Stress echocardiography expert consensus statement

European Association of Echocardiography (EAE) (a registered branch of the ESC)

Rosa Sicari¹*, Petros Nihoyannopoulos², Arturo Evangelista³, Jaroslav Kasprzak⁴, Patrizio Lancellotti⁵, Don Poldermans⁶, Jen-Uwe Voigt⁷, and Jose Luis Zamorano⁸ on behalf of the European Association of Echocardiography
Stress Echocardiography Expert Consensus Statement—Executive Summary

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1Institute of Clinical Physiology, Pisa, Italy; 2Hammersmith Hospital, NHU, Imperial College, London, UK; 3Hospital Vall d’Hebron, Barcelona, Spain; 4Department of Cardiology, Medical University of Lodz, Lodz, Poland; 5Department of Cardiology, University Hospital Sart Tilman, Liège, Belgium; 6Erasmus Medical Center, Rotterdam, The Netherlands; 7Catholic University, Leuven, Belgium; and 8Instituto Cardiovascular, Hospital Clínico San Carlos, Madrid, Spain
The Stressors: Dip and Dob*  
0.84 in 6”* or 0.84 in 10’ + atropine
The Stressors: Dip and Dob*
0.84 in 6* or 0.84 in 10’ + atropine

% Specificity

Dipyridamole
Dobutamine

Key point: Both dobutamine and dipyridamole should be performed with high-dose protocols to obtain high sensitivities, comparable with maximal exercise.


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Key point: Physical or pharmacological (inotropic or vasodilator) stress echocardiography have comparable diagnostic accuracies. The choice of one test over the other will depend on relative contraindications. Large volume laboratories should be fully acquainted with all the three main forms of stress in order to apply the test in all patients. In the presence of a submaximal first-line stress for limiting side effects, the second choice should be applied, since submaximal (physical or pharmacological) stresses have suboptimal diagnostic value.

Ref 120
Stress Echocardiography in 4 equations

1. Rest + Stress = NORMAL
2. Rest + Stress = ISCHEMIA
3. Rest + Stress = VIABILITY
4. Rest + Stress = NECROSIS
Stress Protocols: Dipyridamole for Dual Imaging

Drugs infusion

DIP 0.84 mg/kg in 6'

0 6 10 min

AMINO
120 mg in 1' (up to 240 mg in 2')

TIMELINE

CFR-PW

2D echo

Continuous monitoring and Pulsed recording

1 lead ECG

12 lead ECG

Continuous monitoring and Pulsed recording

BP recording

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Figure 1 State-of-the-art protocol of dobutamine stress echocardiography.
Viability and Stress echo: Not only Dobutamine

Low Level Exercise (25 W x 3')

Low Dose Dipyridamole (0.28 mg/Kg over 4')

Enoximone (1.5 mcg/Kg over 10')

Hoffer et al. JACC 1999

Sicari et al. Am J Cardiol 2001

Lu et al. Circulation 2000
## “Each to his/her own”

<table>
<thead>
<tr>
<th></th>
<th>Inability exercise</th>
<th>Asthma</th>
<th>Tachyarrhythmia</th>
<th>Severe hypertension</th>
<th>Low echogenicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX</td>
<td><img src="image.png" alt="Red" /></td>
<td><img src="image.png" alt="Yellow" /></td>
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<td><img src="image.png" alt="Red" /></td>
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<tr>
<td>DIP</td>
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<td><img src="image.png" alt="Green" /></td>
<td><img src="image.png" alt="Green" /></td>
<td><img src="image.png" alt="Green" /></td>
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<tr>
<td>DOB</td>
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<td><img src="image.png" alt="Red" /></td>
<td><img src="image.png" alt="Red" /></td>
<td><img src="image.png" alt="Yellow" /></td>
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</tbody>
</table>
Indications for Stress Echo

1 – Coronary artery disease
2 – Prognosis and risk stratification in patients with established diagnosis
3 – Preoperative risk assessment
4 – Evaluation of cardiac etiology of exertional dypnea
5 – Evaluation after revascularization
6 – Ischemia location
7 – Evaluation of heart valve stenosis severity
Indications for Stress Echo

**Key point:** Stress echocardiography *should not be* used as a first-line imaging technique for diagnostic and prognostic purposes in patients with known or suspected coronary artery disease but only when exercise ECG stress test is either non-diagnostic or non-interpretable (e.g. for left bundle branch block or pacemaker).

*The less informative and/or interpretable exercise electrocardiography the higher is the level of appropriateness to stress echocardiography.*
Stress Echo Risk Titration of a Positive Test

<table>
<thead>
<tr>
<th>1-year risk (hard events)</th>
<th>Intermediate (1-3% year)</th>
<th>High (&gt;10% year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose/workload</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Resting EF</td>
<td>&gt;50%</td>
<td>&lt;40%</td>
</tr>
<tr>
<td>Anti-ischaemic therapy</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Coronary territory</td>
<td>LCx/RCA</td>
<td>LAD</td>
</tr>
<tr>
<td>Peak WMSI</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Recovery</td>
<td>Fast</td>
<td>Slow</td>
</tr>
<tr>
<td>Positivity or baseline dyssynergy</td>
<td>Homozonal</td>
<td>Heterozonal</td>
</tr>
<tr>
<td>CFR</td>
<td>&gt;2.0</td>
<td>&lt;2.0</td>
</tr>
</tbody>
</table>

LAD, left anterior descending artery; LCx, left circumflex; RCA, right coronary artery.
<table>
<thead>
<tr>
<th>1-year risk (hard events)</th>
<th>Very low (&lt;0.5% year)</th>
<th>Low (1–3% year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td>Maximal</td>
<td>Submaximal</td>
</tr>
<tr>
<td>Resting EF</td>
<td>&gt; 50%</td>
<td>&lt; 40%</td>
</tr>
<tr>
<td>Anti-ischaemic therapy</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>CFR</td>
<td>&gt; 2.0</td>
<td>&lt; 2.0</td>
</tr>
</tbody>
</table>

CFR, coronary flow reserve.

Acute risks of stress

RISK PER EXAM

1 in 100
1 in 1,000
1 in 10,000
1 in 10,000
1 in 7,500
1 in 5,000
1 in 1,000
1 in 700
1 in 350

Death
Major life-threatening events

Ex. Fletcher et al, AHA Statement, Circulation 2000
Dip. Picano et al, EPIC study, Am J Cardiol 1992
Stress Echo: The Safety Rules

- Avoid contraindications
- Never exceed standard dosages
- After signed informed consent
- Always physician attending
- Outpatients kept for 60’ after testing
- Indications must be class I
- Ex whenever possible, Dip first choice for pharmacological testing
**Stress Echo in Special Subsets**

**Aortic Stenosis**

<table>
<thead>
<tr>
<th></th>
<th>Severe AS</th>
<th>Pseudostenosis</th>
<th>Indeterminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic valve area</td>
<td>No change</td>
<td>Increase ≥ 0.3 cm²</td>
<td>No change</td>
</tr>
<tr>
<td>Mean pressure gradient</td>
<td>Markedly increased</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td>Stroke volume &gt;20%</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Key point:** In the presence of LV dysfunction and low-gradient aortic stenosis, low-dose dobutamine stress echocardiography is recommended to assess stenosis severity. In asymptomatic patients with severe aortic stenosis, exercise echo may play a role in decision-making.

**Non-Cardiac Surgery**

**Key point:** Stress echocardiography is recommended in high-risk patients with a previous history of CAD scheduled for elective high-risk surgical procedures. The test is not recommended in low-to-medium-risk patients.

**Emergency Department**

**Key point:** Stress echocardiography is recommended in patients with chest pain admitted to the ER for risk stratification purposes—especially when ECG stress test is submaximal, not feasible, or non-diagnostic.
Stress Echo vs. Competing Techniques

Key point: Stress echocardiography should be preferred due to its lower cost, wider availability and—most importantly—for the radiation-free nature. Stress scintigraphy offers similar information to stress echocardiography, but with a radiation burden between 600 and 1300 chest X-rays for every single stress scintigraphy. This poses a significant biological risk both for the individual and for the society, since small individual risks multiplied by millions of stress tests per year become a significant population burden.

“When similar information is obtained with ionizing and non-ionizing techniques, the latter should be employed”

www.escardio.org/EAE
New technologies for stress

**Key point:** “No new technology application to stress echocardiography is routinely recommended except for contrast for endocardial border enhancement, which should be used whenever there are suboptimal resting or peak stress images. Intravenous contrast for LV opacification improves endocardial border definition and may salvage an otherwise suboptimal study.”

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Learning curve in stress echo

<table>
<thead>
<tr>
<th></th>
<th>Beginners</th>
<th>Experts</th>
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</thead>
<tbody>
<tr>
<td>Pre-training</td>
<td>61</td>
<td>85</td>
</tr>
<tr>
<td>Post-training</td>
<td>83</td>
<td>86</td>
</tr>
</tbody>
</table>

$p < 0.001$  
$p = NS$

Picano E et al JACC 1991;17:666
## The Training Issue

<table>
<thead>
<tr>
<th>Competence in resting TTE</th>
<th>To start</th>
<th>To learn</th>
<th>To keep competence</th>
<th>Top level</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLS and ALS certification</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience with exercise-ECG</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 stresses under qualified supervision</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 stress echo studies per year</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Familiarity with all stresses (exercise, vasodil, dobutamine)</td>
<td></td>
<td></td>
<td>✓</td>
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</tr>
<tr>
<td>Mixed caseload (ischemia, valvular, cardiomyopathy, CHD)</td>
<td></td>
<td></td>
<td>✓</td>
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<tr>
<td>Appropriateness verification</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
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