Stress Testing: Which Test To Order? When, why, how?
Financial Disclosures

None
Educational Objectives

• Upon completion of this session, participants should be able to determine the most appropriate stress testing modality for their patient and how do document that decision.

• Minimize time on the telephone with insurance companies

• Maximize face to face time with patients
Which stress test is most appropriate?

A 62 yo M with HTN, hypercholesterolemia and atypical chest pain that sometimes happens during exercise, but also at rest. He has known chronic and poorly controlled atrial fibrillation in the setting of LBBB, recently underwent pacemaker implantation.

- A. Treadmill Exercise
- B. Treadmill + Stress ECHO
- C. Treadmill + Nuclear myocardial perfusion scan
- D. Pharmacological Nuclear myocardial perfusion scan
- E. Dobutamine Stress Echo
- F. Coronary angiography
Who/ Why?
Types of Patients Considered for Stress Testing

• Patients with symptoms suggesting angina
  • Patients who have symptoms suggestive of angina and who have an intermediate or high pre-test likelihood of IHD are generally appropriate for stress testing.
  • One exception to this is patients with ongoing or unstable symptoms, in which case stress testing should not be performed prior to relief of symptoms.

• Patients with acute chest pain
  • Patients presenting with acute chest pain or suspected acute coronary syndrome (ACS) may also undergo stress testing for the diagnosis of possible CHD. Stress testing in such patients should only be performed following the relief of symptoms and following the evaluation for ACS or infarction.

• Patients with a recent ACS
  • In patients with a prior ACS who were treated conservatively without coronary angiography, stress testing may be used for risk assessment within three months post-ACS, assuming that the patient has stable or no further symptoms
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Definition of Angina

- Substernal chest discomfort with a characteristic quality and duration
- Provoked by exertion or emotional stress
- Relieved by rest or nitroglycerin

Typical Angina 3/3
Atypical Chest Pain 2/3
Non Anginal Chest Pain 1/3

Diamond et al NEJM 1979;300:1350
<table>
<thead>
<tr>
<th>Rest angina</th>
<th>Angina occurring at rest and usually prolonged &gt;20 min, occurring within 1 wk of presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>New-onset angina</td>
<td>Angina of at least CCS Class III severity with onset within 2 mo of initial presentation</td>
</tr>
<tr>
<td>Increasing angina</td>
<td>Previously diagnosed angina that is distinctly more frequent, longer in duration, or lower in threshold (i.e., increased by ≥1 CCS class within 2 mo of initial presentation to at least CCS Class III severity)</td>
</tr>
</tbody>
</table>

CCS indicates Canadian Cardiovascular Society.
Pretest Likelihood of CAD in Symptomatic Patients According to Age and Sex (Combined Diamond/Forrester and CASS Data)

<table>
<thead>
<tr>
<th>Age, y</th>
<th>Nonanginal Chest Pain</th>
<th>Atypical Angina</th>
<th>Typical Angina</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>30-39</td>
<td>4</td>
<td>2</td>
<td>34</td>
</tr>
<tr>
<td>40-49</td>
<td>13</td>
<td>3</td>
<td>51</td>
</tr>
<tr>
<td>50-59</td>
<td>20</td>
<td>7</td>
<td>65</td>
</tr>
<tr>
<td>60-69</td>
<td>27</td>
<td>14</td>
<td>72</td>
</tr>
</tbody>
</table>

CAD indicates coronary artery disease; and CASS, Coronary Artery Surgery Study.

*Each value represents the percent with significant CAD on catheterization.
Adapted from Forrester and Diamond (52,73).
### Pretest Probability of IHD Based Upon Symptoms

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
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<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
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<tr>
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Who To Test

• In patients with symptoms suggesting CHD, cardiac stress testing is most often indicated to aid in making the diagnosis of CHD and for risk stratification.

• In patients with known CHD and prior coronary revascularization or a change in clinical status, cardiac stress testing can be indicated for the diagnosis of new or progressive disease and/or for risk stratification.

• Cardiac stress testing as a screening test for CHD is rarely indicated.
What/ Which?
Considerations When Choosing Which Modality

- Pretest risk of Ischemic Heart Disease
- Exercise ECG vs Exercise ECG with Imaging
- Exercise vs. Pharmacologic Stress
- Do special considerations make one test more suitable in a specific patient?
Pretest Risk Assessment

- Framingham-ATP IV
- Reynolds
- Pooled Cohort Equation (includes cerebrovascular risk)
- ACC/AHA Risk Calculator
- MESA Risk Calculator (includes calcium score)
Definition of Coronary Heart Disease (CHD) Risk

• CHD Risk—Low
  • Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.

• CHD Risk—Moderate
  • Defined by the age-specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10% and 20%.

• CHD Risk—High
  • Defined as the presence of diabetes mellitus in a patient 40 years of age or older, peripheral arterial disease or other coronary risk equivalents, or a 10-year absolute CHD risk of greater than 20%.
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## ACC Recommendations for Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Exercise Status</th>
<th>ECG Interpretable</th>
<th>Pretest Probability of IHD</th>
<th>COR</th>
<th>LOE</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Able</td>
<td>Unable</td>
<td>Yes</td>
<td>No</td>
<td>Low</td>
<td>Intermediate</td>
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<tr>
<td>Patients able to exercise*</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exercise ECG</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Exercise with nuclear MPI or Echo</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Exercise ECG</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Ia</td>
<td></td>
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<td>Exercise with nuclear MPI or Echo</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Ia</td>
<td></td>
</tr>
<tr>
<td>Pharmacological stress CMR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Ia</td>
<td></td>
</tr>
<tr>
<td>CCTA</td>
<td>X</td>
<td>Any</td>
<td>X</td>
<td>X</td>
<td>Iib</td>
<td></td>
</tr>
<tr>
<td>Exercise Echo</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Iib</td>
<td></td>
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<tr>
<td>Pharmacological stress with nuclear MPI, Echo, or CMR</td>
<td>X</td>
<td>X</td>
<td>Any</td>
<td>X</td>
<td>Iib</td>
<td></td>
</tr>
<tr>
<td>Exercise stress with nuclear MPI</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Iib</td>
<td></td>
</tr>
<tr>
<td>Patients unable to exercise</td>
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<td></td>
<td></td>
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<tr>
<td>Pharmacological stress with nuclear MPI or Echo</td>
<td>X</td>
<td>Any</td>
<td>X</td>
<td>X</td>
<td>Iib</td>
<td></td>
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<td>Pharmacological stress Echo</td>
<td>X</td>
<td>Any</td>
<td>X</td>
<td>X</td>
<td>Iib</td>
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<td>X</td>
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**Other**

- **CCTA if patient has any of the following:**
  - a) Continued symptoms with prior normal test, or
  - b) Inconclusive exercise or pharmacological stress, or
  - c) Unwilling to undergo stress with MPI or Echo

- **CAC score**
  - Any | Any | X  | Iib | C  | (173)

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  - Any | Any | X  | Iib | C  | (174)
• SYMPTOMATIC: LOW PRETEST PROBABILITY patients should undergo a treadmill exercise stress EKG alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG.

• SYMPTOMATIC: INTERMEDIATE OR HIGH PRETEST PROBABILITY patients are appropriate for stress imaging (MPI or echo).
Conditions Limiting Accuracy of Treadmill ECG

- LBBB
- Ventricular Pacing
- Left Ventricular Hypertrophy
- Digoxin effect
- Baseline ST changes (depression > 1mm)
- Pre-excitation
**Absolute Contraindications to TMST**

- Recent myocardial infarction (within 2-4 days)
- Unstable angina
- Uncontrolled and hemodynamically compromising arrhythmia
- Active endocarditis
- Severe and symptomatic aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism/deep vein thrombosis
- Acute myocarditis and/or pericarditis
- Active Aortic dissection
- Physical disability that compromises patient’s safety
Advantages of SPECT
- Can be used in patients with moderate to high pre-test probability
- Perfusion and function
- Can localize disease
- Can risk stratify
- Pharmacologic stress may be performed
- Higher sensitivity than stress echo (flow heterogeneity)

Advantages of Echo
- Readily available
- Provides direct visualization of wall motion, LV function, and anatomy
- Can localize region of abnormality
- May detect valvular abnormalities
- Higher specificity than perfusion imaging (77-89% vs 70-88%)
- Higher sensitivity than Treadmill alone (70-85% vs 61-68%)
- No radiation
Imaging: SPECT vs. Echo

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Imaging: SPECT vs. Echo

• In patients with higher pre-test likelihood of CAD and higher risk, higher sensitivity may be preferred over higher specificity, and stress radionuclide MPI with either SPECT or PET may be preferred.

• In patients with lower likelihood and lower risk, specificity may be more vital, and stress echocardiography may be preferred.
Screening Stress Testing in Asymptomatic Patients

38 year old female with mild obesity
• She is planning an exercise program to lose weight. She has no other known risk factors for CAD. You recommend:
  A. Exercise stress echo.
  B. Exercise SPECT.
  C. Exercise treadmill test.
  D. Proceed to exercise program no further testing.
Screening Stress Testing in Asymptomatic Patients

ACC/AHA guidelines for testing in asymptomatic person without CAD

• Class I: none

• Class IIa: Asymptomatic diabetic without known risk factors who are planning an exercise program.

• Class III: Routine screening
Screening Test
Testing in
Asymptomatic
Patients

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  C. Exercise treadmill test.
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Summary

- SYMPTOMATIC: LOW PRETEST PROBABILITY patients should undergo a treadmill exercise stress EKG alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG.

- SYMPTOMATIC: INTERMEDIATE OR HIGH PRETEST PROBABILITY patients are appropriate for stress imaging (MPI or echo).

- Consider vasodilator (Lexiscan, Regadenoson) SPECT in patients with the following: LBBB, Ventricular Pacing, Left Ventricular Hypertrophy, Digoxin effect, Baseline ST changes (depression > 1mm), Pre-excitation

- Avoid Stress Echocardiography in patients with baseline wall motion abnormalities
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• In patients with higher pre-test likelihood of CAD and higher risk, higher sensitivity may be preferred over higher specificity, and stress radionuclide MPI with either SPECT or PET may be preferred.

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