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Long-term ECG recording: findings and implications

ORIGINAL ARTICLE

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BACKGROUND

Long-term ECG recording is a commonly used test. However, there are no clear guidelines on who should be examined using this method, and we lack an overview of the results of testing and their therapeutic implications.

MATERIAL AND METHOD

All long-term ECG recordings performed at Sørlandet Hospital Arendal in the period 2017–18 were included in the study. The tests were identified by searching the medical records system for relevant procedure codes, and all medical records related to the test were subsequently reviewed. Patient characteristics, referrer, indication, results, further assessment, and treatment were recorded.

RESULTS

A total of 1 262 long-term ECG recordings were performed at Sørlandet Hospital Arendal in the period 2017–18. The median age of those tested was 60 years, and 48 % of tests were performed in women. A total of 253 (20 %)

recordings revealed arrhythmias and 168 (13 %) had therapeutic implications. For patients without known heart disease or a history of stroke (n = 619 (49 %)), the test had therapeutic implications in 32 (5 %) cases.

INTERPRETATION

Long-term ECG recording was often used to test patient populations with limited cardiac arrhythmia, and the results rarely had therapeutic implications. The findings of the study may indicate that long-term ECG recording should be used to a greater extent in patients for whom positive findings would have therapeutic and prognostic implications, such as those in whom stroke prophylaxis would be indicated if they were found to have atrial fibrillation.

Main points

At Sørlandet Hospital Arendal in 2017–18, 48 % of long-term ECG recordings were performed after referral from a general practitioner or Accident and Emergency department.

'Palpitations' were the most frequent reason for referral and led to 36 % of all tests – no patients were tested as part of a primary prevention strategy to detect unrecognised atrial fibrillation.

In total, 49 % of tests were performed in patients without known heart disease or previous stroke, and in this group the results had therapeutic implications in 5 % of cases.

The first recordings of the heart's electrical impulses were described in the 1870s. Willem Einthoven, with his string galvanometer, played a key part in the development of electrocardiography (ECG), and in 1924 he received the Nobel Prize in Medicine for his work (1). An ECG recording provides a snapshot of the heart's electrical signals, but disorders of the cardiac electrical system may occur intermittently. In the 1950s, Norwegian-American Norman Jefferis Holter developed equipment for long-term ECG recording, and the test is still referred to today as 'Holter monitoring' (2). There are now several different systems available for continuous recording: recording of automatically detected arrhythmias (e.g. the R-test) and recording initiated by the user (e.g. the thumb ECG). The duration of use is typically 1–3 days for continuous recording and longer for intermittent recording. Common to all systems is that they are mainly used in hospital cardiology outpatient clinics or private cardiology practices, and the data must be read out retrospectively using specialised software.

A total of 65 349 long-term ECG recordings (procedure codes FPFE15 and FPFE30) were registered in the Norwegian Patient Registry in 2018 (3), which corresponds to approximately 1 200 tests per 100 000 population. The number of procedures has increased by almost 70 % since 2010 (n = 38 528). The reasons for this are unknown.

There are no consensus guidelines in either Europe or Norway on which patients should be referred for long-term ECG recording. Little is known as to which patient groups are referred for testing, the findings, and whether the results have therapeutic implications for those tested.

In this study, we examined which patients underwent long-term ECG recording at Sørlandet Hospital Arendal in the period 2017–18, and evaluated the results and therapeutic implications of testing.

Material and method

All long-term ECG recordings (Holter and R-tests) at Sørlandet Hospital Arendal from 1 January 2017 up to and including 31 December 2018 were included in the study.

The tests were identified by searching the hospital's electronic medical records system for the procedure codes for long-term ECG recording (FPFE15 and FPFE30). All medical records related to the tests were reviewed retrospectively, and information on the patients' age, sex, cardiovascular disease history, referring doctor/department, test findings, further investigation due to these findings, and direct therapeutic implications of the findings were recorded in a local electronic study register. The recording itself was not re-evaluated, and information on the subsequent patient course was not recorded.

Continuous variables are presented as median (interquartile range), and categorical variables as number (percentage). Between-group differences were analysed using a chi-squared test or non-parametric tests. P-values <0.05 were considered statistically significant. Data were analysed with the statistical software Stata (version 15).

The study is considered a quality assurance project exempt from the requirement for approval by the Regional Committee for Medical and Health Research Ethics (REC). Data collection and the handling of personal data were approved by the Norwegian Centre for Research Data (NSD).

Results

In the period from 1 January 2017 to 31 December 2018, a total of 1 262 long-term ECG recordings were performed at Sørlandet Hospital Arendal. In addition, approximately 600 tests were performed annually in a private specialist practice in the same hospital catchment area (personal communication). In total, this corresponds to approximately 1 000 tests per 100 000 inhabitants per year in Aust-Agder county (approximately 117 000 inhabitants in 2018).

A total of 606 (48 %) tests were performed in women, the median age of those tested was 60 years (interquartile range 46–71), and in 643 (51 %) cases the patient had a known history of heart disease or stroke (Table 1). Among those

tested, the median age was lower (52 years versus 67 years, p <0.001) and the proportion of women was higher (60 % versus 36 %, p <0.001) in those with no known history of heart disease or stroke compared to those with such a history.

Table 1

Known history of heart disease or stroke in patients who underwent long-term ECG recording at Sørlandet Hospital Arendal in 2017–18 (n = 1 262).

Previous disease or intervention	n (%)	
Cardiac arrhythmia	432	(34 %)
Chronic atrial fibrillation	42	(3 %)
Paroxysmal atrial fibrillation	244	(19 %)
Atrial flutter	31	(2 %)
Supraventricular tachycardia	43	(3 %)
Non-sustained ventricular tachycardia	19	(2 %)
Ventricular tachycardia	9	(1 %)
Atrioventricular block	16	(1 %)
Pacemaker	5	(0 %)
Other	23	(2 %)
Coronary artery disease	272	(22 %)
Myocardial infarction	98	(8 %)
Percutaneous coronary intervention	134	(11 %)
Coronary artery bypass surgery	40	(3 %)
Cardiomyopathy	59	(5 %)
Stroke	84	(7 %)

A total of 612 (48 %) tests were performed as a result of referral by a general practitioner or Accident and Emergency department, 403 (32 %) after referral by doctors in the cardiology department, 117 (9 %) after referral from the neurology department and 130 (10 %) after referral from other hospital departments.

'Palpitations' were the most common indication for long-term ECG recording in referrals from a general practitioner or Accident and Emergency department (369 of 612 tests, 60 %), whereas the most common reason for referral from the cardiology department was to monitor the management and assessment of known arrhythmia (251 of 403 examinations, 62 %). Dizziness was the indication for testing in 79 (6 %) cases and syncope in 121 (10 %) cases. A total of 84 (7 %) tests were performed to investigate whether cardiac arrhythmia might have caused cerebral embolism; all of these patients had been discharged

from inpatient stays in the neurology department due to stroke. Increased risk of stroke was not the explicit reason for testing any other patients for arrhythmia.

A total of 253 (20 %) of the long-term ECG recordings showed arrhythmias (Table 2), including 155 (61 %) cases of atrial fibrillation or flutter. As expected, arrhythmias were more frequent in patients with known heart disease or a history of stroke than in patients without these (Table 2). Tests performed as a result of stroke revealed atrial fibrillation or flutter in 10 out of 84 (12 %) cases, 9 (90 %) of which were previously unrecognised. In patients referred because of dizziness (n = 79) or syncope (n = 121), treatment-requiring sinoatrial or atrioventricular block was detected in <5 (<5 %) and 7 (6 %) tests, respectively. Serious ventricular arrhythmia was recorded in <5 cases in total.

Table 2

Long-term ECG recording at Sørlandet Hospital Arendal in 2017–18 (n = 1 262): findings and therapeutic implications.

	No known history of heart disease or stroke (n = 619)		**History of heart disease or stroke (n = 643)**	
Cardiac arrhythmias	39	(6 %)	214	(33 %)
Chronic atrial fibrillation	< 5	(< 1 %)	64[1]	(10 %)
Paroxysmal atrial fibrillation	5	(1 %)	62	(10 %)
Atrial flutter	< 5	(< 1 %)	21	(3 %)
Supraventricular tachycardia ≥ 5 min	< 5	(< 1 %)	10	(2 %)
Ventricular tachycardia	< 5	(< 1 %)	0	(0 %)
Non-sustained ventricular tachycardia	9	(1 %)	18	(3 %)
Sinoatrial block	6	(1 %)	10	(2 %)
Atrioventricular block, 2nd or 3rd degree	8	(1 %)	16	(2 %)
Other arrhythmias	< 5	(< 1 %)	13	(2 %)
Further testing	50	(8 %)	85	(13 %)
New long-term ECG recording	20	(3 %)	33	(5 %)
Echocardiography	< 5	(< 1 %)	12	(2 %)
Stress test and echocardiography	19	(3 %)	19	(3 %)
Electrophysiological assessment	< 5	(< 1 %)	15	(2 %)
Other assessment	< 5	(< 1 %)	6	(1 %)
New or altered treatment	32	(5 %)	136	(21 %)
New medication	22	(4 %)	35	(5 %)
Change of medication	0	(0 %)	61	(11 %)

	No known history of heart disease or stroke (n = 619)		History of heart disease or stroke (n = 643)	
Pacemaker implantation	5	(1 %)	12	(2 %)
Implantable cardioverter defibrillator (ICD) implantation	0	(0 %)	< 5	(< 1 %)
Cardiac ablation	< 5	(< 1 %)	13	(2 %)
Other	< 5	(< 1 %)	11	(2 %)

[1] Including 22 (34 %) cases of newly discovered chronic atrial fibrillation.

Discussion

This study of long-term ECG recording practice at Sørlandet Hospital Arendal in the period 2017–18 showed that approximately half of patients tested were referred by a general practitioner or Accident and Emergency department and half by the specialist health service. The occurrence of 'palpitations' was the most frequent indication for testing (36 %). In patients with and without a history of heart disease or stroke, arrhythmias were recorded in 33 % and 6 % of tests, respectively, and testing led to new or altered treatment in 21 % and 5 % of cases, respectively (Figure 1).

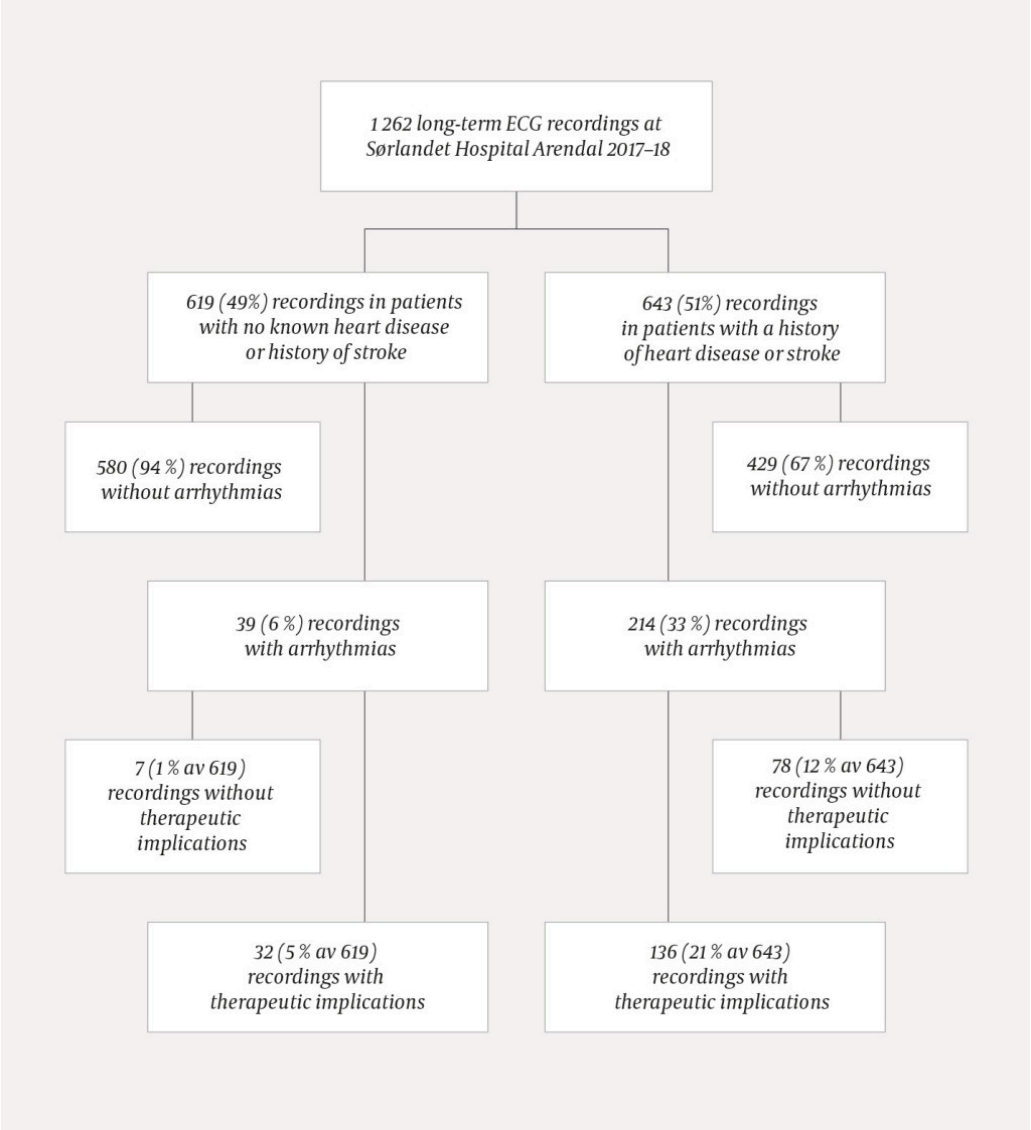

Figure 1 Long-term ECG recordings in patients with and without a known history of heart disease or stroke at Sørlandet Hospital Arendal 2017–18.

We have been unable to find any similar studies, and it is therefore difficult to compare practice at our hospital with practice elsewhere. Figures from the Norwegian Patient Registry indicate a marked increase in the use of long-term ECG in Norway in recent years (3). The number of such tests in our county (Aust-Agder, about 1 000 tests per 100 000 inhabitants per year) was somewhat lower than the Norwegian national average in 2018 (about 1 200 tests per 100 000 inhabitants per year). There is no overview available of geographical differences in testing rates across Norway, but use of the test is assumed to vary with factors including age composition, geography and local provision of medical services.

Performing and analysing long-term ECG recordings involves a considerable amount of work for cardiology departments, and we therefore call for clearer guidelines on who should be referred for such testing.

More than a third of all tests were performed in patients under the age of 65 with no history of heart disease or stroke. The majority of these tests (67 %) were performed after referral from a general practitioner or Accident and Emergency department, but few (3 %) had any therapeutic implications. The most common reason for referral in this group was 'palpitations' (53 %). This is

a poorly defined term that probably encompasses a wide range of symptoms. Although 'palpitations' were found to predict atrial fibrillation later in life in the Tromsø study, detecting paroxysmal atrial fibrillation in otherwise healthy patients under the age of 65 has little prognostic significance (4, 5). We therefore believe there is good reason to question today's referral practices.

Atrial fibrillation is the most common cardiac arrhythmia in adults, and was also the most frequent arrhythmia in this study (6). Other clinically significant arrhythmias were rare. The prevalence of atrial fibrillation is increasing, and one in four 40-year-olds can expect to develop atrial fibrillation at some point in their life (7, 8). In approximately one third of patients with atrial fibrillation, the condition goes unrecognised (9). Undetected or untreated atrial fibrillation is a frequent cause of stroke (10). Prophylactic treatment with anticoagulants is therefore recommended for patients with atrial fibrillation and an increased risk of stroke (5). The risk of stroke in patients with atrial fibrillation increases with one or more of the following factors: heart failure, hypertension, age over 65, diabetes, previous stroke, vascular disease and female sex (5). At Sørlandet Hospital Arendal in the period 2017–18, the only patients to undergo long-term ECG recording with discovery of previously unrecognised atrial fibrillation as the sole indication, were those who had been admitted to the Department of Neurology with stroke. The prevalence of unrecognised atrial fibrillation was relatively high in this group (11 %), even though all of these patients had been assessed with standard ECG or telemetry in connection with hospitalisation.

The European Society of Cardiology recommends opportunistic screening for atrial fibrillation with standard ECG or pulse measurement in all those over 65 years of age (5). Long-term ECG recording increases the likelihood of detecting paroxysmal atrial fibrillation compared with a standard ECG recording. However, there is currently little long-term ECG recording equipment available that is suitable and affordable and sufficiently easy to use for screening purposes in larger populations (11). This is likely to change in the near future, warranting discussion of screening for atrial fibrillation in selected groups.

This study has several weaknesses. It is based on relatively few patients and covers a limited geographical area. Referral practices and procedures may vary across hospitals, and population composition and patterns may have an impact on the results. All information in the study was retrieved retrospectively from patient medical records. The tests were interpreted and described by several different doctors with varying degrees of clinical experience, and the ECG recordings were not reanalysed. The study also has no follow-up data, and therefore we do not know whether any changes were subsequently made to diagnoses or treatment.

In summary, this study shows that long-term ECG recording had therapeutic implications in only 5 % of patients without known heart disease or previous stroke. No patients were referred for testing solely because of an increased stroke risk, even though these patients could potentially benefit greatly from the test. We recommend establishing national guidelines for the use of long-term ECG recording, and believe that the test should be used to a greater extent in patient groups where the results would have therapeutic and prognostic implications, such as those patients who would be considered at increased risk

of stroke if atrial fibrillation were detected. The risk of stroke should be assessed as part of the anamnesis and clinical examination, prior to referral for long-term ECG recording.

This article has been peer-reviewed.

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