Limited Clinical Utility of Holter Monitoring in Patients with Palpitations or Altered Consciousness: Analysis of 8973 Recordings in 7394 Patients

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Aims: To determine the clinical utility of 24 hour Holter monitoring by measuring the frequency of candidate arrhythmias recorded during the investigation of palpitations and altered consciousness.

Methods: Of 9,729 Holter recordings, reports were available in 8,973 (92.2%) performed in the 7394 patients who comprise the study group. The mean age of the study group was 66 ± 19 years and 56.4% were women.

Results: The most common indications were altered consciousness (41.7%) and palpitations (36.2%). Among patients with palpitations and sinus rhythm ($n=2688$), recordings were normal in 2247 (83.6%). Abnormalities included paroxysmal atrial fibrillation (PAF, 6.6%), narrow complex tachycardia (NCT, 2.8%) nonsustained or sustained ventricular tachycardia (NSVT/VT, 2.6%). Among patients with altered consciousness ($n=3075$), recordings were normal in 2589 (84.2%). Abnormalities included PAF (9.5%), NCT (2.6%), NSV/VT (0.2%), pause $>2.8s$ (2.2%) and high degree AV block (1.3%). The diagnostic yield of Holter monitoring was particularly low in patients aged ≤ 50 years, of whom 93.1% had palpitations and 95.3% had altered consciousness had normal recordings.

Conclusions: The diagnostic utility of Holter monitoring in patients being investigated for palpitations and altered consciousness is very limited, particularly in young patients for whom alternative diagnostic methods should be considered.

A.N.E. 2008;13(1):39–43

ambulatory electrocardiography; Holter monitoring; palpitations; syncope; diagnostic utility

INTRODUCTION

Twenty-four-hour Holter monitoring is widely used to investigate patients with palpitations, dizziness, and syncope. These symptoms are frequently benign and self limiting, with noncardiac causes accounting for more than one-third of cases.¹ However, they may also be caused by important abnormalities of cardiac rhythm or conduction that warrant specific treatment to correct symptoms and, occasionally, to improve prognosis. The intermittent nature of these abnormalities is diagnostically challenging and inevitably constrains the usefulness of the 24-hour snapshot provided by Holter monitoring. There have been few large studies in which the diagnostic yield of Holter monitoring in clinical practice has been documented² and despite

considerable consumption of manpower and financial resources, it remains the first-line investigation in many cardiac centers for evaluating palpitations and altered consciousness. In this study we have examined the clinical usefulness of 24-hour Holter monitoring by interrogating the largest clinical database yet reported in order to determine the frequency of candidate arrhythmias in patients being investigated for palpitations and episodes of altered consciousness.

METHODS

Study Population

Consecutive patients referred for Holter monitoring in a district general hospital during the period

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1992 to 2005 were studied. Clinical details including demographics, symptoms, indication, and results were recorded prospectively in a purpose built electronic database. No patients were excluded. The study complies with the declaration of Helsinki and the local research ethics committee has confirmed that this study does not require a formal review by the committee.

Holter Monitoring

Baseline 12-lead electrocardiograms (ECGs) were recorded in all patients. Twenty-four-hour Holter monitoring utilized two-channel tape recorders (Tracker 2, Reynolds Medical Limited, Hertford, UK) in the period up to 1998 and three-channel Aria digital recorders (Delmar Medical Systems, Irvine, CA) after 1998. Data were analyzed by a cardiac physiologist using dedicated systems (Delmar Avionics Model 363 Accuplus Holter analysis system; Delmar Medical Systems) and results were confirmed and reported by a cardiologist.

Paroxysmal atrial fibrillation (PAF) was defined as an irregular rhythm without P-wave activity sustained for ≥ 10 beats. Narrow complex tachycardia (NCT) was defined as a regular narrow complex rhythm > 100 bpm. Nonsustained ventricular tachycardia (NSVT) was defined as a broad complex tachycardia sustained for ≥ 5 beats. If sustained for ≥ 30 seconds, the arrhythmia was termed as sustained ventricular tachycardia (VT). A significant pause was defined by an RR interval of ≥ 2.8 seconds. High-grade atrioventricular (AV) block was defined as Mobitz type II block or third-degree heart block. Frequent ectopy was defined as $> 15/1000$ atrial or ventricular ectopic beats.

Data Analysis

Most demographic and clinical data were entered from drop down menus, but clinical indications for Holter monitoring and cardiologists' reports were in descriptive format. The data were exported for interrogation with multiple queries. Structured queries identified diagnoses and candidate arrhythmias from the descriptive text. All possible word combinations and abbreviations were included in the queries, and spelling errors were also accounted for. Wherever possible, wild card characters were used to ensure that all relevant information was captured. Altered consciousness was defined as dizzy attacks, presyncope, syncope, or

unexplained falls. When more than one candidate arrhythmia was recorded, only the most important was counted, prioritized as follows: VT $>$ NSVT $>$ NCT $>$ PAF $>$ frequent ectopics (palpitations) and VT/NSVT $>$ high-degree AV block $>$ pause longer than 2.8 seconds $>$ NCT $>$ PAF (altered consciousness). In none of our patients did VT and high-degree AV block occur during the same recording. Analysis of Holter monitoring for palpitations was confined to patients in sinus rhythm at baseline.

Statistical Analysis

The frequency of abnormalities in different age groups was compared by the chi-square test.

RESULTS

Clinical Characteristics

Of 9729 Holter recordings during the 13-year study period, reports were available in 8973 (92.2%) performed in the 7394 patients who comprise the study group (Fig. 1). The mean age of the study group was 66 ± 19 years and 56.4% were women. The most common indications for Holter monitoring were investigation of altered consciousness in 3738 recordings (41.7%) and palpitations in 3245 recordings (36.2%). Other indications included monitoring of arrhythmia treatment ($n = 648$, 7.2%) and pacemaker function ($n = 156$, 1.7%), screening for arrhythmias in acute myocardial infarction ($n = 97$, 1.1%), and hypertrophic cardiomyopathy ($n = 54$, 0.6%).

Holter Monitoring for Palpitations

Around 2688 patients in sinus rhythm at baseline underwent 3066 Holter recordings for investigation of palpitations. Of these, 2247 (83.6%) of initial recordings were normal (Table 1). Frequent ectopy was reported in 119 patients (4.4%), PAF in 177 patients (6.6%), and other atrial and ventricular arrhythmias in 145 patients (5.4%). In 276 patients (2.8%), a second Holter was performed and doubled the yield of candidate arrhythmias in this small subgroup.

Analysis by age (Table 2) showed that Holter recordings were normal in $> 90\%$ of patients aged ≤ 50 . The frequency of abnormal recordings increased in older age groups due largely to an increase in the frequency of PAF, which was recorded in 15% of patients aged > 70 years.

Figure 1. Study cohort.

Holter Monitoring for Altered Consciousness

Around 3314 patients underwent 4003 Holter recordings for investigation of altered consciousness. Reports were available for 3738 (93.4%) recordings. Of 3075 initial recordings, 2589 (84.2%)

were normal (Table 3). Paroxysmal atrial fibrillation was reported in 292 (9.5%) patients. Other candidate tachy- and brady-arrhythmias potentially causative of altered consciousness were reported in a total of 2.8% and 3.5% of cases, respectively. Among the 447 (14.5%) patients in whom a second Holter recording was performed, additional

Table 1. Holter Results in Patients Investigated for Palpitations

	Normal	Frequent Ectopics (>15/1000 beats)	Paroxysmal Atrial Fibrillation	Narrow Complex Tachycardia	Ventricular Tachycardia
1st recording (n = 2688)	2247 (83.6%)	119 (4.4%)	177 (6.6%)	76 (2.8%)	69 (2.6%)
2nd recording (n = 276)	210 (76.1%)	15 (5.4%)	34 (12.3%)	8 (2.9%)	9 (3.3%)

Table 2. Holter Results in Patients Investigated for Palpitations: Stratification by Age

Age (years)	Normal	Frequent Ectopics (>15/1000)	Paroxysmal Atrial Fibrillation	Narrow Complex Tachycardia	Ventricular Tachycardia
≤30 (n = 305)	280 (91.8 %)	5 (1.6 %)	4 (1.3 %)	12 (3.9%)	4 (1.3%)
30–40 (n = 430)	399 (92.8 %)	11 (2.6 %)	7 (1.6 %)	7 (1.6%)	6 (1.4%)
41–50 (n = 462)	427 (92.4%)	11 (2.4%)	9 (2.1%)	9 (2.1%)	6 (1.3%)
51–60 (n = 520)	442 (85%)	22 (4.2 %)	29 (5.6%)	12 (2.3%)	15 (2.9 %)
61–70 (n = 492)	380 (77.2%)	26 (5.3 %)	53 (10.8 %)	16 (3.3%)	17 (3.5%)
>70 (n = 767)	546 (71.2 %)	54 (7%)	115 (15%)	22 (2.9%)	30 (3.9%)
P value	<0.0001	<0.001	<0.0001	<0.01	NS

Age-related data not available for 90 patients (2.9%).

candidate arrhythmias or conduction defects were detected in a similar proportion of cases to the first recording (Table 3).

Analysis by age (Table 4) showed that Holter recordings were normal in >90% of patients aged ≤60. The frequency of abnormal recordings increased in older age groups due largely to an increase in the frequency of PAF, which was recorded in 13.0% of patients aged >70 years. The frequency of other candidate tachy- and brady-arrhythmias potentially causative of altered consciousness was very low in all age groups.

DISCUSSION

This study of Holter monitoring in 7394 patients has confirmed a low diagnostic yield among patients with palpitations or altered consciousness, with candidate arrhythmias or conduction defects recorded in <20% of all patients, and <10% of patients aged under 50. The data show that the clinical usefulness of Holter monitoring is limited, particularly in young patients for whom alternative diagnostic methods should be considered for the investigation of these symptoms.

In patients referred for 24-hour Holter monitoring, symptoms often occur at intervals of weeks or even months, which severely limit the chances of capturing culprit arrhythmias. Thus, among our

patients who were investigated for palpitations, arrhythmias were identified in only 16.5% of cases, falling to 12% with the exclusion of frequent ectopy for which there are rarely any therapeutic or prognostic implications. Diagnostic yield was particularly low in patients aged under 50 years, representing 42% of those investigated for palpitations, in whom potentially important atrial and ventricular tachyarrhythmias were recorded in less than 2% and 1%, respectively, of all cases. Repeat investigation, performed in only a small subgroup of patients, doubled the diagnostic yield, presumably because symptoms convincing for an arrhythmia precipitated their further investigation.

In patients investigated for episodes of altered consciousness the age gradient was much steeper, and only 16% were younger than 50. Again, in this younger age group abnormal findings were very infrequent, potentially important tachy- or brady-arrhythmias being recorded in less than 2% of patients. A majority of investigated patients were older but only in those >60 years did the diagnostic yield increase principally due to a sharp increase in the frequency of atrial fibrillation. In all age-groups, including the very elderly, life-threatening rhythm disturbance—high-grade atrioventricular block and ventricular tachycardia—was rare occurring in less than 1% of all patients.

Table 3. Results of Holter Monitoring in Patients Investigated for Altered Consciousness

	Normal	Paroxysmal AF	NCT	Pause >2.8 s	High grade AV Block	Ventricular Tachycardia
1st recording (n = 3075)	2589 (84.2%)	292 (9.5%)	81 (2.6%)	68 (2.2%)	39 (1.3%)	6 (0.2%)
2nd recording (n = 447)	365 (81.7%)	55 (12.3%)	6 (1.3%)	14 (3.1%)	7 (1.6%)	0 (0%)

AF = atrial fibrillation; NCT = narrow complex tachycardia; AV = atrioventricular.

Table 4. Results of Holter Monitoring in Patients Investigated for Altered Consciousness: Stratification by Age

Age (years)	Normal	Paroxysmal AF	NCT	Pause >2.8 s	High-Grade AV Block	Ventricular Tachycardia
≤30 (n = 157)	149 (94.9%)	0	4 (2.5 %)	2 (1.3 %)	2 (1.3 %)	0
31–40 (n = 164)	155 (94.5 %)	1 (0.6%)	3 (1.8%)	1 (0.6 %)	3 (1.8%)	1 (0.6%)
41–50 (n = 199)	188 (94.5%)	8 (4%)	2 (1%)	0	1 (0.5%)	0
51–60 (n = 300)	274 (91.3%)	16 (5.3%)	3 (1%)	4 (1.3%)	3 (1%)	0
61–70 (n = 503)	436 (86.7%)	34 (6.8%)	17 (3.4%)	14 (2.8%)	2 (1.4%)	0
>70 (n = 2312)	1839 (79.5%)	308 (13.3%)	59 (2.6%)	67 (2.9%)	34 (1.5%)	5 (0.2%)
p Value	<0.0001	<0.0001	NS	<0.001	<0.05	NS

AF = atrial fibrillation; NCT = narrow complex tachycardia; AV = atrioventricular.
Age-related data not available for 103 patients (2.8%).

Paroxysmal atrial fibrillation was the most frequently recorded arrhythmia in all patients, whether being investigated for palpitations or altered consciousness. Its frequency increased steeply with age with important therapeutic implications. This provides the clearest justification for 24-hour Holter monitoring in older patients with palpitations or altered consciousness. But, for patients aged under 50 years, our data provide little evidence of diagnostic effectiveness. In this group, patient-activated devices are likely to provide a more reliable diagnostic tool in the minority who cannot be reassured on the basis of a simple history.

The main strength of this study is its large size and its setting within secondary care where a majority of patients with palpitations and altered consciousness are treated in clinical practice. Although the data show that candidate arrhythmias are recorded infrequently, it is a limitation of our study that we do not know the relation between the arrhythmias and the patients' symptoms. The arrhythmia frequency we report, therefore, will tend to exaggerate the diagnostic yield of Holter monitoring, lending further weight to our conclusion of limited clinical usefulness.

Should 24-hour Holter monitoring remain a first-line investigation for patients with palpitations or altered consciousness? Our study shows that it should not and based on the findings of other investigators^{3–6} our recommendation is for patient-activated devices in most patients with troublesome

palpitations and implantable devices for those patients in whom there is reasonable clinical suspicion of a serious cardiac arrhythmia or conduction defect as the cause of altered consciousness. Nevertheless, there remains a role for Holter monitoring in patients with daily symptoms and in patients who have difficulty using patient-activated devices, particularly the elderly in whom atrial fibrillation is relatively common and diagnostic yield higher. But in patients aged less than 50 years with palpitations or altered consciousness, the diagnostic yield of 24-hour Holter monitoring is very low and clinical usefulness negligible in the majority of cases.

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