UNIVERSITÄTSMEDIZIN GÖTTINGEN UMG

Technology-based prescreening (BP devices, Fitbit etc., smartphone apps)

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Rolf Wachter, Göttingen

Conflict of Interest - Disclosure

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed

Affiliation/Financial Relationship	Company
1. Honoraria for lectures	Bayer, Berlin Chemie, Boehringer Ingelheim, CVRx, Medtronic, Novartis, Pfizer, Servier
2. Honoraria for advisory board activities	Boehringer Ingelheim, Novartis
3. Participation in clinical trials	Bayer, Boston Scientific, Celladon, CVRx, Johnson &Johnson, Medtronic, Novartis, Pfizer, Servier
4. Research funding	BMBF (Kompetenznetz Herzinsuffizienz und DZHK), European Union (Horizon 2020) and Boehringer Ingelheim
5. Other	Ich habe 27 Slides, aber nur 12 Minuten Zeit

Devices available for prescreening

MyDiagnostick single lead ECG

QardioCore 3 lead ECG

Kardia single lead smartphone ECG

Pulse palpation

Zenicor single lead ECG

Omron single lead ECG

Zio patch continuous external ECG

Microlife blood pressure cuff

Photo-plethysmograph

Some general considerations

1. The yield of AF in patients with paroxysmal AF is mainly a function of time. The longer you look, the more you will find.

2. Most AF episodes are asymptomatic. So prescreening based on symptoms (e. g. prescreening triggered by the patient) will miss most of the episodes.

3. Prescreening has to be user-friendly. The typical AF patient is not a smartphone maniac.

Zenicor Device

records ECG for 30 seconds, can send data via mobile network

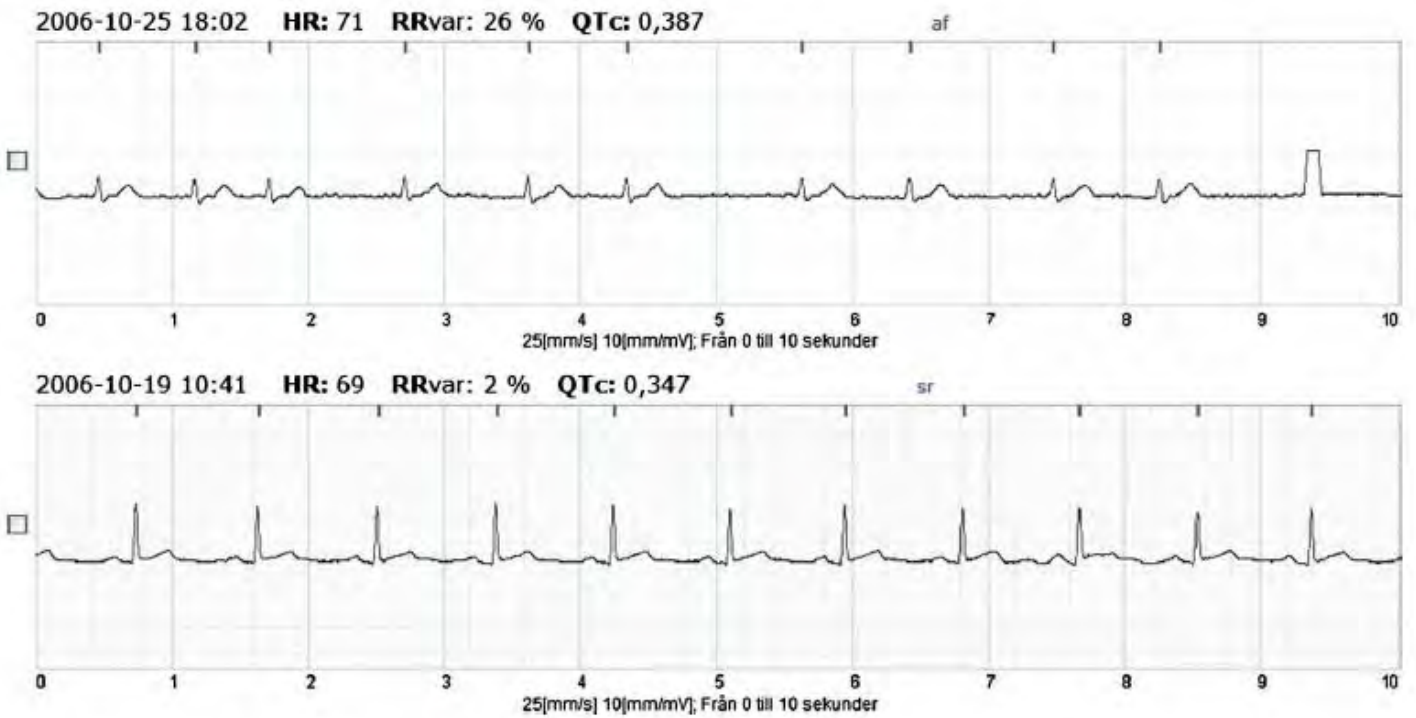


Figure 1. Example of thumb ECG registrations: Atrial Fibrillation above, Sinus Rhythm below.

N=606, Sensitivity 92 %, specificity 96 %

Sobocinski Doliwa et al., Scand Cardiovasc J 2009

iPhone based screening (e. g. Alive Cor)

Pulse waveform analysis

Algorithm based on analysis of RR intervals

Test Characteristics* for our Arrhythmia Detection Algorithm in 104 Subjects with Atrial Fibrillation, 91 with Sinus Rhythm, 14 with Premature Atrial Contraction, and 16 with Premature Ventricular Contractions.

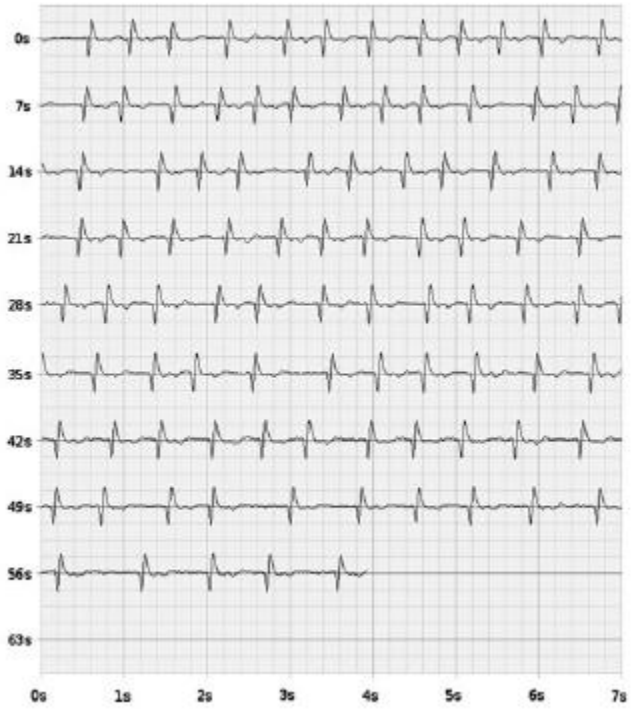
Algorithm	Sensitivity	Specificity	Accuracy
Atrial Fibrillation	0.970	0.935	0.951
Premature atrial Contraction	0.667	0.980	0.955
Premature ventricular contraction	0.733	0.976	0.960

McManus et al., J Cardiovasc Electrophysiol 2016

mydiagnoStick

Sinus rhythm

AF



Comparison between single-lead ECG and modified BP monitors

BMJ Open

Triage tests for identifying atrial fibrillation in primary care: a diagnostic accuracy study comparing single-lead ECG and modified BP monitors

Karen Kearley,[1] Mary Selwood,[1] Ann Van den Bruel,[1] Matthew Thompson,[1,2] David Mant,[1] FD Richard Hobbs,[1] David Fitzmaurice,[3] Carl Heneghan[1]

Watch BP

Omron 801

Merlin ECG

Comparison between single-lead ECG and modified BP monitors

Table 2 Diagnostic performance of WatchBP and Omron autoanalysis for detecting atrial fibrillation

n=999* Prevalence 7.9%	WatchBP with AF indicator flash (95% CI)	Omron autoanalysis* (95% CI)
Sensitivity (%)	94.9 (87.5 to 98.6)	98.7 (93.2 to100)
Specificity (%)	89.7 (87.5 to 91.6)	76.2 (73.3 to 78.9)
Positive likelihood ratio	9.2 (7.6 to 11.2)	4.15 (3.69 to 4.67)
Negative likelihood ratio	0.057 (0.022 to 0.15)	0.017 (0.0024 to 0.12)
Positive predictive value	44.1 (36.5 to 51.9)	26.3 (21.3 to 31.7)
Negative predictive value	99.5 (98.8 to 99.9)	99.9 (99.2 to 100)

*Text message 'irregular' or 'analysis impossible' counted as positive test.
AF, atrial fibrillation.

WatchBP performs better than the single-lead ECG monitors as a triage test for identifying AF in primary care as it does not require any expertise for interpretation and their diagnostic performance is comparable.

Kearley et al., BMJ Open 2014

AliveCor versus WatchBP

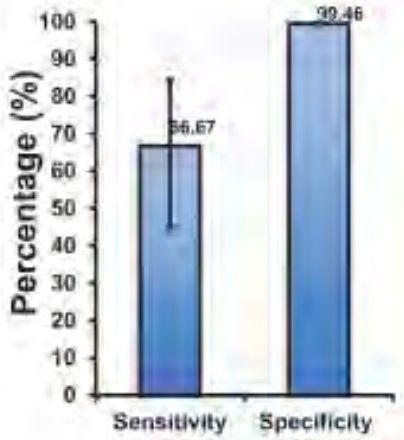
A

AliveCor Automated AF Detector diagnosed AF

	True AF: Yes	True AF: No
+	16	11
-	8	2,017

Rhythm of 11 false positives
- 2 Sinus rhythm
- 6 PAC
- 3 Sinus arrhythmia

Rhythm of 2,017 true negatives
- 1870 Sinus rhythm
- 62 PAC
- 52 PVC
- 33 Sinus arrhythmia



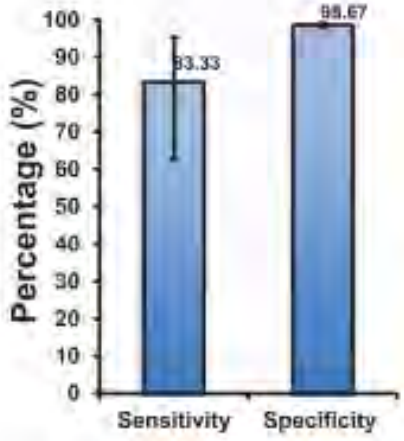
B

Microlife Afib diagnosed AF

	True AF: Yes	True AF: No
+	20	27
-	4	2,001

Rhythm of 27 false positives
- 9 Sinus rhythm
- 11 PAC
- 1 PVC
- 6 Sinus arrhythmia

Rhythm of 2,001 true negatives
- 1863 Sinus rhythm
- 57 PAC
- 51 PVC
- 30 Sinus arrhythmia



Chan et al., Circulation 2017

N=2052, primary care setting

Test characteristics of different devices

Device	Method of interpretation	Sensitivity (%)	Specificity (%)	Reference
Pulse palpation		94 (84-97)	72 (69-75)	Cooke et al., 2006
Handheld single-lead ECGs				
AliveCor (Kardia) heart monitor	Algorithm only (based on presence of P wave and RR irregularity)	98 (89-100)	97 (93-99)	Lau et al., 2013
Merlin ECG event recorder	Cardiologist interpretation	93.9	90.1	Kearley et al., 2014
Mydiagnostick	Algorithm only (based on RR irregularity)	94 (87–98)	93 (85–97)	Tieleman et al., 2014 Vaes et al., 2014
Omron HCG-801	Algorithm only (based on RR irregularity)	98.7 (93.2-100)	76.2 (73.3-78.9)	Kearley et al., 2014
Omron HCG-801	Cardiologist interpretation	94.4	94.6	Kearley et al., 2014
Zenicor EKG	Cardiologist interpretation	96	92	Doliwa et al., 2009
Modified Blood pressure monitors				
Microlife BPA 200 Plus	Algorithm only (based on pulse irregularity)	92	97	Marazzi et al., 2012
Microlife BPA 200	Algorithm only (based on pulse irregularity)	97 (81.4-100)	90 (83.8-94.2)	Wiesel et al., 2014
Omron M6	Algorithm only (based on pulse irregularity)	100	94	Marazzi et al., 2012
Omron M6 comfort	Algorithm only (based on pulse irregularity)	30 (15.4-49.1)	97 (92.5-99.2)	Wiesel et al., 2014
Microlife WatchBP	Algorithm only (based on pulse irregularity)	94.9 (87.5-98.6)	89.7 (87.5-91.6)	Kearley et al., 2014
Plethysmographs				
Finger probe	Algorithm only (based on pulse irregularity)	100	91.9	Lewis et al., 2011
iPhone photo-plethysmograph	Algorithm only (based on pulse irregularity)	97.0	93.5	McManus et al., 2016

Devices for PREscreening

1. ECG diagnosis is always required for validation of AF diagnosis. No therapeutic actions (e. g. anticoagulation) can be taken prior to validation of the diagnosis

2. Handheld ECG devices with a verifiable ECG trace are preferred.

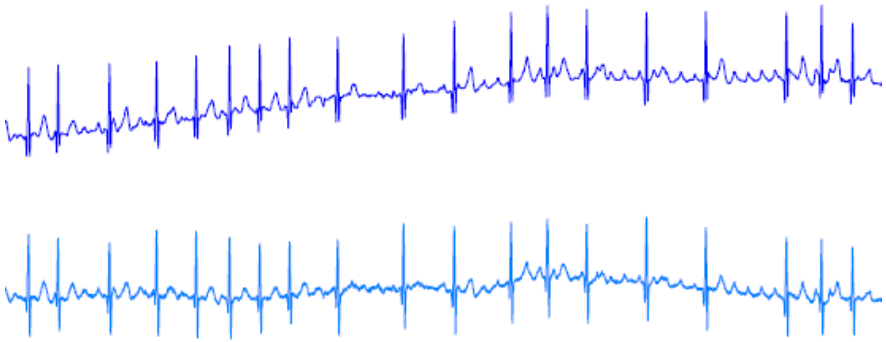
Pitfalls

False positive cases of the myDiagnostick rhythm stab

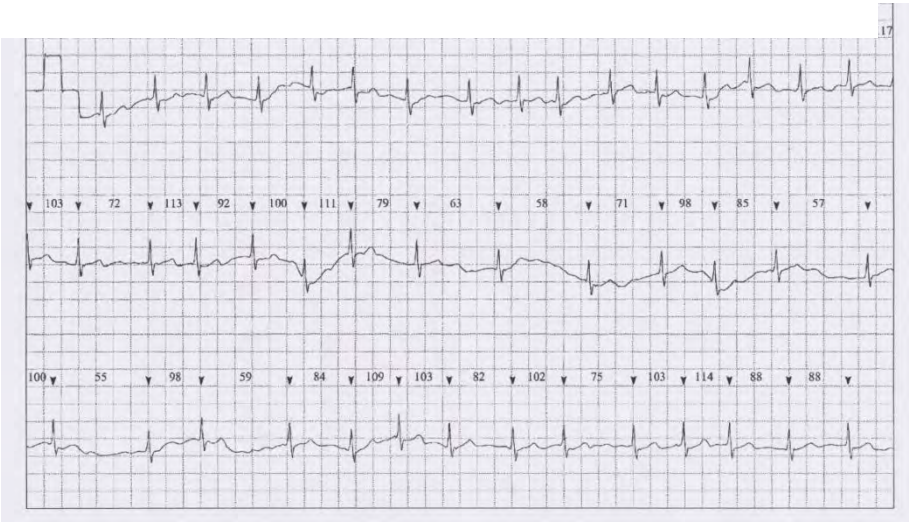
Tielemann et al., Pace 2014

ECG tracings in different monitoring modalities

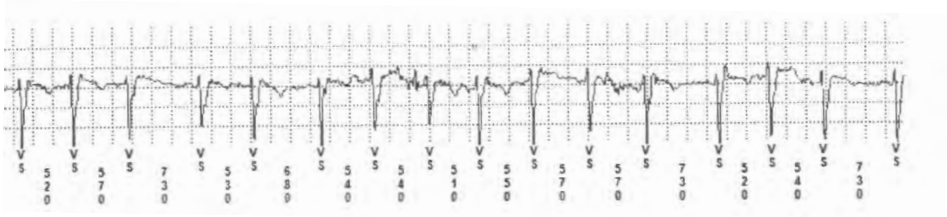
Holter ECG



External
Event Recorder



Implantable
Cardiac
Monitor



Wachter and Rybak, Akt Kardiol 2015

A shift in paradigm for thinking about stroke

Retrospection
(Cryptogenic stroke, ESUS)

Why did this stroke happen? Can I find an explanation? Is it cryptogenic? Does it look embolic? Should I anticoagulate?

Cerebral events
(stroke, TIA)

1st stroke

2nd stroke

Anticoagulate & Prevent

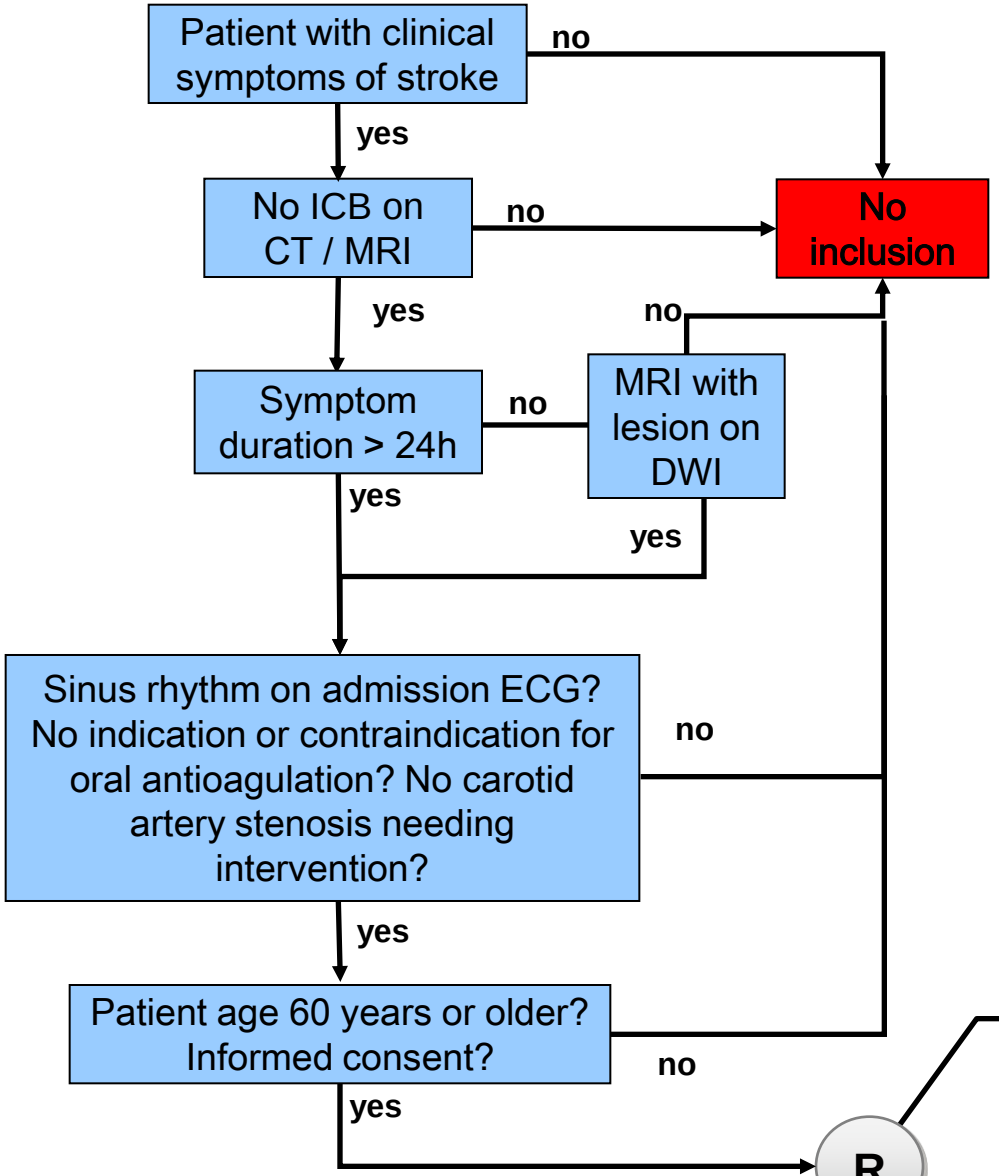
Time

AF cluster

Look ahead
(Find-AF randomised)

Stroke patients have a high risk of underlying AF irrespective of stroke etiology and should be anticoagulated if AF is detected

Find-AF randomise



Primary endpoint:
First detection of AF at 6 months

R

Prolonged Holter-monitoring (10 days and 2x10 days)

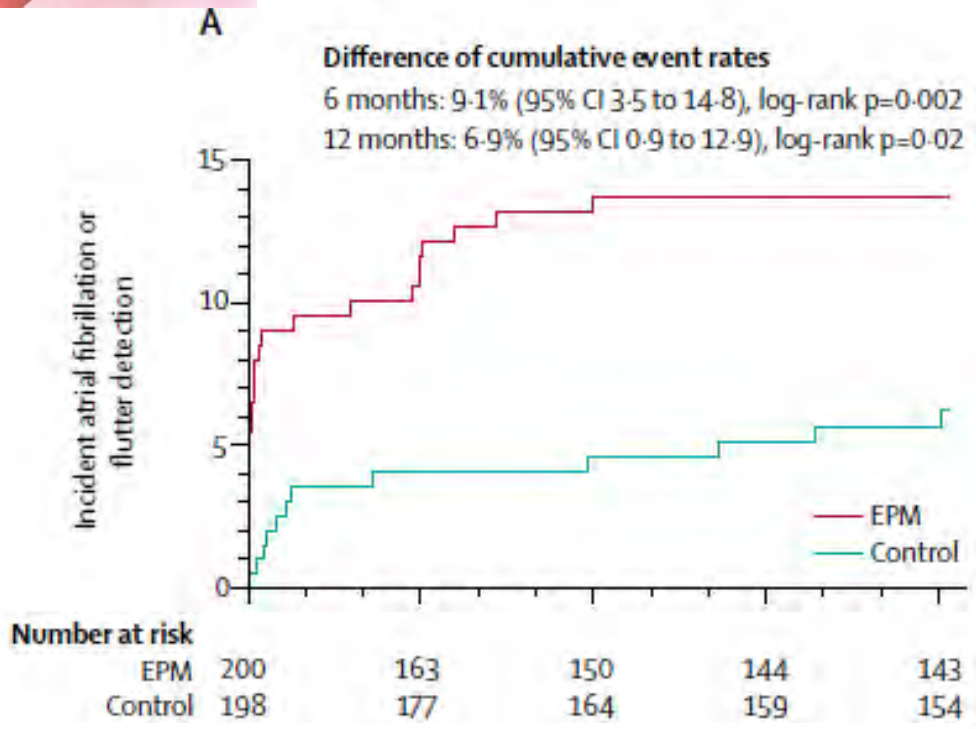
1:1 randomisation, 400 patients

usual stroke-unit care

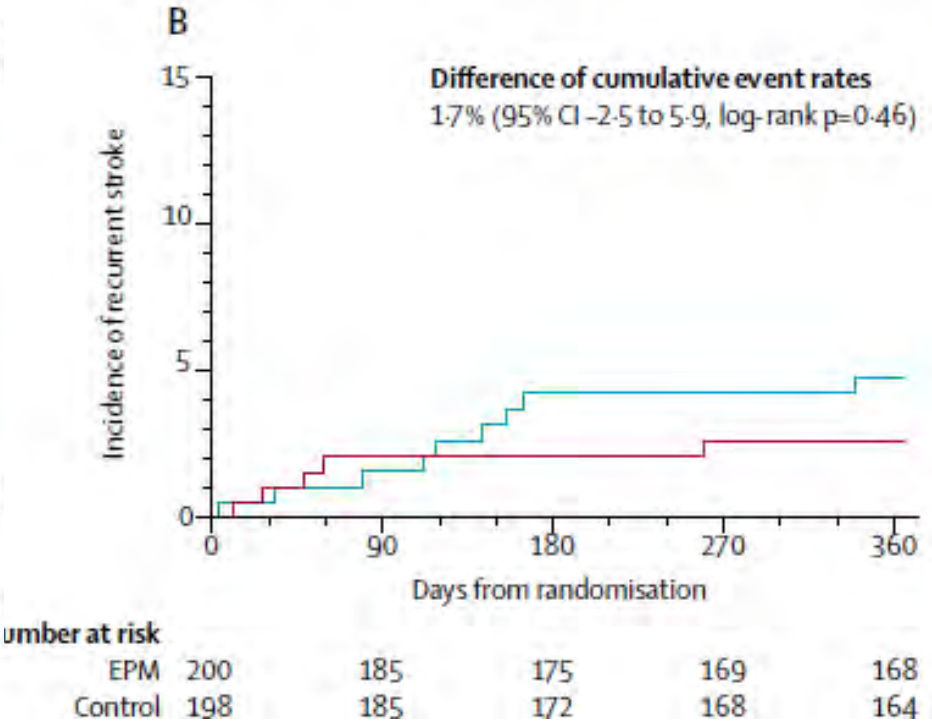
Sponsored by unrestricted grant from
Boehringer Ingelheim

Find-AF randomised

Atrial Fibrillation

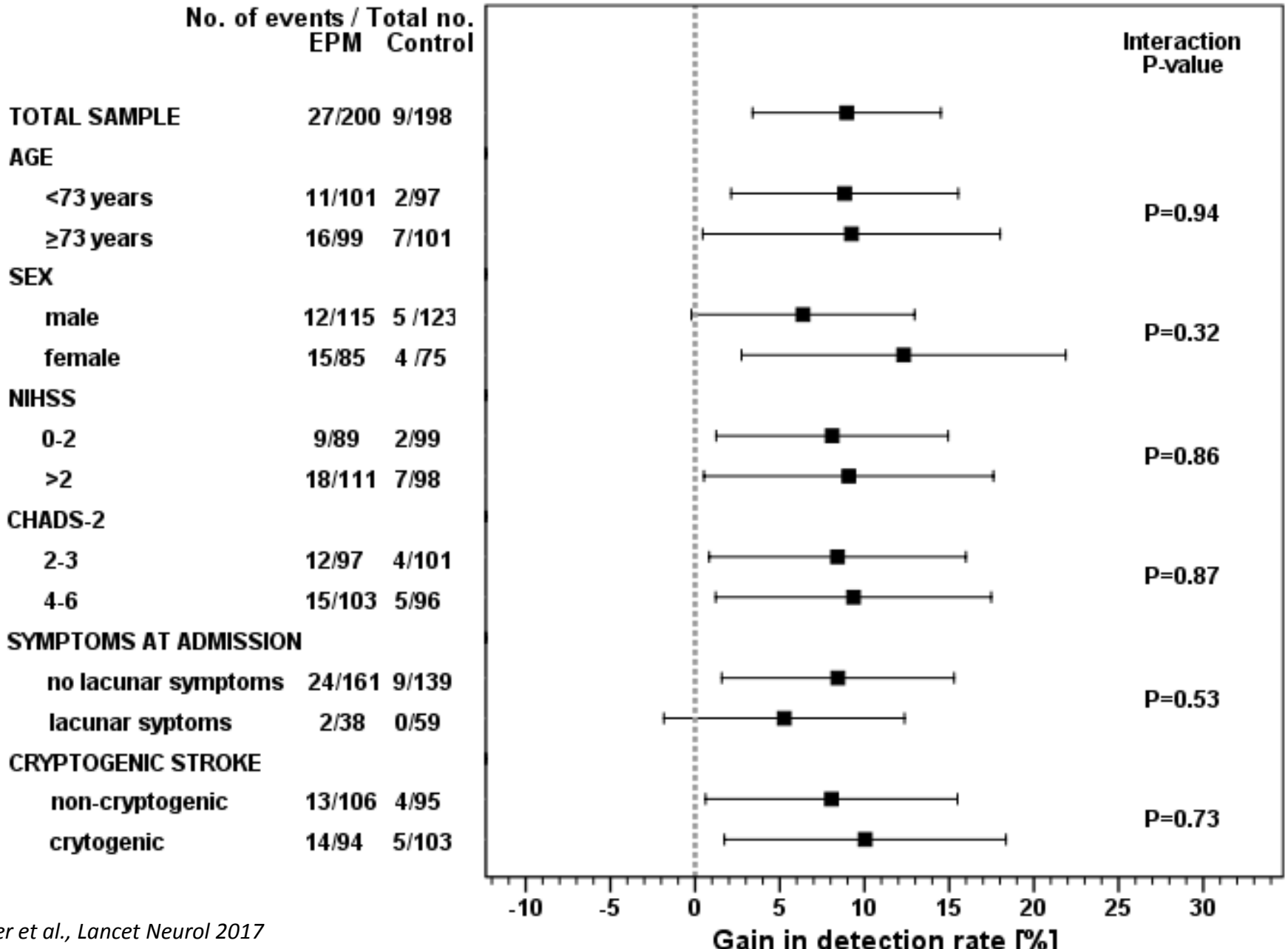


Strokes



Wachter et al., Lancet Neurol 2017

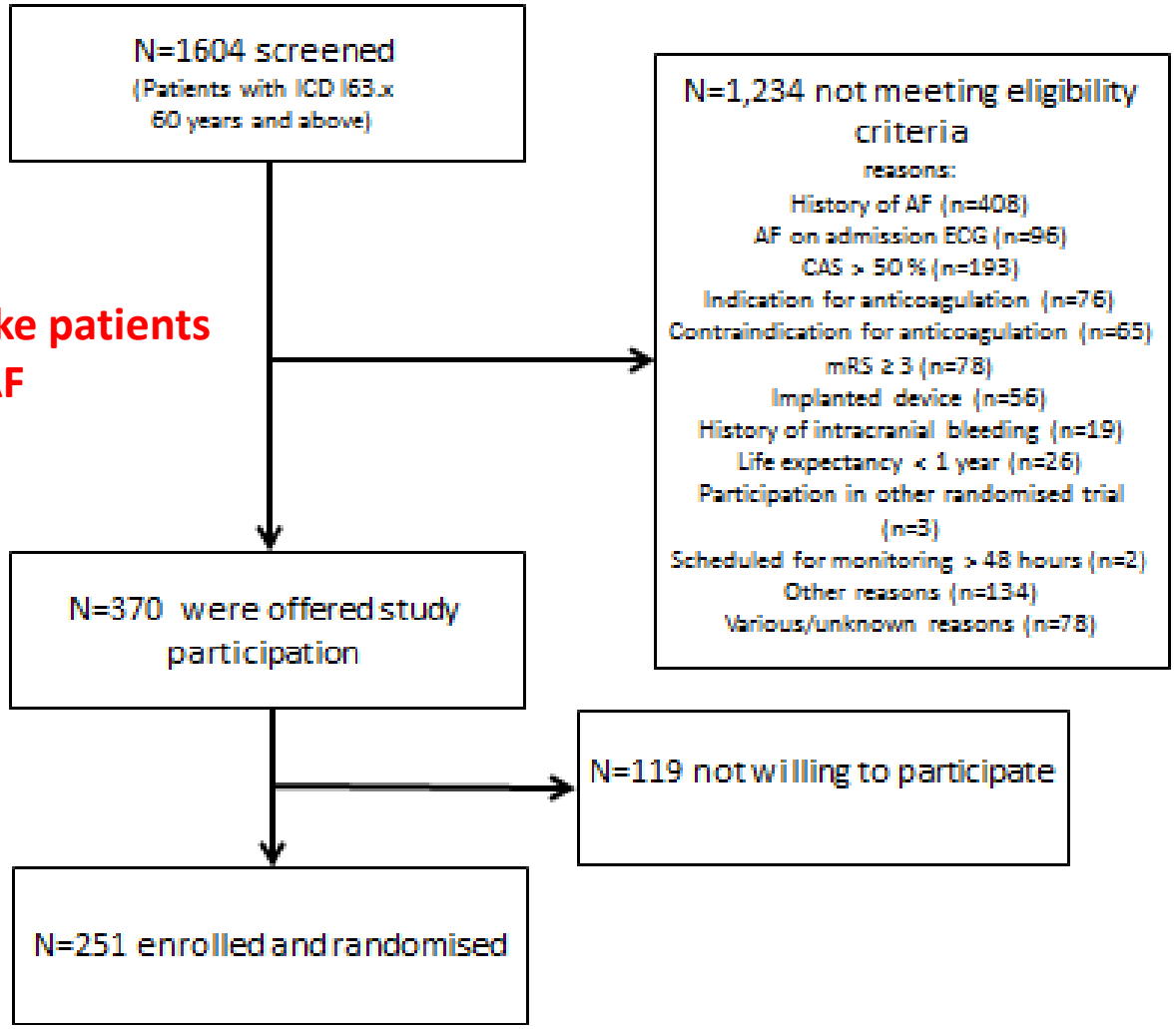
Primary Endpoint in Subgroups



Wachter et al., Lancet Neurol 2017

Candidats for prolonged monitoring in stroke

30-50 % of all stroke patients free of AF



Own experience, Zenicor in Find-AF randomised

n=398 stroke patients, randomised to prolonged and enhanced monitoring or usual care

Prolonged and enhanced monitoring = 3 x 10 day Holter ECG, evaluated in a dedicated core lab.

Patients not willing to have the second or third Holter ECG were offered a Zenicor device

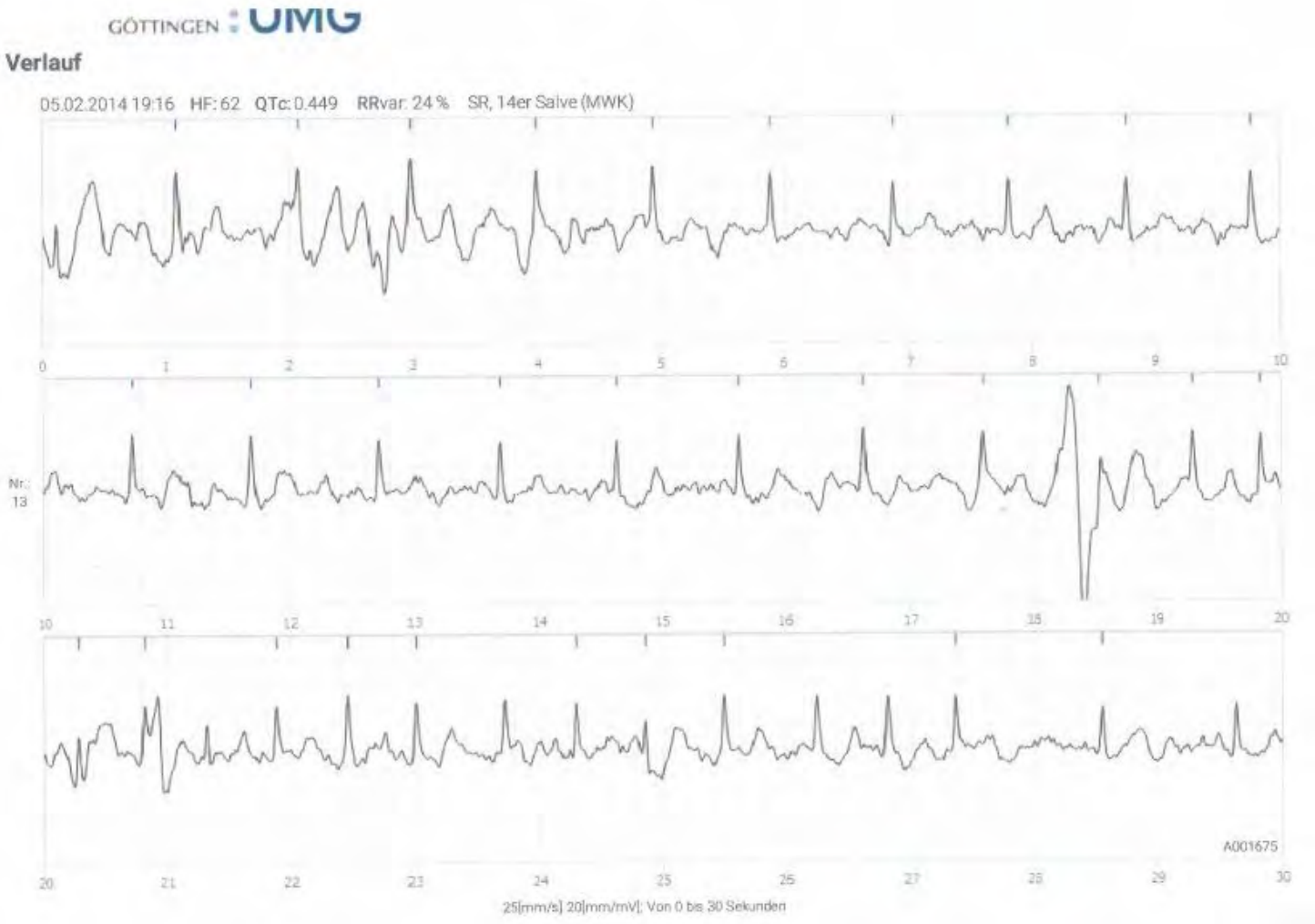
Wachter et al., Lancet Neurol 2017

Compliance with Holter, alternative Zenicor

	baseline	3-month-visit	6-month-visit
scheduled for Holter-ECG by study protocol	200	170	153
any prolonged study ECG-monitoring	199# (99.5 %)	128 (75.3 %)	116 (75.8 %)
study Holter-ECG monitoring	199# (99.5 %)	116 (68.2 %)	100 (65.3 %)
median duration of Holter-ECG (IQR)	9.5 d (8.0; 9.8 d)	9.6 d (8.6; 9.9 d)	9.6 d (8.2; 9.9 d)
thumb-sensor-ECG (Holter-ECG refused)	na	12 (7.1 %)	16 (10.4 %)

AF detected by thumb-sensor = 0

„Longest AF episode“



Zio patch continuous external ECG

SCREEN-AF

Family practice patients age ≥75 years & no known AF

↓

Consent for RCT and Baseline Assessment

↓

Randomize

Control Group:

Standard care

Intervention Group:

Standard care plus
2-week ECG patch monitor
(and concurrent AF-BP monitor)
at baseline and 3 months

Follow-up assessments: 3 and 6 months
Primary outcome: New AF detection at 6 months
Key Secondary outcomes: Adherence; OAC use at 6 months

PI David Gladstone, Toronto Canada, n=822, NCT02392754

Conclusion

Devices that use algorithms to detect rhythm irregularity are mainly able to detect persistent and permanent AF. There is the risk of false positive results and ECG documentation is always necessary.

Handheld ECG devices with verifiable ECG tracing are preferred.

The duration of monitoring is the most important point