Direct access exercise electrocardiography: a new service that improves the management of suspected ischaemic heart disease in the community

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Abstract

***Objective*—To assess the safety and value of an exercise electrocardiography service for the diagnosis of suspected ischaemic heart disease to which general practitioners have direct access.**

***Design*—Direct access to a hospital exercise electrocardiography service was offered on a trial basis to 122 general practitioners in a defined urban area. Maximal exercise tests were performed according to the modified Bruce protocol and the results were despatched promptly to the referring doctors who were responsible for the subsequent management of their patients.**

***Setting*—All general practices in north and west Belfast (combined list size about 180 000) and the regional medical cardiology centre.**

***Patients*—212 request forms were received in a two year period and 192 eligible patients attended for exercise testing. All patients were suspected to have pain due to myocardial ischaemia, were aged $\leqslant$65, and had no contraindications to exercise testing.**

***Main outcome measures*—Proportion of general practitioners who used the service. Proportion of exercise tests that were positive. Referring doctors' assessment of the service.**

***Results*—43% of general practitioners referred patients and 34 tests (18%) were positive. No complications occurred. The pretest likelihood of ischaemic heart disease, assessed by the referring doctor, was high in 48 (25%), moderate in 82 (43%), and low in 62 (32%). A high pretest likelihood of ischaemic heart disease predicted a positive test result with a sensitivity of 50% and specificity of 80%. General practitioners decided to refer 19 (10%) patients to a hospital cardiology department for further assessment, including 16 of the 34 who had a positive exercise test. In most cases the service was found to be helpful and 97% of patients would have been referred directly to a hospital cardiology clinic if it had not been available.**

***Conclusions*—Direct access exercise electrocardiography for patients with suspected ischaemic heart disease is safe, feasible, and helpful to general practitioners. This service seems to reduce the number of patients referred to cardiology outpatient clinics and to facilitate the management of these patients in the community.**

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Patients presenting with pain suspected to be due to ischaemic heart disease constitute a large proportion of new referrals from general practitioners to hospital cardiology departments. In our hospital, this group comprises 33% of all new referrals from general practitioners. Prompt and accurate diagnosis of the cause of pain is essential to the management of these patients. Exercise electrocardiography is an important aid in the diagnosis and prognosis of ischaemic heart disease.[1 2] Where there are no contraindications, exercise electrocardiography is usually performed in our hospital in patients who present for the first time with suspected ischaemic heart disease.

Allowing general practitioners direct access to exercise electrocardiography, specifically as an aid to diagnosis and subsequent management of suspected myocardial ischaemia, might streamline the management of this group of patients and result in advantages not only for the patients but also for general practitioners and hospital cardiology services. This study evaluates the first two years' experience of such a service.

Methods

ORGANISATION OF THE DIRECT ACCESS SERVICE

All general practitioners based in north and west Belfast were sent an information pack about the proposed direct access to an exercise electrocardiography service six weeks before its launch. General practitioners were invited to consider referring patients with possible angina for exercise electrocardiography provided they met certain criteria. It was stressed that the service was only available for patients who were experiencing episodes of pain and was not for screening of asymptomatic patients. Sample request forms and patient information sheets were included along with a guide for practitioners on the usual appropriate actions after negative, inconclusive, positive, and strongly positive exercise tests.

The request form was designed to facilitate rapid completion and had seven sections: (*a*) patient's details; (*b*) details of referring practitioner; (*c*) exclusion criteria; (*d*) details of the

pain and a pretest assessment of the likelihood of ischaemic heart disease based on the character of the pain; (*e*) risk factors for ischaemic heart disease; (*f*) list of patient's medications; (*g*) consent to exercise testing signed by the patient and witnessed by the general practitioner. Request forms were checked by one of the investigators and exercise tests were usually performed within two weeks of receipt of completed forms. Clarification was sought from general practitioners when incomplete or inappropriate requests were received.

EXERCISE ELECTROCARDIOGRAPHY

Immediately before exercise electrocardiography was performed, the request form was reviewed by the supervising doctor, the patient was briefly examined to check for contraindications to exercise testing and a 12 lead electrocardiogram was obtained. A modified Bruce protocol was used.[3] β Blockers were discontinued 24 hours before the test. Exclusion criteria were: (*a*) age > 65; (*b*) uncontrolled hypertension (> 170/100 mm Hg); (*c*) history of myocardial infarction in the previous six weeks; (*d*) signs of aortic stenosis; (*e*) history of syncope or ventricular arrhythmias; (*f*) symptoms suggestive of unstable angina with rest pain in the last six weeks; (*g*) exercise limiting pulmonary, peripheral vascular, or arthritic disease.

A test was considered positive if there was $\geqslant$1 mm of ST segment depression (with reference to the PQ junction) 80 ms after the J point. A test was strongly positive if 3 mm or more of ST segment depression occurred before completion of stage 3 and was accompanied by ischaemic pain. A test was negative for ischaemic heart disease if the patient reached 85% of predicted maximum heart rate without the threshold ST segment depression occurring. If the patient did not reach 85% of predicted maximum heart rate but no ST segment depression occurred, the test was considered inconclusive. The maximum heart rate and blood pressure response, the time of onset and duration of pain, and the reason for ending the test were included in the report.

Exercise test reports were sent to the referring practitioner within 48 hours along with a short questionnaire. General practitioners were advised by telephone about strongly positive exercise tests by the main investigator who also contacted general practitioners when questionnaires were not returned.

STATISTICAL ANALYSIS

Continuous variables are expressed as mean (SD), and the median and range are given for variables that are not normally distributed. Categorical variables were analysed with the χ^2 test and continuous variables were compared by deriving the standard error of the difference between means.

Results

SUBJECTS

Between 1 September 1990 and 31 September 1992, 212 patients were referred directly by their general practitioner for exercise electrocardiography and exercise tests were performed in 192 (91%). Of the 20 patients not tested, 12 did not attend, three had no symptoms of pain and were excluded, four had uncontrolled hypertension when they attended, and one patient was admitted to hospital with a myocardial infarction three days before she was due to attend for exercise testing.

Of the 192 patients who underwent exercise electrocardiography, 100 (52%) were men and the mean (SD) age was 48 (10) (range 26–64) years. Only four patients had a history of myocardial infarction. Twenty seven (14%) had a history of hypertension requiring treatment at the time of referral and 103 (54%) were current or ex-smokers. Considering the five major risk factors for ischaemic heart disease, positive family history, smoking, hyperlipidaemia or hypertension requiring treatment, and diabetes mellitus, a risk factor score (0–5) was derived for each patient. The mean risk factor score was 1·5 (0·9). Twenty five patients had an abnormal resting 12 lead electrocardiogram (non-specific ST or T wave abnormalities (12), voltage criteria for left ventricular hypertrophy (six), conduction abnormalities (two), Q wave infarct (three), atrial fibrillation (one), frequent ventricular extrasystoles (one)).

GENERAL PRACTITIONERS

Fifty two general practitioners referred patients, 43% of those invited to do so. The median (range) number of referrals by individual general practitioners was two (1–27). During the period of this study none of the participating practices was fund holding. The proportion of women among general practitioners using the service was low at 8% (4/52) compared with 30% (21/70) of the non-participating general practitioners ($p < 0·02$). The 52 practitioners who used the service qualified in medicine 15·6 (9·9) years previously compared with 23·4 (13·1) years for non-participating general practitioners ($p < 0·001$).

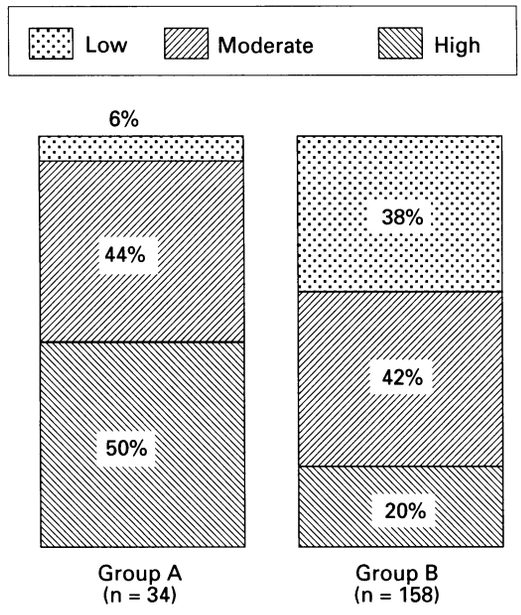
EXERCISE TEST RESULTS

Thirty four (17·7%) patients had positive exercise tests (group A), including four whose tests were strongly positive. Of the 158 patients with no evidence of ischaemic heart disease on exercise electrocardiography (group B), 14 (7·3%) had inconclusive tests due to inability to reach 85% of their predicted

Table 1 Comparison of patients with (group A) and without (group B) evidence of ischaemic heart disease on exercise testing

	Group A	*Group B*	*p Value*
No (%)	34 (18)	158 (82)	—
Age (yr, mean (SD))	55 (8)	47 (10)	<0·001
Men (n(%))	15 (44)	85 (54)	NS
Risk factor score	1·6 (1·1)	1·5 (0·9)	NS
Abnormal resting ECG	8 (24)	17 (11)	<0·05
Duration of Exercise (min, mean (SD))	9·7 (2·6)	12·5 (3·2)	<0·001

ECG, Electrocardiogram.



Assessment by general practitioners of pretest probability of ischaemic heart disease in patients with positive exercise tests (group A) and those with negative or inconclusive exercise tests (group B).

maximum heart rate, and the remaining 144 (75%) had negative tests. Table 1 compares the two groups. There was no significant difference between the groups with respect to sex or risk factor score but group A patients were older and were more likely to have an abnormal resting electrocardiogram. The mean duration of treadmill exercise was significantly longer in group B. No complications occurred as a result of exercise testing.

Among group A patients the pretest likelihood of ischaemic heart disease, as assessed by the referring general practitioner, was high in 17 (50%), moderate in 15 (44%), and low in only two (6%) compared with 31 (20%), 67 (42%), and 60 (38%) respectively in group B (χ^2 $p < 0{\cdot}001$, figure). A high pretest likelihood of ischaemic heart disease predicted a positive exercise test result with a sensitivity of 50% (17/34), specificity of 80% (127/158), positive predictive value of 35% (17/48), and negative predictive value of 88% (127/144).

In the subgroup of 48 patients aged $\leqslant 40$, 30 of whom were men, evidence of ischaemic heart disease during exercise electrocardiography was uncommon. Only two (4%) of this subgroup, one man and one woman had positive exercise tests compared to 32 (22%) of those aged > 40 (χ^2 $p < 0{\cdot}01$).

General practitioners were asked to indicate how they intended to manage each patient in the light of the test result and how they would have managed the patient had the service not been available. After the test general practitioners decided to refer 19 (10%) patients to a hospital cardiology department for further assessment, including 16 of the 34 who had a positive exercise test (table 2). The other 18 patients with positive exercise tests were initially managed in the community by their general practitioner, with 14 being given antianginal treatment. Practitioners intended to look for a non-cardiac cause of pain in 107 of 144 (74%) patients with a negative test result and planned to refer only two patients with negative exercise tests to a cardiology clinic. Referring practitioners said the direct access service was very helpful in 187 cases, quite helpful in five, and unhelpful in none, and in 186 (97%) cases they would have referred the patient directly to a hospital cardiology clinic if the service had not been available.

Table 2 Intentions of general practitioners in relation to results of exercise electrocardiography (n = 192)

	Exercise test result		
Planned action	*Positive*	*Inconclusive*	*Negative*
No (%)	34(18)	14(7)	144(75)
Treat for angina	14	3	6
Review patient, defer treatment	3	3	29
Consider non-cardiac cause	1	7	107
Refer to cardiology clinic	16	1	2

Discussion

There is little experience of electrocardiography services that general practitioners can use without initial referral of the patient to a cardiologist, but the value of exercise electrocardiography in both diagnosis and prognostic assessment of patients with ischaemic heart disease is well established.[1,2] Our results suggest that the number of patients referred to cardiology clinics would be reduced if direct access to exercise electrocardiography were generally available. In this series the actual referral rate immediately after exercise electrocardiography was only 10% but general practitioners claimed that in the absence of the service 97% of patients, most of whom did not have evidence of ischaemic heart disease on exercise testing, would have been referred initially to a cardiology clinic. As most patients with ischaemic heart disease are initially treated medically, in general, direct access to exercise electrocardiography would enable practitioners to limit referral to a cardiologist to those patients who have very abnormal exercise tests or whose symptoms are uncontrolled by medical treatment. Thus properly used, direct access exercise electrocardiography could reduce the number of referrals of patients with non-cardiac pain to cardiology clinics.

This study confirms that direct referral of patients with suspected ischaemic chest pain for exercise electrocardiography is safe. In this series there were no complications. Moreover exercise electrocardiography was rarely requested for patients in whom the procedure was contraindicated. This contrasts with the initial findings of another group of investigators and can be attributed, at least in part, to our efforts to explain from the start to general practitioners the nature of the service and how it should be used.[4] Effective communication with general practitioners and close monitoring of the service is crucial to the success of a direct access exercise electrocardiography service, as others have found already.[5]

Bayesian analysis dictates that for diagnostic purposes, exercise electrocardiography is most useful where the pretest likelihood of

ischaemic heart disease is moderate.[6] At extremes of low and high pretest risk, false positive and false negative results, respectively, limit its usefulness.[7] In an attempt to exclude patients with a very low pretest risk of ischaemic heart disease, access to the service was not open but was restricted to patients with undiagnosed pain in whom, after clinical assessment, ischaemic heart disease was genuinely suspected. Moreover, to ensure that exercise tests were as informative as possible, all tests were maximal and were performed in the absence of β blockade. Eighteen per cent of patients had positive exercise tests but the pretest probability of ischaemic heart disease, assessed by general practitioners, was moderate or high in 68% and low in only 32%, indicating a tendency to exaggerate the probability of ischaemic heart disease. No lower age limit was set in this study and a subgroup analysis indicated that patients aged $\leqslant 40$ had a very low positive exercise test rate. It would be reasonable to exclude patients < 40 from direct access to exercise electrocardiography as an alternative cause for the symptoms is much more likely.

The response of the 43% of general practitioners who used the service was encouraging. It seems that when general practitioners are in genuine clinical doubt about the cause of a pain after simple clinical assessment and they suspect ischaemic heart disease, the service helps them reach a diagnosis. Where the disease is strongly suspected before exercise electrocardiography, a rational decision about the need for referral to a hospital cardiology clinic can be made, based on the degree of symptoms and the exercise test result. When the index of suspicion is lower, a negative test allows general practitioners to reassure their patient with confidence. Thus both negative and positive test results are useful to general practitioners. This service enabled general practitioners to continue to manage 90% of patients in the community. In most cases the action taken by general practitioners on receiving exercise test results seemed appropriate.

The resource implications of a direct access exercise electrocardiography service are important. For this pilot study, about six exercise tests per 100 000 patients per month were needed, on average, for a Belfast population that has high incidence of ischaemic heart disease. This figure, however, could double if most general practitioners were to use the service. As many of the patients would have come indirectly to the exercise laboratory through the cardiology clinic in the absence of this service, it is unlikely that a direct access exercise electrocardiography service, as described here, results in any net increase in the overall workload of the hospital cardiology service. Indeed the converse may be true but activity in the exercise laboratory will increase modestly.

Whereas exercise testing of asymptomatic patients with risk factors for ischaemic heart disease may identify a subgroup who are at a relatively high risk of subsequently developing ischaemic heart disease,[8] the resource implications of such an approach make it impracticable in the United Kingdom, and such an approach has not been shown to result in a noticeable improvement in prognosis in the screened population. Therefore we cannot see a place for exercise electrocardiography in screening of asymptomatic patients.

LIMITATIONS OF THE STUDY

The long-term outcome in this cohort of patients would be of interest and it is hoped to undertake a long-term follow up study of this series of patients in the future. The conventional definition of a positive exercise test, that is—exercise induced ST segment shift—was used in our study but other exercise variables that were also recorded might be of diagnostic or prognostic importance. In particular the duration of exercise has been shown to be of prognostic importance in both asymptomatic patients and those with angiographically confirmed ischaemic heart disease.[9,10] The follow up study will aim to determine the value of these other exercise test variables and to assess whether the results of exercise testing, conventional risk factors for ischaemic heart disease, and symptomatic state can be easily combined to improve the identification of patients in this population with considerable ischaemic heart disease who are likely to benefit most from further investigation and therapeutic intervention.

Use of the service by only 43% of general practitioners invited to do so may have been due to a number of factors. These might include failure to read the information pack sent to them, a reluctance to alter established patterns of practice and referral, and relatively easy access to cardiology clinics even though there may be a considerable delay before the patient is actually seen. The tendency for younger general practitioners to use the service more may reflect the fact that more senior practitioners are less likely to have experience of modern coronary care and of exercise stress testing and are therefore likely to be less confident about managing this group of patients than their younger colleagues. The low proportion of women among referring doctors may be caused by a tendency for woman general practitioners to develop special interests in aspects of primary care that do not involve adult cardiology. Further efforts to involve non-participating general practitioners will be made as part of the future development of the service.

In conclusion, direct access exercise electrocardiography for patients with suspected ischaemic heart disease is safe, feasible, and helpful to general practitioners. The service seems to reduce the number of patients referred to cardiology outpatient clinics and to facilitate the management of these patients in the community, thereby ensuring more efficient use of limited resources. Consideration should be given to offering general practitioners more direct access to exercise electrocardiography for patients with suspected ischaemic heart disease.

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