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Does This Patient With Palpitations Have a Cardiac Arrhythmia?

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Context Many patients have palpitations and seek advice from general practitioners. Differentiating benign causes from those resulting from clinically significant cardiac arrhythmia can be challenging and the clinical examination may aid in this process.

Objective To systematically review the accuracy of historical features, physical examination, and cardiac testing for the diagnosis of cardiac arrhythmia in patients with palpitations.

Data Source, Study Selection, and Data Extraction MEDLINE (1950 to August 25, 2009) and EMBASE (1947 to August 2009) searches of English-language articles that compared clinical features and diagnostic tests in patients with palpitations with a reference standard for cardiac arrhythmia. Of the 277 studies identified by the search strategy, 7 studies were used for accuracy analysis and 16 studies for diagnostic yield analysis. Two authors independently reviewed articles for study data and quality and a third author resolved disagreements.

Data Synthesis Most data were obtained from single studies with small sample sizes. A known history of cardiac disease (likelihood ratio [LR], 2.03; 95% confidence interval [CI], 1.33-3.11), having palpitations affected by sleeping (LR, 2.29; 95% CI, 1.33-3.94), or while the patient is at work (LR, 2.17; 95% CI, 1.19-3.96) slightly increase the likelihood of a cardiac arrhythmia. A known history of panic disorder (LR, 0.26; 95% CI, 0.07-1.01) or having palpitations lasting less than 5 minutes (LR, 0.38; 95% CI, 0.22-0.63) makes the diagnosis of cardiac arrhythmia slightly less likely. The presence of a regular rapid-pounding sensation in the neck (LR, 177; 95% CI, 25-1251) or visible neck pulsations (LR, 2.68; 95% CI, 1.25-5.78) in association with palpitations increases the likelihood of a specific type of arrhythmia (atrioventricular nodal reentry tachycardia). The absence of a regular rapid-pounding sensation in the neck makes detecting the same arrhythmia less likely (LR, 0.07; 95% CI, 0.03-0.19). No other features significantly alter the probability of clinically significant arrhythmia. Diagnostic tests for prolonged periods of electrocardiographic monitoring vary in their yield depending on the modality used, duration of monitoring, and occurrence of typical symptoms during monitoring. Loop monitors have the highest diagnostic yield (34%-84%) for identifying an arrhythmia.

Conclusions While the presence of a regular rapid-pounding sensation in the neck or visible neck pulsations associated with palpitations makes the diagnosis of atrioventricular nodal reentry tachycardia likely, the reviewed studies suggest that the clinical examination is not sufficiently accurate to exclude clinically significant arrhythmias in most patients. Thus, prolonged electrocardiographic monitoring with demonstration of symptom-rhythm correlation is required to make the diagnosis of a cardiac arrhythmia for most patients with recurrent palpitations.

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PALPITATIONS AND CARDIAC ARRHYTHMIA

Box. Differential Diagnosis of Palpitations

Arrhythmia

Defined as atrial fibrillation or flutter, atrioventricular node reentry tachycardia or atrioventricular reentry tachycardia, atrial tachycardia, ventricular tachycardia, premature ventricular contractions or premature atrial contractions, or multifocal atrial tachycardia. The causes are primary electrical abnormality or electrical abnormality secondary to structural cardiac disease or comorbid medical conditions.

Sinus tachycardia

The causes include hyperthyroidism, anxiety or panic disorder, fever, hypovolemia, stimulants (caffeine, alcohol), medications, blood loss, pheochromocytoma, hypoglycemia, and idiopathic.

Normal sinus rhythm

The cause is heightened cardiac perception for an unclear reason.

Because a minority of patients have palpitations while being examined by their physician, the challenge is to capture a recording of the cardiac rhythm during symptoms. While event monitors have been designed to facilitate this process, the diagnostic yield varies with the frequency of symptoms and duration of the monitored period. Arrhythmias also may occur in individuals who have no symptoms at all. Therefore, the presence of an arrhythmia on diagnostic testing does not confirm that it is the cause of a patient’s symptoms. To be certain, their symptoms must be correlated with an electrocardiographically documented rhythm disturbance. Similarly, if the patient repeatedly has a normal cardiac rate and rhythm during typical symptoms, one can reassure the patient that the cause is likely nonarrhythmic.

While palpitations are usually benign, they may be a manifestation of life-threatening conditions. More importantly, recurrent palpitations can be associated with significant disability, including impaired work performance and the inability to perform household duties. However, using diagnostic tests such as event monitors and echocardiograms for every person with palpitationscan be costly and of low diagnostic yield. Therefore, we reviewed the utility of clinical history, physical examination, and resting routine electrocardiography as screening tests for identifying patients with palpitations whose symptoms are likely or unlikely to be due to a cardiac arrhythmia.

HOW TO EVALUATE A PATIENT WITH PALPITATIONS

Patient History

Most demographic and historical features do not significantly influence the likelihood of clinically significant arrhythmias. Patient age may be important because supraventricular tachycardias, particularly ones that use a bypass tract (atrioventricular reentry tachycardia), may be first experienced earlier in life. In young athletes with palpitations, it is important to consider clinically significant arrhythmias associated with sudden cardiac death. Atrial fibrillation, flutter, atrial tachycardia, and ventricular tachycardia (eFigure 1A, B, I) tend to occur later in life and are often associated with structural heart disease. Some arrhythmias such as atrioventricular node reentry tachycardia (eFigure 1C) may be more common in women.

A history of panic disorder should be explored. The details of a family history of palpitations should be recorded, especially if family members have established diagnoses such as arrhythmogenic right ventricular cardiomyopathy or atrial fibrillation. Any history of previous cardiac disease may predispose patients to more clinically significant arrhythmias and suggest the need for a more aggressive search for a cardiac cause.

Patients should be asked to tap out the rhythm of their palpitations, or to choose from cadences tapped by the physician, to identify the regularity and speed of the palpitations. Single skipped beats or a sensation of the heart stopping and then starting with a pounding, flipping, or jumping sensation, especially while sitting quietly or lying in bed and lasting only for brief periods, have traditionally been attributed to premature atrial or ventricular extra systoles. An irregular heartbeat, both in rhythm and strength, that begins and terminates abruptly suggests atrial fibrillation.

The association of polyuria and palpitations may indicate supraventricular tachycardia because increased atrial pressures stimulate production of natriuretic peptides. A regular rapid-pounding sensation in the neck may signify atrioventricular node reentry tachycardia when the contraction of the atria against closed atrioventricular valves produces increased right atrial pressures and reflux of blood into the superior vena cava. Associated shirt flapping, defined as visible movement of patient’s clothes during the episode, also has been described with both atrioventricular node reentry tachycardia...
Palpitations and Cardiac Arrhythmia

Physical Examination

Most patients with episodic palpitations are examined when asymptomatic. Typically, the purpose of the physical examination in this setting is to identify structural heart abnormalities that may give rise to an arrhythmia. When a patient is examined while having palpitations or the examiner detects an asymptomatic arrhythmia, certain physical examination features may be useful. Atrial fibrillation is suggested by a pulse that is not regular and has no repeating pattern (ie, irregularly irregular), the presence of a pulse deficit (ie, obtaining a lower pulse rate at the wrist than at the apex), or the auscultation of variable first heart sound intensity. These findings are due to beat-to-beat variation in stroke volume that occurs during atrial fibrillation. The presence of cannon A waves on the jugular venous pressure suggests an arrhythmia associated with atrioventricular dissociation such as ventricular tachycardia. A cannon A wave is a prominent wave in the jugular venous pressure that occurs due to the contraction of the right atrium against a closed tricuspid valve.

Diagnostic Tests

Standard 12-lead electrocardiography is the initial test in patients with palpitations and may identify the arrhythmia or provide insight into underlying structural and electrical abnormality that may be a precipitant for arrhythmias. Patients with electrical or structural abnormalities on 12-lead electrocardiography may warrant a more aggressive search for a cardiac cause of palpitations.

The prototypical clinical event monitor is the Holter monitor that continuously or simultaneously records 2 or 3 electrocardiographic leads. At the end of the monitoring period (typically 24 or 48 hours), the data are analyzed for arrhythmias (Figure 1) and are correlated with symptoms recorded by the patient. The Holter monitor detects asymptomatic arrhythmias and may capture arrhythmias in patients who are unable to trigger the device (eg, during syncope). Frequently, patients may not experience their usual symptoms during monitoring and the test is nondiagnostic.

Intermittent event recorders can be worn continuously (loop recorders) or applied at the time of symptoms (event recorders). Traditionally, intermittent event recorders store electrocardiographic monitoring for several minutes once activated by the patient and hence cannot capture asymptomatic arrhythmias or those associated with loss of consciousness. Newer loop recorders provide continuous, real-time outpatient electrocardiographic monitoring and can automatically detect asymptomatic arrhythmias in addition to being activated by the patient. Intermittent event recorders allow for prolonged monitoring (weeks to months) in patients who have infrequent symptoms. These devices may have a higher specificity because the patient activates the recording during symptoms. Specifically, loop monitors save information for a predetermined period prior to the patient trigger, and hence, can help identify the initiation sequence for arrhythmias. These stored events can be transmitted through a telephone for physician review.

An electrophysiologic study is an invasive test of the electrical conduction system of the heart. Although often performed for diagnostic and therapeutic purposes in patients with a known arrhythmia or who have presented with syncope or resuscitated sudden cardiac death, it is occasionally performed as a diagnostic test in patients with palpitations in whom there is high suspicion for cardiac origin.

Exercise treadmill testing with a standard Bruce protocol may be useful in patients whose palpitations typically occur during exercise or are provoked by cardiac ischemia.

When palpitations occur infrequently or are associated with serious events such as syncope that cannot be identified using intermittent event recorders, implantable loop recorders (implanted under the skin in the left parasternal region) can record the patient’s electrocardiogram continuously for prolonged periods (several months to years). Patients keep a diary of their symptoms for symptom-arrhythmia correlation. The device can

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also be triggered with an external activator.

Echocardiography may identify structural heart diseases that may be a precipitant for arrhythmias. While the presence of structural heart disease increases the likelihood of a clinically significant arrhythmia and suggests the need for a more aggressive search for an arrhythmic substrate, it does not prove that the patient's palpitations are secondary to an arrhythmia.

**METHODS**

**Search Strategy and Data Collection**

Structured MEDLINE (1950 to August 25, 2009) and EMBASE (1947 to August 2009) literature searches were performed to identify English-language articles relevant to the precision or accuracy of the clinical examination for patients with palpitations. Search terms included palpitations, heart racing, heart pounding, physical examination, medical history taking, professional competence, “sensitivity and specificity,” reproducibility of results, observer variation, “diagnostic tests, routine,” decision support techniques, Bayes theorem, and mass screening. Two authors independently reviewed the abstracts of the search and retrieved potentially relevant articles and a third author resolved disagreements. Additional articles were identified by reviewing the reference lists of retrieved articles and expert suggestions.

Articles reporting original empirical studies evaluating historical features, physical examination, or diagnostic tests against a reference standard for the diagnosis of palpitations secondary to an arrhythmia were included. Acceptable reference standards included clinical event monitors, intermittent event recorders, implantable loop recorders, in-hospital telemetry, 12-lead electrocardiographic monitoring during symptoms, or electrophysiological study. Excluded studies (1) focused primarily on nonarrhythmic diagnoses in patients with palpitations; (2) enrolled patients with several presenting complaints but did not provide separate data for the subgroup with palpitations; (3) focused only on comparison between specific arrhythmias or used the presence of arrhythmias as opposed to palpitations as inclusion criteria; or (4) did not require symptom rhythm correlation for the diagnosis of arrhythmia. From the results of the same literature search, studies were identified providing data on the diagnostic yield of the various tests (eg, electrocardiography and loop monitoring).

The data extracted were the number of patients enrolled, symptoms, signs or tests assessed, the number of patients with and without arrhythmia for each clinical parameter, and the frequency of typical symptoms and clinically significant arrhythmias (when present). From this, the likelihood ratios (LRs) were calculated for the individual findings described, along with the 95% confidence intervals (CIs).

Where possible, the LRs were separately calculated for detecting any arrhythmias and clinically significant arrhythmias. An arrhythmia was defined as any rhythm with a heart rate of 60/min or less, or 100/min or greater, and/or that was not normal sinus rhythm. Clinically significant arrhythmias were those that likely require specific management including ventricular tachycardia, atrioventricular node reentry tachycardia, atrioventricular reentry tachycardia, atrial fibrillation, atrial flutter, atrial tachycardia, junctional tachycardia, or ventricular ectopic beats occurring in salvos.

The yield of the various diagnostic tests was calculated and defined as the number of patients who had any arrhythmia or clinically significant arrhythmia during monitoring. Whenever available, separate data were provided for the subgroup of patients who had their typical symptoms during the monitoring period.

Articles were graded for methodological quality using standard methods with a threshold of more than 100 patients distinguishing level 1 from level 2 studies.

**RESULTS**

Only 7 studies met inclusion criteria for the assessment of diagnostic accuracy (Table 1; eFigure 2 is a flow diagram illustrating the identification of articles and is available at http://www.jama.com). No study evaluated a combination of historical and physical examination features or the precision of any historical or physical examination feature. The reference standards in the included studies were electrophysiological study, 24-hour Holter monitoring, intermittent event recorders, and in 2 studies a combination of methods. Among studies that used loop recorders (both for diagnostic accuracy and yield data), only 1 study had the automatic trigger feature to record asymptomatic arrhythmias.

Only 2 of the 7 diagnostic accuracy studies distinguished clinically insignificant and significant arrhythmias, although only 1 allowed for the calculation of LRs for both types of rhythm disturbances. Other studies looked only at clinically significant arrhythmias or did not differentiate between the 2.

Seven studies examined the utility of the features on history for diagnosing an arrhythmia as the cause of palpitations (Table 2). Most of the data are obtained from studies with small sample sizes. Although several features increase the likelihood that a patient's palpitations were secondary to an arrhythmia, most have 95% CIs crossing unity and thus may not be clinically useful.

The only findings with an LR of 2.00 or greater for any arrhythmia were a history of cardiac disease (LR, 2.03; 95% CI, 1.33-3.11) and palpitations affected by sleeping (LR, 2.29; 95% CI, 1.33-3.94; which are presumably palpitations that are severe enough to wake...
patients up from sleep) or while the patient was at work (LR, 2.17; 95% CI, 1.19-3.96). Although description of palpitations as either regular (LR, 1.66; 95% CI, 1.20-2.29) or irregular (LR, 1.65; 95% CI, 1.22-2.22) had little value in the likelihood of cardiac arrhythmia, this information may be helpful in the right context because certain arrhythmias are typically regular while others are irregular.

The 2 factors with an LR of 0.50 or less for any arrhythmia were an underlying history of panic disorder (LR, 0.26; 95% CI, 0.07-1.01) and duration of palpitation less than 5 minutes (LR, 0.38; 95% CI, 0.22-0.63) (Table 2). However, these observations are based on single studies and the upper bound of the 95% CI for a history of panic disorder included 1.00.

The presence of an associated regular rapid-pounding sensation in the neck (LR, 177; 95% CI, 25-1251) increased the likelihood that the patient’s symptoms of palpitations are due to atrioventricular node reentry tachycardia.18 The absence of an associated regular rapid-pounding sensation in the neck significantly decreased the likelihood of atrioventricular node reentry tachycardia (LR, 0.07; 95% CI, 0.03-0.19). However, a second study11 found that neck fullness is not useful for distinguishing atrioventricular node reentry tachycardia from other arrhythmias (LR, 0.85; 95% CI, 0.44-1.64), but the presence of visible neck pulsations may be useful (LR, 2.68; 95% CI, 1.25-5.78). More recently, the description of palpitations in the neck in patients with documented narrow complex tachycardia was shown to distinguish atrioventricular node reentry tachycardia from atrioventricular reentry tachycardia with an LR of 2.41 (95% CI, 1.54-3.76).10

From the reviewed studies, no other features appear to be useful for ruling in or ruling out a clinically significant arrhythmia.

In these 7 studies,4-6,11,12,18,42 all patients included those who had no symptoms during the monitored period were included in the accuracy analysis. Only 1 study provided data on a subgroup of 81 patients who had their typical symptoms during the monitoring period.2 For these patients, the most useful feature for detecting an arrhythmia was the occurrence of palpitations at work (LR, 2.38; 95% CI, 1.03-5.50). Potentially useful features for detecting clinically significant arrhythmias include palpitations described as

regular (LR, 1.52; 95% CI, 1.04-2.24) or those that were affected by sleeping (LR, 1.83; 95% CI, 1.03-3.27).

Although no study specifically assessed the accuracy of the associated symptom of shirt flapping in patients with palpitations, 1 study19 found that in 326 patients with documented arrhythmias, the proportion of patients with atrioventricular node reentry tachycardia (58%) who reported shirt flapping was greater than that reported by patients with other arrhythmias such as atrioventricular reentry tachycardia (44%), ventricular tachycardia (32%), atrial flutter (17%), and atrial fibrillation (13%).

Based on a single study6 (Table 3), the presence of resting bradycardia (<60/min) during the examination increases the likelihood of a clinically significant arrhythmia (LR, 3.00; 95% CI, 1.27-7.08). No other physical examination findings, including the presence of murmurs, have been evaluated in patients presenting with palpitations.

No studies reported on the sensitivity and specificity of baseline 12-lead electrocardiographic abnormalities in predicting a cardiac arrhythmia as a cause of symptoms. Nevertheless, base-

### Table 1. Accuracy Studies Assessing Clinical Features for the Diagnosis of a Cardiac Arrhythmia in Patients With Palpitations

<table>
<thead>
<tr>
<th>Sourcea</th>
<th>No. of Patients</th>
<th>Patient Population</th>
<th>Reference Standard</th>
<th>Any Arrhythmia, No. (%)</th>
<th>Study Levelb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gürsoy et al,18 1992</td>
<td>244</td>
<td>Patients with palpitations referred for electrophysiological study</td>
<td>Electrophysiological study</td>
<td>NA</td>
<td>3</td>
</tr>
<tr>
<td>Barsky et al,4 1994</td>
<td>145</td>
<td>Patients referred for ambulatory monitoring due to palpitations</td>
<td>24-h Holter monitoring</td>
<td>28 (19)</td>
<td>3</td>
</tr>
<tr>
<td>Barsky et al,12 1994</td>
<td>131</td>
<td>Patients referred for ambulatory monitoring due to palpitations</td>
<td>24-h Holter monitoring</td>
<td>27 (21)</td>
<td>3</td>
</tr>
<tr>
<td>Weber and Kapoor,4 1996</td>
<td>190</td>
<td>Patients with palpitations at least once in the past 3 mo presenting to emergency department, general practitioner, or admitted to hospital</td>
<td>Electrocardiography, Holter monitoring, telemetry, loop monitoring, electrophysiological study</td>
<td>75 (39)</td>
<td>4</td>
</tr>
<tr>
<td>Summerton et al,5 2001</td>
<td>139</td>
<td>Patients with palpitations in past 3 mo presenting to general practitioner</td>
<td>Event recorder</td>
<td>42 (30)</td>
<td>1</td>
</tr>
<tr>
<td>Hoefman et al,6 2007</td>
<td>127</td>
<td>Patients with history of palpitations and/or light-headedness presenting to a general practitioner</td>
<td>Loop monitoring</td>
<td>83 (65)</td>
<td>1</td>
</tr>
<tr>
<td>Sakhuja et al,11 2009</td>
<td>239</td>
<td>Patients with palpitations referred for electrophysiological study, cardiovversion, or ablation</td>
<td>Electrophysiological study, telemetry, Holter monitoring, 12-lead electrocardiography</td>
<td>224 (94)</td>
<td>4</td>
</tr>
</tbody>
</table>

Abbreviation: NA, data not available.

aAll studies were of prospective cohort design.
bMethodologic quality of studies determined using standard methods with a threshold of more than 100 patients distinguishing level 1 from level 2 studies.41
line electrocardiography is typically performed prior to other diagnostic tests.39,43 A total of 16 studies4-6,12,34,37,42,44-52 provided diagnostic yield data (eTable 1 is available at http://www.jama.com). Diagnostic yield refers to the occurrence of a cardiac arrhythmia detected during the monitoring period in either all

### Table 2. Accuracy of Clinical Features for the Diagnosis of Arrhythmia

<table>
<thead>
<tr>
<th>Finding</th>
<th>Source</th>
<th>No./Total (%)</th>
<th>Likelihood Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic and historical features</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>Hoefman et al6</td>
<td>61/190 (32)</td>
<td>2.03 (1.33-3.11)</td>
</tr>
<tr>
<td></td>
<td>Weber and Kapoor4</td>
<td>74/190 (39)</td>
<td>1.73 (1.21-2.48)</td>
</tr>
<tr>
<td></td>
<td>Summerton et al6</td>
<td>46/139 (33)</td>
<td>1.63 (1.02-2.58)</td>
</tr>
<tr>
<td></td>
<td>Hoefman et al6</td>
<td>33/127 (26)</td>
<td>NA</td>
</tr>
<tr>
<td>Male sex</td>
<td>Weber and Kapoor4</td>
<td>71/190 (37)</td>
<td>2.03 (1.33-3.11)</td>
</tr>
<tr>
<td></td>
<td>Summerton et al6</td>
<td>46/139 (33)</td>
<td>1.63 (1.02-2.58)</td>
</tr>
<tr>
<td></td>
<td>Hoefman et al6</td>
<td>33/127 (26)</td>
<td>NA</td>
</tr>
<tr>
<td>Age &gt;60 y</td>
<td>Summerton et al6</td>
<td>33/139 (24)</td>
<td>1.70 (0.95-3.06)</td>
</tr>
<tr>
<td></td>
<td>Hoefman et al6</td>
<td>32/127 (26)</td>
<td>NA</td>
</tr>
<tr>
<td>Smoking (&gt;11 cigarettes/d)</td>
<td>Summerton et al6</td>
<td>16/133 (12)</td>
<td>0.78 (0.27-2.26)</td>
</tr>
<tr>
<td></td>
<td>Weber and Kapoor4</td>
<td>127/190 (67)</td>
<td>1.52 (1.25-1.85)</td>
</tr>
<tr>
<td>Anxiety disorder</td>
<td>Summerton et al6</td>
<td>46/133 (35)</td>
<td>0.98 (0.59-1.63)</td>
</tr>
<tr>
<td></td>
<td>Summerton et al6</td>
<td>29/133 (22)</td>
<td>0.86 (0.41-1.77)</td>
</tr>
<tr>
<td>Family history of palpitations</td>
<td>Summerton et al5</td>
<td>46/133 (35)</td>
<td>0.98 (0.59-1.63)</td>
</tr>
<tr>
<td></td>
<td>Summerton et al5</td>
<td>29/133 (22)</td>
<td>0.86 (0.41-1.77)</td>
</tr>
<tr>
<td>Alcohol use (&gt;10 drinks/wk)</td>
<td>Summerton et al6</td>
<td>21/130 (16)</td>
<td>0.76 (0.30-1.92)</td>
</tr>
<tr>
<td>Panic disorder</td>
<td>Barsky et al12</td>
<td>32/131 (24)</td>
<td>1.02 (0.38-2.79)</td>
</tr>
<tr>
<td>Any psychiatric disorder</td>
<td>Barsky et al12</td>
<td>36/145 (25)</td>
<td>NA</td>
</tr>
<tr>
<td>Description of palpitations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>Summerton et al6</td>
<td>67/139 (48)</td>
<td>1.66 (1.20-2.29)</td>
</tr>
<tr>
<td></td>
<td>Weber and Kapoor4</td>
<td>90/190 (47)</td>
<td>1.65 (1.22-2.22)</td>
</tr>
<tr>
<td>Irregular</td>
<td>Hoefman et al6</td>
<td>50/150 (33)</td>
<td>0.79 (0.46-1.36)</td>
</tr>
<tr>
<td>Duration &gt;5 min</td>
<td>Hoefman et al6</td>
<td>50/150 (33)</td>
<td>0.79 (0.46-1.36)</td>
</tr>
<tr>
<td></td>
<td>Weber and Kapoor4</td>
<td>127/190 (67)</td>
<td>1.52 (1.25-1.85)</td>
</tr>
<tr>
<td>Continuous symptoms</td>
<td>Summerton et al6</td>
<td>102/139 (73)</td>
<td>1.06 (0.86-1.30)</td>
</tr>
<tr>
<td>Heart rate &gt;100/min</td>
<td>Summerton et a6</td>
<td>71/139 (51)</td>
<td>0.91 (0.63-1.31)</td>
</tr>
<tr>
<td>Patient setting during palpitations or precipitating factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affected by sleeping</td>
<td>Summerton et al6</td>
<td>36/138 (26)</td>
<td>2.29 (1.33-3.94)</td>
</tr>
<tr>
<td>Occurring at work</td>
<td>Summerton et a6</td>
<td>31/136 (23)</td>
<td>2.17 (1.19-3.96)</td>
</tr>
<tr>
<td>Affected by caffeine</td>
<td>Summerton et a6</td>
<td>16/138 (12)</td>
<td>1.84 (0.74-4.61)</td>
</tr>
<tr>
<td>Occurring during holiday</td>
<td>Summerton et a6</td>
<td>20/137 (15)</td>
<td>1.56 (0.69-3.53)</td>
</tr>
<tr>
<td>Occurring during weekend</td>
<td>Summerton et a6</td>
<td>29/137 (21)</td>
<td>1.43 (0.74-2.76)</td>
</tr>
<tr>
<td>Affected by alcohol</td>
<td>Summerton et a6</td>
<td>16/137 (12)</td>
<td>1.38 (0.53-3.49)</td>
</tr>
<tr>
<td>While lying in bed</td>
<td>Summerton et a6</td>
<td>84/137 (61)</td>
<td>1.30 (1.01-1.68)</td>
</tr>
<tr>
<td>Affected by exercise</td>
<td>Summerton et a6</td>
<td>33/139 (24)</td>
<td>0.74 (0.36-1.50)</td>
</tr>
<tr>
<td>Affected by breathing</td>
<td>Summerton et a6</td>
<td>38/138 (28)</td>
<td>0.52 (0.25-1.08)</td>
</tr>
<tr>
<td>While resting</td>
<td>Hoefman et al6</td>
<td>71/122 (58)</td>
<td>1.02 (0.69-1.50)</td>
</tr>
<tr>
<td>Associated symptoms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular rapid-pounding sensation in neck</td>
<td>Gurusoy et a8</td>
<td>50/190 (26)</td>
<td>0.77 (25-1251)</td>
</tr>
<tr>
<td>Neck fullness</td>
<td>Sakhuja et al11</td>
<td>48/239 (20)</td>
<td>0.85 (0.44-1.64)</td>
</tr>
<tr>
<td>Visible neck pulsations</td>
<td>Sakhuja et a11</td>
<td>23/239 (10)</td>
<td>2.68 (1.25-5.78)</td>
</tr>
<tr>
<td>Dizzy spells</td>
<td>Summerton et a6</td>
<td>72/137 (53)</td>
<td>0.93 (0.65-1.33)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>Summerton et a6</td>
<td>34/137 (25)</td>
<td>0.81 (0.42-1.59)</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>Summerton et a6</td>
<td>17/139 (12)</td>
<td>0.31 (0.07-1.29)</td>
</tr>
<tr>
<td>Vasovagal symptoms (pale and/or sweaty)</td>
<td>Hoefman et a5</td>
<td>49/127 (59)</td>
<td>1.72 (1.12-2.65)</td>
</tr>
<tr>
<td>Presyncope</td>
<td>Hoefman et a5</td>
<td>72/127 (57)</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; NA, data not available or cannot be calculated.

*Includes clinically significant and nonsignificant arrhythmias (premature atrial or ventricular contractions and sinus tachycardia).
of the patients included in a study or only in the subgroup of patients who had symptoms during monitoring.

The diagnostic yield of 12-lead electrocardiography performed during symptoms ranged from 3% to 26% for any arrhythmias and 2% for clinically significant arrhythmias. The yield of the 24-hour Holter monitoring was 34% for any arrhythmia and ranged between 3% and 24% for clinically significant arrhythmias. One study used a 48-hour Holter monitor as a reference standard and had a diagnostic yield of 21% for any arrhythmia and 0% for clinically significant arrhythmias. The diagnostic yield for loop monitors ranged from 34% to 84% for any arrhythmia and from 8% to 36% for clinically significant arrhythmias. A 2-week loop recorder had a greater yield than a 1-week recorder, however, using it for 3 weeks had minimal or no additional yield. The use of loop recorders with an automatic trigger function for asymptomatic arrhythmias had a slightly higher yield for clinically significant arrhythmias. The yield for event recorders ranged from 30% to 60% for any arrhythmia and from 17% to 19% for a clinically significant arrhythmia (eTable 1). Among patients with typical symptoms during monitoring (eTable 2), the yield of intermittent event recorders was higher for any arrhythmia and for clinically significant arrhythmias. Based on 1 study, the yield of implantable loop recorders was 73% for clinically significant arrhythmias during a mean (SD) monitoring period of 279 (228) days.

LIMITATIONS OF PUBLISHED STUDIES

Only 7 studies provided data on diagnostic accuracy and only 2 of these were of high methodological quality (level 1). Many of the studies had small sample sizes and in some cases data from subgroups in single studies were relied on to evaluate the accuracy of clinical parameters. Therefore, caution should be taken in interpreting our results.

Our review focused on studies of patients presenting with palpitations rather than patients with conditions, such as hyperthyroidism, who had palpitations as part of their symptom complex. As such, our results are most relevant for patients without an obvious underlying medical problem or structural heart disease that might cause their palpitations. Also, the data does not provide information about the specific kind of arrhythmia experienced.

A significant proportion of the patients in the included studies did not have symptoms during the monitored period and only a few features have been evaluated in the 81 patients with symptoms during monitoring. Therefore, the majority of the LRs were calculated using all included patients rather than only those with symptoms during monitoring. Similarly, except in 3 studies (eTable 2), the yield data was extracted from studies in which some of the patients did not experience their symptoms during monitoring. Because some of these patients may actually have an arrhythmia, we could have underestimated the true yield of the diagnostic tests.

Finally, there are no published data evaluating combinations of features or the precision of the clinical examination. As a result, multiplying together individual LRs or applying them sequentially may substantially overestimate posttest probability.

SCENARIO RESOLUTION

The pretest probability of any cardiac arrhythmia in this patient based on a study that would have enrolled this patient is 40%. While the nonspecific description of symptoms as “heart racing” and the inability to tell the cadence of the rhythm are not helpful, the previous diagnosis of panic disorder (LR, 0.26) and the duration of less than 5 minutes (LR, 0.38) decreases the likelihood of any arrhythmia. The posttest probability of any arrhythmia based only on the patient’s previous history of panic disorder would be 15%. The absence of a regular rapid-pounding sensation in the neck decreases the likelihood of atrioventricular node reentry tachycardia (LR, 0.07).

While many physicians would not pursue further testing initially because of the relatively low posttest probability, it is essential to recognize that patients with panic disorders may also have clinically significant arrhythmias and it may be prudent to perform long-term electrocardiographic monitoring to rule out clinically significant arrhythmias before attributing the symptoms to panic disorder. Structural cardiac assessment could be deferred unless the patient has persistent palpitations, develops more alarming symptoms such as syncope, or a clinically significant arrhythmia is identified on electrocardiographic monitoring.

BOTTOM LINE

When evaluating patients with palpitations, the presence of underlying medical conditions should be carefully considered. In the emergency department, primary cardiac diagnoses are the most common reason for palpitations (43%), but anxiety or panic disorders are also frequent (31%).

Table 3. Accuracy of Physical Examination Features for the Diagnosis of Arrhythmias in the Study by Hoefman et al

<table>
<thead>
<tr>
<th>Physical Examination</th>
<th>No./Total (%)</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal heart rate &lt; 60/min or &gt; 100/min</td>
<td>17/127 (13)</td>
<td>3.00 (1.27-7.08)</td>
<td>0.78 (0.60-1.02)</td>
</tr>
<tr>
<td>Obesity</td>
<td>15/126 (12)</td>
<td>1.55 (0.54-4.44)</td>
<td>0.93 (0.77-1.13)</td>
</tr>
<tr>
<td>Hypertension on examination</td>
<td>42/127 (33)</td>
<td>1.01 (0.54-1.90)</td>
<td>1.00 (0.73-1.36)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; LR, likelihood ratio.

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A known history of cardiac disease (LR, 2.03; 95% CI, 1.33-3.11) and palpitations affected by sleeping (LR, 2.29; 95% CI, 1.33-3.94) or while at work (LR, 2.17; 95% CI, 1.19-3.96) slightly increase the likelihood of a cardiac arrhythmia while palpitations lasting less than 5 minutes (LR, 0.38; 95% CI, 0.22-0.63) and a known history of panic disorder make the diagnosis less likely (LR, 0.26; 95% CI, 0.07-1.01). The presence of a regular rapid-pounding sensation in the neck as opposed to neck fullness in association with palpitations increases the likelihood that the patient has atrioventricular node reentry tachycardia (LR, 177; 95% CI, 25-1251), whereas its absence makes atrioventricular node reentry tachycardia less likely (LR, 0.07; 95% CI, 0.03-0.19). The presence of visible neck pulsations also increases the likelihood of atrioventricular node reentry tachycardia (LR, 2.68; 95% CI, 1.25-5.78).

Because of the limitations of the literature and the consequences of missing an important rhythm disturbance, no clinical examination features appear to be sufficiently accurate to exclude other clinically significant arrhythmias, especially in high-risk patients. Therefore, when a clinically significant arrhythmia is suspected, further testing including evaluating cardiac structure with transthoracic echocardiography and attempting to establish symptom-rhythm correlation with prolonged electrocardiographic monitoring should be undertaken. The selection of the monitoring type depends on the frequency of the symptoms. If the symptoms occur daily, a Holter monitor may be of reasonable importance of accurate diary recording. If symptoms occur more infrequently, an intermittent event recorder such as a loop monitor is a more appropriate test.

Author Contributions: Dr Thavendiranathan had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Thavendiranathan, Bagai, Khoo, Dorian, Choudhry. Analysis and interpretation of data: Thavendiranathan, Bagai, Dorian, Choudhry. Drafting of the manuscript: Thavendiranathan, Bagai, Dorian, Choudhry. Critical revision of the manuscript for important intellectual content: Thavendiranathan, Bagai, Khoo, Dorian, Choudhry. Administrative, technical, or material support: Thavendiranathan, Khoo, Dorian, Choudhry. Study supervision: Dorian, Choudhry.

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Additional Information: eTable 1 and eTable 2 and eFigure 1 and eFigure 2 are available at http://www.jama.com.

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REFERENCES

26. Ray WA, Murray KT, Meredith S, Narasimhul...


