Cardiac Stress Testing
What is it? When to use it.

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Disclosures/References

- No conflicts of interests
- References:
  - ACC/AHA Guidelines; online: www.acc.org
  - AUC for multimodality cardiac testing; online: www.acc.org
  - Mayo Clinic Cardiology; 2007 Murphy JG, Lloyd MA; Chapter 17
Outline

- Define Cardiac Stress Testing/Terminology
- Discuss different modalities of stress testing
- Discuss Appropriate Use of Stress Testing
- Clinical Scenarios/Questions
Terminology

- When referencing a “stress test” describe the “stress” then the “test”. i.e., dobutamine stress echo or exercise ECG or exercise nuclear myocardial perfusion imaging (MPI)
- Avoid using radio-isotopes as a descriptor i.e., thallium nuclear test
- This will help avoid confusion and helps with communication between providers
What is a Stress Test?

- Baseline evaluation
  - ECG, Echo, or nuclear perfusion imaging
- Stress evaluation
  - Exercise, pharmacologic (vasodilator or dobutamine), *pacing
- Comparison of rest vs. stress
- Cardiac Catheterization is NOT a stress test
- Coronary CTA is NOT a stress test
- Coronary Calcium Score is NOT a stress test
- Echocardiogram is NOT a stress test
Cardiac Stress Test

- **STRESS**
  - Exercise
  - Dobutamine
  - Vasodilator
    - Regadenoson (lexiscan)
    - Adenosine
    - Persantine
  - Pacemaker**

- **TEST**
  - ECG
  - Echocardiography
  - Nuclear myocardial perfusion imaging
  - Positron emission tomography
  - Cardiac MRI
Outline

• Define Cardiac Stress Testing/Terminology
• Discuss different modalities of stress testing
• Discuss Appropriate Use of Stress Testing
• Clinical Scenarios/Questions
Most Accessible Modalities

- Exercise Treadmill Test (ETT)/Treadmill Exercise Test (TMET)
- Exercise Stress Echocardiogram
- Dobutamine Stress Echocardiogram
- Exercise Nuclear Myocardial Perfusion Imaging
- Pharmacologic Myocardial Perfusion Imaging
Other Modalities

- Stress MRI
- Stress PET
- CT Coronary Angiography*(this is not a “stress” test)
Exercise ECG

- aka-Exercise Treadmill test or TMET
- Walking on Treadmill (bike rarely used)
- Comparison of rest ECG with stress ECG
- Exclude exercise if baseline ECG is LBBB, WPW, ST depression >0.10mV, digoxin use or ventricular paced rhythm
- Patient must be able to exercise safely!
Exercise ECG (cont.)

- Exercise stress test supervised by a physician provides invaluable clinical information.
- Bruce Protocol/Modified Bruce
- Exercise duration; heart rate achieved; arrhythmias; METs achieved; double product (HRxBP); heart rate recovery post exercise.
- Sensitivity 45-67%, Specificity 72-90%
- ECG does not localize disease.
- Exercise ECG can be combined with imaging.
Exercise Echo

- Baseline echocardiogram should be within normal limits
- Standard ETT protocol is used
- Sensitivity averages 85%
- Specificity averages 85%
- Can add information on extent and distribution of CAD
- Depends on ability to interpret images
Dobutamine Stress Echo

- Used for patients who cannot exercise
- Positive inotrope and chronotrope (beware arrhythmia)
- Start at 10mcg/kg/min, increase every 3 minutes to max of 40mcg/kg/min
- Target heart rate is not always achieved
Exercise Nuclear MPI

- Uses radio-isotopes (Th-201 or Tc-99m)
- Rest/Stress is common protocol
- Similar sensitivity to exercise stress echocardiogram
- Can localize CAD
- Pts with LBBB or paced rhythm have increased false positive rates (pharmocologic agent is preferred)
Pharmacologic Nuclear MPI

• Vasodilators
  • Regadenoson aka Lexiscan (most commonly used)
  • Adenosine
  • Dipyridamole

• Side Effects
  • Heart block of varying degrees
  • Bronchospasm
  • Hypotension

• Should not use vasodilators with caffeine
Outline

- Define Cardiac Stress Testing/Terminology
- Discuss Different Modalities of Stress Testing
- Discuss Appropriate Use of Stress Testing
- Clinical Scenarios/Questions
Who

- Detection of CAD/Risk Assessment**
- Evaluation for arrhythmia (suspected or known)
- Pre-Operative Evaluation for Non-cardiac surgery
- Initiation of Exercise Prescription/Cardiac Rehab
- Syncope with intermediate global CV risk
- Evaluation of Cardiomyopathy
- Post MI
Indications/Considerations

- What is the pretest probability of CAD?
- Are there conditions precluding a diagnostic exercise ECG stress test?
- Are there conditions precluding a diagnostic pharmacologic stress test?
- Will the management of the patient change based on the results?
Pretest Probability

- Low pretest probability unlikely to benefit from stress due to high false positive rate
- Patients with intermediate risk who are presenting with symptoms that may be due to the underlying cardiac disease
- High pretest probability have a high likelihood of CAD
Low Risk and High Risk Stress Testing

- Exercise ECG is the only test appropriate for low pretest probability with symptoms
- Exercise ECG is acceptable for asymptomatic high pretest probability
Pretest Probability

- Based on:
  - Clinical history
  - Age and sex
  - Risk factors for CAD
- Global Risk Scoring (Class I indication)
  - Framingham Risk Score (FRS)
  - Strong Heart Risk Calculator
  - CVD Risk Calculator*
Angina

- Typical Angina (Definite)
  - 1) Substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or SLNTG

- Atypical Angina (Probable)
  - Chest pain or discomfort that lacks one of the characteristics of typical angina

- Non-anginal Chest Pain
  - Chest pain or discomfort that meets one or none of the the typical angina characteristics
Pretest Probability

- Based on:
  - Clinical history,
  - Age and sex
  - Risk factors for CAD

- Global Risk Scoring (Class I indication)
  - Framingham Risk Score (FRS)
  - Strong Heart Risk Calculator
  - CVD Risk Calculator*
From: ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 Multimodality Appropriate Use Criteria for the Detection and Risk Assessment of Stable Ischemic Heart Disease:

<table>
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<th>Age (years)</th>
<th>Sex</th>
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<th>Atypical/Probable Angina Pectoris</th>
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<tr>
<td></td>
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</tbody>
</table>

Diamond and Forrester Pre-Test Probability of Coronary Artery Disease by Age, Sex, and Symptoms*
Pretest Probability

- Based on:
  - Clinical history,
  - Age and sex
  - Risk factors for CAD

- Global Risk Scoring (Class I indication)
  - Framingham Risk Score (FRS)
  - Strong Heart Risk Calculator
  - CVD Risk Calculator*
Cardiac Risk Factors

- Diabetes
- Tobacco use
- Hypertension
- Hyperlipidemia
- PAD
- Family History of premature CAD
  - Father <55, Mother <65
Pretest Probability

- Based on:
  - Clinical history,
  - Age and sex
  - Risk factors for CAD
- Global Risk Scoring (Class I indication)
  - Framingham Risk Score (FRS)
  - Strong Heart Risk Calculator
  - CVD Risk Calculator*
Indications/Considerations

• What is the pretest probability of CAD?
• Are there conditions precluding a diagnostic exercise ECG stress test?
• Are there conditions precluding a diagnostic pharmacologic stress test?
• Will the management of the patient change based on the results?
WHO

- Cardiac testing is not benign
  - Patient stress of the unknown
  - Deciding what to do with the results
  - Patient compliance
When NOT to Order a Test

- “Routine” screening in asymptomatic individuals
- Asymptomatic or stable symptoms with last test <2 years prior including cardiac cath
- Normal prior Stress with low to intermediate risk; within 2 years
- Asymptomatic < 5 years post CABG or <2 years post PCI
- Pre-op with functional capacity >4 METS or no clinical risk factors
Special Circumstances

- Diabetes is a CHD equivalent
- CAC is a IIa indication for DM Risk assessment
- Stress MPI may be appropriate if CAC >400
- Higher HbA1C have been associated with elevated risk of CVD in asymptomatic DM
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Question 1

- A 50 year old female with HTN has chest pain with some typical and atypical features of angina. Baseline ECG is normal. She can exercise. TEST?
  - a) Perfusion PET imaging with rubidium and FDG for viability
  - b) Adenosine nuclear MPI with Tc99M
  - c) Exercise ECG
  - d) Dipyridamole Echocardiography
Question 2

- A 45 year old active male with atypical chest pain, HTN, Hyperlipidemia, +FH, and LBBB. TEST?
  a) Regadenoson Nuclear MPI
  b) Exercise Echocardiography
  c) Exercise Nuclear MPI
  d) Cardiac Catheterization
Question 3

A 78 year old obese female has OA of the knees and needs non-cardiac surgery. She cannot complete >4 mets. Which test do you order?

a) Dobutamine Stress Echocardiogram
b) Exercise ECG
c) Lexiscan nuclear MPI
d) Either A or C
Question 4

- A 55 year old male with DM2, PVD, HTN, Hyperlipidemia has angina with minimal exertion. What stress test do you order for diagnosis of CAD?
  - a) Exercise ECG
  - b) Dobutamine nuclear MPI
  - c) Calcium score
  - d) None needed
Thanks

- Questions?