Χρήση έξυπνων τεχνολογιών στην ανίχνευση κολπικής μαρμαρυγής
Use of smart technology in atrial fibrillation detection

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Risk of Stroke and Death in Untreated Screen-Detected AF

- AF is the leading cause of stroke among patients older than 75 years and is responsible for at least 15% of all strokes
  
  *Int J Cardiol. 2015;199:248-252*

- AF induced strokes are associated with greater morbidity and mortality and more severe neurological deficits when compared to strokes not associated with AF
  
  *Ann Intern Med. 2007;146(12):857-867*

- Patients with AF have a 13% increased risk of cognitive decline over 5 years measured by the Mini Mental Status Examination
  
  *Can Med Assoc J. 2012;184:329-336*
Subclinical Atrial Fibrillation Progression and the Risk of Heart Failure Hospitalization

Subclinical atrial fibrillation (SCAF) (episodes lasting >6 minutes and ≤24 hours)

- No progression of SCAF to episodes >24 hours
- SCAF progression (incidence 8.8%/year)

Annual rate of heart failure (HF) hospitalization:
- 2.5%/year
- 8.9%/year

SCAF progression associated with increased risk of HF hospitalization
[HR: 4.58; 95% CI: 1.64 - 12.8; p = 0.004]

Predictors of SCAF progression:
- Older age
- Greater BMI
- SCAF episode duration: 1-hour increase in duration
  - 13% increased risk of SCAF progression

Anticoagulated patients with AF have residual stroke rates similar to matched individuals without AF.
automated blood pressure devices
BP monitors with specific algorithm for AF detection

✓ 3 sequential BP measurements
✓ provide the average BP value together with a yes/no report for AF presence
✓ 6 published clinical trials
✓ compared the results against 12-lead ECG

- WatchBP Home A should be considered for use in people with suspected hypertension and those being screened or monitored for hypertension, in primary care. People suspected of having AF after use of WatchBP Home A should have an ECG.

NICE 2013 [16]

Study | Sensitivity | 95% CI | Weight (%) | Study | Specificity | 95% CI | Weight (%)
--- | --- | --- | --- | --- | --- | --- | ---
Wiesel 2004 | 1.00 (0.94, 1.00) | 32.57 |  | Wiesel 2004 | 0.92 (0.89, 0.93) | 15.51 |  
Strongiou 2009 | 1.00 (0.84, 1.00) | 11.80 |  | Strongiou 2009 | 0.89 (0.75, 0.99) | 7.07 |  
Wiesel 2009 | 0.97 (0.91, 0.99) | 34.47 |  | Wiesel 2006 | 0.89 (0.85, 0.92) | 17.87 |  
Wiesel 2014 | 1.00 (0.86, 1.00) | 11.29 |  | Wiesel 2014 | 0.92 (0.88, 0.96) | 15.71 |  
Kaseley 2014 | 0.95 (0.88, 0.99) | 16.34 |  | Kaseley 2014 | 0.90 (0.83, 0.97) | 19.66 |  
Gandolfi 2015 | 0.89 (0.77, 0.99) | 5.59 |  | Gandolfi 2015 | 0.99 (0.95, 1.00) | 19.60 |  
Overall (I² = 29.3%, p = 0.215) | 0.99 (0.95, 1.00) | 100.00 |  | Overall (I² = 89.8%, p < 0.01) | 0.92 (0.88, 0.96) | 100.00 |

- specificity at 0.92 (95% CI 0.88, 0.96)
- sensitivity at 0.98 (95% CI 0.95, 1.00)
Single lead ECG adhesive recorder

✓ self-applied  
✓ water-resistant properties  
✓ allow patients to participate in almost all activities of daily living  
✓ Improved patient compliance  
✓ Duration 14-30 days  
✓ trigger button that allows patients to mark symptoms of atrial fibrillation
real-time analysis and transmission
Effect of a Home-Based Wearable Continuous ECG Monitoring Patch on Detection of Undiagnosed Atrial Fibrillation

The mSToPS Randomized Clinical Trial

Monitoring (n=1366): 3.9%
No monitoring (n=1293): 0.9%
Absolute difference favoring device monitoring 3.0% (95% CI, 1.8%-4.1%)
Smart phone devices
Smartphone connected to a detector pad

- Detector pad
- Two-electrode cardiac rhythm recorder that hooks up to a smart device.
- It enables patients to record a 30-second rhythm strip.
- The detector sends the data using ultrasound to the user’s smartphone microphone,
- Where the Kardia app’s rendering of the data is displayed as a single ECG lead and is most similar to lead I on a conventional 12-lead ECG.
Assessment of Remote Heart Rhythm Sampling Using the AliveCor Heart Monitor to Screen for Atrial Fibrillation
The REHEARSE-AF Study

✓ Regular twice-weekly iECG screening in people over 65y (CHADS\--VASC score≥2)
✓ 4 times more likely to identify incident AF than routine care

Compliance with ECG Monitoring Protocol

Circulation. 2017;136:1784–1794
Assessing the accuracy of an automated atrial fibrillation detection algorithm using smartphone technology: The iREAD Study

<table>
<thead>
<tr>
<th>KMCM automated algorithm interpretation</th>
<th>Physician interpretation of the KMCM recordings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sinus</td>
</tr>
<tr>
<td>Sinus</td>
<td>91</td>
</tr>
<tr>
<td>AF</td>
<td>2</td>
</tr>
<tr>
<td>Noninterpretable</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
</tr>
</tbody>
</table>

Sensitivity, specificity, and κ coefficient are calculated only for the simultaneous transmission with interpretation (shown in bold). The κ coefficient is 0.91 (95% confidence interval 0.84–0.97) for numbers in bold.

AF = atrial fibrillation; ECG = electrocardiogram; KMCM = Kardia Mobile Cardiac Monitor.

✓ the KMCM automated algorithm interpretation had 96.6% sensitivity and 94.1% specificity for AF detection as compared with physician interpreted ECGs

Heart Rhythm 2018;::1–5
A measure of variations in the capillary volume resulting from ventricular contractions in the arterial BP wave.
Smart detection of atrial fibrillation†

Lian Krivoshei1,4‡, Stefan Weber2‡, Thilo Burkard3, Anna Maseli1, Noe Brasier1, Michael Kühne5, David Conen1, Thomas Huebner6, Andrea Seeck6, and Jens Eckstein1*

✓ A novel heart beat detection algorithm based on a combination of morphology and frequency analysis of the pulse wave was applied to detect all beat-to-beat intervals (BBI).

✓ Three different statistical tests were examined in their ability to discriminate AF from SR

✓ The highest sensitivity and specificity was achieved using the combination of the indices nRMSSD and SD1/SD2 with the tachogram filter. By prolonging the analyzed interval from 2 to 5 min, we reached a sensitivity and specificity of 95%.

Europace (2017) 19, 753–757

No additional peripheral devices are needed
Digital-AF study

Local newspaper article

92,638 subscribers

Download the app
Create account
Scan QR-code

Information
60s recording
Symptoms

Steady position
2 measurements/day
1 week

Instant feedback
Centralized reviewing
Summary report

12,328
registered users
in 48 hours

120,446
60-second PPG traces
in 1 week
136 participants with AF

0.4% AF spot check
1.4% AF one week

38 persistent/permanent AF (28%)
98 paroxysmal AF (72%)

76% asymptomatic
insufficient quality 191 (2%)
Back to the future?

Ballistocardiography

Mechanical action of the heart leads to subtle but reproducible movement of the whole body.
✓ “every action has an equal and opposite reaction”

✓ mechanical cardiac activity is recorded with accelerometers and gyroscopes

✓ positive predictive value was 96.0% (95% CI, 91.6–98.1)

✓ negative predictive value was 95.4% (95% CI, 90.9–97.7)
✓ Self-contained, FDA-cleared, miniaturized ECG device.
✓ Powered by an internal lithium battery with a lifetime of 1-2 years, the sensor in KardiaBand is always ready to use - with the recording screen open on your Apple Watch, simply touch your index finger to the KardiaBand sensor to start a recording.
Smartwatch Algorithm for Automated Detection of Atrial Fibrillation

The smartwatch strap with an electrode sensor that records heart rhythm

Patient places thumb on the sensor to record rhythm

The application utilizes an algorithm to differentiate sinus rhythm (SR) from atrial fibrillation (AF), or would label the recording as unclassified if it does not meet certain criteria

The app informs the patient if AF is detected; the results are transmitted to the patient's physician

<table>
<thead>
<tr>
<th>Method for interpreting the recording:</th>
<th>% of patients with interpretable results</th>
<th>Accuracy of AF diagnosis compared to 12 lead electrocardiogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>App algorithm only</td>
<td>66%</td>
<td>93% sensitivity; 84% specificity</td>
</tr>
<tr>
<td>Physician only</td>
<td>87%</td>
<td>99% sensitivity; 83% specificity</td>
</tr>
<tr>
<td>Recordings labeled as &quot;unclassified&quot; by the app algorithm when reviewed by physician</td>
<td>100%</td>
<td>100% sensitivity; 80% specificity</td>
</tr>
</tbody>
</table>

KB algorithm

Simultaneous ECG
Implantable loop recorder (ILR)

✓ Small size: 1.4 cc – 5cc
✓ MRI compatible: 1.5-3T
✓ Longevity: 2-4 y
✓ Minimally invasive procedure
Cryptogenic stroke and underlying atrial fibrillation

MR Conditional at 1.5 and 3.0 Tesla

Patient Monitor

Network
1. LEARNS

**AF algorithm** tracks R-wave variability in a patient and keeps their P-wave evidence history.

2. ADAPTS

**Self-learning algorithm** collects P-wave evidence for a patient and adapts.

3. REJECTS

**Self-learning algorithm** rejects false AF in patients with irregular sinus.
MORE EFFICIENT REVIEW
- Save clinician time with review of fewer false detects\(^1,2\)

<table>
<thead>
<tr>
<th>Total Device Patients Monitored</th>
<th>Data Transmitted to Device Clinic</th>
</tr>
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<tbody>
<tr>
<td><strong>↓</strong></td>
<td><strong>↓</strong></td>
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<table>
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<tr>
<th>True Cardiac Events</th>
<th>False Positive Events</th>
</tr>
</thead>
</table>

Estimated time reviewing false detects\(^*\)

ILR

ILR + new algorithm

\(↓56\%\)

less clinician time spent reviewing data\(^*^2\)
Bluetooth wireless technology

need for near 100% of successful data transmission
Conclusions

✓ research and innovation regarding devices increasingly is widening the choices for screening and monitoring AF

✓ BP monitors, ecg adhesive recorders, Smartphones, wrist-worn devices, ILR’s can effectively detect atrial fibrillation

✓ Scientific societies should guide their clinical application

- Does CIED detected AF have the same risk and significance as clinical AF?
- What duration of AF causes stroke?
- How much AF causes CHF?
- What treatment should we institute when we see these events?
ideal smart device for AF detection

Noninvasive, cost effective, providing real-time, accurate AF detection in a passive fashion, not limited to any one snapshot in time.