Cardiology Diagnostic Testing

WHAT TO ORDER, WHEN AND WHY

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Cardiac Diagnostic Tests

- Use has increased faster than any other physician service
- Greater Medicare scrutiny in setting of drastic cuts in reimbursement
- Reimbursement refusal on tests currently being done based on indication listed
- Testing centers will have to refuse to perform test without acceptable indication.
- Ordering of tests will require acceptable diagnosis or indication in order for test to be performed.
Appropriateness Use Criteria

- Panel of experts from various fields
- Ongoing effort with frequent updates
- Evidence based information
- Should not be considered as substitute for sound clinical judgment and practical experience (although reimbursement cares neither about judgment nor experience)
Appropriateness Use Criteria

Current guidelines exist for:

- Echocardiography
- Diagnostic cardiac catheterization
- Myocardial Perfusion Imaging
- Cardiac CT/MRI
- Coronary Revascularization
- Peripheral Vascular Ultrasound and Physiologic Testing
Appropriateness Criteria—Definition

- “An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.”
- “The lesser the indication, the greater the complication.”—Dr. William Halstead
Echocardiography

- Audible sound is 20,000 cycles/sec
- Cardiac echo—1-10 million cycles/sec (1-10 MHz)
- Transducer vibrates to produce bursts of sonic waves and receives reflected waves for interpretation.
- No known biologic effect may increase risk of misuse and overuse
- “Risk” of echo is not in sound waves but in false findings leading to further riskier testing that is not needed.
Echo M-Mode
Echo 2-Dimension
Echocardiography

- Allows for assessment of chamber sizes and function of left and right ventricles
- Valvular assessment for stenosis and/or regurgitation
- Congenital heart defects
- Pericardial disease (thickening, constriction, effusion, etc)
- Structural issues (LVH, tumors, masses, thrombus)
- Estimation of pulmonary pressures
- Limited evaluation of aortic pathology
Echo—Acceptable Indications

- **Symptoms suspicious for cardiac etiology**
  - Chest pain, SOB, palpitations, syncope, TIA/stroke

- **Abnormal findings on other cardiac tests**
  - Cardiomegaly on CXR, abnormal CE, abnormal ECG

- **Arrhythmias**
  - A Fib, frequent PVC’s (not SB or infrequent PVC’s/PAC’s)

- **Pulmonary hypertension**
  - Suspected or surveillance of confirmed (>1 year) or with any change in clinical status
Echo—Acceptable Indications (Acute)

- Hemodynamic instability
  - Hypotension of uncertain etiology
- Acute chest pain or suspected ischemia
  - Nondiagnostic ECG or CE’s
- Suspected complications of MI
  - VSD, acute MR, perforation
- Respiratory failure
  - If etiology unclear
- Evaluation of function post ACS or cardiac trauma
  - Immediate and reassessment
Echo Indications--Valvular

- New murmur or known valvular disease with clinical change
- Surveillance—native or prosthetic
  - OK for new prosthetic valve to establish baseline measurements
  - Must be greater than 1 year for moderate to severe valvular disease unless there is a change in clinical status
  - SBE—must have new murmur or positive blood culture with susceptible organism—can also recheck in documented SBE if high risk for progression or complication or change in clinical status
Echo Indications--CHF

- Initial eval in suspicion for CHF
- Re-eval in change in status or exam
- Re-eval to guide therapy
  - ICD
  - VAD
  - Optimization of ICD, CRT, VAD
  - Other surgical treatments
Transesophageal Echocardiography

- High frequency probe passed into esophagus to view cardiac structures from behind
- Best for viewing posterior chambers and valves (mitral valve, left atrium, interatrial septum, etc.)
- Requires topical and IV anesthesia
- Risks include complications of anesthesia, perforation of esophagus (1/3000)
  - Sleep apnea
  - Zenker’s diverticulum
  - Esophageal narrowing or obstruction
TEE—Indications

- **General**
  - Unable to visualize on TTE with no other option
  - Eval for interval change (veg, thrombus)
  - Suspected aortic pathology
  - Guidance for interventions (ASD closure, Alfieri clip, TAVI, RFA)

- **Valvular**
  - Assess for vegetations in high probability situations—staph bacteremia, prosthetic valves, significant regurgitation for surgery
  - Evaluate valvular structure and function in preparation for intervention
• **Embolic event**
  - Cardiovascular source of embolus if no noncardiac source can be found
  - ? Use in cryptogenic stroke in patients >60 yrs of age

• **Atrial fibrillation/flutter**
  - Facilitate decision making regarding cardioversion (chemical or electrical) or PVI/ablation
Stress Testing

- Treadmill stress test
- Bicycle stress test
- Stress echocardiography
- MPI
- Chemical stress test
  - Dipyridamole
  - Adenosine
  - Dobutamine
  - Regadenoson
- Stress MRI
Treadmill Stress Test

- Most studied and validated with multiple protocols
- Multiple levels of information obtained—interpreter needs to know what is desired
  - Level of conditioning
  - Induction of ST/T wave changes
  - Exercise induced dysrhythmias
  - Rate of heart rate increase and decrease
  - Blood pressure variation
  - Effects of medications
  - T-wave alternans
Treadmill Stress Testing—Indications

- Adult patients with normal resting ECG and intermediate pre-test probability of CAD
- Risk assessment and prognosis in patients with known or suspected CAD
- Prognosis after myocardial infarction (old indication)
- Men > 40 or women > 50 who wish to start strenuous exercise program (2B indication)
- Likely of benefit in certain patients with advanced valvular disease.
Treadmill Stress Test—Contraindications

- Abnormal resting ECG— if looking for induced ischemia
  - LBBB, pacing, digoxin, WPW, etc.
- Acute life-threatening condition (USA, PE, MI, aortic dissection, etc.)
- Severe symptomatic aortic stenosis
- Active dysrhythmias (tachy or brady)
- Severe electrolyte abnormalities
- Severe hypertension
- Outflow tract obstruction (HOCM, etc.)
- Inability to exercise
Treadmill Stress Test—No Indications

- Routine screening in asymptomatic patients with few risk factors.
- Evaluation of isolated ectopy in young patients
- Screening before athletic participation in healthy adolescents.
Myocardial Perfusion Imaging

- Nuclear imaging of myocardial perfusion at rest and with exercise—defect suggests reduced perfusion
- Chemical stress used when physical stress is impossible at a cost of accuracy
- Multiple agents used for SPECT cardiac imaging
  - Thallium
  - Sestamibi
  - Tetrofosmin
- Gamma camera, PET imaging, Hybrid PET/CT systems
MPI Limitations

- Patient size/body habitus
- Motion and positioning
  - Breathing, sleeping/snoring/OSA
- Soft tissue attenuation
  - Breast artifact in women with/without implants
  - Diaphragmatic artifact
- Optimization of imaging
  - Attenuation correction software
  - Prone imaging
MPI—Radiation Exposure

### Units of Absorbed Dose

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<th>Units not normalized by $w_R$</th>
<th>mGy</th>
<th>0.1</th>
<th>1</th>
<th>10</th>
<th>100</th>
<th>1,000</th>
<th>10,000</th>
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<td>0.01</td>
<td>0.1</td>
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<td>1,000</td>
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<tr>
<td>Gy</td>
<td>0.00001</td>
<td>0.0001</td>
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### Units of Effective Dose, Equivalent Dose, and Weighted Equivalent Dose

<table>
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<tr>
<th>Units normalized by $w_R$</th>
<th>mSv</th>
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<tr>
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<td>0.01</td>
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### # of Chest x-rays (PA)

- LD50: 5 Sv
- Average dose, atomic bomb survivors (REPER): 200 mSv
- Dual isotope stress test: 29 mSv
- Annual limit to radiation workers (10 CFR 20.1201): 50 mSv
- Sestamibi stress test or CTA with tube current modulation: 11 mSv
- Average US annual background radiation: 3 mSv
- Annual limit to general public from a licensed radiation operation (10 CFR 20.1301): 1 mSv
- Chest x-ray (lateral) or Dental x-rays (4 bitewing films): 0.04 mSv
- Roundtrip flight, New York-Los Angeles: 0.03 mSv
- Chest x-ray (single view, posteroanterior): 0.02 mSv
MPI—Reducing Radiation

- Stress only (about half of patients)
- Improved hardware/software
- Careful patient selection
- New agents
  - Chemical stress only
Myocardial Perfusion Imaging--Indications

- Acute chest pain—?ACS—no ischemic ECG changes
  - Nondiagnostic ECG
  - Medium to high risk of ACS
  - Normal or equivalent Troponins, etc.
  - Active CP in low risk patient—resting images only

- Possible ischemia equivalent
  - Nondiagnostic or uninterpretable ECG
  - Inability to exercise
Myocardial Perfusion Imaging--Indications

- High risk ATP III score in asymptomatic patient
- New onset LV dysfunction with low risk CAD
- Ventricular tachycardia—low suspicion of CAD
- Syncope with intermediate or high risk CAD
- Nonspecific Troponin elevation—low risk ACS
  - Ischemic burden
- Agatston score >400 or risk stratification in known CAD
Myocardial Perfusion Imaging—Pre-op Risk

- Not indicated for low risk surgery or intermediate risk surgery in patients with good functional capacity (greater than or equal to 4 METS)
- Indicated in intermediate or vascular surgery with poor functional capacity, at least one risk factor
- Not indicated if no invasive testing would be performed prior to surgery
MPI—No Indications

- Low pretest probability, able to exercise, normal ECG
- Definite ACS
- Asymptomatic low risk patients
- Asymptomatic but known CAD, previous MPI < 2 years
- Pre-op testing for low risk or “no risk” procedures (tooth extractions, endoscopy, etc.)
- Agatston score <100
Stress Echocardiography

- **Exercise or Dobutamine**
  - Loss of endocardial border definition at higher heart rates
- **Reduced wall motion with stress suggests reduced blood flow**
- **Benefits**
  - Still have stress information
  - No radiation—often use in younger or heavily radiated patients
- **Negatives**
  - Often requires contrast
  - Poor windows—COPD, body habitus
Cardiac Catheterization

- **Indications**
  - High pre-test probability for CAD requiring intervention
  - Need for hemodynamic information—advanced valvular disease

- **Complications**
  - Vascular complications—AV fistula, pseudoaneurysm, bleeding
  - Contrast allergy
  - Renal insufficiency
  - Death