Selecting optimal non-invasive cardiac imaging stress test in intermediate-risk patients using cost effectiveness analysis

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This editorial refers to ‘Incremental cost effectiveness of exercise echocardiography vs. SPECT imaging for the evaluation of stable chest pain” by L.J. Shaw et al., on page 2448

Coronary artery disease is the leading cause of death in the Western society.¹ The use of non-invasive cardiac imaging in combination with exercise or pharmacological stress has become a cornerstone for the objective assessment and subsequent treatment strategy of coronary artery disease. This results in an improved life expectancy and cost savings.² Echocardiography and myocardial perfusion scintigraphy are both frequently used imaging modalities. This has improved the diagnostic accuracy, compared with electrocardiographic testing; considerable as baseline electrocardiographic abnormalities precluded reliable testing during stress in up to 40% of the tested population.³

During stress, in the presence of coronary artery disease, patients develop transient regional mismatch between myocardial oxygen demand and supply. This results in myocardial ischaemia, with a cascade of events over a well-defined time period. At first, flow heterogeneity, especially between subendocardial and subepicardial perfusion, is induced, followed by regional wall motion abnormalities, electrocardiographic changes, and chest pain. Scintigraphy detects perfusion abnormalities, an early marker of stress-induced ischaemia, whereas echocardiography detects wall motion abnormalities that occur later in the ischaemic cascade. Although perfusion abnormalities precede myocardial wall motion abnormalities and may therefore be more sensitive to wall motion abnormalities for the detection of coronary artery disease, the overall sensitivity of exercise echo and nuclear imaging is similar.⁴ However, specificity is reduced in myocardial perfusion scintigraphy. In a meta-analysis of 44 articles, exercise echocardiography had sensitivity for the detection of coronary artery disease of 85% (95% CI, 83–87%) with a specificity of 77% (95% CI, 74–80%). Nuclear imaging had a similar sensitivity of 87% (95% CI, 86–88%) but a reduced specificity of 64% (95% CI, 60–68%).⁵ ⁶ However, perfusion scintigraphy has several advantages over echocardiography; it is more sensitive for the detection of single-vessel disease and can quantify the extent of ischaemia more reproducible.

In applying a stress test, it is mandatory for clinicians to consider the pre-test likelihood of the presence of coronary artery disease. This likelihood, or in Bayesian terms, the prior probability, should then be revised by the applied test into a post-test probability. In patients at low risk, a normal test should rule out the presence of coronary artery disease, whereas an abnormal test should identify those in whom additional, more expensive testing is indicated. In contrast, in patients with an increased likelihood of coronary artery disease, the test should indicate the location and extent of the disease, which will guide the clinician to additional medical or interventional therapy. This strategy may overcome arguments against early testing in intermediate-risk patients, as inappropriate use of more expensive tests, as well as the possible introduction of complications, can be avoided. In order to compare imaging modalities, echocardiography and myocardial perfusion scintigraphy, in intermediate-risk patients, a cost effectiveness analysis, including all costs generated by additional (inappropriate) tests should be taken into account.

The present study by Shaw et al.⁷ evaluated the optimal diagnostic test for intermediate-risk patients using cost effectiveness analysis. Using this concept, all downstream costs, including diagnostic angiography and coronary revascularization, are compared between the two tests in relation to the number of life-saved years. In a prospectively collected group of 9,521 intermediate-risk patients with stable angina, both exercise echocardiography and nuclear imaging are highly effective in long-term risk stratification. The population studied has an annual risk of cardiac death or non-fatal myocardial infarction of 1–3%. Two groups of patients, matched for risk factors, controlled for referral bias, and capable of exercising were compared for total cardiovascular costs throughout the follow-up. The risk-adjusted 3-year death and myocardial infarction, corrected for the presence and extent of ischaemia, were similar for both groups.
However, using cost effectiveness analysis, a difference between echocardiography and nuclear imaging was observed. In patients with suspected coronary artery disease, or a predicted annual risk of cardiac death or myocardial infarction of <2%, echocardiography was more cost effective, whereas in patients with known coronary artery disease, or an annual risk of cardiac death or myocardial infarction of ≥2%, nuclear imaging was superior.

A point of discussion in the present study is the use of quantitative myocardial perfusion scintigraphy compared with qualitative echocardiography. The main limitation of stress echo in intermediate-risk patients is the limited sensitivity for the detection of single-vessel disease. The evaluation of wall motion abnormalities not only at peak stress, but also during the recovery phase after acute beta-blocker blockade increased the sensitivity of dobutamine echocardiography for the detection of single-vessel disease. In a group of 182 patients, sensitivity increased from 81% (95% CI, 75–87%) to 98% (95% CI, 96–100%) with a similar specificity. Furthermore, the introduction of objective, automatic assessment of wall motion abnormalities using endo- and epicardial border tracking, and improvement of image quality by contrast agents, might shift the proposed strategy towards an echocardiographic approach.

The present concept, taking into account the additional cardiovascular costs of intermediate-risk patients, puts the concept of relatively early screening in a realistic perspective and should be regularly updated with the introduction of new imaging techniques.

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References