FAKULTNÍ NEMOCNICE® OLOMOUC

Lékařská fakulta
Univerzita Palackého v Olomouci

KOMPLEXNÍ KARDIOVASKULÁRNÍ CENTRUM
FAKULTNÍ NEMOCNICE OLOMOUC

FEASIBILITY OF EVALUATION OF POLAR H10 CHEST- BELT ECG IN PATIENTS WITH A BROAD RANGE OF HEART CONDITIONS

Skála T, Vícha M, Rada M, Vácha J, Flašík J, Táborský M

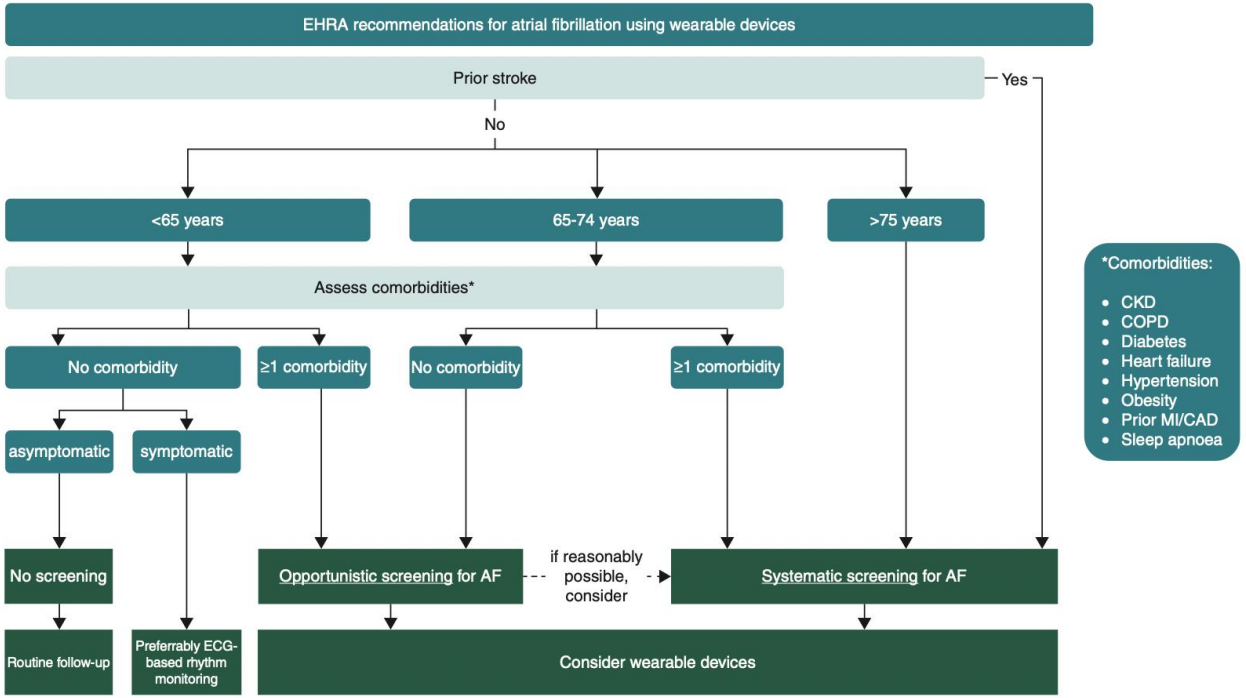
I. Dep. of Internal Medicine – Cardiology, Uni Hospital Olomouc, CZ

The search for AF – WHY?

- Early detection of AF → Treatment → ↓ stroke, hospitalizations, mortality [1-3]

1. Wallenhorst C, et al. Thromb Haemost 2022;122:277–85.
2. Proietti M, et al. Thromb Haemost 2021.
3. Kirchhof, P, et al. NEJM 383.14 (2020): 1305-1316.

The search for AF – In WHOM?



The search for AF – can we rely on symptoms?

- **EAST-AFNET4** - 30,4 % without symptoms [1]

- 52 % asymptomatic episodes in symptomatic pts
- 44 % with symptoms – no AF evidence
- In verified AF pts - 61 % without AF > 3 months [2]

= a lot of pts have no symptoms

= a lot of symptomatic episodes are not AF

= short EKG recordings ≠ AF detection certainty

1. Kirchhof, P, et al. NEJM 383.14 (2020): 1305-1316.
2. Israel CW, et al. J Am Coll Cardiol 2004;43:47–52.

The search for AF – HOW LONG?

1month vs 24-hrs HolterEKG

(Pts after TIA/cryptogenic stroke without known AF po TIA - EMBRACE) [1]

- 16,1 % vs. 3,2 % detection rate

ILR vs HolterEKG [2]

- 6 months 8,9 % vs 1,4 % detection rate
- 3 years 30 % vs 3 % detection rate

The longer and more often you measure, the more you find…

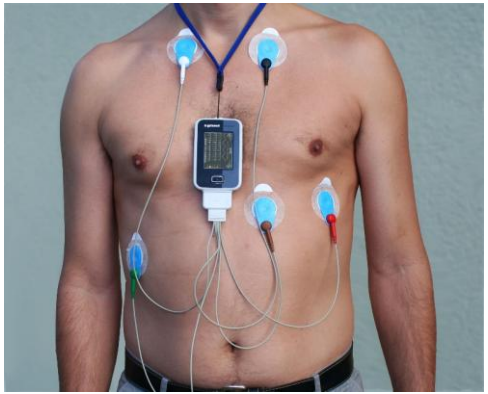
1. *Gladstone DJ, et al. N Engl J Med 2014;370:2467–77.*
2. *. Sanna T, et al. N Engl J Med 2014;370: 2478–86.*

The search for AF – HOW?

Scheduled by doctor:

- **ILR** – expensive, in limited supply
- **HolterEKG, EKG-patches, loop recorders –** unavailable anytime during the year for the majority of patients

  HolterEKG – 1/3 of pts are reluctant to wear week-long EKG Holters repeatedly [1]

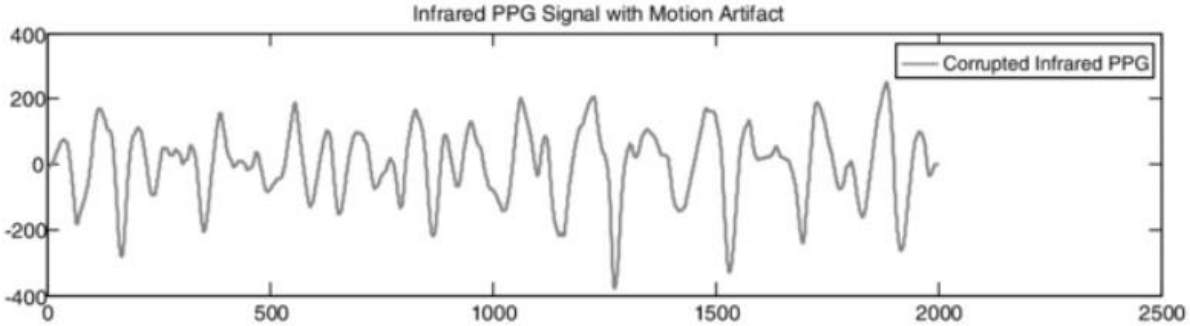


1. Wachter R, et al. Lancet Neurol 2017;16:282–90.

The search for AF – HOW?

<u>Owned by the patient (= available anytime)</u>:

PPG - unreliable



The search for AF – HOW?

<u>Owned by the patient (= available anytime)</u>:

PPG - unreliable

EKG – short recordings (<1 min, no aggregation of all measurements, PPG based measurements in asymptomatic)

Apple iWatch

Pulse-ON

The search for AF – HOW?

<u>Owned by the patient (= available anytime)</u>:

PPG - unreliable

EKG – short recordings (<1 min, no aggregation of all measurements, PPG based measurements in asymptomatic)

Alive-Cor

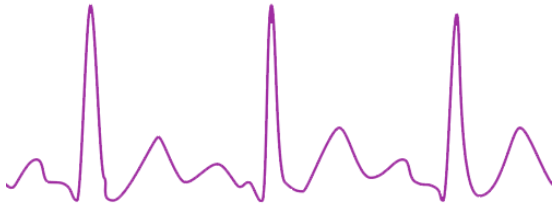
The search for AF – HOW?

<u>Owned by the patient (= available anytime)</u>:

PPG - unreliable

EKG – short recordings (<1 min, no aggregation of all measurements, PPG based measurements in asymptomatic)

Awario



The search for AF – HOW?

<u>Owned by the patient (= available anytime)</u>:

PPG - unreliable

EKG – short recordings (<1 min, no aggregation of all measurements, PPG based measurements in asymptomatic)

CardioSignals

The search for AF – HOW?

Most at-home EKG monitoring devices:
Short (< 1 min) “EKG” recordings at rest or longer unreliable PPG recordings

A need for:
- ✓ a low-cost, *patient-owned* device
- ✓ EKG-based
- ✓ is easy to use
- ✓ is suitable for *long sample* periods
- ✓ provides *automatic evaluation* using AI
- ✓ *automatic aggregation* of all measurements into one conclusion
- ✓ does not increase the burden on doctors

Chest-belt ECG

- Originally designed for heart-rate analysis
- Possibility of continuous 1-lead EKG recording

- EKG **RR intervals vs HolterEKG** <1ms in **99.6%** of QRS [1]

- With **increase in activity** (sports), belt EKG is **even more accurate** (fewer artifacts) than HolterEKG [1]

1. Gilgen-Ammann, Eur J Appl Physiol 2019

Our trial

Validation of a chest-belt to date:

- healthy athletes + AF patients - short recordings, at rest, selected groups

Aim: To test the feasibility of evaluating:

- longer chest-belt EKG recordings
- in unselected patients in a large cardiology department and in an arrhythmology out-patient clinic
- for all types of rhythm (not just AF)

Patient group

A – **hospitalized** pts (n=54)

B – **Out-patient arrhythmology** dep. (n=53)

C – **healthy controls** without CV dg (n=54)

Table 1 – Baseline characteristics of the population

	Hospitalized (A), n = 54	Outpatient (B), n = 53
Male gender	31 (57.4%)	41 (75.9%)
Height (cm)	176.9±8.5	178.6±7.2
Width (kg)	86.4±14.1	86.8±14.2
BMI	27.5±3.5	27.2±3.7
QRS <120 ms	33 (61.1%)	54 (100%)
LBBB	11 (20.4%)	5 (9.3%)
RBBB	4 (7.4%)	2 (3.7%)
Stimulated QRS	6 (11.1%)	0 (0.0%)
Pacemaker	6 (11.1%)	0 (0.0%)
Defibrillator	1 (1.9%)	1 (1.9%)
Ischemic heart disease	19 (35.2%)	5 (9.3%)
Arterial hypertension	41 (75.9%)	16 (29.6%)
Diabetes mellitus	22 (40.7%)	7 (13.0%)
Heart failure	20 (37.0%)	4 (7.4%)
Acute myocardial infarction	7 (13.0%)	0 (0.0%)
Infective endocarditis	3 (5.6%)	0 (0.0%)
Acute arrhythmia	14 (25.9%)	0 (0.0%)

Patient group

- The aim was to **obtain more than 1 million heartbeats** from longer recordings lasting **1-2 hours for each patient**
- **Patient** movement was **not restricted in any way**, including the ability to be transported to any examinations and/or interventions

The study was approved by a multicentre ethics committee and all patients signed the ICF

Trial goal - I

Determination of rhythm (SR/AF/Unclear) and **comparison** of methods

Hospitalized:

A: 12-lead EKG

B: Telemetry (live EKG)

X1: Chest belt: live EKG (phone app) - quick diagnosis

X2: Chest belt: evaluation of the entire measurement record (web-based)

Out-patients:

A: 12-lead EKG

X: Chest belt: evaluation of the entire measurement record (web-based)

Trial goal - II

In-patients, out-patients and healthy controls:

Evaluation of all QRS complexes (SR/AF/APB/VPB/NOISE)

% of heartbeats that can be reliably evaluated by an experienced cardiologist

(= % NOISE ?)

NOISE = unrecognizable + recognizable rhythm but unpleasant

Results - I

1-lead EKG from chest-belt vs 12-lead. EKG:

excellent agreement in decision on heart rhythm

Hospitalized: 94.4% agreement

(3 failed cases in patients with paced rhythm)

Outpatients: agreement in all cases (100%)

Results - I

Live ECG from chest-belt phone app vs telemetry

Hospitalized: agreement in 53/54 patients (98.1%)

Including 3 cases that were assessed as unclear from both telemetry and live-ECG in the app

In 1 case, the correct diagnosis of AFLU was made from telemetry but the live-ECG from the app was assessed as unclear

Results - II

Of the 1,153,229 QRS complexes:

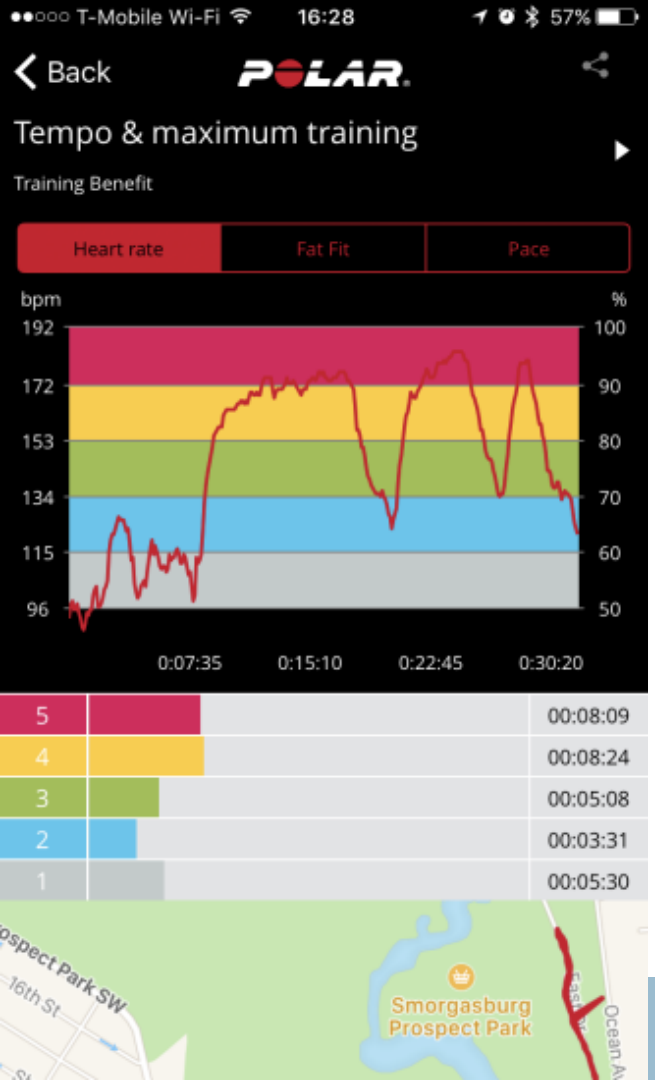
1,128,319 (**97.84%**) evaluated by a cardiologist as **easily recognizable and categorizable**

In real-world conditions, **only 2.16% of all QRS evaluated as artifacts** or as interpretable, but uncomfortable due to noise/artifacts for rapid determination of QRS presence and rhythm type

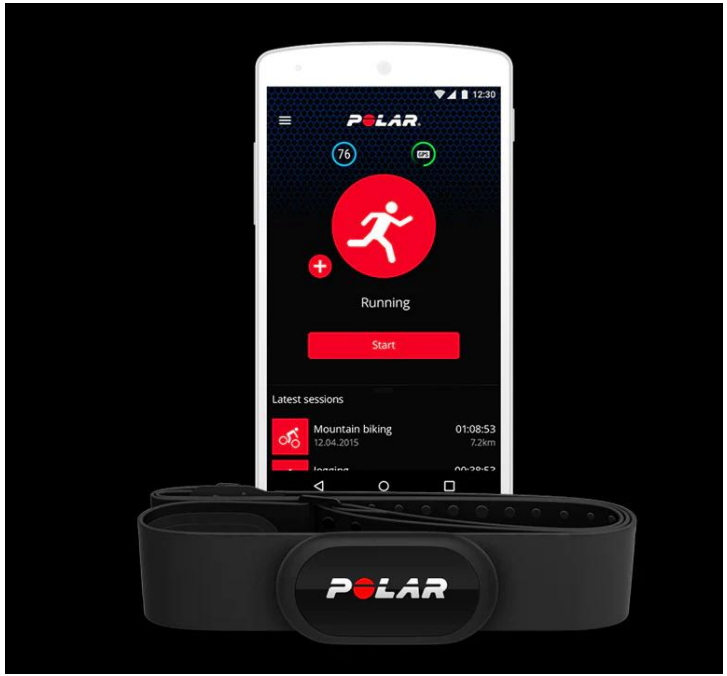
Pitfalls

Possibility of misinterpretation of the rhythm:

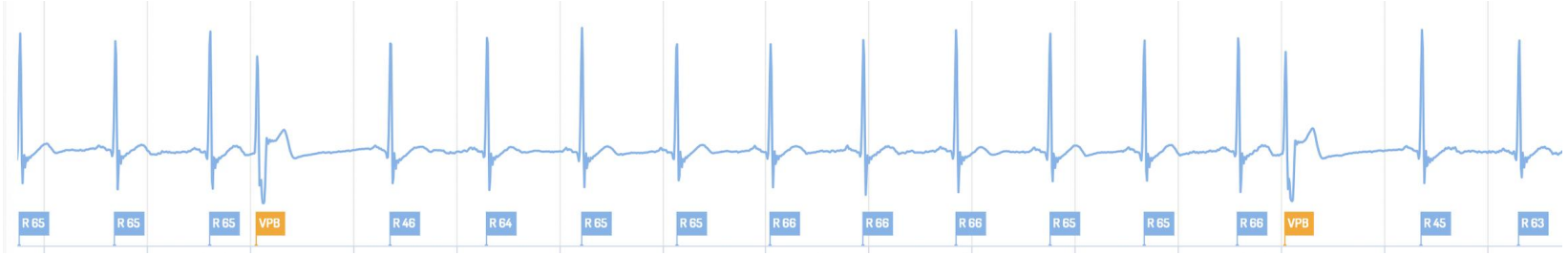
- 100% paced QRS complexes
- AFLU with regular RR intervals and rapid ventricular response
- VPBs of septal localization (differentiation from APBs)



Native applications – just **Heart Rate**



EKG from Polar H10 chest-belt



KARDI-AI

- Polar H10 chest-belt + mobile app + cloud-based AI and algorithms + web-based environment for analysis

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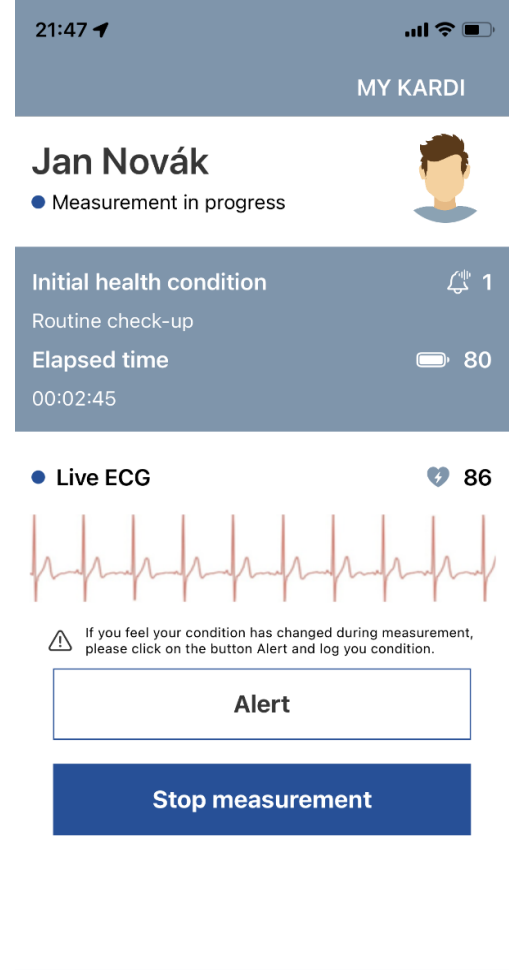
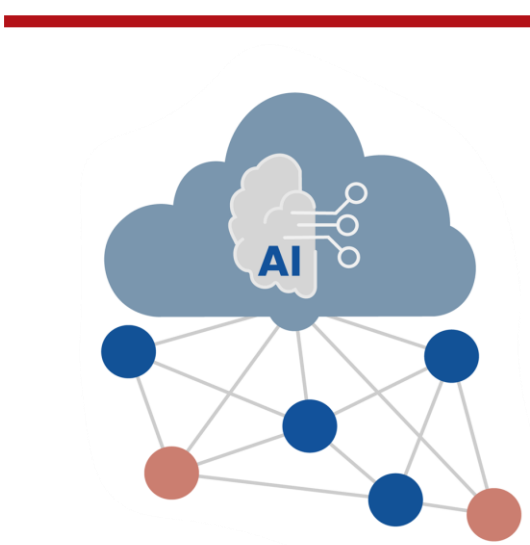
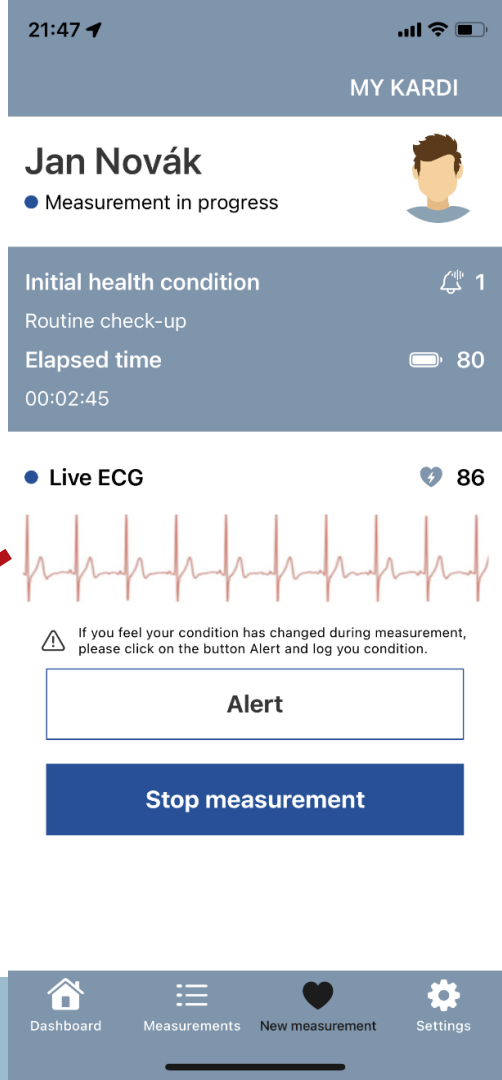


KOMPLEXNÍ KARDIOVASKULÁRNÍ CENTRUM

KARDI-AI

- Polar H10 chest-belt + mobile app + cloud-based AI and algorithms + web-based environment for analysis





KARDIAI

- Dashboard
- List of Measurements
- List of patients

ADMIN

- Super Admin
- User Settings
- Experimental mode
- Application Settings
- My institution
- Logout

AI ACTIONS

- AI Request AWS
- AI Request KAFKA
- Copy Calculation
- Compare Calculation
- Restore Calculation
- Resubmit Main
- Detector

User detail

[redacted]
1969
Male
[redacted]

Measurements

Measurements count: 61
Duration: 58h 20m
Beats: 228,040
LAST MEASUREMENT: NOV. 27, 2022, 6:36 P.M.

Patient Alerts

Patient with AF in past: Yes
Email alert in case of new AF episode: On

CHANGE E-MAIL ALERT SETTINGS

ECG strips saved by Doctor

Number of saved strips: 20

(CLICK TO SHOW DETAIL)

AF Summary - Summary of last 6 months

[*] AF Detection

Measurements with AF: 5 (8.2%)
Num of Measurements: 61

[*] AF - Longest Episode

DURATION: 1H 13M
SEPT. 13, 2022, 10:22 P.M.
(CLICK TO SHOW DETAIL)

[*] AF - Episode with highest BPM

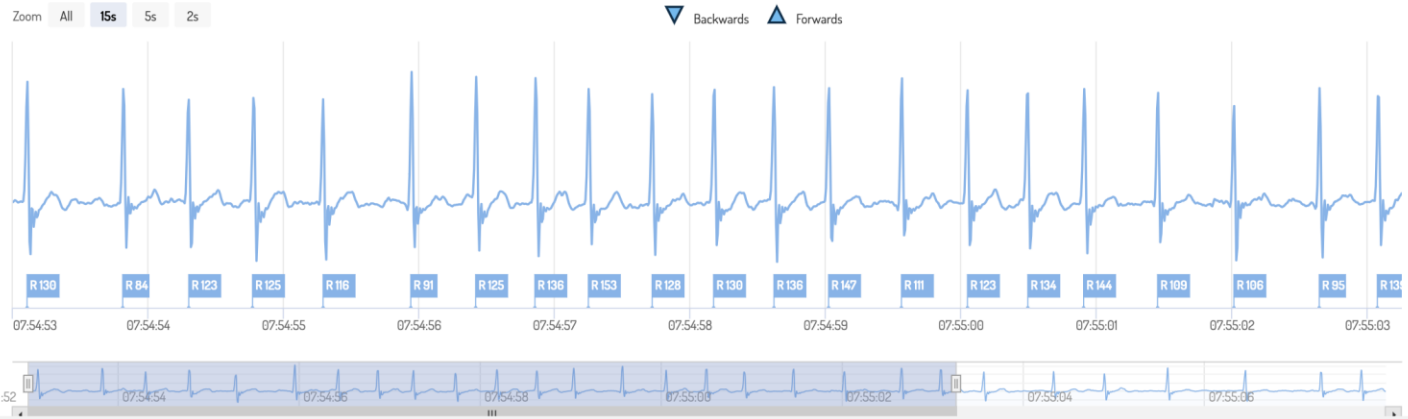
PRŮMĚRNÝ TEP: 135
SEPT. 24, 2022, 9:54 A.M.
(CLICK TO SHOW DETAIL)

[*] AF - Last Episode

DATE: SEPT. 24, 2022, 9:54 A.M.
(CLICK TO SHOW DETAIL)

ECG during FS, longer than 30s, confirmed by specialist

24-09-2022 09:54:53 - 09:55:08



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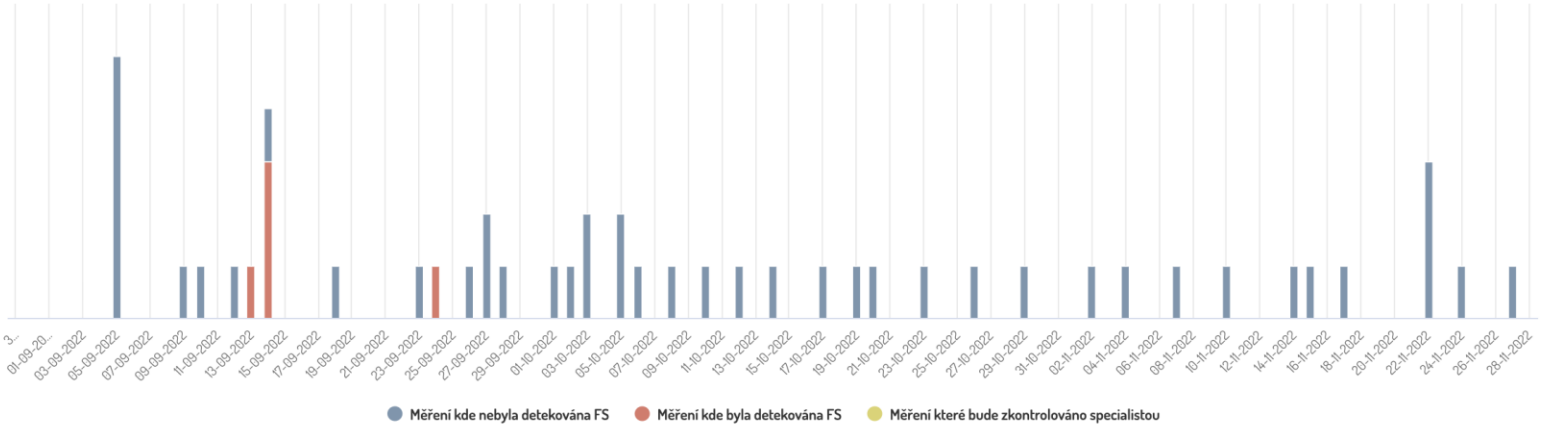
Number of measurements in last 90 days



List of all measurements

[*] AF detected

User Alerts

Measurements done in last #days

filter

#	DATE	DURATION HH:MM	[*] AF FOUND	# USER ALERTS	LINK
1	Nov. 27, 2022, 6:36 p.m.	01:03	—	0	>>>
2	Nov. 24, 2022, 7:15 p.m.	01:00	—	0	>>>
3	Nov. 22, 2022, 8:41 p.m.	00:38	—	0	>>>


23:06
Nahraj EKG pro zvolený čas
Previous 10m
Next 10m
1m
15s
5s
2s
Scroll left
Scroll Right
Save annotation of ECG strip
RR
APB
00:08:25
00:08:26
00:08:27
00:08:28
00:08:29
00:08:30
00:08:31
00:08:32
00:08:33
00:08:34
00:08:35
00:08:36
00:08:37
00:08:38
00:08:39
Možná AF
R 123
R 132
R 102
R 104
R 125
R 78
R 128
R 128
R 132
R 153
R 153
R 96
R 128
R 134
R 82
R 125
R 130
R 144
R 128
R 137
R 123
R 132
R 142
R 122
R 86
R 110
R 106
R 108
R 150
09:20:44
09:20:45
09:20:46
09:20:47
09:20:48
09:20:49
09:20:50
09:20:51
09:20:52
09:20:53
09:20:54
09:20:55
09:20:56
09:20:57
09:20:58

KARDI AI

EN CS [redacted]@gmail.com

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Detail of measurement

PATIENT DETAILS
[redacted]
1969
Male

MEASUREMENT DETAILS
17-11-2022
18:09 - 20:11
Duration 2h 1m 33s

BEATS ANALYSIS
Max HR: 84
Min HR: 58
Avg HR: 63

AF ANALYSIS
[*] APB - 0.0 %
[*] VPB - 0.25 %

19 :29 | Load ECG for selected time | Previous 10m | Next 10m | PDF report for this measurement

Measurements summary with events highlighted - AVG BPM

Zoom All 15m 5m 1m

Dashboard
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Resubmit Main
Detector

Detail of measurement

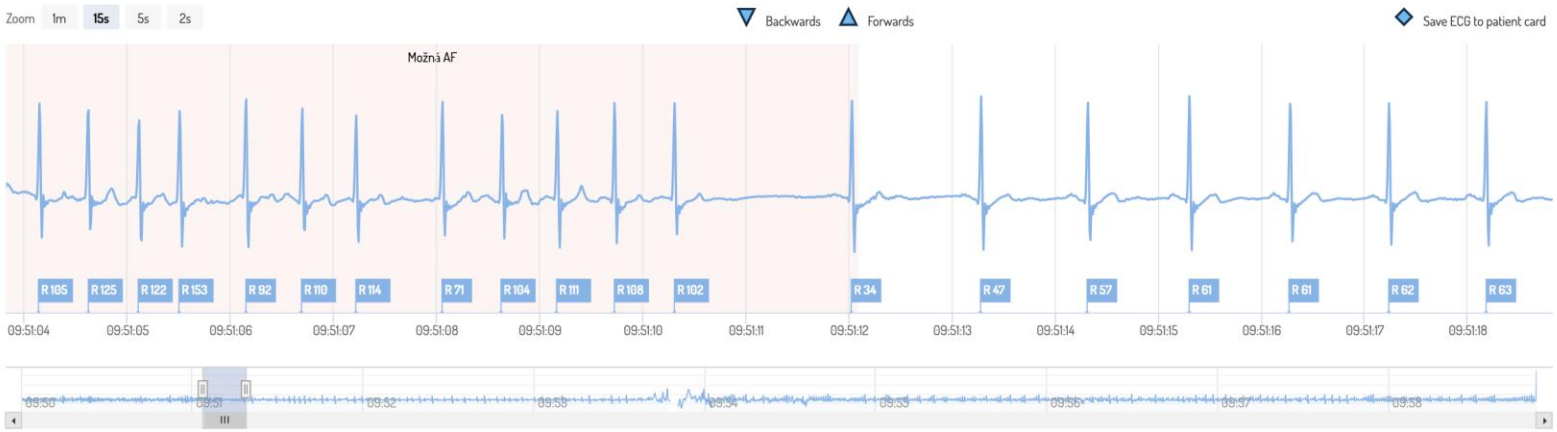
PATIENT DETAILS
[redacted]
1969
Male

MEASUREMENT DETAILS
24-09-2022
09:54 - 10:58
Duration 1h 4m 37s

BEATS ANALYSIS
Max HR: 137
Min HR: 61
Avg HR: 113

AF ANALYSIS
Detected AF
[*] APB - 0.35 %
[*] VPB - 0.45 %

10:50 | Load ECG for selected time | Previous 10m | Next 10m | PDF report for this measurement



Measurements summary with events highlighted - AVG BPM

Zoom All 15m 5m 1m

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AI ACTIONS

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- AI Request KAFKA
- Copy Calculation
- Compare Calculation
- Restore Calculation
- Resubmit Main
- Detector

12 :55 | Load ECG for selected time | Previous 10m | Next 10m | PDF report for this measurement

Measurements summary with events highlighted - AVG BPM


Subscriptions
Proceeds
ADMINISTRACE
Administrátor
Nastavení uživatele
Nastavení aplikace
My institution
Mobile QRcode
Odlogovat se
AI AKCE
AI požadavek
Zkopíruj výpočet
Porovnej výpočet
13:13
Nahraj EKG pro zvolený čas
Previous 10m
Next 10m
Zoom
1m
15s
5s
2s
Scroll left
Scroll Right
Save annotation of ECG strip
RR
APB
13:15:18
13:15:19
13:15:20
13:15:21
13:15:22
13:15:23
13:15:24
13:15:25
13:15:26
13:15:27
13:15:28
13:15:29
13:15:30
13:15:31
13:15:32


Subscriptions
Proceeds
ADMINISTRACE
Administrátor
Nastavení uživatele
Nastavení aplikace
My institution
Mobile QRcode
Odlogovat se
AI AKCE
AI požadavek
Zkopíruj výpočet
Porovnej výpočet
12:45
Nahraj EKG pro zvolený čas
Previous 10m
Next 10m
Zoom
1m
15s
5s
2s
Scroll left
Scroll Right
Save annotation of ECG strip
RR
VPB
13:51:40
13:51:41
13:51:42
13:51:43
13:51:44
13:51:45
13:51:46
13:51:47
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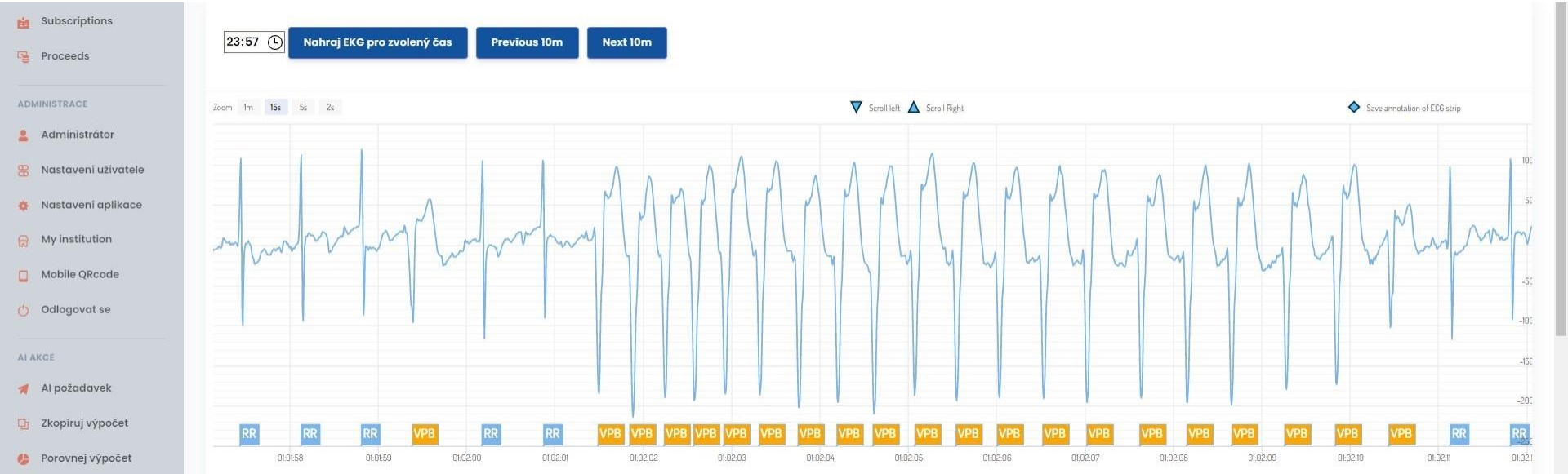
13:51:49
13:51:50
13:51:51
13:51:52
13:51:53
13:51:54


Subscriptions
Proceeds
ADMINISTRACE
Administrátor
Nastavení uživatele
Nastavení aplikace
My institution
Mobile QRcode
Odlogovat se
AI AKCE
AI požadavek
Zkopíruj výpočet
Porovnej výpočet
23:57
Nahraj EKG pro zvolený čas
Previous 10m
Next 10m
Zoom
1m
15s
5s
2s
Scroll left
Scroll Right
Save annotation of ECG strip
RR
VPB
01:01:58
01:01:59
01:02:00
01:02:01
01:02:02
01:02:03
01:02:04
01:02:05
01:02:06
01:02:07
01:02:08
01:02:09
01:02:10
01:02:11

Conclusion

- The chest belt can be used as a tool for EKG acquisition (and arrhythmia screening)
- When used correctly, most EKGs are easy to interpret
- Caution is needed in interpreting EKGs in patients with paced rhythm and AFLU with regular RR intervals

Thank you

for your attention