Choosing the Appropriate Stress Test:

Brett C. Stoll, MD, FACC
February 24, 2018
Choosing the Appropriate Stress Test: Does it Really Matter?

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Conflicts of Interest

• No conflicts of interest
Objectives

• Be able to list the indications and contraindications for stress testing.

• Appreciate the different modalities available for cardiac stress testing.

• Appropriately select the optimal cardiac stress test for each patient.
Stoll’s Words of Wisdom …

- Don’t stress patients you think you might kill with the study
- Don’t order a study if you already know the answer
- If a patient can’t exercise, don’t order an exercise study
- If the patient’s resting EKG is abnormal, something other than “EKG imaging” is needed to make it a useful study
- LBBB and paced rhythms may cause false positive studies in tests that increase HR (exercise or dobutamine stress)
More Words of Wisdom ...

- Echo imaging is only useful if you can image the endocardium
- Dobutamine can induce arrhythmias (AF, VT, VF)
- Adenosine, Persantine, Lexiscan can induce bronchospasm
- Stress tests are not perfect
Case Study

A 60 yo man is evaluated for chest pain of 4 months’ duration. He describes the pain as sharp, located in the left chest, with no radiation or associated symptoms, that occurs with walking one to two blocks and resolves with rest. Occasionally, the pain improves with continued walking or occurs during the evening hours. He has hypertension. Family history does not include cardiovascular disease in any first-degree relatives. His only medication is amlodipine.

On physical examination, he is afebrile, blood pressure is 130/80 mHg, pulse rate is 72/min, and respiration rate is 12/min. BMI is 28. No carotid bruits are present, and a normal S1 and S2 with no murmurs are heard. Lung fields are clear, and distal pulses are normal. EKG showed normal sinus rhythm w/ LBBB.
Case Question

Which of the following is the most appropriate diagnostic test to perform next?

a. Adenosine nuclear perfusion stress test
b. Coronary angiography
c. Echocardiography
d. Exercise treadmill
General Overview

- Stress testing is generally a safe procedure
- Commonly performed (1998 Medicare data)
  - Treadmill 533,000
  - Stress Echo 354,000
  - Stress SPECT 1,362,000
- Low risk of MI or death (1 per 2500)
- Requires appropriate supervision
Indications

Who to stress?

• Screening for obstructive CAD
• Symptoms suggesting angina (low to moderate risk)
• Acute chest pain
• Known CAD with change in clinical status
• Assessment of prognosis and severity of disease
Indications

Who to stress?

• Valvular heart disease
• New heart failure or cardiomyopathy
• Chronic left ventricular dysfunction and CHD (who are candidates for revascularization)
• Selected arrhythmias
• Undergoing non-urgent non-cardiac surgery
Contraindications

Who *NOT* to stress?

- Unstable angina (high risk)
- Acute myocardial infarction (< 6 days)
- Known severe LM disease
- Arrhythmia with hemodynamic instability
- Aortic dissection
Contraindications

Who NOT to stress?

- Symptomatic (critical) aortic stenosis
- Decompensated heart failure
- Severe HTN (SBP > 220 mmHg, DBP > 120 mmHg)
- Pulmonary embolism
- Myocarditis, Pericarditis
Who should get a stress test??
Bayes’ Theorem

\[ p(A|X) = \frac{p(X|A)p(A)}{P(X|A)p(A) + p(X|\sim A)p(\sim A)} \]

Given some phenomenon \( A \) that we want to investigate, and an observation \( X \) that is evidence about \( A \), we can update the original probability of \( A \), given the new evidence \( X \).
Fundamentals of Stress Testing
Fundamentals of Stress Testing
Fundamentals of Stress Testing

Positive

Negative
Fundamentals of Stress Testing

Positive

Negative
Fundamentals of Stress Testing

- Positive
- Negative
Fundamentals of Stress Testing

Positive

Negative
Fundamentals of Stress Testing
Pre-Test Probability

ACC/AHA Guidelines

**Low probability** - <10% - no further testing, except for prognostic information

**Intermediate probability** - 10-90% - non-invasive testing for diagnosis (exercise ECG as first modality)

**High probability** - >90% - noninvasive testing for prognosis/management prior to cardiac cath
## Pre-Test Probability

<table>
<thead>
<tr>
<th>Age</th>
<th>Nonanginal 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>
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<td>40-49</td>
<td>13%</td>
<td>3%</td>
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</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>
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Definitions of Chest Pain

- **Typical angina (definite)**
  - Substernal chest discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by NTG or rest

- **Atypical angina (probable) – meets 2 of the above**

- **Non-anginal chest pain – meets 1 or none of the typical characteristics**
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But which test to order ??
Anatomy of a Stress Test

• Each cardiac stress test has two components:
  • **Stressing agent**: treadmill, dobutamine, or adenosine (or persantine or regadenosine)
  • **Imaging agent**: EKG, echo, or radionuclide tracer (thallium or technetium)
# Stress Agents

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<td>Physiologic, simple, less expensive, good for patient who <strong>can walk</strong></td>
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<td>Dobutamine</td>
<td>No exercise needed</td>
<td>Caution in patients with <strong>arrhythmias</strong></td>
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<td>Adenosine/Regadenosine (or dipyridamole)</td>
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<td>Good if patient has pre-existing EKG abnormalities. More info than EKG. Less expensive than nuclear.</td>
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<td>Localizes ischemia and infarcted tissue.</td>
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Imaging Agents

EKG

FIGURE 12-11. The ECG of a 50-year-old-man with severe disease of the right and left anterior descending coronary arteries. Note J-point changes, which evolve into horizontal and finally downsloping ST-segment depression.
Imaging Agents

EKG - LBBB
Imaging Agents

EKG - Paced Rhythm
Imaging Agents

EKG - Abnormal Baseline
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Imaging Agents

Nuclear
## Sensitivity and Specificity

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<th>Sensitivity</th>
<th>Specificity</th>
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<tr>
<td>Exercise EKG</td>
<td>68%</td>
<td>77%</td>
</tr>
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<td>Stress Echo</td>
<td>76%</td>
<td>88%</td>
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<tr>
<td>Nuclear Imaging</td>
<td>79-92%</td>
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Patient able to exercise?
(no contraindication to exercise –
ie. severe AS, ACS/acute MI, etc.)

Yes  No
Patient able to exercise?
(no contraindication to exercise –
  ie. severe AS, ACS/acute MI, etc.)

- Yes
  - Normal resting EKG
    - Yes
    - No
  - No
    - Poorly controlled or severe bronchospastic lung disease
      - No
      - Yes
Selecting Modalities

Patient able to exercise?
(no contraindication to exercise –
  ie. severe AS, ACS/acute MI, etc.)

Yes

Normal resting EKG

No

Poorly controlled or severe bronchospastic lung disease

Yes

Graded exercise stress test

No

LBBB or Pacemaker

Yes

Adenosine Cardiolite stress test

No

Obesity

Yes

No
Selecting Modalities

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Yes

Obesity

Yes

Dobutamine stress Cardiolite

No

Yes

Dobutamine stress Cardiolite or Echo
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Adenosine Cardiolite stress test

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Yes

Obesity

No

H/o MI / wall motion Abnormality

Yes

Exercise Cardiolite stress test

No

Exercise stress Cardiolite or Exercise stress echo

Dobutamine stress Cardiolite

Yes

Dobutamine stress Cardiolite or Echo

No
Case Study

A 60 yo man is evaluated for chest pain of 4 months’ duration. He describes the pain as sharp, located in the left chest, with no radiation or associated symptoms, that occurs with walking one to two blocks and resolves with rest. Occasionally, the pain improves with continued walking or occurs during the evening hours. He has hypertension. Family history does not include cardiovascular disease in any first-degree relatives. His only medication is amlodipine.

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Case Question

- Non-cardiac, Atypical or Typical chest pain?
- Pretest probability (60 y.o. / Male)? 65-72%
- Can he exercise? Yes or No
- Interpretable resting EKG (LBBB)? Yes or No
- Lung Disease or Obesity (BMI 28)? Yes or No
Case Question

• Which of the following is the most appropriate diagnostic test to perform next?

  a. Adenosine nuclear perfusion stress test
  b. Coronary angiography
  c. Echocardiography
  d. Exercise treadmill
Take-Home Points

• Know the **contraindications** for stress testing
• Stress testing is generally indicated for patients with **intermediate** pre-test probability
  • Positive test in a low-risk population is frequently false positive
  • Testing in high-risk populations may help determine prognosis
• Each stress test has two components: an imaging modality and a stress modality
• When determining which stress test to order, keep in mind the patient’s ability to exercise and whether any confounding variables are present
Yes ...ordering the proper stress test does matter !!
Questions ???
“This is the stress test. Run until you start huffing and puffing.”