A Primary Care Experience of Open Access to Exercise Stress Test

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SUMMARY

This study described the practice profile of an open access exercise stress test (EST) service to the primary care physicians at a teaching hospital in 2000. We performed a retrospective review of all ESTs ordered and conducted by the primary care physicians. A total of 145 ESTs were conducted, of which 80.7% were referred for assessment of chest pain. Proportions of positive, negative, uninterpretable and inconclusive ESTs were: 22.1%, 52.8%, 18.1% and 6.9%. Typical chest pain was independently associated with a positive EST in this study (p=0.008, OR 5.50, 95% CI 1.56-19.37). Although referral to the open access EST service seemed appropriate, there is a need to reduce the number of uninterpretable and inconclusive results.

KEY WORDS:
Exercise stress test, primary medical care, chest pain, coronary artery disease

INTRODUCTION

Chest pain is a common diagnostic problem in primary care and electrocardiogram (ECG) has been frequently used in primary care to diagnose or exclude the possibility of coronary artery disease (CAD). Although ECG is relatively cheap, accessible and easy to perform, it has a low sensitivity[1] making it a less useful test to rule out CAD. As a result, exercise stress test (EST) is increasingly being used for the diagnosis of CAD among patients presenting with chest pain. A meta-analysis by Gianrossi *et al* showed that exercise-induced ST depression had a mean sensitivity of 68% (23-100%) and a specificity of 77% (17-100%), using coronary angiography as the gold standard[2].

Open access to ESTs is available to primary care physicians in some countries[3]. Although it can serve as a useful adjunctive tool to the diagnosis of CAD, there are inherent problems in the test; the accuracy of the test depends on appropriate patient selection, functioning equipments and trained staff to conduct the test and interpret the results[4]. To ensure diagnostic accuracy, it is crucial for patients to achieve clinical targets, such as reaching maximal predicted heart rate and stage 4 of the exercise.

In Malaysia, EST service is restricted only to main hospitals. There are few centres that allow primary care physicians to gain direct access to this service. At the University of Malaya Medical Centre, the cardiology unit runs the EST service. This service is also opened to primary care physicians who work in the outpatient clinic of the hospital. The primary care physicians conduct ESTs two afternoons per week for patients who are referred from their own clinic. This set-up provides an opportunity to study an open access service of EST in a primary care context. The objectives of this study were to describe the practice profile of this unique service, in particular looking at the indications, barriers and outcome of ESTs.

MATERIALS AND METHODS

This study reviewed all ESTs performed by primary care physicians in the year 2000. We obtained the complete list of ESTs from the cardiology laboratory. We retrieved the EST tracings, reports and medical records of all patients during this period. A team of cardiologists from the hospital independently reported on the baseline ECGs and outcome of the ESTs (positive, negative, inconclusive and un-interpretable) based on the American Heart Association guideline[5]. Other information such as achievement of target maximal heart rate [(220-age) x 0.85] and reasons of termination were extracted from the EST reports. Clinical information (age, gender, ethnicities, indications of EST, risk factors, follow-up and final diagnosis) were collected from the medical records. This study was approved by the hospital ethics committee.

We analysed the data using the SPSS 11.5 software. Categorical data were presented in percentages while continuous data were presented as means with standard deviations. Associations between independent variables and outcome of EST were determined using chi-square test for categorical variables and student t-test for continuous variables. We analysed the predictors of positive EST using a binary logistic regression model.

RESULTS

Patients' profile

In the year 2000, a total of 145 ESTs were conducted for patients attending the primary care clinic in the hospital. The mean age of the patients was 52.9 years (SD=9.7, range 24-78 years). Majority of them were male (66.2%) with an equal distribution of ethnicity (Chinese 33.8%; Indian 33.8%; Malay 29.4%). The proportions of patients with cardiovascular risk factors (RF) were: hypertension 44.1% (n=64), dyslipidaemia 40% (n=58), diabetes mellitus 24.8% (n=36), smoking 16.6% (n=24) and family history of coronary artery disease 10.3% (n=15). 76.6% of the patients had at least

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one risk factor for coronary artery disease (No RF 23.4%; one RF 35.2%; two RF 24.8%; three RF 15.2%; four RF 1.4%)

Indications of EST (Table I)
Majority of patients (80.7%) were referred for assessment of chest pain, out of which 76.4% were atypical chest pain. Twenty patients (13.8%) were referred for EST because of abnormal baseline ECG.

Targets of EST achieved
77.2% (n=112) achieved their maximal predicted heart rate while 20.0% (n=29) attained stage 4 according to Bruce protocol. Four patients stopped prematurely because of chest pain and one met the ECG criteria for positive EST. There was no patient who experienced hypotension, developed heart murmurs or extra heart sounds. Thirteen percent (n=19) did not achieve the EST targets and the reasons for early termination were tired legs 5.5% (n=8), fatigue 4.8% (n=7), shortness of breath 2.1% (n=3), and blood pressure ≥230mm Hg 0.7% (n=1).

Outcome of EST
22.1% (n=32) of the EST results were positive. (Table II) All positive ESTs showed ST changes, either with horizontal or down sloping ST depression ≥1mm, or up sloping ST depression of >2mm at 0.08s from the J-point. Two individuals experienced a drop of ≥10mmHg in systolic blood pressure.

There were significant associations between positive EST and age ≥ 55 (p=0.004), diabetes mellitus (p=0.01) and typical chest pain (p=0.001). (Table III) Using binary logistic regression analysis, typical chest pain was the only independent predictor of a positive EST (p=0.008, OR 5.50, 95% CI 1.56-19.37). There was no association between positive EST and number of risk factors.

Final Diagnosis (Table II)
Among those who were referred for EST, almost half (46.9%) of them did not have a final diagnosis in the medical record and 22.8% did not return for follow-up. Coronary artery disease (15.1%), musculoskeletal pain (5.5%) and gastrointestinal causes (4.1%) were the three most common diagnoses.

DISCUSSION

In this study, majority (80%) of the ESTs were ordered to rule out CAD in patients presenting with chest pain. It is important to understand that EST is an assessment tool of CAD, but it, on its own, is not a gold standard for diagnosing CAD. The pre-test probability of significant CAD should be determined based on a combined analysis of risk factors such as age (older > younger), gender (male > female) and the type of chest pain (typical > atypical > non-anginal chest pain >

Table I: Indications of ESTs

Indications	Frequency (%) n=145
Evaluation of chest pain	
Typical	110 (80.7)
Atypical	17 (11.7)
Non-angina	84 (57.9)
Not recorded	1 (0.7)
Evaluation of abnormal rhythm	7 (4.8%)
Evaluation of abnormal ECG	20 (13.8%)
Evaluation of dyspnoea	12 (8.3%)

* The number did not add up to 145 due to multiple response stems

Table II: Outcome of ESTs and Final diagnoses

Outcome	Frequency (%)
EST outcome (n=144)*	
Positive	32 (22.2)
Negative	76 (52.8)
Inconclusive	10 (6.9)
Un-interpretable	26 (18.1)
Final diagnosis (n=145)	
CAD	22 (15.2)
Musculoskeletal pain	8 (5.5)
GIT causes	6 (4.1)
Arrhythmia	3 (2.1)
Psychiatric	2 (1.4)
Normal	3 (2.1)
Unknown	68 (46.9)
Default	33 (22.8)

* One missing response

Table III: Associations between positive ESTs and patient's socio-demography, CAD risk factors and indications of EST.

Independent Variables	Positive EST (%) (n=32)	Negative EST (%) (n=76)	P value
Age (years)	57.1	50.8	0.003
Gender			NS
Male	19 (26.8)	52 (73.2)	
Female	13 (35.1)	24 (64.9)	
Ethnicity			NS
Chinese	13 (36.1)	23 (63.9)	
Indian	11 (27.5)	29 (72.5)	
Malay	8 (28.6)	20 (71.4)	
Others	0	4 (100)	
Risk factors			
Diabetes	14 (48.3)	15 (51.7)	0.005
Hypertension	15 (34.9)	28 (65.1)	NS
Family history of CAD	4 (30.8)	9 (69.2)	NS
Dyslipidaemia	15 (35.7)	27 (64.3)	NS
Smoking	6 (33.3)	12 (66.7)	NS
Indications			
Typical chest pain	10 (66.7)	5 (33.3)	0.002
Atypical chest pain	15 (22.1)	53 (77.9)	

asymptomatic). The greatest diagnostic value of EST is achieved in patients with an intermediate pre-test likelihood of CAD between 20% and 80%. The probability of CAD can be refined further by the presence and the degree of ST segment changes[6]. In this study, majority of the patients were male, above 50 years of age, had atypical chest pain with more than one risk factor. These patients had intermediate pre-test probability of CAD that would fit into the ACC/AHA Class I classification where "there is evidence that a given procedure or treatment is useful and effective"[5].

However, 20.7% (n=30) had an abnormal resting ECG and 13.8% (n=20) were referred as the main indication for EST. Although the presence of ECG abnormalities is not an absolute contraindication for EST, they may mimic ECG changes that are consistent with ischaemia during exercise, making it difficult to arrive at definitive conclusions. In these situations, imaging studies such as stress echocardiography or nuclear imaging would be more appropriate[7].

It is interesting to note that there was no asymptomatic individual who underwent EST to screen for CAD in this study. Recent evidence suggests that it may be appropriate to screen for CAD among high-risk healthy individuals with two or more risk factors. In a 7-year prospective study among healthy middle-aged and older men, Katzel *et al* demonstrated that there were significant higher cardiac events in those with silent ST depression compared to those without silent ischaemia (46% vs 11%)[8]. Laukkanen *et al* also found that silent ischaemia during EST was associated with a 5.9, 4.7 and 3.8-folds increased risk of cardiac mortality among men who smoked, had hypertension and hypercholesterolaemia respectively[9]. The American Diabetes Association recommended using EST to screen for CAD in asymptomatic diabetic patients with history of peripheral or carotid occlusive disease; those with sedentary lifestyle, age >35 years, and plans to begin a vigorous exercise programme[10]. However, this recommendation was based on consensus of an expert panel, rather than rigorous research evidence. Future studies are needed to guide the selection of asymptomatic high-risk individuals to undergo ESTs.

In this study, 77% (n=112) of those who underwent ESTs achieved their target heart rates. There were 20.9% (n=29) who attained stage 4, four experienced chest pain and one met the ECG criteria of positive EST. The main reasons for early termination of EST were "legs tiredness" and "fatigue". Therefore, it is important to select and prepare patients prior to ESTs to ensure completion of the investigation. Otherwise, early termination of EST renders the results un-interpretable and a repeat EST or other imaging studies are needed to evaluate the patients' cardiac status.

All positive ESTs in this study were diagnosed based on significant exercise-induced ST segment changes. However, the quantitative value of ST depression in measuring ischaemia is conflicting and remains unclear[11]. Besides the depth and amount of exercise required for its induction, the other important features include: the duration of ST changes, degree of down sloping, number of leads in which it appears and the presence or absence of T wave inversion. Recent studies have suggested using more sophisticated ECG parameters to improve diagnostic and prognostic value of EST: heart rate or blood pressure response to exercise, heart rate and blood pressure recovery patterns, and an integrated treadmill score[12-15].

In this study, age (≥ 55 years), diabetes mellitus and typical chest pain were significantly associated with positive EST. However, using binary logistic regression, typical chest pain was the only factor that was independently associated with positive EST. Other risk factors such as gender, age, dyslipidaemia, hypertension, smoking and family history of CAD were not associated with positive EST results. The lack of significant associations in this study is probably due to the small sample size and incomplete data in some of the medical records.

More than half of the final diagnoses of patients in this study remained unknown. This reflects the diagnostic difficulty of patients presenting with chest pain in primary care, and, possibly, the preoccupation of the primary care doctors with excluding CAD, rather than making a definitive diagnosis of the chest pain. Although coronary artery disease is an uncommon diagnosis in a patient presenting with chest pain in primary care,[16] doctors' tend to focus on excluding coronary artery disease rather than trying to determine the actual cause of chest pain. Educating primary care doctors on diagnostic strategy of chest pain and providing an evidence-based EST guideline will improve diagnostic accuracy and reduce the number of unnecessary referrals.

There are a few limitations in this study. Some of the information from the medical records was incomplete and this resulted in some missing data such as risk factors and indications of EST. Furthermore, 22.8% did not turn up for follow-up making it difficult to confirm the final diagnoses. These are limitations commonly encountered in a retrospective study.

In conclusion, the indications of ESTs in this study were appropriate as majority of the individuals referred for ESTs had an intermediate pre-test probability of CAD. However, there is room for improvement in terms of reducing the number of referrals for abnormal baseline ECG and increasing the number of individuals attaining the EST targets. This can be achieved by educating the primary care physicians about the indications and targets of ESTs. An EST protocol, catering to the needs of primary care, should be designed, implemented and reinforced with regular audits to ensure appropriate referral. Future research on the use of clinical scores and improvements of the quantitative values of ST changes during or after the exercise may further enhance the accuracy of this test in diagnosing and prognosticating CAD in the primary care setting.

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