Technician run open access exercise electrocardiography

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Abstract

***Objective*—To evaluate the safety, efficacy, and feasibility of the technician run open access exercise electrocardiography service at Freeman Hospital.**

***Design*—Questionnaire analysis of the responses of the general practitioners of randomly selected patients who used the service.**

***Setting*—A tertiary care cardiac centre, providing an open access service to general practitioners in the community.**

***Patients*—269 patients randomly selected from 552 who underwent open access exercise electrocardiography over a 2.5 year period.**

***Outcome measures*—Utilisation of service: the reasons for referral, whether the service was optimally used by the general practitioners, and its effect on their management practice; effect on number of cardiology referrals; benefit to the patients; safety, efficacy, and feasibility of a technician run service; general practitioners' assessment of the service.**

***Results*—147 of 178 general practitioners (82.6%) responded to the questionnaire, on 247 of 269 patients (91.8%). General practitioners used the service for diagnosing ischaemic heart disease in 72.5% of cases, for prognostic purposes in 17.8%, or both in 5.3%. In 197 cases (79.8%), the general practitioners felt that the service had changed the way they managed their patients. The exercise test was positive in 90 patients (36.5%) and identified 38 as at high risk. The service was effective in optimising the cardiology service by reducing referrals by 47%.**

***Conclusions*—The service was used by general practitioners primarily for diagnosing ischaemic heart disease and not so often for prognosis. The utilisation of the service was optimal as assessed by the high positivity rate. The service meets its primary objective of assisting general practitioners in the management of patients with suspected ischaemic heart disease, and may have helped to optimise resources by reducing the number of referrals to cardiologists. It has helped prioritise patient management and may have benefited high risk patients by facilitating rapid identification and referral. It can be run safely and effectively by trained technicians.**

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Keywords: exercise stress testing; open access services; cardiac technician; audit

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Exercise electrocardiography is a well established investigation in the diagnosis and prognostic assessment of patients with suspected ischaemic heart disease.[1–3] The risk prediction by the treadmill scoring system may even be a better predictor of outcome than the clinical assessment based on all the available clinical variables and prognostic factors.[4] Therefore the working party of the British Cardiac Society and the Royal College of Physicians,[5] and the Northern and Yorkshire Regional Health Authority (NRHA)[6] issued guidelines for the management of the patients with ischaemic heart disease. According to these guidelines, all patients less than 70 years of age with possible or definite angina and without coexistent life threatening disease should be assessed by exercise electrocardiography to identify those at high risk, who might benefit from further investigation and treatment. However, as the facility for exercise electrocardiography, like many other cardiac investigations, was restricted to hospital based specialists, the guidelines could result in a large number of referrals to cardiologists and an increased burden on already overextended hospital cardiology services.[7]

Open access exercise electrocardiography was therefore initiated in the Freeman Hospital, along with several other centres in the UK, as a newer concept of providing direct access for general practitioners to this specialist service. It was hoped that this service would assist general practitioners in the assessment and management of patients with ischaemic heart disease and identify those at high risk who might benefit from cardiological referral.[8–10] It was feared, however, that it would be used as a screening tool for angina in patients with atypical or non-anginal chest pain with a low pretest likelihood of ischaemic heart disease; this might result in more false positive and inconclusive results and more cardiology referrals,[8 11] or even mismanagement of some patients owing to misinterpretation of the results.[9] Reports from different parts of the UK have differed in their assessment of the usefulness of the procedure,[8 10] and some have argued that it may be an inappropriate use of scarce resources.[12] It is therefore essential that the providers of open access service should continually monitor the proper use of the investigation.[11]

The fact that the service is essentially run by trained technicians in the Freeman Hospital makes it among the first of its kind in the country. The present audit was designed to assess the initial experience of open access exercise electrocardiography. We aimed to analyse

whether the service has fulfilled its primary objective of helping general practitioners in the management of patients with suspected ischaemic heart disease, and the effect of the service on the number of referrals by general practitioners to hospital cardiology services. We also assessed whether the service was being used appropriately by general practitioners, their selection of patients, and the reasons for referral. In addition, we analysed the safety, efficacy, and feasibility of the technician run service, the comments of general practitioners on value, and their expectations from the service.

Methods

Before the launch of the open access exercise electrocardiography service at the Freeman Hospital, general practitioners of the region were sent guidelines for the management of patients with suspected ischaemic heart disease. These guidelines were prepared by the Northern and Yorkshire Regional Health Authority, which has representatives from among general practitioners and cardiologists in the region. The guidelines included the possible indications and contraindications for the test.[6]

QUESTIONNAIRE

A questionnaire (multiple choice question format) was developed and sent to the general practitioners of a randomly selected sample of patients undergoing open access exercise electrocardiography at Freeman Hospital over a 30 month period (July 1994 to December 1996). The questionnaire included the patient's personal data and reasons for referral for the exercise test—that is, for diagnosis of chest pain or risk stratification of patients with known ischaemic heart disease. General practitioners were asked to comment on the pretest likelihood that their patients had significant ischaemic heart disease, based on their clinical assessment, and what their management plan would have been had the service not been available to them. They were then asked to comment on the impact of the test report on their management decisions, and for their post-test assessment of the likelihood that the patients had significant ischaemic heart disease. The actions taken by the general practitioners following receipt of the test result were also assessed.

OPEN ACCESS EXERCISE SERVICE

General practitioners were asked to complete a simple request form which included general information on the patient, reasons for referral (possible indication), information about cardiovascular risk factors, and the patient's current symptoms and drug treatment. There was a check list of possible contraindications for the test on the request form (table 1). General practitioners were asked to exclude them clinically. We asked for a recent resting 12 lead ECG from the patient to be enclosed with the form (this could also be obtained by referral to the open access ECG service at Freeman Hospital). The completed request form was then assessed by the cardiologist in charge, and unless there was a clear reason not to, an appointment was sent to the patient, with information on the procedure.

Table 1 Check list for possible contraindications to the test

1	Aortic stenosis
2	Other severe valve stenosis
3	Hypertrophic cardiomyopathy
4	Severe heart failure
5	Unstable angina
6	Myocardial infarction (< 4 weeks)
7	Unstable heart rhythm
8	Uncontrolled hypertension (> 200/100 mm Hg)
9	Myocarditis/pericarditis
10	Limiting arthritis/claudication
11	Other intercurrent illness
12	Is full blood count abnormal?

If "yes" to any of these, patient is not suitable for exercise testing.

EXERCISE TEST

The open access exercise service in the Freeman Hospital was largely run by a team of trained technicians. All the safeguards suggested in the British Cardiac Society/Medical Practice Committee guidelines for carrying out the exercise tests when a doctor is not there[13] were enforced before starting this technician supervised service. All patients underwent a standard Bruce protocol treadmill test on Marquette CASE 16 exercise testing system (Marquette, Kettering, UK). A 12 lead ECG was recorded before exercise, at the end of each exercise stage, at peak exercise, and at two minute intervals during recovery. Three standard ECG leads were continuously monitored during the exercise. The exercise was continued until the patient developed the limiting symptoms (angina, dyspnoea, or fatigue), significant abnormalities of rhythm or blood pressure, or marked and progressive ST segment depression, or achieved the target heart rate (220 minus the patient's age in years).

REPORTING

Although the tests were technician run, the reports were prepared by the consultant in charge of the service in all cases. The report included the test duration, reasons for stopping, haemodynamic response, and ECG morphology and rhythm. The tests were classified as positive, negative, or inconclusive. A positive result was defined as planar ST segment depression of $\geq$ 1 mm or ST elevation in the leads without Q wave, measured at 0.08 seconds after the J point. A test was considered negative if there was a normal pulse and blood pressure response and no ST morphological changes, despite attaining at least 85% of the target heart rate. An inconclusive test was one in which there were no ST segment changes but 85% of the target heart rate could not be achieved.

RISK STRATIFICATION BY CARDIOLOGIST

The report also included the risk stratification by the cardiologist in charge of the service, if it was positive for exercise induced ischaemia. The patients were stratified on the basis of their exercise test results into "high risk" and "not high (or moderate and low) risk" categories for

Table 2 Reasons for not carrying out the test at the first referral (of 560 patients referred for open access exercise testing)

Reason for deferment	*Number of patients*
Left bundle branch block	4
Paced ventricular rhythm	1
High blood pressure (< 200/100 mm Hg)	3
Total	8

adverse cardiovascular outcomes, in an objective and reproducible way, according to the treadmill score system published elsewhere.[4] The treadmill score was calculated as follows: duration of exercise (min) − (5 × the maximum ST segment deviation during or after exercise (mm)) − (4 × the treadmill angina index). The angina index has a value of 0 if the patient had no angina during the exercise, 1 if the patient had non-limiting angina, and 2 if angina was the reason for stopping the exercise test. The score of < −10 indicated high risk categorisation, −10 to +4 moderate risk, and ⩾ +5 low risk. The report was sent (including the full exercise ECG trace) directly to the referring practitioner.

Results

In all, 560 patients were referred for open access exercise testing over a 30 month period from July 1994 to December 1996. In eight patients (1.4%) the test was not carried out in the first instance for several different reasons (table 2). The remaining 552 patients had open access exercise testing and of these 269 were randomly selected for this audit and questionnaires were sent to their general practitioners; 147 of 178 general practitioners responded (response rate 82.6%) on 247 of 269 patients (91.8% patients). There were no complications.

The present study includes the analyses of the responses of 147 general practitioners on 247 patients who underwent open access exercise testing. There were 142 men (57.5%) and 105 women (42.5%) with an age range of 22 to 80 years, mean (SD) 55.1 (14.2) years, and a median of 57 years. Thirty two patients (12.9%) were over 70.

REASONS FOR REFERRAL

There were 179 patients referred for the diagnosis of ischaemic heart disease (72.5%; $\chi^2 = 173.63$, degrees of freedom (df) = 12, $p < 0.001$), 44 (17.8%) for a prognosis in case of known ischaemic heart disease, and 13 (5.3%) for both diagnosis and prognosis. Reasons were not specified or not available for comment in 11 patients (4.4%).

Table 3 Age and sex distribution of the patients, with their exercise test results

	Exercise test results				
	Positive (n = 90)	*Negative (n = 108)*	*Inconclusive (n = 39)*	*No comment (n = 10)*	*Statistic*
Sex					
Male (n = 142)	56	52	26	8	$\chi^2 = 10.07$ df = 2
Female (n = 105)	34	56	13	2	p = 0.03
Age					
< 40 years (n = 12)	1	7	3	1	$\chi^2 = 91.51$ df = 3
> 40 years (n = 235)	89	101	36	9	p<0.001

df, degrees of freedom.

EXERCISE TEST RESULT

The exercise test was classified as positive in 90 patients (36.5%), negative in 108 (43.7%), and inconclusive in 39 (15.8%). In 10 cases (4%), the exercise test results were not available for analysis as their general practitioners did not comment on the result on the questionnaire. The exercise test results in relation to age and sex distribution of these patients are shown in table 3. The cardiologist categorised 38 of 90 (42.2%) with positive exercise test results into the "high risk" category on the basis of a treadmill score of < −10, as described above. Thus 14.1% of all the patients referred for exercise testing (38 of 269) had a "high risk" positive exercise test result.

PRE- AND POST-TEST LIKELIHOOD OF PATIENTS HAVING ISCHAEMIC HEART DISEASE

General practitioners' assessment of the likelihood that their patients had ischaemic heart disease before and after the open access exercise test is shown in table 4. There was a highly significant shift in their opinion towards a lower likelihood of ischaemic heart disease after the test ($\chi^2 = 113.50$, df = 4, $p < 0.0001$). Although 120 patients (48.6%) were thought by their general practitioners to have a moderate probability of ischaemic heart disease before the test, after the test only 41 (16.6%) were actually categorised in that group. Consequently the number of patients categorised as having a low probability of ischaemic heart disease increased from 35 (14.2%) to 121 (49.0%). There was, however, only a small and non-significant decline in the numbers of patients classified in the high probability group after the test 37.2% (n = 92) *v* 34.4% (n = 85) suggesting that general practitioners were good at identifying such patients.

DID ACCESS TO OPEN EXERCISE TESTING ALTER THE MANAGEMENT OF PATIENTS?

General practitioners were asked if the availability or the result of open access exercise testing had altered the management of their patients with suspected ischaemic heart disease. Their response was that in 197 patients (79.8%) the availability of open access exercise testing had changed their management, in 34 (13.8%) it had not changed their management, and in 16 (6.5%) they were not sure.

IMPACT OF OPEN ACCESS EXERCISE TESTING ON CARDIOLOGICAL REFERRAL

General practitioners were asked to indicate whether, in the absence of open access exercise testing, they would have referred their patients to a cardiologist. Their response was that they would have referred 186 cases (75.3%), would not have referred 26 (10.5%), and were uncertain about referral in the remaining 35 (14.2%). With the availability of an exercise test result, the general practitioners actually referred only 70 patients (28.3%). Those referred to a cardiologist were not only those

Table 4 General practitioners' assessment of the likelihood of their patients having ischaemic heart disease (IHD) before and after carrying out the open access exercise test

	Likelihood of presence of IHD		
GP assessment	*High*	*Moderate*	*Low*
Before the test	37.2% (n = 92)	48.6% (n = 120)	14.2% (n = 35)
After the test	34.4% (n = 85)	16.6% (n = 41)	49.0% (n = 121)

with positive test results; they included 45 patients with a positive test (50% of all positive tests), 10 with a negative test (9% of the negative tests), and nine with an inconclusive test (23% of inconclusive tests), and no comment in six. Of 38 patients with positive high risk tests, 32 (84.2%) were referred to a cardiologist. No information was available about the remaining six patients; this might reflect the reluctance of these patients to undergo invasive diagnostic procedures and possible revascularisation.

OUTCOME OF THE PATIENTS

Of the 70 patients (28.3%) referred to a cardiologist, 52 were referred to Freeman Hospital and 18 were sent to other hospitals in the region. Analysis of the outcome as reported by their general practitioners showed that 32 of these patients (46%) had already had coronary angiography by the time of questionnaire, 31 (44%) were continuing on medical treatment, and in seven (10%) no comment was made. Of the 38 patients identified as high risk, three developed unstable angina and two had a myocardial infarct while awaiting their investigation.

Besides the 70 cardiology referrals, seven patients (2.8%) were referred for non-cardiological (gastrointestinal) investigations by their general practitioners. No comment on the action taken was made for nine cases (3.6%). The remaining 161 patients (65.2%) were managed by their general practitioners, who gave reassurance in 75 cases (30.4%), continued the same drug treatment in 53 (21.5%), and made changes in the treatment regimen in 33 (13.4%), though the details of the changes are unknown.

Discussion

The main findings of this audit on open access exercise testing were as follows: the chief reason for referral was for a diagnosis of ischaemic heart disease; the availability of open access exercise testing reduced the number of cardiology referrals; several high risk patients with ischaemic heart disease in the community were identified; open access exercise testing could be carried out safely as a technician based service; and the general practitioners responding to the questionnaire found it a useful service.

Although the NRHA guidelines did state that exercise testing is of limited value in the diagnosis of ischaemic heart disease,[6] general practitioners used the service mainly as a diagnostic test in large majority of patients (72.5%). This raises the question as to whether or not the open access exercise test was being used optimally. This is important but difficult to answer as there are no clear cut criteria for evaluating optimal utilisation of the service. Among various criteria suggested in earlier studies, there are two that may be of value: first, and possibly more useful, is the percentage of positive tests; if this is high, it may be an indirect reflection of the proper selection of patients with a high pretest likelihood of ischaemic heart disease[11]; second is the percentage of general practitioners using the service (of all those invited to do so). The difficulty with this kind of evaluation is the absence of any set criteria, so that any chosen level would be arbitrary. McClements *et al* reported that 18% of their patients referred for open access exercise testing had a positive test and 43% of catchment general practitioners referred patients.[10] In another study, Thwaites reported a 45% positivity rate for the open access tests compared with a 41% positivity rate of hospital based referrals and concluded that these findings strongly indicated the appropriateness of the use of the open access investigation by general practitioners.[11] Using the same criteria the positivity rate of 36.5% in our study may indicate the appropriate use of the service.

The analysis of the general practitioners' pre- and post-test assessment of the likelihood that ischaemic heart disease was present showed that they were very accurate in identifying patients with a high probability of ischaemic heart disease (table 4). On the other hand their assessment was not so accurate in patients whom they thought had a moderate or low probability of ischaemic heart disease.

In this study we have also shown that the availability of open access exercise testing resulted in a large reduction in cardiological referrals (by 47%; 116 patients). This is in line with other published data, Sulke *et al* reporting a 50% reduction,[9] and McClements *et al* an 87% reduction.[10] Reduced referrals would mean that the majority of patients (65.2% in our study) may be managed by their general practitioners in the community, avoiding the anxiety and delays associated with a cardiology referral. In addition it was possible for general practitioners to identify a group of patients who might be at high risk and could be referred for further assessment directly to a centre with appropriate cardiological facilities. Thus the service may have helped in the optimal utilisation of resources and prioritisation of patient management.

In a significant departure from other published reports on open access exercise testing, the service at Freeman Hospital was primarily run by a team of trained technicians. It was encouraging that in the 552 tests performed over a 30 month period we did not encounter any significant complications, despite a high positivity rate and significant proportion of high risk patients. Recently Davis *et al* have shown that technician supervised stress testing may be comparable to tests supervised by experienced doctors in diagnostic efficacy and complication rates in the patients referred by hospital based specialists.[14] Our results, however, suggested that trained technicians may perform open access exercise testing safely and effectively in properly screened patients. Its use

may therefore be encouraged, provided all the safeguards for the patient's safety[13] are observed.

Although this study was not designed to assess the cost–effectiveness of the service, it does suggest—as did other studies[8–10]—that such a service should be cost–effective by identifying and separating the relatively larger subgroup of patients with a low probability of ischaemic heart disease and thus allowing the withdrawal of expensive anti-anginal drug treatment. In addition it may also be cost–effective by reducing the number of cardiological referrals and identifying a subgroup of patients at high risk of ischaemic heart disease for direct referral for further investigation.

It was also clear from this audit that general practitioners are faced with a large number of patients with chest pain of uncertain character with moderate or low probability of ischaemic heart disease. It would appear that the practitioners have found the availability of open access exercise testing beneficial in these patients. However, it has also raised some questions. Should the service continue to remain available to these patients or is more appropriately restricted to those with a high pretest likelihood of ischaemic heart disease? Would the alternative, such as an open access specialist chest pain clinic,[15] be a more appropriate way of dealing with patients with chest pain of uncertain origin? This merits further study and until this is initiated we propose to continue with the current service.

CONCLUSIONS

Our experience with open access exercise testing shows that the service has fulfilled its primary objective of assisting general practitioners in the management of their patients with suspected ischaemic heart disease. It also assisted the practitioners in reducing the number of referrals to cardiologists and thereby may have helped indirectly in the optimal utilisation of resources. Although the service was used by general practitioners primarily for diagnostic purposes, and not so commonly for assessment of prognosis, it could be argued that the service was used appropriately, as indicated by the high positivity rate. It has helped in prioritisation of patient management and may have benefited the high risk patients by facilitating their quick identification and referral. General practitioners have found the service useful and acknowledged that it changed the way they managed their patients with suspected ischaemic heart disease. Their assessment of patients with a high likelihood of ischaemic heart disease was very accurate. The service can be run safely and effectively by a team of trained technicians. It was, however, unclear whether the open access exercise testing or a chest pain clinic is a more appropriate means of assessing the patients with a low or moderate probability of ischaemic heart disease in the community. This merits further study.

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