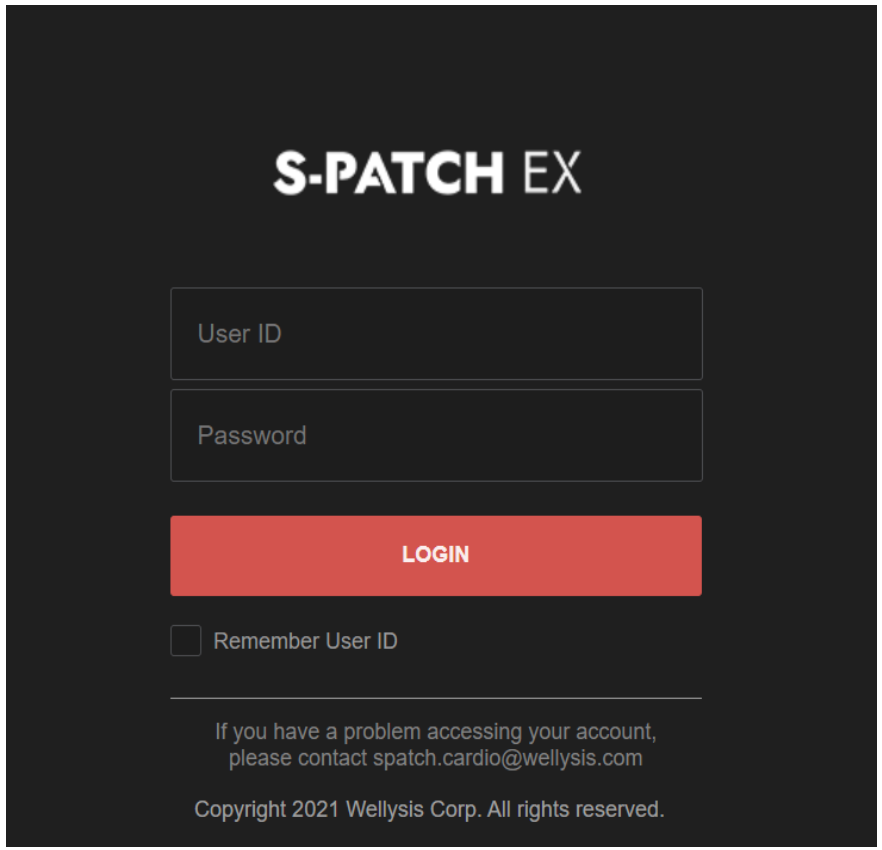
편리한 유저 인터페이스



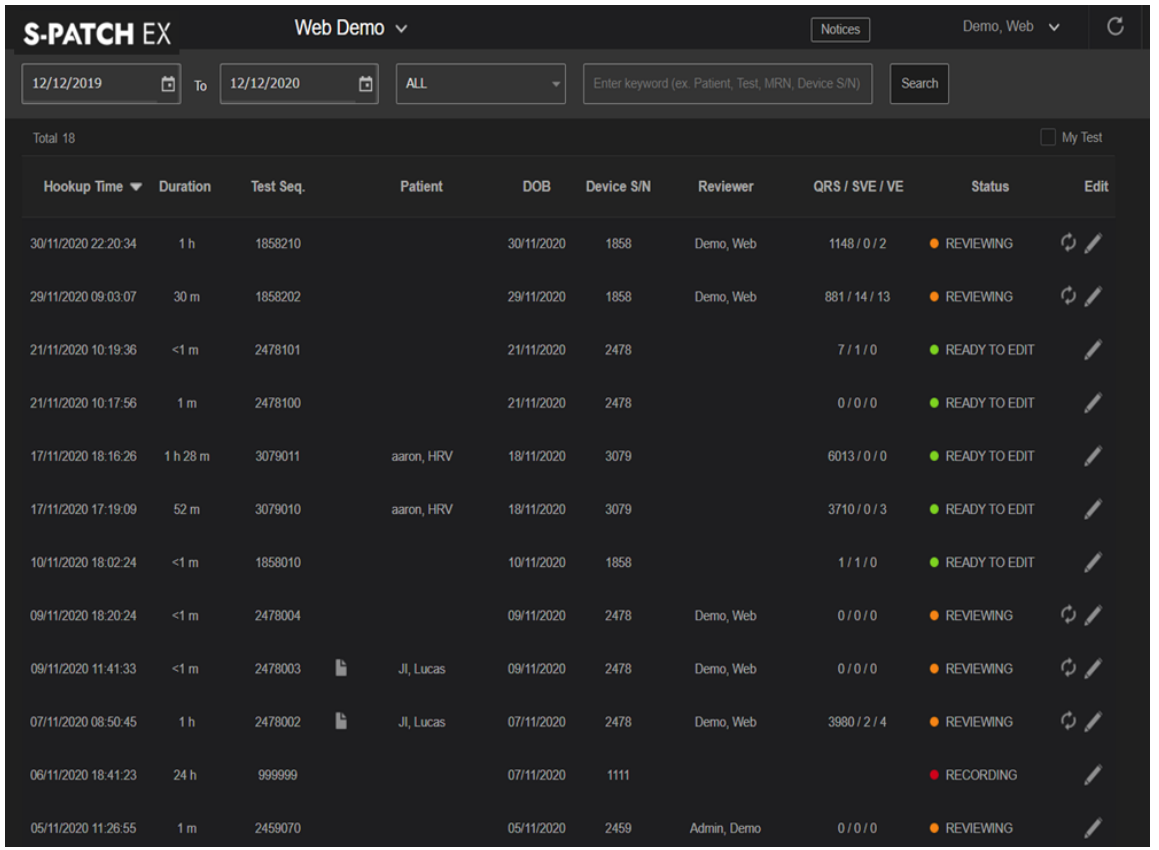
- 실시간 ECG streaming
- 대시보드 기능 추가
  (남은 테스트 기간, 배터리 잔량, 블루투스 연결 여부)

S-Patch Ex: Software

클라우드 기반의 웹 포탈로
언제 어디서나 동시에 접속이 가능합니다



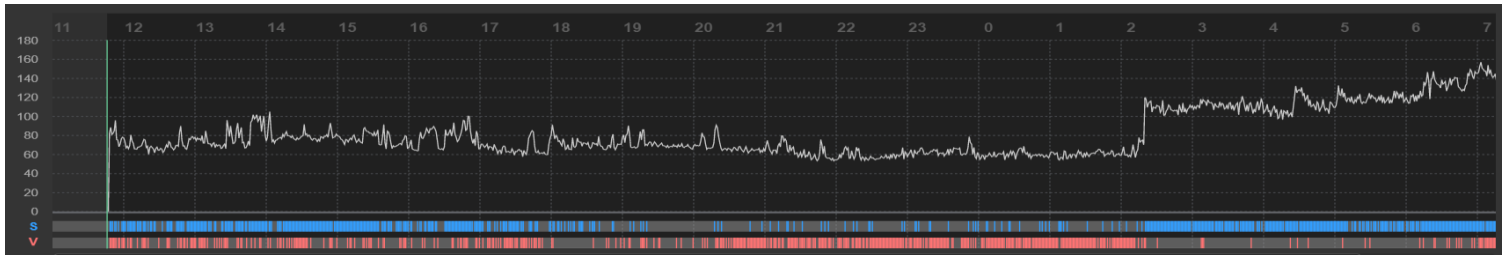
한눈에 진행 사항이 보여 검사 관리가 용이합니다



S-Patch Ex: Software

Trend Review

심박수(HR)의 추이를 기반으로
전반적 Trend를 보며 검토

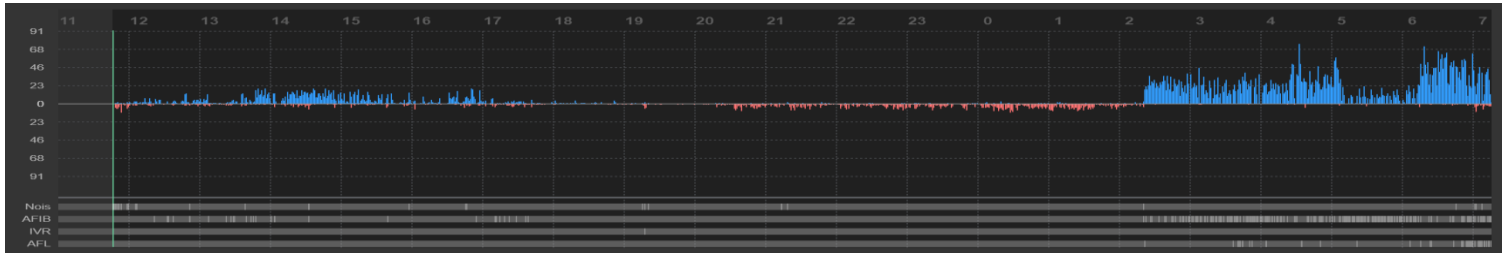


Shape Review

동일 유형 박동(Beat)을
그룹핑하여 편집 최소화 지원

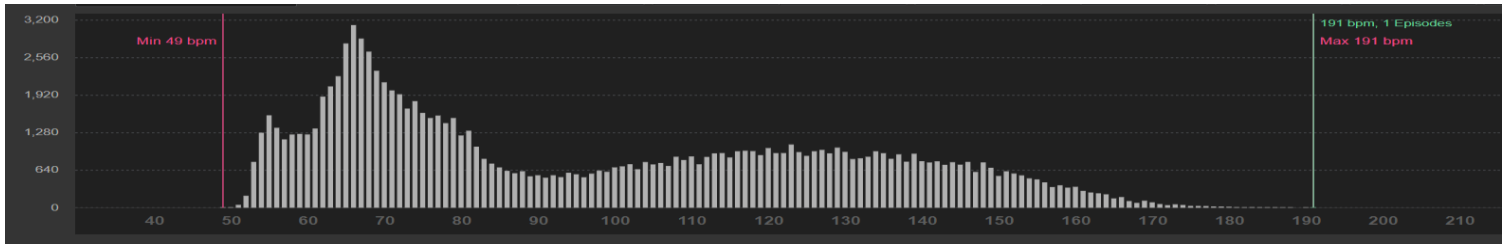
Event Review

부정맥 리듬 발생 Event를
빠르게 확인하고 검토

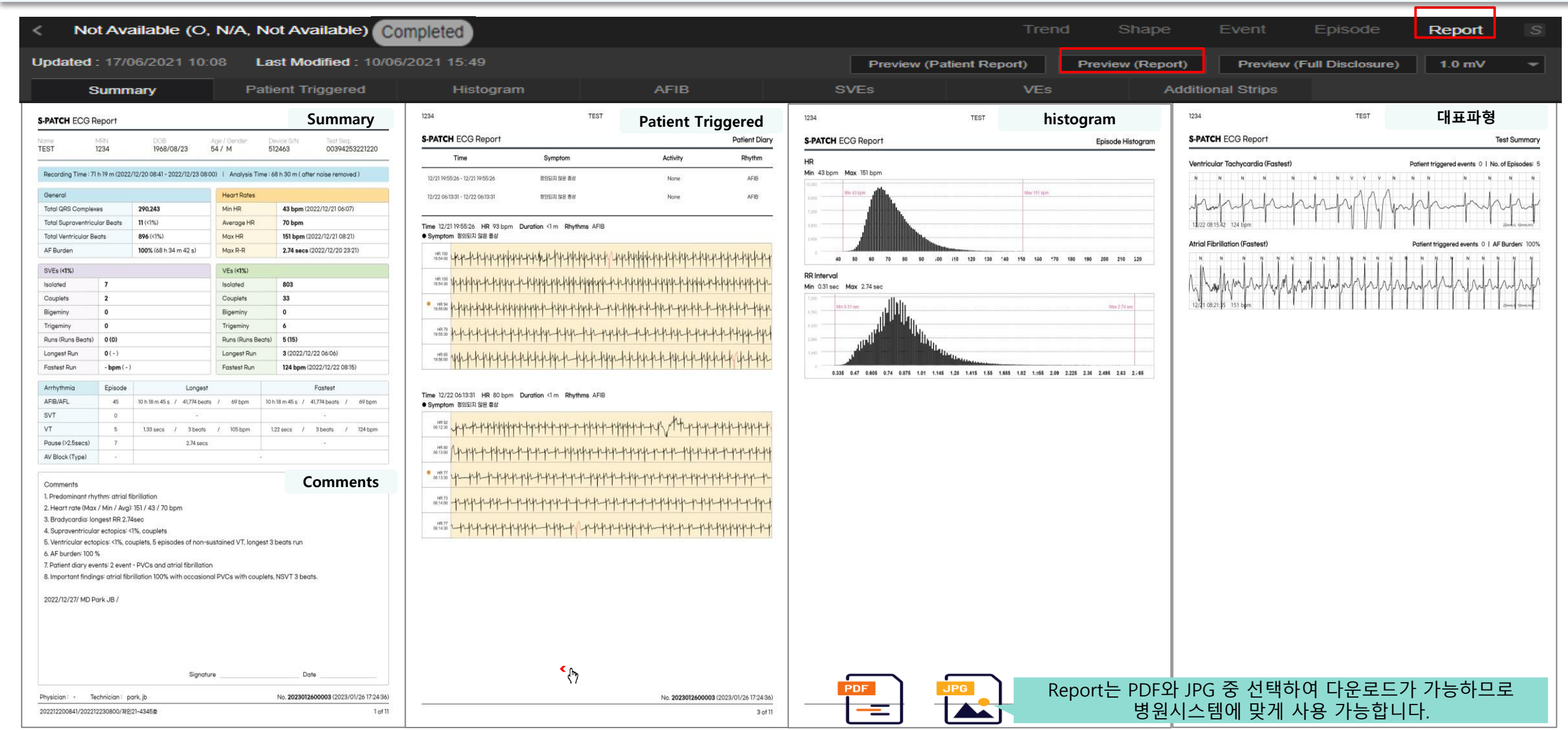


Episode Review

최소/최대 심박수 등 주요 Episode를
쉽게 확인하고 리포트 반영



ECG REPORT


Not Available (O, N/A, Not Available)
Completed
Trend
Shape
Event
Episode
Report
Updated : 17/06/2021 10:08
Last Modified : 10/06/2021 15:49
Preview (Patient Report)
Preview (Report)
Preview (Full Disclosure)
1.0 mV
Summary
Patient Triggered
Histogram
AFIB
SVEs
VEs
Additional Strips
Summary
Patient Triggered
histogram
대표파형
Comments
PDF
JPG
Report는 PDF와 JPG 중 선택하여 다운로드가 가능하므로
병원시스템에 맞게 사용 가능합니다.

Case 1 : Palpitation

General	**Total QRS Complexes** 239,695		**Average HR** 55 bpm			**Longest R-R** 2.9 secs (2022/07/23 07:15)		
	S Beats 583 (<1%)		**Min HR** 31 bpm (2022/07/23 04:31)			**Longest N-N** 2.9 secs (2022/07/23 07:15)		
	V Beats 72 (<1%)		**Max HR** 148 bpm (2022/07/24 12:25)			**R-R Pause** 20 (>2,500ms)		
	Paced Beats 0 (0%)		**AF Burden** 10.2%			**N-N Pause** 20 (>2,500ms)		
	Min QTc 350 ms (2022/07/25 06:30)		**Max QTc** 568 ms (2022/07/23 04:18)			**Average QTc** 422 ms		
	Min ST -2.7 mV (2022/07/22 18:01)		**Max ST** 2.8 mV (2022/07/22 12:43)			**Average ST** 0.0 mV		
SVEs	**Total SVE Beats**	583 (<1%)	**Isolated**	217	**Runs** 11	**Longest Runs**	8 (2022/07/25 07:54)	
	Bigeminy	49	**Couplets**	22	**Run Beats** 45	**Fastest Runs**	93 bpm (2022/07/24 12:07)	
	Trigeminy	36						
VEs	**Total VE Beats**	72 (<1%)	**Isolated**	57	**Runs** 0	**Longest Runs**	0 (-)	
	Bigeminy	6	**Couplets**	0	**Run Beats** 0	**Fastest Runs**	-- bpm (-)	
	Trigeminy	0						

Comments

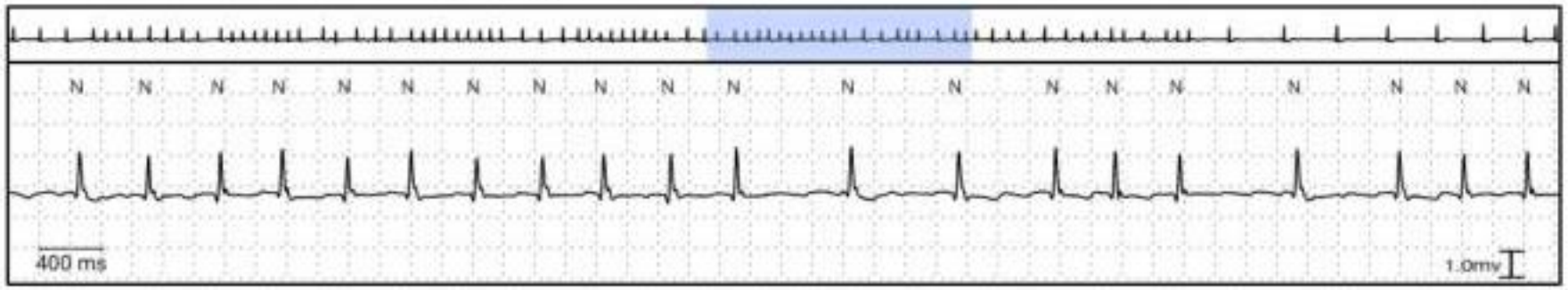
1. Predominant rhythm: normal sinus rhythm, atrial flutter-fibrillation
2. Heart rate (Max / Min / Avg): 148 / 31 / 55 bpm
3. Bradycardia: longest RR,2.9 sec
4. Supra ventricular ectopic: <1%, couplets, and run of max 8 beats
5. Ventricular ectopic: <1%
6. AF burden: 0%
7. Patient diary events: 4 events - no arrhythmia
8. Important finding: atrial flutter- fibrillation with AF burden 10.1%, with long pause 2.9 sec

Case 1 : AF

Total AFIB during analysis time <1% Heart rate range 34 - 144 bpm

AFIB with Fastest heart rate

14/06 19:04:21 Beats 77 HR 108 bpm(Avg.), 66 - 144 bpm(Range) Patients triggered events 4



AFIB with Slowest heart rate

14/06 19:34:51 Beats 40 HR 83 bpm(Avg.), 34 - 115 bpm(Range) Patients triggered events 0

Case 2 : palpitation and Dizziness

Recording Time 69 h 17 m (2021/12/28 15:25 - 2021/12/31 12:42) **Analysis Time** 68 h 54 m (after noise removed)

General	**Total QRS Complexes** 269,047		**Average HR** 65 bpm			**Longest R-R** 5.93 secs (2021/12/30 05:48)	
	S Beats 570 (<1%)		**Min HR** 35 bpm (2021/12/30 05:55)			**Longest N-N** 4.28 secs (2021/12/31 00:09)	
	V Beats 0 (0%)		**Max HR** 132 bpm (2021/12/31 10:14)			**R-R Pause** 72 (>2,500ms)	
	Paced Beats 0 (0%)		**AF Burden** 0%			**N-N Pause** 67 (>2,500ms)	
	Min QTc 350 ms (2021/12/28 15:31)		**Max QTc** 596 ms (2021/12/30 00:04)			**Average QTc** 408 ms	
	Min ST -2.1 mV (2021/12/28 20:14)		**Max ST** 2.8 mV (2021/12/30 18:56)			**Average ST** -0.4 mV	
SVEs	**Total SVE Beats**	570 (<1%)	**Isolated**	133	**Runs** 17	**Longest Runs**	11 (2021/12/31 00:15)
	Bigeminy	36	**Couplets**	52	**Run Beats** 87	**Fastest Runs**	115 bpm (2021/12/29 07:52)
	Trigeminy	21					
VEs	**Total VE Beats**	0 (0%)	**Isolated**	0	**Runs** 0	**Longest Runs**	0 (-)
	Bigeminy	0	**Couplets**	0	**Run Beats** 0	**Fastest Runs**	-- bpm (-)
	Trigeminy	0					

Comments

1. Predominant rhythm: normal sinus rhythm
2. Important observations: atrial flutter with the slow ventricular response, and intermittent Wenchkebach phenomenon
3. Ventricular ectopics: none
4. Supraventricular ectopics: occasional <1%
5. Bradycardias: longest RR, 5.93 sec
6. Patient diary events: 3 times during A Flutter and just after

Conclusion: atrial flutter with the slow ventricular response, and intermittent Wenchkebach phenomenon, symptomatic
long sinus pause after atrial flutter
Atrial Flutter 31/12 09:58:13

Case 2 : AF & AFL

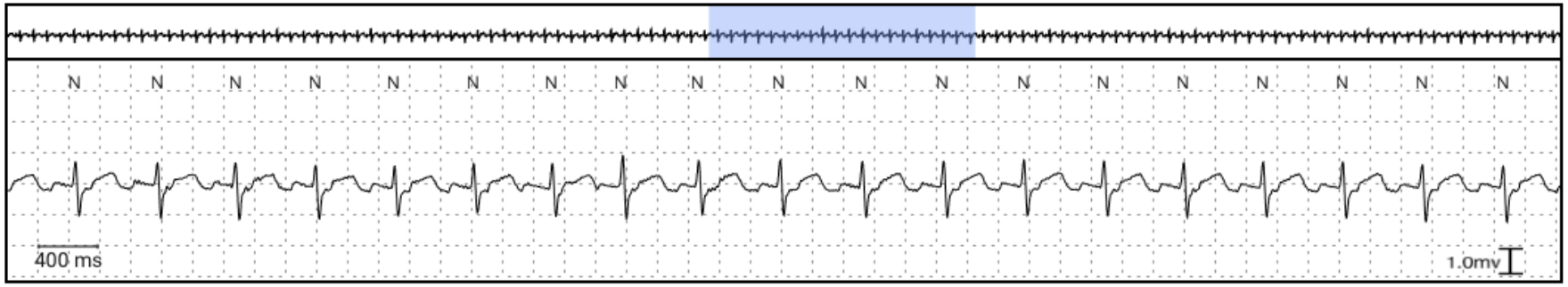
Number of Episodes 16 Average heart rate 86 bpm Heart rate range 36 - 131 bpm

AFL with Fastest heart rate

12/31 11:27:49 Duration 4,970.88 sec(s) Beats 7268 HR 90 bpm(Avg.), 54 - 131 bpm(Range) Patients triggered events 0

Longest AFL

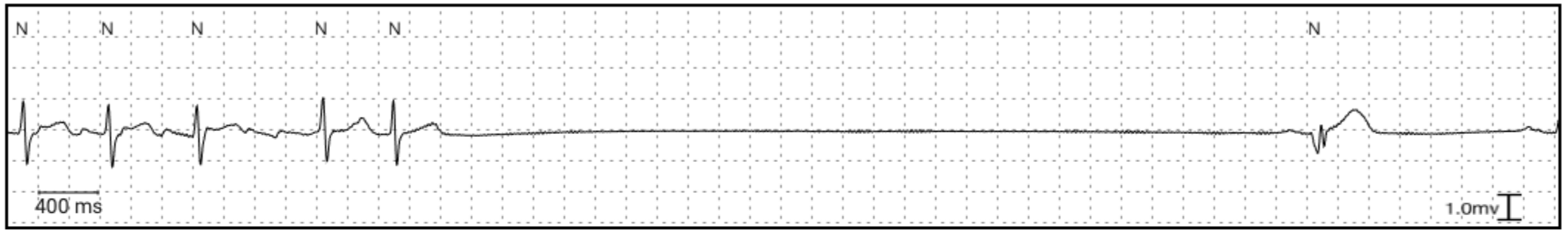
12/30 04:40:38 Duration 20,537.48 sec(s) Beats 30628 HR 90 bpm(Avg.), 36 - 120 bpm(Range) Patients triggered events 0



Case 2 : AF followed by long sinus pause

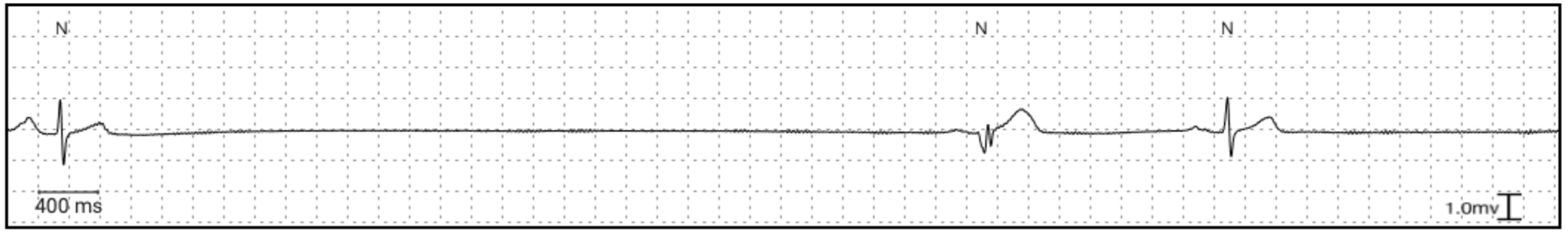
Strip #2 (31/12 20:22)

2021/12/30 05:48:49 **HR** 36 bpm **Rhythms** AFL **Patient triggered events** 0



Strip #3 (31/12 20:22)

2021/12/30 05:48:51 **HR** 16 bpm **Rhythms** AFL **Patient triggered events** 0



Summary and unmet needs

- ESC & KHRS:
  - Opportunistic screening for SCAF is recommend in patients > 65 years-old.
  - Systematic screening should be considered in >75 year-old pts or higher-risk group.
- US (USPSTF) : insufficient evidence
- Wearable devices are showing great promise for the early detection of SCAF.
- ECG patch (3days~several weeks) is cost-effective and useful in AF screening (S-patch Ex solution)

- Does NOAC for screening detected AF respond the same as clinical AF?
- What is the AF/burden/duration that benefits from treatment?
- What is the most cost-effective way to screen for AF?

  → Intermittent vs continuous, PPG vs single lead ECG
- Can we impact outcomes beyond stroke?
- Rate vs rhythm control for screen-detected AF?

Thank you for your attention!