

# 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](http://www.acc.org)
  - AUC for multimodality cardiac testing; online: [www.acc.org](http://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

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# 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  $>0.10\text{mV}$ , 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 (pharmacologic 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

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# 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\*

# JACC Journals



JACC Journals

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:

Age(years)	Sex	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40-49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50-59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

J Am Coll Cardiol. 2014;63(4):380-406. doi:10.1016/j.jacc.2013.11.009

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
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# Cardiac Risk Factors

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

# Pretest Probability

- Based on:
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  - Age and sex
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- 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 HbA<sub>1c</sub> 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 DM<sub>2</sub>, 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?