The Contribution of 24-Hour Ambulatory ECG Monitoring in a General Medical Unit

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Twenty-four hour ambulatory monitoring is a standard procedure in major cardiac centres, but is it essential in a district general hospital?[1]. If so, is it necessary to have local facilities for both recording and analysis or is it satisfactory to have remote analysis of recordings obtained in the district hospital? To answer these questions it is important to establish which patients benefit from the procedure. We therefore describe the use of a system of recording and analysing 24-hour ambulatory electrocardiograms in a general medical unit of a district hospital, to help physicians in similar circumstances to decide whether or not it is worthwhile establishing ECG monitoring of this type.

Subjects and Methods

A total of 272 tapes from 165 patients with an age range of 9 to 80 years was recorded over a two-and-a-half-year period. Forty-six patients required more than one recording because of failure to produce symptoms during initial monitoring, review of drug treatment, assessment of pacemaker function or recurrence of symptoms. There were 78 males and 85 females. The patients kept a diary giving details of their normal daily activities and any symptoms. Most were co-operative in doing this, but time was taken in explaining how to keep the diary and use the event button. There was no difficulty in wearing the recorder or using the event marker, and the patients were fully mobile, taking part in sports such as tennis, squash and golf. One child used a trampoline daily; in this case the records were adequate but the belt finally gave way. All patients were advised to avoid bathing or showering and also to switch off electric blankets and avoid machines with strong magnetic fields such as X-ray apparatus.

The indications for 24-hour ECG monitoring are shown in Table 1. Patients who were investigated routinely after myocardial infarction were excluded from this survey.

The tapes were recorded on a Medilog 4-24 cassette tape recorder (Oxford Instruments) using a single AD2 ECG amplifier, and also incorporating the AME2 event marker amplifier and AT2 timing modules. A modified V5 lead was used. The analysis was made on the DA11 ECG analysis system developed by Oxford Instruments using the PB2 tape play-back system fitted with a PD2 direct replay amplifier. The approximate cost of the equipment is £8,000.

The ECG was correlated with the patient’s diary and the range of heart rate was reported during the day and night. Arrhythmias and an estimate of their frequency were noted. Atrial and ventricular premature complexes were reported as occasional or frequent on visual inspection and ventricular premature complexes were subdivided into unifocal or multifocal groups. Examples were written out on standard ECG paper and checked by a physician with a special interest in cardiology.

Technical Difficulties

Initially, we spent two months familiarising ourselves with the equipment and assessing faults before proceeding to investigate patients. Most of the faults occurred within the first 12 months and in the main they involved the three recorders. These required careful regular servicing by an experienced technician. The original clutches, on/off switches and battery contacts were redesigned and are now satisfactory. Careful watch was kept on the various fine leads which could easily fracture. The timing was checked frequently, though with the new ATE-1 module it was accurate to the nearest minute. The pinch wheel and recording head needed regular scrupulous cleaning, as build-up of emulsion could be considerable and could result in the tapes sticking, and one recorder had a motor and gear box.

Table 1. Indications for 24-hour ambulatory ECG recording.

(Many patients had more than one indication.)

| Indication                                      | No.  |
|------------------------------------------------|------|
| Diagnostic                                     |     |
| Palpitation                                    | 79   |
| Syncope                                        | 43   |
| Dizziness                                      | 27   |
| Angina/Arrhythmia                              | 5    |
| Abnormal ECG (further investigation)           | 7    |
| Wolf Parkinson White syndrome                  | 1    |
| Chest pain                                     | 19   |
| Previous infarction                            | 1    |
| Review of Management                           |     |
| Efficacy of drug treatment                     | 14   |
| Pacemaker assessment                           | 2    |
| Others                                         | 24   |

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replaced owing to an unacceptable increase in current consumption. The fast replay unit gave virtually no trouble but there was one major fault on the analyser, fortunately within the warranty period, requiring replacement of the memory store board.

Because of the way in which the electrical supply was distributed within the hospital, there were difficulties with spurious triggering of the analyser from other electrical equipment but a constant voltage transformer inserted into the main electrical supply lead to the analyser minimised this problem. The synclock mechanism was fitted and this automatically adjusted for any tape speed variation and gave a more accurate ECG read-out.

Results

The presenting clinical features (see Table 1) show that palpitations, syncope and dizziness were the commonest indications for 24-hour monitoring. For the purpose of this article we have defined syncope as episodes of disturbed conscious level and have included subjects with loss of consciousness as well as those complaining of faint feelings, short-lasting weakness and ill-defined blackouts. Patients frequently had more than one symptom requiring investigation. The miscellaneous group consisted of patients with fatigue or anxiety about their heart, often with a family history of ischaemic heart disease.

Recording Difficulties

Of the 272 recordings, five tapes did not record at all, four others recorded for a very short time, and one had frequent intermittent loss of record. These 10 tapes were not considered suitable for analysis, and the patients had at least one more record taken.

The remaining 262 records showed sufficient information to be used for diagnosis. Of these, 15 showed evidence of recurrent artefacts due to movement of the electrodes or leads, 5 had intermittent loss of recording for short lengths of time and 19 lasted less than 24 hours but longer than eight hours. In 6, this was due to a local skin reaction to the electrodes developing on the third or subsequent days. The three patients in whom this occurred had multiple recordings. Other artefacts closely simulating true ECG abnormalities were recognised in a minority of tapes.

Rhythms Recorded and Subsequent Management of Patients

Thirty-two patients had normal records with no rhythm abnormalities, eight having had more than one recording. Six of these were considered to have neurological causes for their disorder, four emotional causes and two are awaiting exercise stress testing. In two patients, drugs were withdrawn with no adverse effects. The remaining patients were reassured and have not been seen since.

The 131 remaining patients had 218 recordings analysed for rhythm abnormalities. Atrial premature complexes were the sole abnormality in seven patients, in two of which they were regarded as numerous. These patients were not offered specific therapy. Eighty-two patients had ventricular premature complexes, often associated with abnormal atrial ectopic activity, and ventricular tachycardia also occurred in four of them. In three cases, bouts of ventricular tachycardia alone were recorded. Anti-arrhythmic treatment was considered when frequent ventricular premature complexes were closely associated with disabling symptoms and whenever they were associated with significant underlying ischaemic heart disease. Of the seven patients with ventricular tachycardia, two were treated with procainamide, one with propranolol, one with amiodarone and three received no anti-arrhythmic agents.

Most of the 26 patients with supraventricular tachycardia were being treated with β-blocking agents and, as a result of the 24-hour recordings, either the dose of the β-blocker was raised, or alternatives such as digoxin, verapamil, disopyramide and amiodarone were tried. Of the seven patients with intermittent atrial fibrillation, one was thyrotoxic and responded to treatment with neomercazole, and digoxin or β-blockers were used in the rest, except one patient who was tried on various drugs until eventually controlled on amiodarone. Most of these patients complained of dizziness or disturbed conscious level as well as palpitations. Clinically, it was difficult or impossible to distinguish them from patients who were eventually shown to have ventricular ectopic rhythms.

CASE HISTORIES

1. A male patient aged 65 years complained of palpitations up to two hours in duration, despite treatment of thyrotoxicosis with carbimazole. The 24-hour ECG (Fig. 1) showed one run of atrial fibrillation, and another of multiple atrial premature complexes.

Figure 1. Palpitations coinciding with episodes of atrial premature complexes and atrial fibrillation. (Male aged 65 years.)
both of which correlated with his diary complaint of palpitations. The arrhythmias responded to propranolol.

2. A female patient aged 33 years had infrequent palpitations for many years but then noticed tachycardia lasting up to one hour when playing tennis. The ECG (Fig. 2) recorded during a tennis match showed supraventricular tachycardia of 200 to 240 impulses/min on three occasions which corresponded to her symptoms. She also had occasional supraventricular ectopic complexes while asleep. A later recording, when taking propranolol, showed normal sinus tachycardia and there were no symptoms.

Figure 2. Supraventricular tachycardia induced by a game of tennis. (Female aged 33 years.)

The sick sinus syndrome or its near relative the bradycardia-tachycardia syndrome was diagnosed in nine patients. Three of the five patients with bradycardia-tachycardia syndrome were successfully treated with amiodarone, one patient improved on propranolol and one failed to improve with a period of pacing, and subsequently improved spontaneously. Of the four patients with the sick sinus syndrome, one required permanent pacing, one child has remained well on oral atropine, one improved when oxprenolol was stopped and one was well except for mild exertional angina and did not require treatment. Two other patients had inappropriate sinus bradycardia without other features of the sick sinus syndrome and did not require treatment.

Six patients had intermittent heart block and two of these had periods of complete block which were successfully treated by the institution of pacing. Mobitz type II block in three patients was considered to be caused by viral myocarditis in one patient who subsequently improved with no treatment and the other two patients improved after withdrawal of diazepam and propranolol respectively. A further patient with intermittent Wenkebach phenomenon died before treatment could be started. Two other patients were investigated because of symptoms occurring while apparently pacing normally on routine pacemaker analysis.

CASE HISTORIES

1. A male patient aged 70 years complained of repeated dizzy attacks and the 24-hour ECG (Fig. 3) clearly demonstrated intermittent failure of pacing. Further investigation suggested that the catheter tip had become displaced and was freely mobile in the right ventricular cavity. Satisfactory re-implantation of the catheter resulted from the 24-hour recording.

Figure 3. Intermittent pacemaker failure coinciding with bouts of dizziness and dyspnoea. (Male aged 70 years.)

2. A female patient aged 73 years had similar symptoms but the recording showed no correlation between her dizzy bouts and the ECG and clinical improvement resulted from the use of a cervical collar for presumed vertebro-basilar insufficiency.

Clinical Value

The overall effects of 24-hour ECG monitoring on the management of patients are summarised in Table 2. Eighty-two patients with abnormalities of cardiac rhythm had a change of regime as a result of the prolonged ECG recording. Four patients (2.5 per cent) had a pacemaker inserted or replaced with improvement in their clinical condition, and the remaining 78 patients, divided into four groups, had alterations to their drug therapy. Improvement on clinical grounds was judged to have occurred on 54 (33.1 per cent) occasions as a result of starting or altering drug treatment, and in a further nine (5.5 per cent) cases inappropriate drugs were stopped.
Table 2. Management following 24-hour ECG monitoring (163 patients).

|                         | No. | %   |
|-------------------------|-----|-----|
| Reassured               | 61  | 37.4|
| Cardiac abnormality     |     |     |
| Alteration in drug therapy | 78  | 47.8|
| Pacemaker               | 4   | 2.5 |
| Referred for exercise stress test or coronary arteriography | 4 | 2.5 |
| Death before treatment  | 1   | 0.6 |
| Non-cardiac diagnosis   |     |     |
| Verteobasilar insufficiency | 14  | 8.6 |
| Psychiatric referral    | 1   | 0.6 |

The other two groups consisted of 13 (8 per cent) patients where the drug treatment was altered without clinical improvement and two (1.2 per cent) patients in whom drugs which were considered to be of little value were stopped and the symptoms remained. Thus, 63 out of 163 patients (38.7 per cent) were improved by alteration in drug treatment.

Discussion

Extension of the use of 24-hour ambulatory ECG monitoring to most or all district hospitals requires recognition of the facts that artefacts may mimic abnormal rhythms, difficulty arises in the interpretation of some records, and there is a risk of overuse of the data in the management of individual patients[2]. Krasnow and Bloomfield (1976)[3] have described 15 artefacts that could lead to misinterpretation of a portable ECG record, the majority simulating abnormal rhythms. We have recognised most of these artefacts among our recordings. Body movement, particularly during major exercise, has been responsible for abnormalities resembling ventricular premature complexes, ventricular tachycardia, aberrant conduction and QRST changes, mimicking ischaemic change. Care in the choice of electrodes, preparation of the skin, site of electrodes and a short observation period using an oscilloscope have helped to minimise body movement artefacts. We have also seen mechanical and electrical artefacts causing apparent atrial premature complexes, junctional rhythm, low voltage and sinus arrest, and experience has shown that the recorders have been responsible for many of these artefacts.

Since the introduction of 24-hour ambulatory ECG monitoring by Holter[4] in 1961, it has been increasingly possible to plan management based on the precise rhythm abnormality detected, since the 24-hour records provide approximately 1000 times more complexes for analysis than the standard 12 lead ECG. Studies of normal subjects with prolonged ambulatory ECG monitoring have given varying results and have pointed to the need to revise concepts of normal and abnormal cardiac rhythms. Major ventricular arrhythmias have been detected in 10 of 86 cases[5] and 33 of 74 cases[6], whereas other series have shown no serious arrhythmias[7-9]. Increased frequency of abnormal cardiac rhythms has been demonstrated in a survey of active elderly patients[10].

Because of these difficulties in assessing normal and abnormal as it applies to 24-hour ambulatory ECG recording, we have insisted on diary correlation of abnormal events with ECG evidence of significant arrhythmia whenever possible before starting antiarrhythmic drugs. In other patients, serious arrhythmias with underlying ischaemic heart disease have been regarded as sufficient to indicate that drug treatment is necessary.

Epidemiological studies and prolonged ECG monitoring have shown an association between ventricular premature complexes and sudden death in patients with coronary artery disease[11-14]. Similarly, ventricular tachycardia has been regarded as a life-threatening arrhythmia when it occurs following myocardial infarction, but the same prognostic significance may not apply to other patients[15-17]. In our series, anti-arrhythmic drugs have been reserved for patients with coronary artery disease associated with multifocal premature ventricular complexes or numerous unifocal complexes, and patients without obvious underlying heart disease have only been treated when symptoms have coincided with periods of abnormal ventricular activity. Prolonged or frequent bouts of ventricular tachycardia have been regarded as necessitating urgent therapeutic intervention.

Sinoatrial disorder has been increasingly recognised since the introduction of ambulatory ECG monitoring, and it has been suggested that this will lead to the use of more permanent pacemakers in the UK[1]. Permanent pacing is essential for patients with syncope due to the sick sinus syndrome, but asymptomatic cases may not require treatment and the bradycardia-tachycardia syndrome has been successfully controlled by amiodarone[18].

There have been different opinions on the value of 24-hour ECG monitoring in patients with chest pain and ST segment changes. Such changes have been regarded as unreliable, and exercise testing has been preferred[19] but it has been reported as a useful technique for evaluating the response of anginal attacks to β-blocking agents by other authors[20]. In our patients with chest pain, prolonged ECG recording has been used to see if the pain has been associated with an arrhythmia, but when pain has been clearly related to greater than 2 mm depression of the ST segment we have accepted this as a significant finding.

Transient cerebral disturbances resulting in dizziness, confusion, syncope or epileptiform attacks may be caused by intermittent cardiac arrhythmias[21-24]. Because of the cardiologic interest of one of the authors, referrals for 24-hour records have mainly been on the basis of suspected arrhythmias. Nevertheless, an alternative diagnosis of cerebral ischaemic disease has been considered in most of the patients with syncope or dizziness, and a cardiac cause has been clearly shown in 40 per cent. These subjects have had multiple recordings in most cases and if the ambulatory ECG service were to be extended to cover the neurology and geriatric departments,
a large increase in the number of tape recordings could be expected.

Ambulatory ECG monitoring has been particularly valuable in the diagnosis of intermittent heart block and in the detection of intermittent pacemaker failure. Although coronary care monitoring and telemetry have provided similar information[25], they have required constant observation or a system of alarms. The ambulatory technique has the advantage of recording in the normal environment including situations that may have provoked symptoms previously.

We have made infrequent use of ambulatory ECG monitoring to assess the efficacy of drug treatment because of possible spontaneous day-to-day variation in the frequency of abnormal rhythms[14, 26]. We have accepted satisfactory relief of symptoms as adequate evidence for the benefit of treatment in our patients.

The value of the reassurance provided by normal ambulatory ECG recordings was unexpected. Patients volunteered the information that they were satisfied their clinical features were not of cardiac origin when it was demonstrated that normal electrocardiograms were recorded at the time they were experiencing symptoms. In previous reports insufficient emphasis has been placed on this aspect of the value of ambulatory ECG monitoring.

We conclude that 24-hour ambulatory ECG monitoring in a district general hospital can provide a valuable service for the investigation of a variety of symptoms that may be caused by cardiac arrhythmias. Twenty-four hour tapes provide data that are significantly different from routine electrocardiography. A physician with a special interest in cardiology is probably necessary as part of a team which should also include an engineer for frequent servicing of equipment and, most important, a competent assistant capable of regularly obtaining records suitable for analysis. There are considerable demands on time and staff, and a single analysis takes approximately one hour. A busy district hospital may not have sufficient personnel to develop the service and an alternative is to use the facilities for analysis at a major cardiac centre or at a commercial firm. The cost of commercial analysis must be weighed against the capital expense of acquiring an analyser plus the salary bill if extra staff are necessary, and the number of patients involved must be taken into account.

The main advantage of local analysis of recordings is that the results can be obtained immediately after the completion of the monitoring period. This is important if life-threatening arrhythmias are present, and also further recordings can be made without delay if the first 24-hour tape fails to show abnormalities or is unsatisfactory from the technical point of view.

Summary

Twenty-four hour ambulatory ECG records were obtained from 163 patients attending a general medical unit of a district general hospital. The main indications for recording were palpitations, syncope and dizziness and 262 tapes were suitable for analysis. Problems and benefits of the system were discussed. Abnormalities detected were supraventricular tachycardia, ventricular tachycardia, atrial fibrillation, intermittent heart block, sinoatrial disease and pacemaker malfunction. Sixty-one patients were reassured and in 78 patients an alteration in drug regime was advised with clinical improvement in 63 cases. Vertebrabasilar insufficiency was diagnosed in 14 patients, 4 patients were referred for further cardiac investigations, 4 required insertion or replacement of a pacemaker, 1 was referred for psychiatric opinion, and 1 patient died.

Selected 24-hour ambulatory ECG monitoring in a district general hospital provides a valuable service for investigation of symptoms that may be caused by cardiac arrhythmias. The question of local or centralised analysis of recordings should be decided on the grounds of time and staff available and the capital cost of equipment.

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**Book Review**

*The Problem Orientated Medical Record.* Edited by J. C. Petrie and Neil McIntyre Churchill Livingstone 1979. Price £7.

As most people probably know, the problem-orientated medical record (POMR) was invented in the USA and is very widely used there. This is the first substantial book arising from predominantly British experience of the use of POMR for routine clinical work in hospitals and general practice, and in medical education.

It makes compelling reading. Few of us could fail to acknowledge the gross deficiencies of the conventional patient record used in British practice. These deficiencies arise primarily from incompleteness and lack of structure. They frequently make it impossible either to reconstruct what has happened to the patient or what therapeutic goals were contemplated. The logic behind diagnostic processes and investigational and therapeutic manoeuvres is all too often obscure. These deficiencies impede the optimal management of the patients, lead to errors and unnecessary investigation and treatment, make it extremely difficult to carry out any form of efficient audit and make the monitoring of the progress of clinical students a haphazard exercise.

We must ask ourselves what is the cost in terms of patient care and money of the inefficiencies and errors directly or indirectly due to the conventional record. The view of many, including the writer, is that this cost is very high indeed. This book shows that POMR, if properly used, can rectify these problems. The point about POMR is that the cost of implementing the system is not a financial one but rather an effort of will and of overcoming rooted habits and behaviour. Implementation of POMR is one of the very few major improvements that can be made at little cost, which should give it the highest priority in an era of financial starvation.

If the views so cogently expressed in this book are correct, the key to widespread implementation lies in introducing medical students to POMR at the start of their clinical course. The burden of organising this lies mainly on those members of staff of our medical schools who are responsible for teaching students clinical method and record construction. They also have to convince their academic colleagues and the NHS consultants who participate in undergraduate and postgraduate teaching of the virtues of POMR. So far, with some notable exceptions, few have grasped the nettle; they should read this book.

Of the six excellent chapters which make up this volume, I must single out as outstanding the essay by Professor McIntyre on 'Educational aspects of the problem orientated record'. In it he erects a vision and ethos of medical education which is both exciting and convincing. Idealistic though some of it may be, it is important for someone to point the way ahead and to state the goals at which most of us would aim. In doing so, Professor McIntyre states the case for audit of students by their teachers and by doctors of their juniors and their peers in a most acceptable way, which should go far to overcome the widespread fears and resistance that exist on this subject.

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