NON-INVASIVE CARDIAC STRESS TESTING

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UNM DEPARTMENT OF FAMILY & COMMUNITY MEDICINE
OBJECTIVES

• List indications & contraindications for stress testing
• Understand use of stress testing for diagnosis of obstructive CAD
• Understand risk assessment for chronic CAD
• Discuss how to select the correct stress test
• THIS PRESENTATION WILL NOT focus on pre-op stress testing
ACC/AHA Guidelines for Exercise Testing: Executive Summary

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing)

Committee Members

Raymond J. Gibbons, MD, FACC, Chair; Gary J. Balady, MD, FACC; John W. Beasley, MD; FAAFP; J. Timothy Bricker, MD, FACC; Wolf F. C. Duvernoy, MD, FACC; Victor F. Froelicher, MD, FACC; Daniel B. Mark, MD, MPH, FACC; Thomas H. Marwick, MD, FACC; Ben D. McCallister, MD, FACC; Paul Davis Thompson, MD, FACC; FACSM; William L. Winters Jr, MD, FACC; Frank G. Yanowitz, MD, FACP
## TWO COMPONENTS OF STRESS TESTING

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<th>Stress Modality</th>
<th>Outcome Measures</th>
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<td>Symptoms</td>
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<td>Treadmill</td>
<td>EKG</td>
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<td>Bicycle</td>
<td>ECHO</td>
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<td>Pharmacologic</td>
<td>Nuclear perfusion imaging</td>
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<td>Dobutamine</td>
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INDICATIONS FOR TESTING

- Diagnosis of obstructive coronary artery disease (CAD) in patients with intermediate pre-test probability
- Risk stratification of patients with chronic stable CAD
- Risk stratification before non-cardiac surgery with patients with known CAD or with high-risk profile
- Evaluate efficacy of therapeutic interventions for CAD
- Prognostication (exercise modalities best)
- Assess symptoms due to other cardiac conditions (valvular disease, HOCM, etc.)
CHEST PAIN/PRESSURE

- **Typical Chest Pain/Pressure (definite angina):**
  - Substernal chest discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved with rest or nitroglycerine

- **Atypical Chest Pain (probable angina):**
  - Chest pain with two of the three above typical angina characteristics

- **Non-cardiac Chest Pain:**
  - Chest discomfort with one or none of the above typical

- **Chest pain syndrome or anginal equivalent:**
  - Any constellation of symptoms that the physician feels might represent **obstructive** CAD
### Table 4. Pretest Probability of Coronary Artery Disease by Age, Gender, and Symptoms*

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CONTRAINDICATIONS FOR STRESS TESTING

**ABSOLUTE**
- Acute MI
- Uncontrolled arrhythmias
- Severe symptomatic AS
- Acute PE
- Acute aortic dissection
- Severe pulmonary hypertension
- Acute MI (<4 days)
- Myo-pericarditis

**RELATIVE**
- Uncontrolled HTN
- Electrolyte abnormality
- HOCM
- Left main CAD
EXERCISE STRESS EKG

STRESS = EXERCISE
MEASUREMENT OF EFFECT = EKG
EXERCISE STRESS EKG

- Preferred modality in patients who are able to exercise
  - Age-adjusted achievement of 85% of MPHR (max predicted heart rate) needed for diagnosis of CAD
  - Normal baseline EKG
- Several exercise protocols available
  - Bruce protocol
  - Modified Bruce protocol
- Exercise modalities: treadmill or bike
- Excellent prognostic value
and According to the Percentage of Age-Predicted Exercise Capacity Achieved (Panel B) and Survival Curves for Subjects with Cardiovascular Disease Stratified According to Peak Exercise Capacity (Panel C) and According to the Percentage of Age-Predicted Exercise Capacity Achieved (Panel D).

In all the analyses, the stratification according to exercise capacity discriminated among groups of subjects with significantly different mortality rates — that is, the survival rate was lower as exercise capacity decreased (P<0.001).
EXERCISE PARAMETERS ASSOCIATED WITH ADVERSE PROGNOSIS

- Stop at < 5 METs because of symptoms
- Failure to increase SBP > 120mmHg
- Impaired HR recovery
- ST segment depression
- ST segment elevation
- Angina at low exercise workloads
- Reproducible sustained or symptomatic Vtach
EXERCISE STRESS EKG: IS IT CAD?

• ST segment depression $\geq 0.10\text{mV}$ in 3 consecutive leads
  • Does not localize ischemia
  • Lead V5 is most specific for ischemia
• Not recommended in patients with abnormal EKG
  • LBBB
  • LVH
  • ST segment abnormalities ($> 1\text{mm baseline depression}$)
  • WPW
  • Pace rhythms
  • Digoxin
ABNORMAL ST SEGMENT RESPONSE
INDICATIONS FOR EARLY TERMINATION OF STUDY

• Drop in SBP > 10mmHg or hypertensive response
• Moderate to severe angina
• Sustained Vtach (> 30 seconds) or development of LBBB
• ST segment elevation OR excessive ST depression (> 2mm)
• Ataxia, dizziness, near syncope
• Signs and symptoms of poor perfusion (cyanosis and pallor)
• Patient’s request to stop test
• Difficulty monitoring vitals signs
• **Achieving MPHR is NOT a reason to stop**
WOMEN & EXERCISE STRESS TESTING

- Increased number of false positive results
- Imaging studies recommended
EXERCISE & PHARMACOLOGIC
STRESS ECHOS

STRESS = EXERCISE/MEDS
MEASUREMENT OF EFFECT = ECHO
EKG STRESS VS STRESS IMAGING: INITIAL TEST SELECTION

- EKG Stress Test
  - Lower cost
  - More widely available
  - Less technical expertise

- Imaging
  - Accurate in setting of abnormal EKG
  - Can perform with pharmacologic stress (if patient cannot exercise)
  - Localization of ischemia
# STANDARD EKG STRESS VS IMAGING: INITIAL TEST SELECTION

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<thead>
<tr>
<th></th>
<th>Stress EKG</th>
<th>IMAGING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to exercise</td>
<td>Able</td>
<td>Unable</td>
</tr>
<tr>
<td>Prior PCI/CABG</td>
<td>No (unless assessing Sx control/prognosis)</td>
<td>Yes</td>
</tr>
<tr>
<td>Resting ECG</td>
<td>Normal</td>
<td>Abnormal*</td>
</tr>
</tbody>
</table>

* LBBB, WPW, ST >1mm, paced
STRESS ECHO

- Exercise protocols include treadmill, upright bicycle, or supine bicycle
- Supine bicycle allows to obtain images at peak exercise
  - Preferred for evaluation of exercise-induced hemodynamics
- Pharmacologic use for patients who are unable to exercise
  - Dobutamine is the most commonly used agent
STRESS ECHO DIAGNOSIS OF CAD

- New wall motion abnormalities or worsening of existing defects
- Lack of hyperdynamic motion
- LV cavity dilatation & decreased global systolic motion
STRESS ECHO AS PROGNOSTIC INDICATOR

- Likelihood of cardiac event occurring after a normal stress echo is extremely low
NUCLEAR PERFUSION SCANS

STRESS = EXERCISE/MEDS
MEASUREMENT OF EFFECT = NUCLEAR
MYOCARDIAL PERFUSION SCAN

- Stress modalities:
  - Exercise remains the preferred mode of stress
  - Pharmacologic stress
- Perfusion markers: thallium 201 and technetium 99
  - Myocardium takes up marker
  - Marker uptake measured before and after stress
INDICATIONS FOR MYOCARDIAL PERFUSION SCAN VS MODALITIES

• NEED TO FINISH!!
<table>
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<tr>
<th><strong>Mech of Action</strong></th>
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<td><strong>Indication</strong></td>
<td>β1 &amp; β2 agonist</td>
<td>Coronary artery vasodilators (steal phenomenon)</td>
<td>N/A</td>
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<tr>
<td><strong>Contra-indications</strong></td>
<td>Vasodilator contra-indicated</td>
<td></td>
<td>Wheezing 2°/3° block Sick sinus ACS</td>
<td>Bronchospasm 2°/3° block SBP &lt; 90</td>
</tr>
<tr>
<td><strong>Notes</strong></td>
<td>Mimics actual exercise stress</td>
<td>Not very physiologic because does not mimic exercise stress</td>
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BUT HOW WELL DO ALL THESE TESTS WORK???
EKG, NUCLEAR, & ECHO STRESS TESTS: DIAGNOSTIC ACCURACY FOR OBSTRUCTIVE CAD

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<th>Test</th>
<th>Sensitivity</th>
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<tr>
<td>ETT</td>
<td>68%</td>
<td>77%</td>
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<td>SPECT</td>
<td>87%</td>
<td>73%</td>
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<td>Echo</td>
<td>86%</td>
<td>81%</td>
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+ likelihood ratio: 3.0, 3.2, 4.5
- likelihood ratio: 0.4, 0.2, 0.2
SUMMARY

• Assess pre-test probability first, then decide on test!
• In regard to DIAGNOSIS:
  • Stress testing for diagnosis of intermediate pre-test probability of CAD
  • EKG stress test: does not localize ischemia
  • Echo: identifies wall motion abnormality
• PROGNOSIS: exercise stress preferred modality
• INITIAL TEST CHOICE
  • Exercise EKG: if able to exercise & has normal EKG
  • Imaging: if has abnormal EKG
  • Chemical: unable to exercise, avoid vasodilators in patients with bronchospasm
PEARLS

• DO NOT stress patients with acute MI
• Routine screening of ASYMPTOMATIC patients is NOT recommended
• Routine assessment of ASYMPTOMATIC patient with established CAD is NOT recommended
GROUP QUESTIONS

PLEASE SPLIT INTO 3-4 GROUPS AROUND ROOM
60 yo F w/ DM type II presents w/ sudden onset of substernal chest pressure, transiently improved with NTG but has reoccurred in ED. EKG shows ST depressions in anterior leads.

1) What stress test would you perform or would you go straight to cath?

2) What medications would you treat this patient with?
## Pre-Test Probability of CAD with Chest Pain

**Table 4. Pretest Probability of Coronary Artery Disease by Age, Gender, and Symptoms***

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CASE 2

45 yo F presents to clinic with complaint of substernal chest pressure during daily morning run (not in clinic). Improves with rest. Has Hx of type II DM but no other CV risk factors. Has normal resting EKG.

What would you like to do next?

- a. Order an echocardiogram
- b. Schedule exercise stress EKG
- c. Refer her to cardiology for heart cath
- d. Reassure and see her back in 4 weeks
## PRE-TEST PROBABILITY OF CAD WITH CHEST PAIN

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CASE 3

65 yo F with multiple risk factors for CAD, normal baseline EKG referred for exercise stress EKG 2/2 atypical angina. Pt unable to achieve MPHR achieving only 4 METS. Test stopped due to 2mm ST segment depression that lasted > 5 minutes into recovery.

What is your interpretation of findings?

a. Patient requires a different stress test
b. Patient most likely needs cardiac rehabilitation
c. Patient with likely obstructive CAD requires heart cath
d. Patient is having a bad day bring her back later
# Pre-Test Probability of CAD with Chest Pain Pain

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45 yo M with atypical chest pain & no risk factors referred for exercise stress EKG. Achieved MPHR & able to achieve 15 METS. Test stopped due to knee pain. EKG showed ST depression in inferior leads. What should you recommend next?

a. Encourage primary prevention with diet and exercise
b. Refer for heart cath
c. Admit to the hospital & start a heparin drip
d. Refer for imaging study for more information
55 yo M w/ long Hx of smoking, COPD, severe OA admitted with atypical chest pain. On exam: HR 95, BP 145/70, 2L NC to keep sats >90%, audible wheezing. EKG shows normal sinus with RBBB. You’ll like to evaluate for underlying ischemia.

What stress test would you order?

a. Stress EKG
b. Exercise stress echo
c. Dobutamine myocardial perfusion scan
d. Dipirydamole myocardial perfusion scan
THANKS! QUESTIONS?

THANK YOU TO SONIA PONCE FOR THIS PRESENTATION!
ADENOSINE

- Direct coronary vasodilator
- Common side effects include flushing, chest pain, dyspnea, dizziness, and symptomatic hypotension
- AV block occurs ~ 7.6%
- Fatal or non-fatal MI extremely rare
- **Contraindications to adenosine stress testing include:**
  - Asthma with ongoing wheezing (bronchospasm absolute contraindication)
  - Second or third degree AV block without pacemaker
  - Sick sinus syndrome without pacemaker
  - Hold caffeine for at least 12 hrs
  - Hypersensitivity to adenosine
  - ACS
REGADENASONE (LEXISCAN)

- Low affinity adenosine receptor agonist
- Most common side effects include headache, flushing, and shortness of breath
- Aminophyline can be used to reverse effects
- Contraindicated in patients with 2\textsuperscript{nd} and 3\textsuperscript{rd} degree AVB, bronchospasm, and SBP <90
DOBUTAMINE

- Direct β1 and β2 stimulation with dose-related increase in HR, BP, and myocardial contractility
- Common side effects: Palpitations, chest pain, flushing, dyspnea, significant SVT or VT
- Recommended in patients with contraindication for vasodilator
- Contraindications similar to absolute contraindications for stress testing
DIPYRIDAMOLE

- Indirect coronary vasodilator
- >50% experience side effects (flushing, chest pain, HA, dizziness, hypotension)
- Contraindications include same as with adenosine