Application of the Duke's treadmill score to a rapid access chest pain clinic

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Abstract

In an observational study, we sought to determine the effect of applying the Duke's treadmill score on patient assessment and prioritisation to coronary angiography waiting lists within a rapid access chest pain clinic in a UK district general hospital.

After attending the rapid access chest pain clinic, patients requiring subsequent coronary angiography were placed on either an urgent or a routine waiting list. We determined the number of patients subsequently shown to have severe coronary artery disease (left main stem or three-vessel disease) in both waiting lists. We then assessed the effect of applying the Duke's treadmill score retrospectively on these patients to produce regraded waiting lists (urgent and routine); these were compared with the actual lists generated clinically.

The actual urgent list had 43/111 (39%) patients with severe disease; the actual routine list had 28/98 (29%) patients with severe disease (p=NS). Application of the Duke's treadmill score to produce re-graded lists reduced the total number of patients on the urgent list from 111 to 68. Thirty-three of 68 (49%) patients on the Duke's treadmill score urgent list had severe disease compared to 43/111 (39%) on the actual urgent waiting list. Specificity for allocating patients with severe disease to the urgent waiting list improved from 50% to 75% by application of the Duke's treadmill score compared with the clinically generated list.

Thus, the Duke's treadmill score could be used in a rapid access chest pain clinic to prioritise patients objectively for cardiac catheterisation in a resource-limited system.

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Introduction

Each year in the UK, 20,000 new patients develop angina. To improve standards of care the Department of Health's National Service Framework for Coronary Heart Disease (NSF for CHD) has set goals for its diagnosis and treatment.[1] Chapter Four of the NSF states that a specialist should assess patients presenting with symptoms consistent with angina within two weeks of referral.[1] To achieve this goal, the Department of Health has encouraged the development of rapid access chest pain clinics for the evaluation and investigation of patients with suspected angina. Chapter Four also recognises that, due to under-investment, the waiting times for diagnosis and treatments are long.[1] Rapid assessment of patients with chest pain will increase demand on coronary angiography lists and it is important to use these limited resources in an objective and cost-effective manner.

At St Mary's Hospital (Portsmouth Hospitals Trust), 30–40 patients per week are assessed in daily rapid access chest pain clinics by a consultant, specialist registrar or general practitioner. Patients undergo exercise stress testing, incorporating the standard Bruce protocol. Patients who require angiography are prioritised to either a routine or an urgent cardiac catheterisation waiting list to facilitate the most efficient use of limited resources. This decision is left to the individual clinician.

The Duke's treadmill score has been shown to provide prognostic and diagnostic information on symptomatic patients who present with suspected angina.[2,3] It is a simple score, endorsed by the American Heart Association.[4] The four-year survival rates according to the Duke's treadmill score are as follows: score ≥ 5, survival 99%; score -10 to 4, 95%; score < -10, 79%. (These figures are adapted from Mark DB *et al.*)[3]

The aim of this retrospective study was to determine the severity of coronary artery disease found at angiography in patients who had been allocated to the urgent or routine lists on the grounds of clinical judgement alone. The Duke's treadmill score was then applied to produce regraded waiting lists and the incidence of severe coronary artery disease was re-determined. We decided to concentrate on three-vessel disease and left main stem stenosis as this group of patients benefits most from revascularisation[5] and therefore swift assessment.

Table 1. Severity of coronary artery disease found in clinically decided waiting lists and regraded (by Duke's treadmill score) waiting lists

Waiting lists	Patients Total number	LMS or 3VD Number (%)	2VD or less Number (%)
Actual			
Urgent	111	43 (39)	68 (61)
Routine	98	28 (29)	70 (71)
Regraded			
Urgent	68	33 (49)	35 (51)
Routine	141	38 (27)	103 (73)

Key: LMS = left main stem; VD = vessel disease

Table 2. The effect of the Duke's treadmill score on prioritisation of patients to coronary angiography (i.e. left main stem/three-vessel disease to urgent list and ≤ two-vessel disease to routine list) (McNemar's 2 by 2 table, p<0.05)

	Regraded list		Total
	Correct grading	Inappropriate grading	
Actual list			
Correct grading	80	33	113
Inappropriate grading	56	40	96
Total	136	73	209

Materials and method

The study included all patients who attended the rapid access chest pain clinic in 2002 (n=1,416). Of these, 270 were referred for cardiac catheterisation. By the time of this review, 209 (77%) had undergone their investigation and had sufficient information in the notes to calculate a Duke's treadmill score. The following formula is used:

D – (5 x mST) – (4 x TAI)

(where: D = duration of exercise [minutes]; mST = maximal set ST-segment deviation during or after exercise [millimetres]; TAI = treadmill angina index [0 = no angina; 1 = non-limiting angina; 2 = exercise test stopped due to angina]).

Patients were grouped as having either severe or non-severe coronary artery disease (severe disease was defined as three-vessel disease or left main stem stenosis).

The results were analysed on a two-by-two contingency table using Fisher's exact test (a p value of < 0.05 was considered significant). McNemar's test was used to compare referral to the urgent and non-urgent coronary angiography waiting lists generated by application of the Duke's treadmill score against decisions by clinic physicians. Regraded waiting lists were derived as follows: patients with a score <-10 were prioritised to the urgent waiting list while those with a score >-10 were graded as routine.

Results

A total of 209 patients were included (29% female) and the mean age was 62 years (range 40–84). The prevalence of coronary risk factors was as follows: diabetes mellitus 12%; hypertension 45%; hypercholesterolaemia 65%; smoking 23%; family history of CHD 36%.

Of the 209 patients who underwent angiography, 71 (34%) had left main stem or three-vessel disease. Table 1 demonstrates the actual waiting list and the regraded waiting list, generated by application of the Duke's treadmill score, for these 209 patients according to whether they were given an urgent or routine priority.

After clinical assessment within the rapid access chest pain clinic, 111 patients were referred for urgent angiography and 98 for routine angiography. Thirty-nine per cent of patients prioritised to the urgent waiting list were subsequently found to have severe disease at angiography compared to 28% of patients with severe disease referred to the routine list (p=NS).

Application of the Duke's treadmill score produced a 39% decrease in the number of patients on the regraded urgent waiting list, from 111 patients to 68.

The regraded waiting lists show 49% of patients on the urgent list have severe coronary artery disease compared to 27% on the routine regraded list (p<0.01) (table 1).

Specificity for detecting severe disease is improved by the application of the Duke's treadmill score compared with clinical judgement alone, from 50% to 75%. There is, however, a drop in sensitivity from 61% to 47% (Fisher's exact test). Application of the score significantly improved appropriate grading of patients for cardiac catheterisation waiting lists compared with grading derived from subjective decision of the physicians (McNemar's test, table 2). Using the Duke's treadmill score, 136/209 (65%) patients on the regraded list were appropriately classified (severe disease to urgent list and two-vessel disease or less to routine list) compared with 113/209 (54%) on the actual waiting list. Analysis using McNemar's test shows that the Duke's treadmill score is significantly better at prioritising patients than subjective clinical judgement (p<0.05, table 2).

Discussion

Coronary artery disease is the leading cause of mortality in the UK. Rapid access chest pain clinics have been developed for the rapid assessment and diagnosis of patients with chest pain. Patients need to be reviewed within two weeks of referral and patients diagnosed with angina are treated medically with anti-anginal and secondary prevention drugs and/or prioritised for coronary angiography as deemed necessary. The advent of the rapid access chest pain clinic has shifted the waiting lists from time to be seen in clinic and subsequent diagnosis, to time waiting for diagnostic angiography, leading to an increased burden on an already overstretched outpatient angiography service. Staffing of these clinics varies nationally involving physicians and nurses of varying experience. Chapter Four of the NSF for CHD states that there should be "clear protocols and guidance specifying the indications and routes of referral for angiography".[1]

This study sought to determine the effect of applying, retrospectively, the Duke's treadmill score to patient prioritisation for coronary angiography after they attended the Portsmouth rapid access chest pain clinic. Other studies have used the score to prioritise patients but this is the first to apply this score in a chest pain clinic setting with several different clinicians.[6]

The Portsmouth service is staffed by a heterogeneous group of physicians. Analysis of their referral pattern demonstrated that, using clinical decisions alone, there was no significant difference in the proportion of severe coronary artery disease that was subsequently found in patients on the urgent compared to the routine waiting lists. Clinically informed patient prioritisation was no more effective than random chance despite the fact that the urgent waiting list was larger than the routine list. Thus, subjective assignment of patients to urgent and routine angiography increased urgent angiography waiting time without appropriately stratifying high-risk coronary disease to the urgent list. On the basis of clinical decision-making in a rapid access chest pain clinic there is no advantage in having 'urgent' and 'routine' waiting lists. Within a resource-limited system it is difficult to increase the total number of cardiac angiograms performed to accommodate the demand for this service from chest pain clinic referrals.

However, using the Duke's treadmill score to prioritise patients, the urgent angiography waiting list was reduced significantly by 39%. This would allow the urgent list to be rationalised and would allow these patients to be investigated more quickly. In addition, use of the score improved specificity compared to clinician decision-making by decreasing the number of patients with less severe coronary artery disease on the urgent list and improved the assignment of severe disease. Use of the Duke's treadmill score improved significantly overall patient allocation to urgent and routine waiting lists compared with clinical judgement alone.

The score did decrease the number of severely diseased patients in the urgent group of the regraded waiting list by 10 people (from 43 to 33) compared to the actual list in this study. This may be possibly clinically important to the individual patient but this analysis cannot determine whether their outcome was disadvantaged. These 10 patients will be at relatively low cardiovascular risk as they have a score of >-10 (thus a 95–99% four-year survival) and after their early assessment in clinic they will have been given a diagnosis of coronary artery disease and commenced on disease-modifying secondary prevention medication. Application of this objective score for all patients will provide risk stratification and will facilitate targeting optimal medical therapy for symptoms and risk factors at an early stage of their assessment. Further studies will be required to assess the effect of such a risk stratification on patient management.

The current study has several limitations, in keeping with all retrospective analyses. The total number of patients included in this study was relatively small and did not include details of all patients who underwent angiography due to a combination of factors. In addition, the score calculated in this study used ST-segment deviation as recorded in the notes stated in whole millimetres and not fractions of millimetres, as used in previous trials.[2,3] Nonetheless, this does not detract from the overall qualitative effect that we observed of using the score to rationalise patient investigation.

A number of cut-off Duke's treadmill score values have been used to denote high-risk coronary artery disease. These include studies examining patients with values of < -10 (outpatients with suspected coronary artery disease),[3] < -11 (identifying subgroups of patients with coronary artery disease),[2] ≤ -11 values (determining prognostic value of the score).[7] We used a value of < -10 to signify high-risk disease as this study[3] closely resembles the situation in a rapid access chest pain clinic. In a previous diagnostic study, 75% of patients with a score of < -11 demonstrated left main stem or three-vessel disease on angiography.[2] By comparison, in this study 49% of patients with < -10 score had severe disease. This difference in severe disease proportion is probably multifactorial as our retrospective study is smaller and used a different cut-off value in a different patient population.

Key messages

- Subjective clinically-based decisions in a rapid access chest pain clinic do not stratify high-risk patients to urgent coronary angiography appropriately
- The Duke's treadmill score is significantly better than clinical judgement at prioritising referral of patients to urgent and routine coronary angiography
- Use of the Duke's treadmill score reduces referrals to urgent angiography waiting lists by 39%
- The Duke's treadmill score can easily be calculated for patients by staff running a rapid access chest pain clinic and used in their risk stratification and management

Summary

In summary, the Duke's treadmill score can easily be applied in the setting of a rapid access chest pain clinic. It could be used to help to prioritise objectively the urgency for patients to be listed for cardiac catheterisation in a resource-limited system and proves more effective than subjective decisions based on clinical findings alone.

Conflict of interest

None declared.

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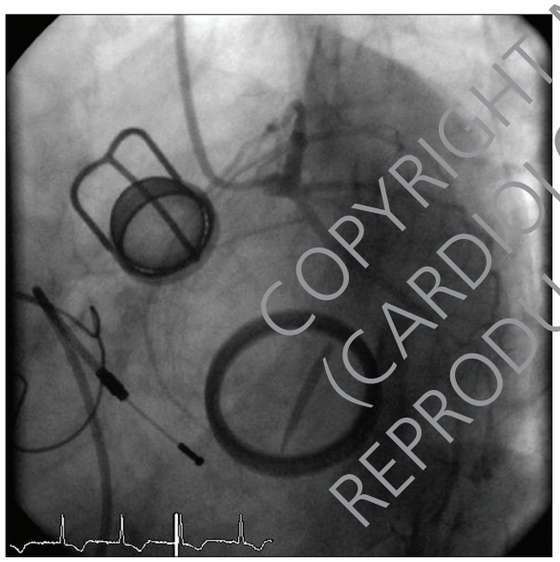
References

1. National Service Framework for Coronary Heart Disease. Chapter Four: Stable Angina. London: Department of Health UK, 2000;2-10.

2. Shaw LJ, Peterson ED, Shaw LK *et al.* Use of a prognostic treadmill score in identifying diagnostic coronary disease subgroups. *Circulation* 1998; **16**:1622-30.
3. Mark DB, Shaw LK, Harrell FE Jr *et al.* Prognostic value of a treadmill exercise score in outpatients with suspected coronary artery disease. *N Engl J Med* 1991;**325**:849-53.
4. Gibbons RJ, Balady GJ, Beasley JW *et al.* ACC/AHA guidelines for exercise testing: executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise testing). *Circulation* 1997;**96**:345-54.
5. Solomon AJ, Gersh BJ. Management of chronic stable angina: medical therapy, percutaneous transluminal coronary angioplasty, and coronary artery bypass graft surgery: lessons from the randomized trials. *Ann Intern Med* 1998;**128**:216-23.
6. Smith E, Azeem T, Vassallo M, Martin M. Identifying priority patients for coronary angiography in the District Hospital setting. *Heart* 2000;**83** (suppl):1:4.
7. Mark DB, Hlatky MA, Harrell FE Jr, Lee KL, Califf RM, Pryor DB. Exercise treadmill score for predicting prognosis in coronary artery disease. *Ann Intern Med* 1987;**106**:793-800.

Cardiac investigation in rheumatic heart disease (let's leave the MRI for now shall we...)

Figure 1. Coronary angiography reveals a patient's past medical history



A 61-year-old woman with a past history of rheumatic fever presented with increasing chest pain and breathlessness. Coronary angiography elegantly illustrated the patient's past cardiac history (see figure 1).

In 1973 she required an aortic valve replacement (size 9 Starr-Edwards prosthesis) for severe aortic regurgitation. In 1991 she developed increasing breathlessness and palpitations. Echocardiography demonstrated significant mitral and tricuspid valve disease; further valve replacement surgery was performed. The mitral valve was calcified posteriorly and stenotic, and the tricuspid valve regurgitant and stenotic with fused leaflets. A 33 mm carbomedics mitral valve prosthesis and a 35 mm Carpentier Edwards tricuspid prosthesis were inserted. Atrial fibrillation remained a clinical problem despite numerous antiarrhythmic medications. She was readmitted in 1997 with syncope and found to have intermittent episodes of ventricular standstill, for which a VVI permanent pacemaker was inserted.

On this admission she required further coronary angiography for recurrent chest pain. In view of the difficulties with ECG interpretation and her inability to exercise, further coronary angiography was performed from the radial artery in order to reduce any thrombotic risk caused by termination of anticoagulation. It showed normal epicardial coronary arteries with clear visualisation of the three prosthetic valves and the ventricular pacing lead. Transoesophageal echocardiography demonstrated good left ventricular function, normal mitral and aortic prosthetic function and mild degeneration of the tricuspid prosthesis with moderate tricuspid stenosis. She continues to be managed medically.

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