EDITORIAL

Stress echocardiography in contemporary clinical cardiology: practical considerations and accreditation

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Abstract

Stress echocardiography is a widely utilised test in patients with known or suspected coronary artery disease (CAD), valvular heart disease and cardiomyopathies. Its advantages include the ubiquitous availability of echocardiography, lack of ionising radiation, choice of physiological or pharmacological stressors, good diagnostic accuracy and robust supporting evidence base. SE has evolved significantly as a technique over the past three decades and has benefitted considerably from improvements in overall image quality (superior resolution), machine technology (e.g. digital cine-loop acquisition and side-by-side image display) and development of second-generation ultrasound contrast agents that have improved reader confidence and diagnostic accuracy. The purpose of this article is to review the breadth of SE in contemporary clinical cardiology and discuss the recently launched British Society of Echocardiography (BSE) Stress Echocardiography accreditation scheme.

Key Words

- stress echocardiography
- training
- ischaemia
- valve disease
- cardiomyopathy

Introduction

Stress echocardiography was initially employed as a non-invasive means of assessing patients with suspected coronary artery disease (CAD) by comparing regional and global left ventricular systolic function at rest and on stress (1). As 2-dimensional echocardiography became more widely available, a wealth of data accrued during the 1980s and 1990s demonstrating the feasibility, safety and accuracy of exercise (2), dobutamine (3) and dipyridamole (4) stress echocardiography, resulting in it becoming a mainstream clinical investigation for symptomatic patients with possible CAD. The limited image quality and sub-optimal endocardial border visualisation observed in certain patients was directly addressed by the development of transpulmonary ultrasound contrast. These microbubble agents significantly improved the interpreting clinician's confidence and diagnostic accuracy, in particular if ≥2 adjacent myocardial segments were not clearly visualised (5). Indeed, so effective is the improvement in image quality following contrast administration that excellent feasibility, accuracy and

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effectiveness in clinical triaging of even significantly obese patients undergoing stress echocardiography was recently reported in the Stress Ultrasonography in Morbid Obesity (SUMO) study (6). The advent of ultrasound contrast agents also permitted the assessment of myocardial perfusion during stress imaging, a technique known as myocardial contrast echocardiography (MCE) (7). Although largely a research tool for many years, the recently published Incorporation of Myocardial Perfusion Assessment into Clinical Testing with Stress Echocardiography (IMPACT-SE) study (8) demonstrated the feasibility and clinical utility of MCE in real world clinical practice and the follow-up study (9) revealed additive prognostic value of perfusion assessment.

Stress echocardiography is most frequently performed in stable outpatients as an elective procedure but can also be safely performed in hospitalised patients. In the pre-primary angioplasty era, low-dose dobutamine echocardiography was frequently employed after thrombolysis for acute myocardial infarction to determine the residual myocardial viability (10). Stress echocardiography – both physiological and pharmacological – can also be utilised safely and effectively in acute chest pain admissions with negative cardiac biomarkers prior to hospital discharge (11).

Although assessment of inducible ischaemia remains the cornerstone of any stress echocardiography service, the clinical utility of the technique has broadened significantly in the ensuing years. As an example, there is growing appreciation of the value of stress testing in patients with valvular heart disease. These patients have traditionally been evaluated by resting echocardiography only, although their symptoms are typically triggered by exertion. A modern SE operator must therefore also have the ability to assess stenotic and regurgitant valve lesions and cardiomyopathies, such as hypertrophic cardiomyopathy (HCM).

SE in valvular heart disease

Exercise echocardiography can be used for risk stratification in asymptomatic patients with severe aortic stenosis. Stress-induced significant increases in mean trans-aortic gradient (>18 mmHg (12) or >20 mmHg (13)) and trans-tricuspid gradient are independently associated with worse outcome. However, the most recent European guidelines on the management of patients with valvular heart disease (14) have removed this recommendation as a criterion upon which to suggest valve intervention, predominantly due to the lack of hard outcome events in the original studies. The test may still have some clinical utility in selected patients in whom the decision to operate remains unclear. Additionally, dobutamine echocardiography is frequently used to help differentiate true severe AS from pseudo-severe (moderate) AS in patients with low-flow low-gradient aortic stenosis (15).

Exercise stress echocardiography is also useful in certain patients with mitral valve disease. Patients with mitral stenosis (MS) who have symptoms disproportionate to the degree of MS at rest (e.g. marked exertional dyspnoea but only moderate MS at rest) should undergo exercise echocardiography – an increase in mean trans-mitral gradient to >15 mmHg or pulmonary artery pressure to >60 mmHg may help identify patients that could benefit from valvular intervention (16). With regards to mitral regurgitation (MR), Pierard and Lancellotti demonstrated the dynamic nature of ischaemic MR by performing quantitative Doppler echocardiography during exercise stress in patients with ischaemic cardiomyopathy (ICM) and recently admitted with pulmonary oedema and comparing with ICM patients without pulmonary oedema (17). Patients with recent pulmonary oedema had significantly greater increases in MR and pulmonary pressures during exercise than those without pulmonary oedema. With respect to degenerative MR, exercise stress echocardiography has been shown to be of clinical benefit in asymptomatic patients with severe MR (18) as well as symptomatic patients with 'only' moderate MR on resting echocardiography. In asymptomatic severe MR, the test can help unmask symptoms, detect subclinical LV systolic dysfunction and pathological rises in pulmonary pressures, which are associated with poorer outcome (19). As primary MR can have a dynamic component – increasing with exercise – it is a key test in the symptomatic patient with moderate MR at rest (20). Finally, appropriateness criteria have been developed in stress echocardiography and the clinical and prognostic value of these in patients with valvular heart disease assessed by stress echocardiography have recently been demonstrated (21).

SE in cardiomyopathy

Aside from valvular heart disease, exercise SE can be used in patients with hypertrophic cardiomyopathy to detect dynamic left ventricular outflow tract obstruction or diastolic dysfunction, which may account for impaired exercise capacity (22). Finally, myocardial viability determined by low-dose dobutamine echocardiography can predict survival in heart failure patients (23) and can potentially identify responders to cardiac resynchronisation therapy (24).

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Competence and accreditation in stress echocardiography

Against this background, therefore, in which a contemporary echocardiologist or echosonographer needs to acquire proficiency in the evaluation of myocardial ischaemia, myocardial viability, valve disorders and cardiomyopathy, it is pertinent to revisit the guidance for optimum training required to become a competent SE operator in the modern era. In 1991, a landmark study was published in which the operator dependence of SE was demonstrated but, importantly, the authors showed it can be overcome with instruction under expert supervision (25). In a two-part study, the authors initially found a marked difference in diagnostic accuracy between novice and experienced SE readers when evaluating 50 SE studies (62% vs 85% respectively). In the second part, they showed that this difference is eliminated after repeating the exercise (with a different set of 50 studies) following a training period of 100 cases for the SE novices (83% vs 86%, respectively). They concluded that '100 SE studies are more than adequate to build the individual learning curve and reach the plateau of diagnostic accuracy that the test can yield' (25). The timing of this publication was key, given the questions about operator dependence and diagnostic accuracy surfacing at that time (26).

However, SE has evolved significantly over the past quarter century since that study was conducted and the indications for SE have broadened considerably though this is not reflected in international guidelines and training documents. The former European Association of Echocardiography's 2008 consensus statement (27) supports the notion that 100 studies are 'more than adequate to reach a plateau of diagnostic accuracy'. The 2007 SE recommendations of the American Society of Echocardiography are more cautious, stating that 'to achieve the minimum level of competence for independent interpretation, training should include interpretation of at least 100 stress echocardiograms under the supervision of an echocardiographer with level-III training and expertise' (28). These recommendations are echoed in the 2008 American College of Cardiology Foundation Training Statement on Echocardiography (29). Finally, the core curriculum for cardiology trainees in the United Kingdom states that 'an indicative case number that is likely to be necessary to achieve competence and provide sufficient experience is 100 for stress echocardiography' (30). The concept of an 'expert' deserves brief discussion, as in reality, this title is often self-designated and is hard to define. With regards to stress echocardiography, we suggest that an expert is 'an individual that has received training under a respected exponent of the craft, has a high-volume experience (e.g. greater than 1000 scans), has a track record of teaching and training others, has conducted research and is generally recognised by the echocardiography community as having advanced knowledge and skills in the field (which may be reflected in publication history and invited lectures at national and international conferences).'

There are no recent studies to indicate how many SE cases are necessary to gain expertise in modern practice. However, this should not preclude exploration of requirements for a modern stress echocardiologist. In most countries, there are no studies to guide how many invasive cardiac procedures are required to achieve competence or expertise; the number of coronary angiograms, angioplasties, permanent pacemakers or defibrillators that an individual must perform has, traditionally, been decided as the consensus of experts within that country. Consequently, although contemporary studies that define the numbers needed to gain proficiency in SE would be ideal, an alternative pathway could be for the appropriate authorities to re-evaluate the minimum number of cases likely to be necessary to gain sufficient depth and breadth of experience to become a safe and competent exponent of SE.

Accordingly, following the success of accreditation schemes in transthoracic and transoesophageal echocardiography, the British Society of Echocardiography (BSE) has recently developed and introduced accreditation in stress echocardiography. Accreditation is the noun derived from the verb 'to accredit', meaning 'to state officially that something is of a satisfactory standard'. Accreditation in echocardiography is widely perceived as the achievement of a minimum standard based upon objective demonstration of knowledge, ability and experience in the technique (31). In keeping with the existing format of transthoracic and transoesophageal echocardiography accreditation schemes, candidates must initially pass a written examination (consisting of multiple choice questions and video cases for image interpretation). If successful, the candidate is then invited to attend a practical assessment in which a mock exercise SE is undertaken, as well as review of the candidate's logbook and video cases. The logbook must comprise 200 studies collected over a (maximum) two-year period, of which at least 20 cases (10% of logbook) must be for valve/cardiomyopathy indications. The requirements for the accreditation process are summarised in Fig. 1 and the syllabus, upon which the accreditation examination is

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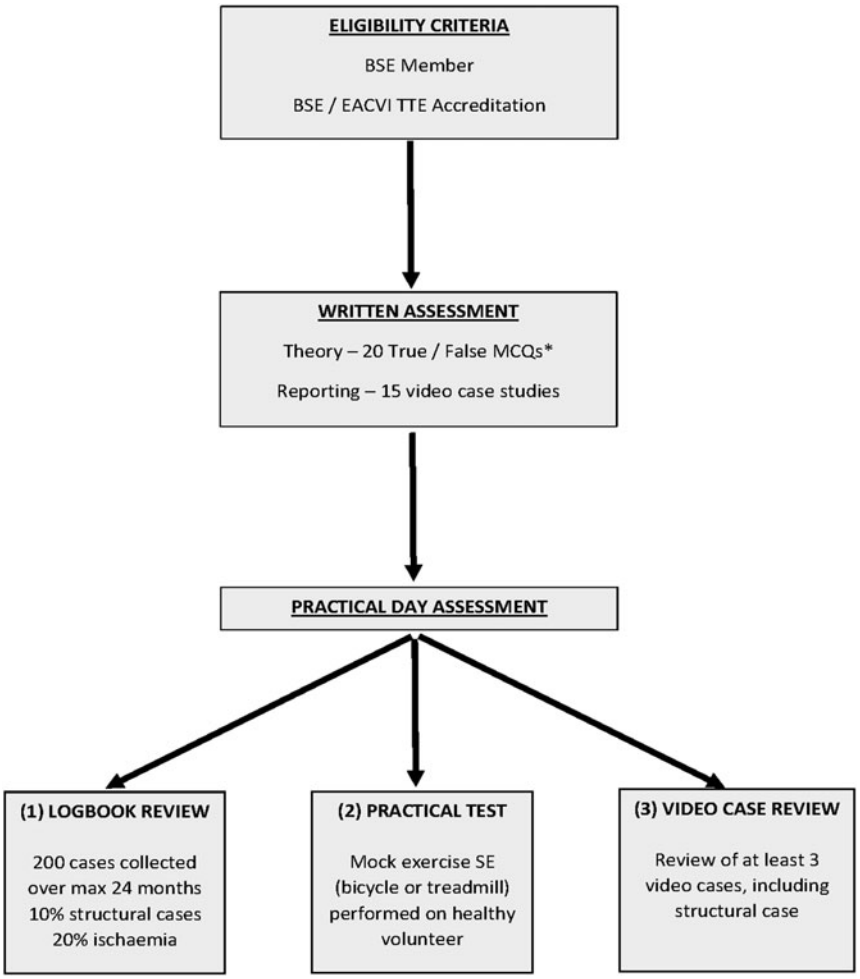

Figure 1
Flow chart illustrating the accreditation process in stress echocardiography. The asterisk denotes that each of the 20 multiple choice questions (MCQs) comprises 5 individual True/False questions, thus giving a total mark out of 100 for the written MCQ section. EACVI, European Association of CardioVascular Imaging; TTE, TransThoracic Echocardiography.

based, are provided as a supplementary online appendix. The recently published Practical Guide for Performing Stress Echocardiography in Coronary Artery Disease (32) by the BSE will also be of help to practising clinicians as well as those preparing for the accreditation process.

Thus, although we believe that 100 stress echocardiograms should be performed annually to *maintain* competence, initially we propose that at least double that number is required to *achieve* competence in the image interpretation across the entire spectrum of stress echocardiographic studies, including ischaemia, viability, valve diseases and cardiomyopathies. Furthermore, the prevalence of CAD (and thus abnormal SE studies) is lower than it used to be in stress echo labs – a trainee who reports 100 SE studies may see as few as 10 abnormal scans and 90 normal scans. Hence, although we believe that the minimum number required to be trained should increase to 200, there also needs to be emphasis on individuals learning SE having exposure to enough abnormal studies – online libraries of abnormal case examples may be one mechanism for assisting with this. Successful navigation of the SE Accreditation process does not confer or imply 'expertise' but, as with the other BSE Accreditation schemes, implies that a minimum level of knowledge and technical expertise has been demonstrated. In particular, only twenty studies on structural heart disease (e.g. heart valve disease) are required for the logbook and further experience in high-volume centres is recommended for those who wish to perform such studies over the longer term in their local hospitals. The accreditation process has commenced and several doctors and advanced echosonographers have obtained BSE SE accreditation.

Conclusion

Over the past quarter century, the utility of SE in modern clinical cardiology has increased significantly, with a broad range of indications including dynamic assessment of valvular heart diseases and cardiomyopathies.

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In 2018, we need to re-explore requirements for operator competence based upon contemporary practice of stress echocardiography. The introduction of accreditation in stress echocardiography is designed to provide objective evidence of knowledge and technical expertise in contemporary stress echocardiography.

Declaration of interest
The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of this editorial.

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