Optimal testing for coronary artery disease in symptomatic and asymptomatic patients

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Cardiac testing

• Functional studies: Treadmill ECG testing, stress echocardiography and nuclear stress testing
• Anatomic studies: calcium scoring and coronary CT scan
• Combined anatomic/functional studies: cardiac catheterization, measurement of FFR
Diagnostic testing (utility)

- Test accuracy (Se and Sp)
- Pre-test probability of disease
- Clinical impact of finding disease
Clinical impact of finding obstructive >70% disease?
Coronary Stenosis Severity Prior to MI

Falk, Circulation 1995; 92:657-71
Vulnerable Plaque

Libby P, Circulation 1995; 91:2644
Clinical impact of screening symptomatic patients?
MI as Initial Presentation of CAD

Myocardial infarction (MI) or death as initial presentation of CAD

<table>
<thead>
<tr>
<th></th>
<th>Percentage of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>62%</td>
</tr>
<tr>
<td>Women</td>
<td>46%</td>
</tr>
</tbody>
</table>

(Adapted from Levy et al.)

Levy, Textbook of Cardiovascular Medicine 1998
Angiography and Remodeling

3.1 mm

3.1 mm
Starting point:

- Understand cardiac testing is effective in establishing a cardiac cause for symptomatic patients and has prognostic value in symptomatic patients
  – Definition of symptomatic should include classic symptoms, as well as dyspnea and ischemic-equivalents

- Incorporating asymptomatic patients may permit earlier diagnosis and treatment; or improved assessment of risk

- Avoidance of testing in some patients may reduce direct and downstream costs and patient risks (contrast, radiation)
How to best utilize diagnostic studies? (Appropriateness criteria)

ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM
Appropriate Use Criteria

ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM
2009 Appropriate Use Criteria for Cardiac Radionuclide Imaging
A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine

ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate Use Criteria for Cardiac Computed Tomography
A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the Society of Cardiovascular Computed Tomography, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the American Society of Nuclear Cardiology, the North American Society for Cardiovascular Imaging, the Society for Cardiovascular Angiography and Interventions, and the Society for Cardiovascular Magnetic Resonance
Symptomatic patient
Who?

• 35 year old female with no risk factors with precordial chest pain occur after a day of stressful work

• 55 year old male smoker who develops chest pain while carrying heavy boxes, pain improves with rest after 10-15 min

• 75 year old male, smoker, diabetic, peripheral vascular disease and chronic renal insufficiency with exertional SOB.
Typical Angina

Precordial (retrosternal) chest pain that...

- Is triggered by physical or emotional stress
- Is relieved by rest or SL NTG
- Lasts for 15-20 minutes each episode

2-3/3: typical angina
1/3: atypical angina
0/3: likely non-cardiac chest pain

## Stress Testing: Who?

**Adults with intermediate (10-90%) pre-test probability of CAD**

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Typical</th>
<th>Atypical</th>
<th>Non-anginal</th>
<th>Asymp</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-39</td>
<td>Male</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Intermediate</td>
<td>Very Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40-49</td>
<td>Male</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50-59</td>
<td>Male</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>60-69</td>
<td>Male</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>

Stress Testing: Who else?

- **Patients with symptoms or prior history of CAD**
  - Known CAD with change in status
  - Assess response to medications
- **Acute setting**
  - Acute chest pain syndrome, low risk, 8-12 hours after presentation free of symptoms ("rule out time")
  - Acute chest pain syndrome, intermediate risk, unstable angina, 2-3 days free of active ischemia
- **Other**
  - Post-MI
  - Arrhythmias
  - Valvular heart disease
Asymptomatic patients?
ADENOSINE Tc-99m SESTAMIBI SPECT IMAGING IN ASYMPTOMATIC DIABETICS (n=522)

The DIAD Study

- Gated SPECT abnormal in 22%
- 40% of perfusion defects were marked
- Routine clinical and biomarker variable were NOT predictive of abnormal SPECT
- Only predictor of abnormal SPECT was autonomic dysfunction (OR=2.4)

Wackers et al, 2004
Diabetes Care 27:1954
CUMMULATIVE INDICENCE OF CARDIAC DEATH AND NFMI IN DIAD BASED ON SPECT SCREENING

Young et al, 2009
JAMA 301; 1547
VALUE AND COST-EFFECTIVENESS OF SCREENING DIABETICS FOR CORONARY HEART DISEASE

ENRICHING THE TARGET POPULATION
Asymptomatic Diabetics Undergoing Evaluation with Calcium Scoring and SPECT MPI

<table>
<thead>
<tr>
<th>ISCHEMIA ON SPECT MPI</th>
<th>CAC &lt;100</th>
<th>CAC 100-400</th>
<th>CAC &gt;400</th>
</tr>
</thead>
<tbody>
<tr>
<td>He, 2000</td>
<td>1%</td>
<td>10%</td>
<td>48%</td>
</tr>
<tr>
<td>Anand, 2004</td>
<td>0%</td>
<td>18%</td>
<td>45%</td>
</tr>
</tbody>
</table>

- 50% of normal SPECT have CAC<100\(^1\)
- 82% of events occur with CAC>400\(^2\)

\(^1\) Berman, 2004
\(^2\) Anand, 2004
ASYMPTOMATIC DIABETIC PATIENTS
A Step-wise Evaluation With an “Enriched” Population

- Asymptomatic Diabetic Patient
  - EBCT/MSCT
    - CAC <100
      - Risk modification
    - CAC 100-400
      - Lower risk
      - Higher risk*
        - Risk modification
        - MPI
          - MPI in 2 yrs
          - Cath/Revasc
    - CAC >400
      - MPI
        - MPI in 2 yrs
        - Cath/Revasc

* DM>10 yrs, end organ damage, > 65 y.o.a.
Stress MPI may be considered for advanced CV risk assessment in asymptomatic adults with diabetes or asymptomatic adults with a strong family history of CHD or when previous risk assessment testing suggests high risk of CHD, such as a coronary artery calcium (CAC) score ≥400.

Stress MPI is not indicated for CV risk assessment in low- or intermediate-risk asymptomatic adults.

Stress ECHO and CCTA is not indicated for CV risk assessment in asymptomatic adults.

Measurement of CAC is reasonable for CV risk assessment in asymptomatic adults at intermediate risk (10%-20% 10-yr risk)

Measurement of CAC may be reasonable for CV risk assessment persons at low to intermediate risk (6%-10% 10-yr risk)

Persons at low risk (<6% 10-yr risk) should not undergo CAC measurement for CV risk assessment

Asymptomatic patients

- High risk due to concomitant disease (DM, PVD, CRF, >CS 400)
- Men > 45 and women > 55
  - Starting exercise
  - Impact public safety
- Peri-operative evaluation
Should we screen peri-operative patients?

J Am Coll Cardiol, 2008; 51:1913-1924
Coronary-Artery Revascularization
vs Vascular Surgery

Figure 1. Long-Term Survival among Patients Assigned to Unifactorial Coronary-Artery Revascularization or No Coronary-Artery Revascularization in Elective Major Vascular Surgery.

European Heart Journal (2009) 30, 2769–2812
Stress testing for peri-operative evaluation

Hendel RC et al, JACC 2009 53: 2001-29
How often?
Previous stress test

Hendel RC et al, JACC 2009 53: 2001-29
Post-revascularization

Hendel RC et al, JACC 2009 53: 2001-29
Stress Testing: Absolutely Who Not!

• Acute MI
• High risk unstable angina
• Uncontrolled arrhythmias with symptoms
• Uncontrolled, symptomatic heart failure
• Symptomatic, severe aortic stenosis*
• Acute aortic dissection
Coronary CT angiography scan

- Coronary disease evaluation
- Structural heart disease
CT angio

Figure 3. Detection of CAD in symptomatic patients without known heart disease symptomatic acute presentation.

Hendel RC et al, JACC 2009 53: 2001-29
Figure 10. Evaluation of cardiac structure and function: evaluation of intra- and extracardiac structures.

Hendel RC et al, JACC 2009 53: 2001-29
Limitations:

- Limited ability to define hemodynamic significance
- Heavy calcified vessel may overestimate disease
- Radiation/contrast
Coronary Flow Wire

A severe lesion has a large pressure gradient even at resting flow.
Fractional Flow Reserve versus Angiography for Guiding Percutaneous Coronary Intervention

Pim A.L. Tonino, M.D., Bernard De Bruyne, M.D., Ph.D., Nico H.J. Pijls, M.D., Ph.D., Uwe Siebert, M.D., M.P.H., Sc.D., Fumiaki Ikeno, M.D., Marcel van ‘t Veer, M.Sc., Volker Klauss, M.D., Ph.D., Ganesh Manoharan, M.D., Thomas Engstrøm, M.D., Ph.D., Keith G. Oldroyd, M.D., Peter N. Ver Lee, M.D., Philip A. MacCarthy, M.D., Ph.D., and William F. Fearon, M.D., for the FAME Study Investigators*
Identification of all lesions with stenosis ≥50% for which stenting is planned

Randomization

Angiography-guided PCI

Stent placement for all indicated stenoses

FFR-guided PCI

Measurement of FFR for all indicated stenoses

Stent placement only for stenoses with FFR ≤0.80
Results:

N Eng J Med. Tonino, Jan 15, 2009
Take home messages

- Functional stress testing for symptomatic patients
- Studies that detect atherosclerotic plaque may add to his factor assessment and may further detect patients at risk in whom further testing may be warranted
- Adding a functional study to coronary angiography help select patients more likely to benefit from revascularization