Appropriateness of Stress Echocardiography and Nuclear Stress Thallium/Sesta Mibi Testing Methods

Review by
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Objectives:

A basic description and review of appropriate use of stress by Nuclear Spect and Stress echo testing for Cardiac evaluation.

Define and address: Sensitivity, Specificity, and Exam Cost.

Address preferred results versus possible consequences of the Stress Test.
Coronary arteries

The Gold Standard: Coronary Angiogram
Stress testing for Cardiac Evaluation

Two types:
1. Nuclear SPECT Stress Testing

2. Echocardiography Stress Testing

Nuclear Stress Testing
SPECT Imaging using radioisotope infused intravenously to perfuse through the coronary arteries and highlight the myocardium. A Gamma camera is used to evaluate myocardial sectors from long and short axis angles. These images are performed both at rest and then after stress.
Frequently used Stress types for Cardiac Nuclear imaging

Treadmill

Adenosine

Dipyridomole
Example of Nuclear images of Cardiac sectors in a normal subject at rest and post stress

Spect imaging
Spect imaging of ischemia

Left Ventricle:
Long axis Horse shoe     short axis  doughnut
Stress Echocardiography uses Myocardial ultrasound images, comparing pre and post stress. Evaluation includes: motion, thickening and direction.
Frequently used Stress Types for Stress Echocardiography include:

- Treadmill
- Bicycle
- Dobutomine

Echo anatomy
Factors Affecting Accuracy of Stress Echo

1. Quality of images
2. R wave triggering / acquisition
3. Tomographic planes:
   - Foreshortening
   - Comparability of tomographic planes

Example of Stress Echocardiography images in a normal subject pre and post stress.
Specificity:

probability of a negative test among patients without disease
Sensitivity:

probability of a positive test among patients with disease

Sensitivity and specificity by themselves are only useful when either is very high (over typically, 85% or higher)

NUCLEAR STRESS TEST: UP TO 95%
STRESS ECHO: UP TO 90%
Exercise Echo or SPECT Imaging?
A Meta-Analysis of Test Performance
Fleishmann KE et al, JAMA 1998;280:913-920

SENSITIVITY SPECIFICITY

Ex ECHO 87 84%
(CI, 84-89%) (CI, 81-88%)

Ex SPECT 86 62%
(CI, 83-88%) (CI, 55-70%)

Exam Cost: Total out of pocket cost for a patient. Does not include insurance, Medicare, Medicaid, or discounted procedures.
**Prevalence** = probability of disease in the entire population at any point in time (i.e. 2% the U.S. population has diabetes mellitus)

**Incidence** = probability that a patient without disease develops the disease during an interval (the incidence of diabetes mellitus is 0.2% per year, referring only to new cases)
ACCF/AHA/ASE/SCAI/SCCT/SCMR 2008
Appropriateness Criteria for Stress Echocardiography


Endorsed by the Heart Rhythm Society and the Society of Critical Care Medicine

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Application of Appropriateness Criteria

to Stress Single-Photon Emission Computed
Tomography Sestamibi Studies and Stress
Echocardiograms in an Academic Medical Center

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Objectives
The purpose of this study was to apply published appropriateness criteria for single-photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) in a single academic medical center.

Background
The American College of Cardiology Foundation (ACCF) and the American Society of Nuclear Cardiology (ASNC) have developed appropriateness criteria for stress SPECT MPI to address concern about the growth in cardiac imaging studies.

Methods
We retrospectively examined 294 patients who underwent stress SPECT MPI and 298 patients who underwent stress echocardiograms before publication of these criteria.

Results
The overall level of agreement in characterizing appropriateness between 2 experienced cardiovascular nurse abstractors was moderate (kappa = 0.56), but notably poorer (kappa = 0.27) for patients with previous SPECT or echo studies. Similar proportions of each imaging modality were assigned to the 3 appropriateness categories: 64% of stress SPECT and 64% of stress echo studies were classified inappropriate; 11% of stress SPECT and 9% of stress echo were of uncertain appropriateness; and 24% of stress SPECT and 18% of stress echo were inappropriate. Of the inappropriate studies, 88% were performed for 1 of 4 indications. Approximately 50% of the patients were undiagnosed.

Conclusions
Application of existing SPECT MPI appropriateness criteria is demanding and requires an established database or detailed data collection, as well as a number of assumptions. Four percent of stress SPECT studies and 18% of stress echo studies were performed for inappropriate reasons. Quality improvement efforts directed at reducing the number of these inappropriate studies will benefit patients by reducing unnecessary tests.
Stress Echo
Results comparable to nuclear although specificity might be higher (except for LBBB)
Operator dependant
Large learning curve
Limited by image quality
Contrast can improve images and facilitate detection of Ischemia

Post-Treadmill Stress Echo
Advantages
1. Standardized protocols
   - provide additional information
2. Widely available
Limitations
1. Sonographer-intensive
2. Mild ischemia may recover prior to imaging
3. Only two stages seen
   - rest and post-exercise
Stress Echocardiography: Situations Limiting Accuracy

- LBBB - decreased specificity
  - Vasodilator-stress perfusion SPECT is more accurate
- Concentric LVH - decreased sensitivity with Dobutamine
  - Exercise is preferable
- Excessive afterload - decreased sensitivity
- Poor Image Quality
  - Operator dependent / subjective assessment / experience is essential

Nuclear:
- Accurate results although specificity may be lower
- Less operator dependent
- Newer SPECT technology allows EF and wall motion added to perfusion
- Attenuation artifacts are a frequent cause of false positives
Treadmill Stress Test

What if emotional stress worked?
THE PURPOSE OF:
TREADMILL STRESS AND
PHARMACOLOGICAL STRESS

Arterial dilation to evaluate circulation to myocardium

Inappropriate population for treadmill stress testing
Case 1:
74 year old Female, History of Bilateral Mastectomy and subsequent breast implants.

Referring Physician ordered Treadmill Stress Echo due to Abnormal ECG, pre-op for hip replacement surgery

Nuclear Spect with adenosine would be appropriate:

Implants make echo images more difficult due to artifacts, Endocardium sometimes not seen clearly from some views.

Back, Hip, Knee, Foot problems should be referred for pharmacological stress test, injury is not part of the exam.
Case 2:
52 year old obese male
Chest pain for 3 weeks with exertion
1 pack smoker
Family history of CAD
Altius insurance

Stress echo may not be optimal:
Obese: poor images with echo
Smoker: poor images with echo
Insurance requires Stress Echo
First….Why?
Cost: the dollar stress test

Stress Echo $900
Nuclear Spect $1500
Cardiac Angiogram $3000
Case 3:
45 year old male
Complaints of exertional chest pain
family history of CAD
Able to jog without joint pain
Not on beta blockade

Stress echo may be optimal:

age appropriate, echo images must be evaluated for quality

able to exert rigorously without injury

Beta blockers suppress heart rate. Treadmill stress requires a near maximal heart rate and blood pressure stress.
A brief explanation and a review of the appropriate use of stress by Nuclear Spect and Stress echo testing for Cardiac evaluation has been presented.

Defined and addressed: Sensitivity, Specificity, and Exam Cost.

Examined preferred results versus possible consequences of the Stress Test.

Review:
Thank You