Diagnosing arrhythmias in general practice: the BEAT study
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Chapter 6

Efficacy of diagnostic tools for detecting cardiac arrhythmias: systemic literature search

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Patrick J.E. Bindels
Henk C.P.M. van Weert

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**ABSTRACT**

**Background/objectives**
Symptoms suggestive of cardiac arrhythmias are a challenge to the diagnosis. Physical examination and a 12-lead ECG are of limited value, as rhythm disturbances frequently are of paroxysmal nature. New technologies facilitate a more accurate diagnosis. The objective of this study was to review the medical literature in an effort to define a guide to rational diagnostic testing.

**Methods**
Primary studies on the use of a diagnostic tool in the evaluation of palpitations were searched in MEDLINE and EMBASE with an additional reference check.

**Results**
Two types of studies were found: descriptive and experimental studies, which compared the yield of two or more devices or diagnostic strategies. Holter monitors seemed to have less diagnostic yield (33%-35%) than event- recorders. Auto-triggered recorders detect more arrhythmias (72%-80%) than patient-triggered devices (17%-75%). Implantable devices are used for prolonged monitoring periods in patients with infrequent complaints or unexplained syncope.

**Conclusion**
The choice of the device depends on characteristics of symptoms and patients. Due to methodological shortcomings of included studies no evidence-based diagnostic strategy can be proposed.
INTRODUCTION

Physicians commonly face patients with symptoms suggestive of cardiac arrhythmias, such as palpitations. However, as the majority of patients do not experience symptoms during consultation and medical history and physical examination are usually inconclusive, diagnostic evaluation is difficult and further diagnostic tests are often indicated. An ECG during symptoms is considered to be the reference standard, but obtaining a symptomatic standard ECG often is not possible. Increased emphasis on outpatient diagnosis and recent technical developments has created techniques that facilitate obtaining a symptomatic ECG of an ambulant patient. A systematic literature search was performed to analyze the available monitoring techniques to diagnose patients with symptoms of palpitations. Based on this research and clinical reasoning we define a guide to rational diagnostic testing in these patients.

METHODS

Search Strategy

We performed a literature search, using MEDLINE (01/1966-03/2007) and EMBASE (01/1988-03/2007). The complete search strategy is available upon request from the corresponding author. Searches were limited to original studies in humans. We excluded letters and editorials. Languages other than German, French, English, Dutch or Italian were excluded.

Inclusion of studies

The first selection was on title and abstract. The article had to describe an original study on the use of a diagnostic tool, other than a standard ECG in the evaluation of adult outpatients with complaints of palpitations. Duplicates and articles without abstract were removed. The search was supplemented by reference checking for any missing studies. Although we planned to include only prospective or transversal studies with a clear reference standard this did not prove to be feasible, so we included all original studies on the use of new technology, irrespective of study design. Two authors (EH, HvW) independently assessed the methodology of the included studies, using the appropriate instruments and extracted data. In case of any disagreement, consensus was reached after extensive discussion.

End points

In a true diagnostic study the results of an index test are compared with the results of a reference test. However, when studying the results of new technologies, that are
supposed to be more sensitive and/or specific than existing ones, such study-designs not feasible. Therefore evaluation of such new technologies should focus on the clinical consequences. Thus adequate end-points of diagnostic studies in case of palpitations, in which a new technology is studied, can be ‘detected arrhythmias’ (with or without clinical consequences) or ‘explained symptoms’ (with or without consequences in management). These outcomes are different, as a detected arrhythmia does not necessarily explain the symptoms for which patients seek medical help, and not all arrhythmias are clinically relevant. On the other hand relevant arrhythmias do not always produce symptoms. Therefore we report both endpoints, detected arrhythmias as well as explained episodes, whenever possible. We use the term ‘relevant arrhythmia’ when treatment and/or further clinical evaluation is needed. We considered an arrhythmia relevant in case of (paroxysmal) atrial fibrillation (PAF), atrial flutter, atrial tachycardia, other supraventricular tachycardia (SVT), ventricular tachycardia or escape rhythm. We intended to perform a meta-analysis, but as data could not be combined, studies are reported in a narrative form.

RESULTS

The results of the search and subsequent assessment of identified studies are summarized in figure 1. Our search yielded 1700 articles. After reading title and abstract 38 articles were labelled potentially relevant. Four reviews were excluded because these reviews were not systematic and included no original data. One reference could not be retrieved, even after mailing the author, 11 articles did not describe a diagnostic method or included patients without palpitations. Reference checking yielded a total of six additional relevant articles. Finally 28 studies were available for analysis (Figure 1). Performing meta-analysis did not prove to be possible, either due to clinical heterogeneity or due to methodological heterogeneity.

Available technologies

Our search yielded six different diagnostic devices, which currently are available to register an ECG while the patient is ambulant (table 1).

1. Holter monitoring continuously records a 12 ECG-lead over a 24 to 48 hour period. Recently even up to 72 hours. Since 1960, it used to be the first choice for additional workup in detecting and quantification of suspected arrhythmias. To link ECG changes to occurring symptoms patients must keep up a diary during the monitoring period.

2. External event recorders without loop, also known as Trans Telephonic Monitoring (TTM) are a form of non-continuous ambulatory recordings. After activation by the pa-
Patient an ECG is recorded. The recorded event must be directly transmitted by telephone to a receiving center.

3. **Event recorders with looping memory** (continuous event recorders: CER) make a continuous one-lead recording, but the rhythm strip will only be saved when a patient activates the device. Most devices can be programmed to save pre-activation and post-activation rhythm strips. Several designs are available, for example, with electrodes attached to the chest, with a device around the wrist or a hand held credit card design.
Table 1. Types of devices for specific patient groups and their complaints of palpitations

<table>
<thead>
<tr>
<th>Device</th>
<th>Patient activated</th>
<th>Automatic activated</th>
<th>Memory</th>
<th>Duration</th>
<th>Leads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holter monitor</td>
<td></td>
<td>X</td>
<td>24-48 hours</td>
<td>Variable till 12-leads</td>
<td></td>
</tr>
<tr>
<td>Event recorder no-loop (TTM)</td>
<td>X</td>
<td></td>
<td>unlimited</td>
<td>variable</td>
<td></td>
</tr>
<tr>
<td>Event recorder with loop (CER)</td>
<td>X</td>
<td>X</td>
<td>unlimited</td>
<td>2-3 leads</td>
<td></td>
</tr>
<tr>
<td>Auto triggered event Recorder</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>7 days</td>
<td>1-3 leads</td>
</tr>
<tr>
<td>(R-test evolution, MCOT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implantable loop recorder</td>
<td></td>
<td>X</td>
<td>X</td>
<td>12-24 months</td>
<td>2-leads</td>
</tr>
</tbody>
</table>

4. **Auto triggered event monitors with looping memory (At-CER)** automatically recognize (pre-specified) high or low heart rates and were introduced a few years ago. Several types of devices are now available, R-Test Evolution (RTE) performs continuous ECG analysis combined with an automatic storage of abnormal events detected in a 20-minute solid-state memory with autonomy of up to seven days. In addition, the patient can trigger a recording in case of symptoms. These functions can run simultaneously. The most recent advancement in ambulatory arrhythmia monitoring is The **Mobile Cardiac Outpatient Telemetry**. Patients wear three chest leads attached to a portable sensor that continuously detects asymptomatic pre-specified arrhythmias and transmits the ECG data in real-time to a pocket-sized monitor at the patients home. If the algorithms in the monitor detect an abnormal heartbeat, the monitor automatically transmits the patient’s ECG data to the monitoring Center using wireless communications. Also away from home the device communicates continuously with the service center.

5. **Implantable autotriggered loop recorders (ILR)** require a minor invasive procedure. Recording possibilities are the same as with non-implantable autotriggered loop recorders. Because external electrodes are not necessary the ILR can be used by patients for a long period of time (12 to 24 months). Currently, remote transmission capabilities are not available.

6. **Pacemakers and Cardiodefibrillators** are implanted primarily to pace and/or shock the heart. These devices can be programmed to detect and store rhythm abnormalities as well and send data to a remote receiving facility.

**The yield of available devices**

The search yielded two types of studies. Descriptive (prospective and historical) cohort studies, describing the yield of a device in terms of explained episodes or diagnosed arrhythmias. The second type are experimental studies, which compare the yield of two
or more devices or diagnostic strategies in the same patient or in randomized groups of patients.

For all included studies we report on the aim, setting, inclusion criteria, completeness of follow-up, sample size documented, statistical analyses described and outcomes. In case of a randomised trial we used the quality criteria as mentioned by Jadad: 1) randomisation of participants; 2) blinding of patients, caregivers and those assessing outcome; and 3) full description of withdrawals and dropouts.9

**Descriptive studies**

Of the 28 studies 12 were simple descriptive studies, which described the yield of Holter monitoring and event recording with and without loop in a group of patients. The study device serves as its own reference test and the outcomes are described in terms of proportions of patients in which a relevant or less relevant arrhythmia is diagnosed or changes in medical management have been implemented. These studies are described in table 2. The patients, included in these studies are not comparable and many studies

<table>
<thead>
<tr>
<th>Table 2. Descriptive studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td><strong>Holter</strong></td>
</tr>
<tr>
<td>Erikson 1980</td>
</tr>
<tr>
<td>Rana 1989</td>
</tr>
<tr>
<td>McClennen 2000</td>
</tr>
<tr>
<td><strong>Event recorder no loop</strong></td>
</tr>
<tr>
<td>Safe 1990</td>
</tr>
</tbody>
</table>
Table 2 (continued)

<table>
<thead>
<tr>
<th>Source</th>
<th>Study design aim</th>
<th>Inclusion criteria</th>
<th>Setting gender/ mean age</th>
<th>Instrument/ Registration time</th>
<th>drop-out</th>
<th>Outcome and diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assayag 1992</td>
<td>Retrospective; diagnostic yield</td>
<td>Palpitations</td>
<td>Tertiary care, n=1287</td>
<td>CER no loop</td>
<td>196</td>
<td>42% diagnoses</td>
</tr>
<tr>
<td>Schuchert 2002</td>
<td>Prospective descriptive; diagnostic yield</td>
<td>Palpitations, Holter neg., 43% cardio pathology</td>
<td>Out-pts, n=55 38% males 46 yrs</td>
<td>One-channel ECG (hand held), 6 weeks</td>
<td>ND</td>
<td>32% relevant diagnoses</td>
</tr>
<tr>
<td>Shanit 1996</td>
<td>Prospective, descriptive; diagnostic yield</td>
<td>Chest pain, arrhythmia, hypertension, reassurance</td>
<td>Out-pts, n=2563 ?? ??</td>
<td>12 leads ECG (hand held)</td>
<td>ND</td>
<td>26% relevant diagnoses</td>
</tr>
</tbody>
</table>

Event recorder with memory loop

| Summerton 2000 | Prospective; diagnostic yield | Palpitations | primary care pts, n=139 33% male 45 yrs | rhythm card (hand held), no pre event memory 2 weeks | ND       | 30% diagnoses, 19% relevant diagnoses |
| Fogel 1997     | Prospective; diagnostic yield, cost | Palpitations, pre-syncope 25% cardio pathology | Out-pts, n=184 31% males 44 yrs | Wrist CER 4 weeks | ND       | 66% patients with palpitations, 43% relevant diagnoses palpitation most cost effective |
| Zimetbaum 1998 | Prospective; diagnostic yield, cost, diagnoses timing | Palpitations | Out-pts, n=112 26% males 52 yrs | CER 4 weeks | 7 patients, incomplete files | 84% diagnoses <2weeks, 36% relevant diagnoses two weeks cost-effective |
| Brown 1987     | Retrospective; diagnostic yield   | Palpitations, dizziness, syncope, abnormal Holter, symptoms after treatment 39% cardio pathology | Out pts, n=106 58 yrs ?? | CER 3 weeks | 6 patients, incomplete files | 66% diagnoses, 7% relevant diagnoses |
| Wu Chih-Cheng 2003 | Retrospective; diagnostic yield | Palpitations, pre-syncope, chest pain, dyspnoea 50% cardio pathology | Tertiary care n=660 47% males 53 yrs | CER 30 days | Not described | 64% diagnoses, palpitations group 66% diagnoses |

ND = not described, AF = atrial fibrillation, CER = continuous event recorder
described inclusion criteria superficially; patients mostly were tertiary care patients with a variable amount of (sometimes previously known) cardiac pathology. Event recording with loop seems to generate most diagnoses, but comparison of the results of these studies is methodologically not possible and would probably lead to false conclusions. Recommendations have to be based on studies, which compared the yield of two or more devices in the same or in randomized groups of patients.\textsuperscript{10,11,12,13,14,15,16,17,18,19,20,21}

**Comparative studies**

These studies have in common that the outcomes of the studied devices are compared with another diagnostic test. As in descriptive studies, combining of results was methodologically not possible in these studies because of the diversity of the studied populations and the variation in tested devices. Most patients were in tertiary care with a variable amount of (sometimes previously known) cardiac pathology. Many studies described inclusion criteria superficially although in more recent studies this is done more appropriate following a protocol. (table 3).

**CER vs. Holter monitoring**

In six studies the CER is compared with Holter monitoring (24 to 48 hours). Registration time with the CER varied from one week to six months. The studied populations consisted of 50 to 100 patients, one study described 310 patients. The patient populations consisted of primary-and secondary care patient groups. From the latter, about 41% of the patients had documented structural heart disease. Outcomes were described in terms of proportions of patients in whom a relevant or less relevant arrhythmia was diagnosed or in whom changes in medical management have been implemented. With the CER, a diagnosis was established in a range 21 to 62% of the studied patients, compared with a maximum of 30% with Holter monitoring. The CER was better in excluding arrhythmias during symptoms than with Holter monitor (34 and 2%, respectively).\textsuperscript{22,23,24,25,26,27}

**CER vs. ECG monitoring**

Records of 91 patients were reviewed. Within 30 days the CER was diagnostic in 37% of patients, while a 12-lead ECG was diagnostic in 10% of patients.\textsuperscript{28}

**CER vs. usual GP care**

In a randomised trial the diagnostic yield of CER versus usual care in general practice was compared. Within one month 83% of the patients recorded an episode. The CER diagnosed 67% of patients with a cardiac arrhythmia, while the GPs diagnosed 27% of patients with a cardiac arrhythmia (P<0.05) after six months.\textsuperscript{29}
### Table 3. Comparative studies

<table>
<thead>
<tr>
<th>Source</th>
<th>Study design aim</th>
<th>Inclusion criteria</th>
<th>Setting gender/mean age</th>
<th>Blinding observer</th>
<th>drop-out</th>
<th>Instrument/Registration time</th>
<th>Proportion patients with diagnoses*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CER vs Holter</strong></td>
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<tr>
<td>Grodman 1979</td>
<td>Prospective comparative; diagnostic yield</td>
<td>Palpitations</td>
<td>Out-pts n=59 45% males 50 yrs</td>
<td>ND</td>
<td>19 failed transmitting, 4 failed for technical reason</td>
<td>CER (cardio-beeper) vs Holter, simultaneously 1 week</td>
<td>Holter 3 pts, CER 3 pts, Holter and CER together 9 pts</td>
</tr>
<tr>
<td>Visser 1984</td>
<td>Prospective, comparative; diagnostic yield</td>
<td>Palpitations</td>
<td>Out-pts n=50 34% males 44 yrs</td>
<td>ND</td>
<td>3 pts, ND</td>
<td>CER (cardio-beeper) vs Holter, same patient group, max 6 wks</td>
<td>CER 62%, Holter 12%</td>
</tr>
<tr>
<td>Scalvini 2005</td>
<td>Prospective randomized 1:1; diagnostic yield</td>
<td>Palpitations, 41% cardiac pathology</td>
<td>Tertiary care n=110 24% males 52 yrs</td>
<td>no</td>
<td>ND</td>
<td>CER vs Holter at same time 7 days</td>
<td>CER 52%, Holter 48%</td>
</tr>
<tr>
<td>Kus 1995</td>
<td>Prospective cross over; diagnostic yield</td>
<td>Palpitations</td>
<td>Tertiary care n=100 34% males 55 yrs</td>
<td>ND</td>
<td>3 pts, technical reasons</td>
<td>First Holter than CER max 25 days</td>
<td>CER 21%, Holter 30%, Exclusion diagnoses CER 34% vs Holter 2%</td>
</tr>
<tr>
<td>Kinlay 1996</td>
<td>Prospective randomised, crossover; diagnostic yield</td>
<td>Palpitations</td>
<td>Out-pts n=43 12% males 45 yrs</td>
<td>NA</td>
<td>2 pts, non complianc</td>
<td>Post-event monitor (hand-held) vs 48-hr Holter 3months</td>
<td>CER 67%, Holter 30%*</td>
</tr>
<tr>
<td>Klootwijk 1986</td>
<td>Prospective cohort; diagnostic yield</td>
<td>Palpitations 24-hr Holter twice neg.</td>
<td>Out-pts n=100 ?? ??</td>
<td>NA</td>
<td>ND</td>
<td>First 2 * Holter, than CER (Hand-held) max 6 months</td>
<td>2* negative Holter, CER 48%,</td>
</tr>
<tr>
<td><strong>CER vs ECG</strong></td>
<td></td>
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<tr>
<td>Wu Jenny 1995</td>
<td>Retrospective; diagnostic yield, costs</td>
<td>Palpitations presyncope, syncope, dizziness</td>
<td>Out-pts n=91 94% males 64 yrs</td>
<td>NA</td>
<td>5 pts from TTM; 5 incomplete files</td>
<td>First Ambulatory ECG than CER 30 days</td>
<td>CER 37%, ECG 10%</td>
</tr>
<tr>
<td><strong>CER vs GP care</strong></td>
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</tr>
<tr>
<td>Hoefman 2005</td>
<td>Prospective; randomized 1:1; diagnostic yield</td>
<td>Palpitations and/or dizziness</td>
<td>General practice n=244 26% males 50 yrs</td>
<td>No blinding</td>
<td>1 pt, non compliance</td>
<td>CER/ usual care GP, 30 days</td>
<td>CER 67%, Usual care 27% Significant*</td>
</tr>
<tr>
<td>Roche 2002</td>
<td>Prospective; diagnostic yield</td>
<td>Palpitations and neg. 24-hr Holter. 40% cardio pathology</td>
<td>Out-pts n=65 69% males 63 yrs</td>
<td>NA</td>
<td>ND</td>
<td>R-Test evolution (RTE) manual and automatic triggered 77 hours</td>
<td>AT-CER 80%, pt-triggered 67%</td>
</tr>
</tbody>
</table>
### Table 3 (continued)

<table>
<thead>
<tr>
<th>Source</th>
<th>Study design aim</th>
<th>Inclusion criteria</th>
<th>Setting/mean age</th>
<th>Blinding observer</th>
<th>drop-out</th>
<th>Instrument/Registration time</th>
<th>Proportion patients with diagnoses*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CER vs AT-CER</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Martinez 2004</td>
<td>Prospective; diagnostic yield</td>
<td>Palpitations, dizzi, syncope, neg Holter 11% cardio pathology</td>
<td>Out-pts n=96 52% males 37yrs</td>
<td>NA</td>
<td>ND</td>
<td>R-Test evolution (RTE) manual and automatic triggered 5.2 days</td>
<td>CER-mode 22%, automatic recordings 17%</td>
</tr>
<tr>
<td>Balmelli 2003</td>
<td>Prospective; diagnostic yield</td>
<td>Palpitations, dizzi, syncope, 52% cardio pathology</td>
<td>Out-pts n=101 60% males 54 yrs</td>
<td>Cardio blinded for results</td>
<td>ND</td>
<td>R-Test evolution (RTE) manual and automatic triggered 7 days</td>
<td>Pt-triggered 37%, auto triggered 63%, additional diagnoses in a-symptomatic pts 61%</td>
</tr>
<tr>
<td>Reiffel 2005</td>
<td>Retrospective 1:1:1; diagnostic yield</td>
<td>Unknown Tertiary care n=1800 40% males</td>
<td>Tertiary care n=1800 40% males</td>
<td>NA</td>
<td>ND</td>
<td>HM/CER/AT-CER 30 days</td>
<td>AT-CER 71%, CER 27% HM 6%</td>
</tr>
<tr>
<td>Rothman 2007</td>
<td>Prospective randomized 1:1; diagnostic yield</td>
<td>Palpitations; cardio patholoy: MCOT 84%, CER 62%</td>
<td>Out-pts n=266 34% males, 56 yrs</td>
<td>Double blinded to history randomisation</td>
<td>MCOT 13 pts, CER 7 pts technical reasons, non-compliance</td>
<td>AT-CER (MCOT), CER 30 days</td>
<td>MCOT 41% CER 15%*</td>
</tr>
<tr>
<td>Olson 2007</td>
<td>Retrospective; palpitation n=76 syncope n=17, evaluation therapy n=19; diagnostic yield</td>
<td>Palpitations, (pre)syncope, therapy evaluation,33% cardio pathology</td>
<td>Out-pts n=122 43% males 58 yrs</td>
<td>NA</td>
<td>ND</td>
<td>MCOT, automatic mode patient-triggered mode Duration??</td>
<td>Palpitation group73% symptomatic diagnoses in 11% a-symptomatic diagnoses, previou diagnosed group 47%</td>
</tr>
</tbody>
</table>

| **CER vs ILR** |                                   |                                         |                  |                   |          | ILR (Reveal plus) automatic and Pt triggered 12 months | Auto-triggered 10%, pt-triggered 16%, inappropriate activation auto-triggered mode |
| Ng 2003        | Retrospective; diagnostic yield    | Palpitations, (pre)syncope              | Tertiary care n=50 44% males 54yrs | NA                | ND       | ILR (Reveal plus) automatic and Pt triggered 12 months | Auto-triggered 10%, pt-triggered 16%, inappropriate activation auto-triggered mode |
| Giada 2007     | Prospective randomized 1:1; diagnostic yield | Palpitations initial negative evaluation | Out-pts n=50 34% males 47yrs | No blinding       | ND       | Conventional group: Holter, CER, electrophys. vs ILR 12 months | conventional strategy group 21%, ILR 73%* |

* = \( p < 0.05 \)

NA = not applicable, ND = not described, GP = general practice, MCOT = mobile cardiac output telemetry, CER = continuous event recorder, ILR = implantable loop recorder, TTM = trans-telephonic monitoring, EP = electrophysiological testing, pts = patients
**AT-CER (R-test evolution) vs. patient-triggered mode of the AT-CER**

In three studies with 262 (range 65 to 101) patients, automatic triggered mode was compared to the patient-triggered mode of the device. In two of these studies, patients had a negative 24-hour Holter monitoring. All studies included selected patients with a history of pre-existent cardiac pathology. Registration time varied from 77 to 103 hours. With both modes of the device, in more than 80% of the patients (range 75%-88%) a diagnosis could be established. When compared to the patient-triggered mode, in all three studies the automatically triggered mode of the device found an additional amount of relevant diagnoses (range 11 to 17%).5,30,31

In a fourth larger study by Reifel et al32, with 1800 patients, the AT-CER was compared to the traditional CER and 24 hour Holter monitoring. Each group consisted of 600 patients. The patient group who used the AT-CER had a diagnostic yield of 71%, versus 27% with the patient triggered CER and 6% diagnosis with 24-hour Holter monitoring. Recording time of CER and AT-CER was one month.

**CER vs. AT-CER (by MCOT)**

In a randomised trial the diagnostic yield of CER versus AT-CER (by MCOT), was tested during 30 days in 266 patients. Previous Holter monitoring was non-diagnostic. With the Autotriggered mode, an arrhythmia was detected in 41% of the patients, compared with 15% in the CER group.33

**Diagnostic yield in automatic vs. patient-triggered mode using an MCOT-CER**

Olson et al.34 reviewed records of 122 patients, evaluated with an MCOT AT-CER. An arrhythmia was recorded in 73% of the patients with new onset palpitations. In 11% of the patients, an automatic registration of an asymptomatic arrhythmia occurred. In patients with previously diagnosed arrhythmias, an arrhythmia was documented in 47%. Documentation of these arrhythmias was automatically triggered in 63%, and 41% of the arrhythmias remained asymptomatic.

**Automatic implantable loop recording (ILR) versus patient-triggered recordings**

Ng et al.35 compared the diagnostic yield of patient-triggered vs. automatic activation mode of the ILR in 50 patients. Using patient-triggered mode, arrhythmias occurring simultaneously with symptoms were registered in 16% of the patients. No relevant arrhythmias were detected by auto-activation only. The effectiveness of auto-activation to detect arrhythmia was reduced due to a high rate of inappropriate activation (83%), due to under- and over-sensing of the device. Withdrawals were not described.
**ILR vs. conventional strategy**

Giada et al. studied 50 patients in whom initial cardiologic evaluation did not yield a diagnosis. The diagnostic yield of the ILR was randomly compared to conventional strategy (24-holter recording, a 4-week period of CER, and/or electrophysiological testing if the previous 2 strategies yielded negative results). A diagnosis was obtained in 5 patients (21%) of the conventional strategy group: two patients were diagnosed with a CER and 3 patients were diagnosed with electrophysiological studies. With the ILR, in 19 patients (73%) arrhythmias were documented within one year.

**DISCUSSION**

We searched for studies, evaluating the clinical utility of available technologies to diagnose palpitations and found six different groups of devices with different application characteristics. Twenty-eight studies were identified. Most of these studies described the yield of a specific device in a small group and of mostly highly selected patients. Therefore many of the studies are not very informative. Comparative studies provided more information, but most studies suffered from methodological shortcomings. Advise on which device to use for which problem or for which patient therefore is not straightforward and mainly based on the frequency of symptoms and the consideration of whether or not patients feel palpitations. When diagnosing palpitations and a standard ECG does not provide an explanation of the symptoms, Holter monitoring can be used when a patient has very frequent (daily) symptoms, an event-recorder (auto- or patient-triggered) can be used when a patient has weekly symptoms. In symptomatic patients patient-activated devices preferred above autotriggered devices as the relation between symptoms and ECG abnormalities is clear. Autotriggered devices may more often detect an abnormality of the rhythm, but as direct linkage to perceived symptoms is missing, these devices are less well capable of explaining symptomatic episodes, unless used in the patient-triggered mode. Besides, the patient triggering can be used to demonstrate that the rhythm is not abnormal during symptoms, thus providing reassurance to anxious patients (and to their physicians because of exclusion of relevant arrhythmias). When a patient cannot operate the device (co-morbidity, old age) an autotriggered recorder or MCOT can be used. A second reason for an auto triggered device is palpitation of an irregular pulse without the patient feeling any irregularity in case of possible PAF.

**Limitations**

Cardiac monitoring devices are described in the literature with different names. Although we tried to perform a maximal sensitive search strategy, some studies may have been
missed. Many of the identified studies are of weak methodology and comparison of the results of the studies is hazardous. The lack of true diagnostic studies is not just caused by weak methodology however, but also by the lack of an accepted reference standard. Obtaining a registration of a rhythm that shows abnormalities might be considered as a reference standard, but linking of such an abnormality to symptoms is not without uncertainties and sometimes even wrong.

CERs come in a variety of models. As the design of the devices may influence capability and readiness of recording arrhythmias, this may in part explain the observed differences in diagnostic yield.

CONCLUSION

Recent developments in ambulatory ECG recording offer the opportunity to diagnose most symptoms of palpitations, also in ambulant patients and in primary care. The choice of the device depends on frequency and character of the symptoms and is not evidence-based. Infrequent paroxysmal asymptomatic arrhythmias can best be documented using an AT-CER or an ILR for an extended period. In primary care patient-triggered event recording has the advantage of a direct link between arrhythmias and symptoms, which makes it possible to not only diagnose relevant arrhythmias, but also demonstrate harmless rhythm disturbances (as sinus tachycardia) as an explanation of symptoms to the patient. When asymptomatic episodes are suspected or patients are incapable to operate the device an auto-triggered device is preferred.

Future research should focus on comparison of different devices in homogenous patient-groups. The outcome should be reported in two ways: explained episodes and clinically relevant arrhythmia.
Efficacy of diagnostic tools for detecting cardiac arrhythmias

REFERENCES


