Common symptoms and symptom complexes are addressed by this tool. Imaging requests for patients with atypical symptoms or clinical presentations that are not specifically addressed will require physician review. Consultation with the referring physician may provide additional insight.

This version incorporates MSI accepted revisions prior to 11/30/06
ABBREVIATIONS and GLOSSARY for CARDIAC GUIDELINES

ACC: American College of Cardiology
AHA: American Heart Association
ASCOT: Anglo-Scandinavian Cardiac Outcomes Trial
ARVD/ARVC: Arrhythmogenic right ventricular dysplasia/cardioomyopathy
A potentially lethal inherited disease with syncope and rhythm disturbances, including sudden death, as presenting manifestations.
BMI: body mass index
CABG: coronary artery bypass grafting
CAD: coronary artery disease
CHF: congestive heart failure
COPD: chronic obstructive pulmonary disease
CT: computed tomography
CTA: computed tomography angiography
EBCT: electron beam computed tomography
EKG: electrocardiogram
ETT: exercise treadmill stress test
FDG: fluorodeoxyglucose
LAD: left anterior descending coronary artery
LDL-C: low-density lipoprotein cholesterol
LV: left ventricle
LVEF: left ventricular ejection fraction
MI: myocardial infarction
MPI: myocardial perfusion imaging; SPECT study; nuclear cardiac study; “triple study”
MRA: magnetic resonance angiography
MRI: magnetic resonance imaging
mSv: millisievert
MUGA: multiple-gated acquisition scan
PAH: pulmonary artery hypertension
PCI: percutaneous coronary intervention  Includes percutaneous coronary angioplasty (PTCA) and coronary artery stenting.
PET: positron emission tomography
PTCA: percutaneous coronary angioplasty (PTCA)
SPECT: single photon emission computed tomography
TEE: Transesophageal echocardiogram
VSD: ventricular septal defect

**GLOSSARY**

**Agatston Score:** The only calcium score accepted by MedSolutions (MSI). This is a calcium score for the arteries.

**Volume Score:** another type of calcium scoring under consideration for acceptance.

**Angina:** principally chest discomfort, exertional

**Anginal variants or equivalents:** a manifestation of myocardial ischemia which is perceived by patient to be (otherwise unexplained) dyspnea, unusual fatigue, more often seen in women and may be unassociated with chest pain.

**Fabry’s disease:** An infiltrative cardiomyopathy, can cause heart failure and arrhythmias.

**Hibernating myocardium:** viable but poorly functioning or non-functioning myocardium which likely could benefit from intervention to improve myocardial blood supply.

**Moderate exercise:** the ability of a patient to perform the equivalent of a trot.

**Platypnea:** shortness of breath when upright or seated (the opposite of orthopnea) and can indicate cardiac malformations, shunt or tumor.

**Silent ischemia:** Cardiac ischemia discovered by testing only and not presenting as a syndrome or symptoms.

**Syncope:** loss of consciousness; Near-syncope is NOT syncope
Cardiovascular disease imaging is rapidly changing.

These guidelines address many adult, as well as pediatric, trauma, postoperative, pre- and post-transplant, post-procedure (e.g. PCI), and certain occupational situations.

These guidelines are based upon appropriate imaging in the context of a patient willing to proceed with further imaging, invasive evaluation, or procedures.

- If the patient has no desire for these, advanced imaging may be curtailed or quite limited.

Cardiac imaging appropriateness criteria published by professional specialty organizations are not precisely concordant with these guidelines, as there is a large area of “uncertain” benefit for many imaging modalities in the specialty society criteria (i.e. the evidence is substantially incomplete, particularly as it relates to CT coronary angiography and cardiac MRI). Even some of the “appropriate” criteria are open to interpretation, since these criteria are largely consensus-based and not evidence-based.

Risk assessment is an inexact process and always requires judgment as to overall cardiovascular risk.

- Generally speaking, diseases such as diabetes are considered an equivalent for coronary disease risk.
- Metabolic syndrome is considered a risk.
- Patients who have undergone organ transplant are at increased risk for ischemic heart disease secondary to their medication.
  - Imaging for ischemia including MPI or cardiac MRI can be performed.
- Other risks for coronary artery disease are outlined in these guidelines but should not be considered definitive.

Refer to CD-2 Nuclear Cardiac Imaging for general risk scoring for all cardiovascular imaging modalities.

- Advanced imaging is generally not indicated for patients who are considered low risk.

Women are known to have unique presenting characteristics of coronary artery disease. In some instances, this leads to gender-based variations in guidelines/diagnostic criteria which are reflected in these guidelines.*

*J Am Coll Cardiol 2006 Feb;47(3):4S-20S

Stress testing with MPI, PET, or cardiac MRI can be performed with exercise or chemical stress (dipyridamole, adenosine or dobutamine). This does not alter the CPT codes used for these studies.

Hybrid imaging (e.g SPECT/CT) which involve SPECT (MPI) imaging and CT for optimizing location, accuracy, and attenuation correction is on the horizon to combine functional and anatomic information.

- There is currently no evidence-based data to formulate appropriateness criteria for these hybrid scans.
• **Pediatric guidelines:** The Cardiac guidelines are the same for both the pediatric population and the adult population, unless there are specific Pediatric guidelines (highlighted in yellow).

**CD-2.1 General**
- MPI studies should include perfusion, left ventricular ejection fraction, and wall motion (CPT 78465, 78478, 78480). Other coding requests should be sent for Medical Director review.
  - CPT 78465 includes exercise or “chemical stress” testing.
- If a decision to perform cardiac catheterization has already been made, there is no need for nuclear cardiac stress testing.
- In some patients with small perfusion abnormalities on advanced imaging, there may be no benefit to revascularization above that of medical management (imaging results are on a spectrum representing a spectrum of risk).
  - A subset of patients with high pretest risks may require revascularization, even with small defects.
- Using MPI to assess extent of ischemia is helpful in determining management in a small minority of equivocal cases where there may be difficulty deciding between mechanical/surgical intervention versus continuing medical management.
  - This can help “risk stratify” a patient and is appropriate if there is documentation that that decision process is underway in a patient with poor or marginal exercise tolerance.

**CD-2.2 Asymptomatic Patient or Patient with Stable Symptoms**
- The U.S. Preventive Services Task Force (USPSTF) recommends against routine screening with resting EKG, exercise treadmill test, nuclear cardiac imaging, or EBCT in asymptomatic adults at low risk for coronary heart disease (defined as men <50 years old and women<60 years old with no other risk factors for coronary artery disease (CAD) such as high blood pressure, smoking, abnormal lipid levels, parental or sibling history of cardiovascular disease before age 55, vascular disease, diabetes or obesity). In these patients, the harm of false-positive tests, including unnecessary invasive procedures, over-treatment, and patient labeling, outweigh the potential benefits.
- Asymptomatic patients with an intermediate or moderate pretest likelihood of coronary disease (defined as having two of the following risk factors: males over age 50, females over age 60, high blood pressure, renal failure, documented peripheral artery disease, smoking, abnormal lipid levels, diabetes, family history of MI, acute coronary syndrome, or sudden cardiac death in a first degree relative less than 60 years old), who are not taking digoxin, have a normal resting EKG, and are able to do moderate exercise can undergo treadmill exercise stress test as the initial study.
• MPI can be considered in patients with 3 or more known risk factors (as defined above).
  o NOTE: Borderline cases (e.g. a 51 year old male with hypertension and mild hyperlipidemia or a 50 year old female smoker with hypertension and hyperlipidemia) should be sent for Medical Director review.
  o Exception: MPI is appropriate in asymptomatic individuals with at least 2 risk factors (as defined above) who have high risk occupations (e.g. airline pilots and bus drivers).

• If diabetes is the only risk factor in the asymptomatic patient, imaging requests should be sent for Medical Director review.
  o The emerging evidence recommends MPI in diabetics, especially those with evidence of peripheral or carotid atherosclerosis, symptoms of dyspnea, or 2 or more additional coronary disease risk factors. Easy fatigability can be an anginal equivalent.
  o Reference: J Am Coll Cardiol 2005;46(8):1587-1605

• Patients with low or intermediate Duke Treadmill scores but high clinical risk (defined by one point each for: typical angina or suspicion of anginal variants, a history of acute coronary syndrome, mild MI, diabetes, insulin use, male gender, documented vascular disease, metabolic syndrome, renal failure and one point for each decade for age over 40 years; high risk is greater than or equal to 5 of these points) benefit from further noninvasive risk stratification with MPI. This is especially true of women with diabetes, who have the worst outcome for any given extent of reversible myocardial defect on MPI.

• Patients with a high pretest likelihood of coronary artery disease (high clinical risk with clinical score greater than or equal to 5 [see preceding bullet]) before any diagnostic testing benefit from MPI for further risk stratification and can have MPI performed as the initial stress test.

• Patients with complete left bundle branch block, ventricular paced rhythm, pre-excitation syndrome (Wolff-Parkinson-White), significant left ventricular hypertrophy with repolarization changes, resting bradycardia with heart rate less than 50 beats per minute due to beta-blocker or calcium channel blocker medication, or inability to do moderate exercise can undergo MPI as the initial study.

• Patients with angiographic evidence of coronary stenosis of unclear significance can undergo MPI even if asymptomatic.

• Patients at high risk or who have known coronary artery disease who are asymptomatic or have stable symptoms and have had a normal prior MPI study can have repeat MPI studies every 2 years (also see CD-3).

• Patients who are asymptomatic or have stable symptoms and have known coronary artery disease based on prior cardiac catheterization or MPI study and have not had a revascularization procedure (either PTCA/stent or bypass surgery) can have repeat MPI studies every 2 years.

• Asymptomatic patients who are candidates for any type of organ or bone marrow transplant can undergo MPI every year prior to transplant.
• The frequency of MPI studies in the asymptomatic post-transplant patient should be at the discretion of the transplant physician following the patient, and depends on the risk of cardiac ischemia imposed by the transplant medications.
• Asymptomatic patients undergoing non-cardiac surgery who have had normal catheterization, normal stress test, or previous revascularization within a year, do not need MPI for preoperative cardiac evaluation.*
  *J Am Coll Cardiol 2005;46(8):1587-1605

**CD-2.3 Symptomatic Patient**

**New Symptoms** (angina or anginal equivalents) EXCEPT in patients with none or one of the above risk factors, whose EKG is interpretable AND who are able to exercise, will support doing MPI as a general principle.
  o However, the appropriate imaging study in this context is highly case-specific, and no single guideline can consistently dictate appropriateness.
**Acute chest pain (or anginal equivalent):** Patients with intermediate pre-test likelihood of coronary disease (defined under CD-2.2 above) with normal cardiac enzymes and no evidence of ST elevation on EKG can undergo MPI.
• Patients with worsening symptoms can undergo MPI.
• In symptomatic premenopausal patients and any symptomatic patient in the low risk category, stress echocardiography or treadmill exercise stress test (if baseline EKG is normal and patient can adequately/moderately exercise) should be performed initially.
• In symptomatic postmenopausal female patients (generally over age 45), MPI is the preferred initial study due to the high false positive rate and frequent inadequate duration of exercise for females in this age group undergoing routine exercise treadmill stress testing.
• **Syncope:** patients being evaluated for syncope can undergo one MPI study if they are at intermediate or high risk for CAD.*
  o Patients at low risk for CAD should undergo exercise treadmill test or stress echocardiogram initially.
  *Circulation 2006;113:316-327
  o Also see CD-10 Syncope
• Patients with new onset/diagnosed heart failure or evidence of LV dysfunction with or without chest pain syndrome who have intermediate or high pre-test likelihood of coronary disease can undergo MPI unless cardiac catheterization is planned.
• Valvular heart disease patients with or without chest pain syndrome with moderate or high CAD risk benefit from MPI to help guide decisions for invasive testing.
• Patients with complete left bundle branch block, ventricular paced rhythm, pre-excitation syndrome (Wolff-Parkinson-White), significant left ventricular hypertrophy with repolarization changes, resting bradycardia with heart rate less than 50 beats per minute due to beta-blocker or calcium channel blocker medication, or inability to do moderate exercise can undergo MPI as the initial study.
Some effort should be made to obtain copies of reported “abnormal” EKG’s in patients being considered for MPI or other advanced cardiac imaging.

Patients at intermediate or high risk of CAD or with known coronary disease who have new onset atrial fibrillation or ventricular tachycardia can undergo MPI. Other rhythm abnormalities should be sent for Medical Director review.

MPI is appropriate to assess myocardial viability in patients with ischemic ventricular dysfunction (suspected hibernating myocardium). MRI is thought to be more accurate in that assessment but MPI testing is also appropriate.

**CD-2.4 Preoperative evaluation**

**For preoperative cardiac evaluation in symptomatic patients undergoing non-cardiac surgery:**

- Noninvasive preoperative testing is best directed at patients considered to be at intermediate clinical risk (diabetes, stable coronary artery disease, compensated heart failure, peripheral vascular disease, chronic renal failure) who are scheduled to undergo intermediate or high risk surgery and who are considered candidates for PCI or coronary bypass.

- Exercise treadmill stress test is preferred in patients capable of achieving adequate exercise workloads.

- Stress echocardiogram should be considered prior to considering MPI.

- MPI should be reserved for patients whose baseline EKG studies render exercise interpretation invalid or who cannot tolerate moderate exercise.

- Reference:

- Asymptomatic patients who have had normal catheterization, normal stress test, or previous revascularization within a year, do not need MPI for preoperative cardiac evaluation.*
  
  *J Am Coll Cardiol 2005;46(8):1587-1605

**CD-2.5 MUGA study**

- For a quantitative determination of ejection fraction, patients may be studied with a nuclear ventriculogram or MUGA study (CPT 78472 [default code] or 78494). This may be the preferred study for pre- and post-chemotherapy evaluation as well as in patients who have had chest radiation treatment or a non-diagnostic echocardiogram. However, this study may not be accurate in patients with cardiac arrhythmias or left bundle branch block. (Also see Cardiomyopathy in CD-6 Cardiac MRI).

- Chemotherapeutic agents such as Adriamycin, Herceptin, and others are considered cardiotoxic and can result in myocardial dysfunction and cardiomyopathy. These patients can be assessed by MUGA scan (CPT 78472 or 78494) or echocardiography.*
  
  *J Clinical Oncology 2006;24:4107-4115
  *Cancer Drugs Can Cause Heart Damage. Cancer and Chemotherapy. MD Anderson Cancer Center
• Patients on active Herceptin treatment can undergo MUGA (CPT 78472 or 78494) at 3, 6, and 9 months.*

*Invasive Breast Cancer. NCCN Practice Guidelines in Oncology v.2.2006

CD-3~ NUCLEAR CARDIAC IMAGING AFTER PERCUTANEOUS CORONARY INTERVENTION (PCI) OR CORONARY BYPASS SURGERY

• Patients who develop worsening chest pain syndrome, suspicious EKG changes, or cardiac enzyme abnormalities within any length of time following a revascularization can undergo MPI at least once.
• Asymptomatic patients or patients with chronic stable symptoms who have had PCI can undergo an initial follow-up MPI study 2 or more years after PCI and then every 2 years after that.
  o **Exception:** MPI following PCI is not indicated in asymptomatic patients who had identifiable ischemic (anginal-type) symptoms prior to PCI.
• Patients who have had bypass surgery and are asymptomatic or have chronic stable symptoms can undergo an initial follow up MPI study 5 or more years after surgery and then every 2 years after that.
  o **Exception:** MPI following bypass surgery is not indicated in asymptomatic patients who had identifiable ischemic (anginal-type) symptoms prior to surgery.

CD-4~ ULTRAFAST CT, EBCT, OR MULTIDETECTOR CT FOR CORONARY CALCIUM SCORING

• Certain payers consider coronary calcium scoring investigational, and their coverage policies will take precedence over MedSolutions’ guidelines. Prior authorization does not guarantee payment of the study.
• Coronary calcium scoring is not a covered benefit for any of the current health plans who have delegated utilization review to MedSolutions.
• Currently, there is insufficient evidence-based data to support performing coronary calcium scoring in symptomatic or asymptomatic patients with any degree of CAD risk.*
  *J Am Coll Cardiol 2006;48(7):1475-1497
• It is currently unclear whether coronary calcium scoring contributes significantly to management decisions, including achieving certain optimal lipid levels.
  o Recommendations based on the ASCOT trial are that patients with a 10% to 20% 10-year risk of CAD should have an optimal LDL-C target of less than 100, regardless of coronary calcium score.*
    *Lancet 2003 April;361:1149-1158
• The optimal interval for obtaining repeat coronary calcium scoring has not yet been determined.
CD-5~NUCLEAR CARDIAC IMAGING BASED ON CORONARY CALCIUM SCORE

- MPI can be performed in non-diabetic symptomatic or asymptomatic patients who have a recent Agatston coronary calcium score greater than or equal to 400.
- Diabetics with recent Agatston score over 100 can undergo MPI.
- MPI guidelines for asymptomatic patients with Agatston score less than 100 should follow those under CD-2 Nuclear Cardiac Imaging.
- The Agatston score is the only accepted coronary calcium score for these guidelines.

CD-6~CARDIAC MRI

- All requests for cardiac MRI should be sent for Medical Director review.
- MRA of the coronary arteries is not yet adequately sophisticated to replace coronary angiography in evaluating coronary disease and should not be authorized.
- **Indications for cardiac MRI include**:
  - Myocardial viability study. Use CPT 75554 and 71555.
  - Stress perfusion study. Use CPT 71555, 75553, and 75555 (may add 75556 only if valve or shunt flow abnormality likely).
  - Assessment of global ventricular function and mass (especially with poor or difficult echocardiogram visualization). Cardiac MRI is particularly useful in evaluating cardiomyopathy, amyloid heart disease, post cardiac transplant, chemical toxicity including chemotherapy, hemochromatosis, hypertrophic heart disease or cardiomyopathy, myocarditis, cardiac aneurysm, trauma and contusions. Use CPT 75554.
  - Pre- and postoperative congenital heart disease assessment (e.g. patent ductus arteriosus, platypnea, coarctation of the aorta, atrial septal defects, restrictive VSD, anomalous pulmonary veins or coronary arteries). Use CPT 75554 and 71555 (may add 75556). Chest MRA alone (CPT 71555) can be performed in certain situations, especially if requested by the cardiovascular specialist.
  - Clinical suspicion of arrhythmogenic right ventricular dysplasia or cardiomyopathy (ARVD/ARVC) especially if patient has presyncope or syncope. MRI (CPT 75554 or 75552) is considered the optimal test for this disorder.*

* *Circulation* 2006;113:316-327
  *Eur Heart J* 1989;10:127-132
  *Circulation* 2005;112(25):3823-3832

- Pericardial disease (constrictive pericarditis versus restrictive and perimyocarditis). Use CPT 75554.
- Evaluate cardiac tumor or mass (e.g. in sarcoidosis or tuberous sclerosis [see HD-27.13 Neurocutaneous syndromes]). Use CPT 75553.
- Anomalous coronary arteries: Cardiac MRI (CPT 75554) or CTA (CPT 0146T) (which is still favored) is much better at detecting this than conventional angiography.
- Fabry’s disease: late enhancement MRI may predict the effect of enzyme replacement therapy on myocardial changes that occur with this disease. Use CPT 75554.
- Aortic dissection. CPT 71555 can be used and add 74185.
- Valvular disease including Libman-Sach endocarditis, other endocarditis, and assessing valve abnormalities associated with ankylosing spondylitis. Use CPT 75554 and 75556. Alternatively, cardiac CTA (CPT 0145T) can be used.
- Diagnosing paravavular abscess in patients with endocarditis. Use CPT 75554.
- Pulmonary vein anatomy for planned ablation procedures in patients with supraventricular tachycardia or atrial fibrillation. Use CPT 71555 and 75554 (may add 75556). Also see CD-9 Pulmonary Vein Imaging.
- Rule out cardiac thrombus. Use CPT 75552.*
  *J Am Coll Radiol 2006;3:665-676
  *J Am Coll Cardiol 2006;48(7):1475-1497
  *J Am Coll Radiol 2006;3(9):665-676

- The aortic root and proximal ascending aorta can be adequately evaluated during a cardiac MRI. Thus, if a patient (e.g. Marfan’s or Loeyes-Dietz syndrome) with known ascending aortic aneurysm needs a cardiac MRI to evaluate another problem and the physician wishes to evaluate the ascending aorta, this evaluation should be included with the cardiac MRI interpretation. If the ascending aortic aneurysm is quite distal, near the arch, it is appropriate to include the thoracic MRI code (CPT 71551) or thoracic MRA code (CPT 71555).
- Echocardiogram is the initial imaging study of choice to evaluate pericardial effusions or diagnose pericardial tamponade. However, contrast enhanced cardiac MRI is useful for evaluating pericarditis, neoplastic effusion, tamponade or myocardial infiltration. Cancers that can metastasize to the pericardium or myocardium and can cause a malignant effusion include lung, breast, renal cell, lymphoma and melanoma.
- There are a few institutions that will perform cardiac MRI in patients with pacemakers or defibrillators. These cases should be sent for Medical Director review.

**CD-7~CARDIAC PET SCAN**

- All requests for cardiac PET scan should be sent for Medical Director review.
- CPT 78459 should be used for cardiac PET scans used to determine myocardial viability (i.e. identification of jeopardized but viable “hibernating” myocardium that can be salvaged with revascularization).
  - This study uses FDG tracer and is used to determine metabolically active myocardium. A reduction of FDG uptake indicates nonviable tissue.
With the excellent results given by cardiac MRI in viability studies, this application for PET is diminishing.

- CPT 78492 should be used for stress cardiac PET scans used to determine ischemia (i.e. coronary artery disease).
  - This study uses rubidium tracer and is similar to, but more sensitive than, MPI.
  - In most circumstances, cardiac PET does not need to replace MPI for determining coronary artery disease, and CD-2 Nuclear Cardiac Imaging guidelines should be followed.

- There are unusual circumstances in which cardiac PET can be useful. For example, a morbidly obese patient in whom an MPI study shows abnormalities, but these abnormalities may be due to ischemia or attenuation artifact. Cardiac PET is more accurate than MPI in obese patients in differentiating ischemia from attenuation artifact.

- Cardiac PET can be useful in a subset of women with an equivocal nuclear perfusion (MPI) stress test because PET demonstrates unequivocal normal perfusion in as much as 77% of these patients.*

  *J Am Coll Cardiol 2006;48:1029-1039

### CD-8–CT OF THE HEART and CTA of the CORONARY ARTERIES

#### CD-8.1 General

- Certain payers consider coronary calcium scoring and/or cardiac CT and coronary CTA investigational, and their coverage policies will take precedence over MedSolutions’ guidelines. Prior authorization does not guarantee payment of the study.

- Metallic interference including surgical clips, pacemaker devices, defibrillator devices and tissue expanders can also cause interference with CTA imaging.

- Relative contraindications for CT angiography of the heart include:
  - Elevated calcium score
    - CTA of the coronaries should not be performed if there is extensive coronary calcification (calcium score >1000).
  - Irregular rhythm (atrial fibrillation or multiple premature ventricular contractions)
  - Extreme obesity with a BMI of greater than 40 kg/m^2
  - Renal insufficiency with creatinine greater than 1.8 mg/dl
  - Patients with serious valve disease with marked dyspnea and COPD

#### CD-8.2 CT Used For Coronary Calcium Scoring

- Also see CD-4 Ultrafast, EBCT, or Multidetector CT for Coronary Calcium Scoring.

- Coronary Calcium Scoring: Currently, there is insufficient evidence-based data to support performing coronary calcium scoring in symptomatic or asymptomatic patients with any degree of CAD risk.
o Reference:
  - *J Am Coll Cardiol* 2006;48(7):1475-1497

- The optimal interval for obtaining repeat coronary calcium scoring has not yet been determined.

**CD-8.3 Coronary CTA in the Asymptomatic Patient**

- CTA should not be used in asymptomatic patients.
  - “Use of CT angiography in asymptomatic persons as a screening test for atherosclerosis (noncalcific plaque) is not recommended.”
    *Circulation* 2006;114:1761-1791
    [http://circ.ahajournals.org/cgi/content/full/114/16/1761](http://circ.ahajournals.org/cgi/content/full/114/16/1761)
    Accessed November 29, 2006
  - “Future trials are needed to evaluate whether multidetector CT is useful as a screening method in a selected patient population, as an alternative to exercise testing, myocardial perfusion, or dobutamine stress testing, or as an alternative to conventional angiography in patients with favorable characteristics.”
    *J Am Coll Cardiol* 2004;44:1224-1229

**CD-8.4 Coronary CTA in the Symptomatic Patient**

- Intermediate risk or low risk patients with chest pain syndrome and uninterpretable EKG or inability to exercise may be considered for coronary CTA if stress testing was uninterpretable and/or equivocal.
  - Stress testing (e.g. stress echocardiogram or MPI) should be attempted initially.
  - If no functional stress test has been performed, stress echocardiogram or MPI is needed in some cases to determine whether the coronary artery stenosis seen on coronary CTA is causing functional ischemia.
- Patients with high risk of coronary artery disease should undergo conventional coronary angiography rather than coronary CTA, especially if an interventional procedure (e.g. PCI) is anticipated.
- There is insufficient data to support performing “triple rule out” studies to exclude coronary artery disease, aortic dissection and pulmonary embolism in a patient with chest pain.
  - Requests for “triple rule out” should be sent for Medical Director review.
  - Also see CH-19 Pulmonary Embolism and CH-22 Thoracic Aortic Dissection or Aneurysm in the Chest guidelines.

**CD-8.5 Coronary CTA and Other Cardiac Imaging Studies**

- The high negative predictive value (98%-99%) of CTA of the coronaries in ruling out significant coronary artery disease has been found on multiple studies, although no large, randomized, prospective trials have been performed. CTA (CPT 0148T) can be useful in ruling out coronary artery disease in patients with low or intermediate probability of disease who have equivocal stress tests.
  - If CTA shows no significant coronary artery disease, then no further cardiac imaging is necessary.
If coronary artery disease is present and no functional stress test has been performed, exercise stress test, stress echocardiogram or MPI is needed to determine whether the coronary artery stenosis seen on CTA is causing functional ischemia.

- See CD-2 Nuclear Cardiac Imaging for guidelines regarding which functional stress test would be appropriate.

- **There is no data to support performing serial follow-up coronary CTA studies in symptomatic or asymptomatic patients.**
  - Serial imaging studies to evaluate for coronary artery disease should follow the guidelines in CD-2 Nuclear Cardiac Imaging.

### CD-8.6 Coronary CTA in Patients with Previous Coronary Artery Procedures

- **Detection of coronary artery disease post-revascularization (PCI/CABG):**
  - Evaluation of bypass grafts and coronary anatomy, especially in symptomatic patients, for preoperative planning (re-operation) **if there is no planned conventional angiography** is generally an appropriate indication for coronary CTA (CPT 0148T).
  - Coronary CTA can be helpful in post-bypass patients who are going to undergo re-do bypass surgery in order to identify whether bypass grafts such as the mammary are located directly beneath the sternum, so that alternative ways to enter the chest can be planned. Additionally, the precise course of the LAD (including an intramyocardial route) and the relationship of target vessels to intercostal spaces can be accurately determined by CTA. However, **not every patient who is scheduled for re-do surgery needs a CTA**, and there are no evidence-based data that performing CTA in these patients improves health outcome.
    - Requests for coronary CTA in post-bypass patients should be sent for Medical Director review.
  - Evaluation of coronary stents is difficult due to metal artifact and the clinical value of coronary CTA after stent placement is currently limited to detection of stent occlusion. Other degrees of in-stent re-stenosis cannot be accurately determined. Therefore, based on current data, coronary CTA to follow-up stent placement cannot be recommended.*

  *Circulation 2006;114:1761-1791
  [http://circ.ahajournals.org/cgi/content/full/114/16/1761](http://circ.ahajournals.org/cgi/content/full/114/16/1761)
  Accessed November 29, 2006

### CD-8.7 Other Indications for Coronary CTA

- **Evaluating coronary artery anomalies and other complex congenital heart disease of cardiac chambers or great vessels** is an appropriate indication for coronary CTA. (CPT 0146T for evaluating coronary artery anomalies; CPT 0150T for congenital heart disease—can add CPT 71275 to evaluate great vessels).
  - The use of coronary CTA to rule out anomalous coronary artery(ies) should be limited to patients less than age 40 with a history that includes one or more of the following:
    - angina or myocardial infarction without high atherosclerosis risk
• full sibling(s) with history of sudden death syndrome before age 30 or with documented anomalous coronary artery
• resuscitated sudden death
• unexplained syncope (not presyncope)
  ▪ Patients should have had a thorough negative evaluation for syncope as outlined in HD-32 Syncope in the Head Guidelines and CD-10 Syncope (e.g. echocardiogram, cardiac evaluation for postural blood pressure changes, resting low blood pressure, or low heart rate, MPI study, exercise treadmill test, or stress echocardiogram, consideration for situational syncope) prior to considering coronary CTA.
• unexplained new onset of heart failure (e.g. without atherosclerotic coronary disease or other causes for cardiomyopathy)
• documented ventricular tachycardia (6 beat runs or greater)
• equivocal coronary artery anatomy on conventional cardiac catheterization
  o The presence of other congenital heart disease is not a separate indication for coronary CTA to rule out anomalous coronary artery(ies).
- Evaluation of coronary artery status in patients with new onset heart failure is an appropriate indication for coronary CTA (CPT 0148T).
- Coronary CTA (CPT 0148T) for preoperative assessment of the coronary arteries in patients who are going to undergo surgery for aortic dissection, aortic aneurysm, or valvular surgery can be performed if CTA will replace invasive coronary angiography.
- Vasculitis/Takayasu's/ Kawasaki's disease (see HD-33.1Kawasaki syndrome in the Head guidelines and PVD-5 Aortic Disorders in the Peripheral Vascular Disease guidelines) can be imaged with coronary CTA (CPT 0148T).
- Cardiac/coronary CTA (CPT 0148T) can help determine the age of a myocardial infarction as can cardiac MRI.* Requests for this application should be sent for Medical Director review.
  *Am J Cardiol 2006;98:303-308
- Cardiac trauma: thoracic CTA (CPT 71275) and coronary CTA (CPT 0148T) are useful in detecting aortic and coronary injury and can help in the evaluation of myocardial and pericardial injury.*
  *Am J Cardiol 2006;98:402-406

CD-8.8 Indications for Cardiac CT
- Cardiac CT (CPT 0145T) is a useful study to accurately identify coronary veins for lead placement in patients needing biventricular pacemaker devices.
- Cardiac CT (CPT 0145T) can be performed for preoperative evaluation of pulmonary veins in patients in whom pulmonary vein isolation procedure (ablation) for tachycardia or atrial fibrillation is planned and for follow-up studies (See CD-9 Pulmonary Vein Imaging).
- Cardiac CT (CPT 0145T) can be used to assess cardiac tumor or mass, pericardial mass, pericarditis, complications of cardiac surgery, etc.
- Cardiac CT (CPT 0145T) can be used to evaluate cardiac thrombus in patients with technically limited echocardiogram, MRI, or TEE.
• Native aortic abnormalities can be investigated with cardiac CT (CPT 0145T) if echocardiogram is indeterminant.
• Cardiac CT may be helpful in the evaluation of recurrent laryngeal nerve palsy due to cardiac chamber enlargement.

**CD-8.9 Unproven Uses of Cardiac CT and Coronary CTA**

**There is insufficient data to support the routine use of cardiac CT and/or coronary CTA for the following:**
- As the first test in evaluating patients with chest pain (see CD-8.4).
- Preoperative assessment for non-cardiac, nonvascular surgery (see CD-2 Preoperative evaluation).
- Patients at high coronary disease risk with coronary calcium score greater than or equal to 400 should undergo MPI rather than coronary CTA (see CD-5).
- There is no data to support performing serial follow-up coronary CTA studies in symptomatic or asymptomatic patients.
  - Serial imaging studies to evaluate for coronary artery disease should follow the guidelines in CD-2 Nuclear Cardiac Imaging.
- Identification of plaque composition and morphology is possible with CTA, especially using 64-slice scanners. However, this technique currently has limited sensitivity, and the reproducibility of the measure has not been reported.
  - Therefore, the use of coronary CTA for determining plaque morphology or for quantification of coronary atherosclerotic plaque burden is not recommended at this time.*
    *Circulation 2006;114:1761-1791
    [http://circ.ahajournals.org/cgi/content/full/114/16/1761](http://circ.ahajournals.org/cgi/content/full/114/16/1761)
    Accessed November 29, 2006
- Evaluation of left ventricular function following myocardial infarction or in chronic heart failure.
- Myocardial perfusion and viability studies.
- Evaluation of patients with postoperative native or prosthetic cardiac valves who have technically limited echocardiograms, MRI or TEE.
  - Patients with indeterminate echocardiogram should undergo MUGA (CPT 78472 or 78494) or cardiac MRI (see CD-2.5 MUGA study and CD-6 Cardiac MRI).
- Considerable question remains as to whether CTA improves net health outcomes as well as any established imaging alternatives.*
    *Blue Cross Blue Shield Association, Technology Evaluation Assessment Program Volume 20, No.4 May 2005

**CD-8.10 Radiation Dose and Coronary CTA**

• Radiation dosage for CTA of the coronaries varies by facility and the particular protocol used. The American College of Radiology Clinical Statement on Noninvasive Cardiac Imaging states that “as a general rule a multi-detector CT scan encompassing the heart should not result in an effective dose of greater than 12 mSv”.*
Current 16-slice CT scanners usually keep the radiation dose <13 mSv.
- 64-slice CT scanners can deliver a radiation dose from 15-25 mSv (especially in women due to needing to penetrate breast tissue).
- Using dose modulation, in which much less radiation is delivered during the portion of the cardiac cycle not normally used for reconstruction, the radiation dose can be reduced to <13 mSv, but not all facilities have this capability.

*C J Am Coll Radiol 2005;2:471-477*

**CD-8.11 CPT Coding**

- The 3D rendering code 76376 or 76377 and nuclear medicine codes for ventricular function or ejection fraction should not be used in conjunction with coding for CTA of the coronaries with left ventricular function assessment.
- In October 2006, the American Medical Association (AMA) modified CPT 71275 (CTA chest) to clarify that coronary imaging is not included in that CPT code definition.
  - The description for CPT 71275 in the 2007 AMA CPT code book reads: “CTA Chest (non-coronary), without contrast, followed by contrast and further sections, including image postprocessing.”
  - Some health plans have not adopted the T codes for cardiac and coronary CTA; therefore, CPT 71275 will need to be used since there is no other option currently.
- Category III T (temporary) CPT codes took effect on January 1, 2006. These codes have no specific reimbursement tied to them and it is left to the discretion of each payer whether and how much these CPT codes will be reimbursed.
- The American College of Cardiology (ACC) has indicated that unless specific payers have instructed otherwise, the Category III T codes should be used to report coronary CTA studies since they most accurately describe the procedures performed.*

  *ACC Advocacy Weekly, July 11, 2005*

- The T codes are as follows:
  - **0144T** CT, heart without contrast material, including image post processing and quantitative evaluation of coronary calcium.
    - Used if only calcium scoring is being performed.
    - This code should be used as a stand-alone code and **never** should be used in conjunction with 0145T-0151T.
  - **0145T** CT, heart without and with contrast, including cardiac gating and 3D image post processing; cardiac structure and morphology.
    - Used for cardiac CT (does not include the coronary arteries), pulmonary vein imaging, and imaging of the cardiac veins.
  - **0146T** CTA of coronary arteries without quantitative evaluation of coronary calcium
    - Used to image the coronary arteries (e.g. for evaluating anomalous coronary arteries).
  - **0147T** CTA of coronary arteries with quantitative evaluation of coronary calcium
    - Used to evaluate coronary artery disease and perform calcium scoring.
Cardiac structure and morphology and CTA of the coronaries without quantitative evaluation of coronary calcium
- Used to evaluate cardiac morphology as well as coronary artery disease; calcium scoring is not included.
- This code is a combination of 0145T and 0146T.

Cardiac structure and morphology and CTA of the coronaries with quantitative evaluation of coronary calcium
- Used to evaluate cardiac morphology as well as coronary artery disease; calcium scoring is included.
- This code is a combination of 0145T and 0147T.

Cardiac structure and morphology in congenital heart disease.
- Used to evaluate congenital heart disease.

CT, heart, without and with contrast including cardiac gating and 3D image post processing; function evaluation (left and right ventricular function, ejection fraction, and segmental wall motion).
- Used to evaluate wall motion and ventricular function
- This is an add-on code and should never be used as a stand-alone procedure. It should be used in conjunction with 0145T-0150T. However, it can be entered alone on a separate case in the instance of a RETRO review.

### CD-9–PULMONARY ARTERY and VEIN IMAGING

- **Pulmonary artery hypertension (PAH):** CT or CTA of the pulmonary arteries (CPT 71260 or 71275) is useful in the assessment of PAH, especially if there is suspicion for recurrent pulmonary emboli (also see PVD-4 Pulmonary Artery Hypertension in the Peripheral Vascular Disease guidelines and CH-19 Pulmonary Embolism in the Chest guidelines).

- **Pulmonary vein imaging:** A preoperative cardiac MRI (CPT 71555, 75554, may add 75556) or cardiac CTA (CPT 71275 or 0145T) can be performed to evaluate anatomy of the pulmonary veins prior to an ablation procedure performed for atrial fibrillation or ventricular tachycardia.
  - A routine post-procedure MRI or CTA can be performed 3 months after ablation.
    - If no pulmonary vein stenosis is present, no further follow-up imaging is required.
    - The routine follow-up study is due to a 1%-2% incidence of asymptomatic pulmonary vein stenosis following ablation procedures. These patients may benefit from treatment (anti-inflammatory medication, angioplasty or stenting), although there are no large, prospective studies to help establish guidelines in this area.
  - Patients who have symptoms (usually shortness of breath) following ablation should be imaged at 1, 3, 6, and 12 months post-ablation. The majority (81%) of pulmonary vein stenosis remain stable over 1 year. Progression occurs in 8.8% and regression occurs in a small percentage.
CD-10~SYNCOPE

- Also see HD-32 Syncope in the Head guidelines and CD-2.3 Symptomatic Patient.
- Evaluation of syncope:
  - Echocardiogram should be performed initially to look for valvular or cardiomyopathic dysfunction.
  - Cardiac evaluation for postural blood pressure changes, resting low blood pressure, or low heart rate should be performed.
- One MPI can be performed in patients with syncope who are intermediate to high risk for coronary artery disease (see CD-2 Nuclear Cardiac Imaging for risk factors).
  * *Circulation* 2006;113:316-327
- Patients at low risk for CAD should undergo exercise treadmill test or stress echocardiogram initially.
- Cardiac MRI (CPT 75554) or coronary CTA (see CD-8.11 for CPT codes) can be considered if there is concern for anomalous coronary arteries, infiltrative heart disease or certain types of cardiomyopathy (see CD-6 Cardiac MRI and CD-8.7 Other indications for coronary CTA).
- Duchenne muscular dystrophy: usually imaged by echocardiogram but evaluation for ischemic or cardiomyopathic changes using MPI or (typically) cardiac MRI (CPT 75554) can be performed (see CD-6 Cardiac MRI).
- Cardiac MRI (CPT 75554 or 75552) can be performed to evaluate pre-syncope or syncope in patients with suspected ARVD/ARVC (see CD-6 Cardiac MRI).
  - Pediatric syncope: generally the evaluation includes echocardiogram and possibly exercise testing.
    - If congenital heart disease is suspected, cardiac MRI or cardiac CT is appropriate (see CD-6 Cardiac MRI and CD-8.11 CPT coding).

CD-11~CONGESTIVE HEART FAILURE (CHF)

- Cardiac CTA should not be used for evaluation of left ventricular function following myocardial infarction or in chronic heart failure.
  - Patients with indeterminate echocardiogram should undergo MUGA (CPT 78472 or 78494) or cardiac MRI (CPT 75554).
- Cardiac CT has an unacceptably high radiation dose for routine assessment of patients with congestive heart failure (CHF).
  - However, in patients with CHF undergoing coronary CTA for an appropriate indication (see CD-8 CT of the Heart and CTA of the Coronary Arteries), additional CT imaging for ventricular function (CPT 0151T) will not add significant radiation.
- MPI imaging, echocardiogram, and/or ideally cardiac MRI (which is the most accurate in assessing cardiac pump function) (CPT 75554) can be used to assess patients with CHF.
• Right-sided congestive heart failure can be a manifestation of pulmonary hypertension or serious lung disease.
  o Chest CT (CPT 71260) or chest CTA (CPT 71275) to evaluate for recurrent pulmonary embolism can be considered in patients with right-sided CHF.
• Post-cardiac transplant heart failure should be assessed by echocardiogram or cardiac MRI (CPT 75554).
• The major goal of performing noninvasive cardiac imaging is the identification of subsets of patients at high risk for subsequent cardiac death or nonfatal infarction who may benefit from prompt referral for cardiac catheterization and possible revascularization. Conversely, patients deemed to be at low risk for subsequent cardiac events based on imaging studies are treated medically. Medical therapy in most stable patients is a competitive product.

• Risk factors associated with a higher risk of coronary heart disease events such as a nonfatal myocardial infarction and coronary death include:
  o Older age
  o Male gender
  o High blood pressure
  o Smoking
  o Abnormal lipid levels (increased total serum cholesterol and LDL; low serum HDL; increased serum triglycerides)
  o Diabetes
  o Known vascular disease
  o Renal failure
  o Obesity
  o Family history of premature coronary artery disease
  o Metabolic syndrome

• The U.S. Preventive Services Task Force (USPSTF) found insufficient evidence to recommend for or against screening with EKG, exercise treadmill testing or EBCT for coronary artery stenosis in asymptomatic adults at increased risk for coronary heart disease events.

• The SHAPE task force has published a paper supporting noninvasive imaging as an additional mass screening tool. Due to a clear lack of outcomes data this is considered too controversial for widespread application.

• Men <50 years old and women < 60 years old who have no other risk factors for coronary heart disease (less than 5% -10% 10 year risk) are considered to be at low risk.

• In a study of 1,461 symptomatic patients with low risk exercise treadmill scores who underwent myocardial perfusion imaging (MPI), patients with low risk treadmill scores and a low clinical risk score (clinical risk derived by assigning one point to each of the following: typical angina, history of MI, diabetes, insulin use, male gender, and one point for each decade of age over 40 years; high risk is >/=5 points), MPI was limited was of limited prognostic value. This is because patients with a low treadmill score and a low clinical score had an excellent 7-year survival (99%) regardless of whether the subsequent MPI was normal, mildly abnormal, or severely abnormal. In patients with low-risk treadmill score and a high clinical risk score, MPI had an independent prognostic value. In this population of patients, survival rate was 94% for patients with normal MPI scans,
94% for patients with mildly abnormal scans, and 84% for patients with severely abnormal scan.*

*J Am Coll Cardiol 2004;43:194-199

- The sensitivity of exercise treadmill testing (ETT) for predicting coronary heart disease events in 3 – 12 years ranges from 40% to 62%, with a positive predictive value (PPV) from 6% to 48%. The yield of ETT in detecting coronary artery stenosis in asymptomatic middle-aged men is estimated to be 0.5%. The low PPV of ETT is due to the low prevalence of coronary artery stenosis in asymptomatic persons and cannot be corrected by improving test accuracy.*


- The sensitivity of stress ECHO is 79% and negative predictive value (NPV) is 83.7%. The sensitivity of exercise treadmill testing is 43% and specificity is 66%.*

*Am Heart J 2005;149:527-533

- In patients without previous MI or revascularization who are judged to have >85% pretest likelihood of coronary artery disease based on age, gender, character of the chest pain syndrome and coronary artery disease risk factors, initial referral to MPI is more cost-effective than initial referral to either treadmill exercise testing or cardiac catheterization.*

*J Am Coll Cardiol 2004;43:200-208

- The American College of Cardiology/American Heart Association (ACC/AHA) gives a class IIb (usefulness/efficacy is less well established by evidence/opinion) recommendation for screening higher-risk patients for coronary artery stenosis, and does recommend screening for asymptomatic patients with diabetes. High risk patients are defined as patients with a >20% 10-year-risk of developing coronary artery disease.*

*Circulation 1999;100:1481-1492

- From a study of 7,456 patients with normal MPI study followed for 665+/- 200 days:
  o The predicted rate of cardiac death or nonfatal myocardial infarction (MI) in patients with no history or previous coronary artery disease (i.e. no previous MI or revascularization) was <1% per year in the two years following normal MPI in nondiabetic males and females age 80 and older, in diabetic males age 80 and older and in diabetic females age 60 and older.
  o The predicted rate of cardiac death or nonfatal MI in patients with a history of CAD (i.e. previous MI or revascularization) was <1% per year in males (nondiabetic and diabetic) age 50 or greater, in females with diabetes age 50 or greater and in nondiabetic females age 80 or greater. *

*J Am Coll Cardiol 2003;41:1329-1340

  o Historically, a normal MPI study is considered to indicate low risk if the event rate (cardiac death or nonfatal MI) is below 1% per year.

- The ACC/AHA 2003 Guidelines for Clinical Use of Cardiac Radionuclide Imaging state:
  o Resting left ventricular ejection fraction (LVEF) is universally recognized as one of the most important determinants of long-term prognosis in patients
with chronic stable coronary artery disease. LV function during exercise reflects disease severity and provides prognostic information.

- Studies estimating the extent of LV dysfunction are excellent predictors of cardiac mortality.
- Markers of provokable ischemia (exertional symptoms, EKG changes, extent of reversible perfusion defects, and stress-induced ventricular dyssynergy) are better predictors of the subsequent development of acute ischemic syndromes.

- “A stress imaging technique (MPI) should be used for patients with widespread resting ST depression (>1 mm), complete left bundle branch block, digoxin use, ventricular paced rhythm, pre-excitation syndrome (Wolff-Parkinson-White), or left ventricular hypertrophy (LVH) with repolarization changes” (in patients with LVH, ST depression during exercise is frequently present in the absence of significant coronary artery disease).

- Cardiovascular disease in women is often times substantially different in its presentation and symptoms than it is in men. Substantial discomfort and morbidity can be experienced by women who have normal or at worst, equivocal cardiac imaging results and who have persisting chest pain syndrome. Oftentimes this is considered due to the presence of microvascular disease which does not lend itself to surgical or mechanical intervention such as PCI and all too frequently does not respond ideally to current medication therapy.

- Women first develop anginal symptoms an average of 10 years later than men and have their first myocardial infarction (MI) an average of 20 years later than men. Women with typical angina have a high prevalence of coronary artery disease (CAD): 60% – 72%. Women with atypical symptoms have a very low prevalence of CAD: 2% – 7%. There is an extremely low risk of CAD in premenopausal women with atypical chest pain. Women with persisting chest pain syndrome despite normal cardiac imaging are thought to have a poor prognosis with higher risk of subsequent cardiac events. Cardiac disease in women is thought by some to be quite a different disease relative to that seen in men. *

*Am J Cardiol 1995;75:52D-60D

- In women with typical angina, 50% of premenopausal versus 90% of older women will have significant coronary artery disease. There is a sharp rise in coronary heart disease morbidity and mortality in women after age 70.

- One study examined 158 women who presented with chest pain and had at least 2 cardiac risk factors. Women were followed for 26.2 months. Only 2.5% had hard cardiac events (2 MI’s, 2 unstable angina). 81% had experienced chest pain unrelated to a cardiac event. The remaining 19% continued to have chest pain during the follow up period but experienced no adverse events. Only a history of diabetes was significantly associated with a cardiac event.*

*J Women’s Health 2005;14:240-247

- There is a lower sensitivity and specificity for EKG stress treadmill testing in women compared with men. This is thought to be due to women being more likely to have low or inadequate duration of exercise stress test and estrogen having a digitalis-like effect on the EKG (giving false ST segment change) thus,
there is a high false positive rate. However, in women with a normal baseline EKG, an adequate duration of exercise, and no ischemic changes, risk of significant CAD is very low.*

*Am J Cardiol 1995;75:52D-60D

- 22% – 58% of asymptomatic patients with Type 2 diabetes show evidence of ischemia on stress myocardial perfusion imaging (MPI). A number of studies have confirmed that stress MPI provides incremental prognostic value and achieves adequate risk stratification in diabetic cohorts.*

*J Am Coll Cardiol 2005;45:50-53

- Diabetics with abnormal resting EKG, evidence of peripheral or carotid occlusive arterial disease, or symptoms suspicious for CAD (chest pain, dyspnea) have a high yield of positive MPI studies. MPI is low yield in lower risk asymptomatic diabetic patients. Further investigation of sequential testing strategies is needed in order to identify an efficient means for screening this population of patients. *

*J Am Coll Cardiol 2005;45:50-53

- No randomized trial has proven that asymptomatic diabetic patients with severe CAD have an improvement in survival if treated with revascularization. However, patients with diabetes appear to accrue greater survival benefit with revascularization over medical therapy in the setting of significant ischemia.*

*J Am Coll Cardiol 2005;45:43-49

*J Am Coll Cardiol 2005;45:50-53

CD-3~ NUCLEAR CARDIAC IMAGING AFTER PERCUTANEOUS CORONARY INTERVENTION (PCI) OR CORONARY BYPASS SURGERY
Evidence Based Clinical Support

- PCI includes percutaneous coronary angioplasty (PTCA) and coronary stenting.
- More than one million PCI procedures were performed in the U.S. in 2000. Current PCI procedures usually involve placement of a coronary artery stent.
- Restenosis of the coronary artery occurs in one third of patients, half of whom remain asymptomatic, while disease progression occurs at rates approaching 7% per year.
- Restenosis usually happens within variable times depending on type of stent.
- Although stents decrease restenosis, deployment of stents in high-risk lesions has led to in-stent restenosis rates as high as 58%. With the increased use of drug-eluting stents, restenosis has begun to decrease, however issues have been recently raised about the increased longterm effect of coated stents on thrombotic occlusion (which can be lethal).
- Chest pain following PCI is a poor indication of restenosis, as 45% of these patients do not have angiographic evidence of restenosis.
- Patients with asymptomatic restenosis are at increased risk for adverse events.
- There is currently no reliable method of predicting which patients are most at risk of developing asymptomatic restenosis and silent ischemia following PCI.
- Appropriate use of noninvasive testing following PCI has never been systematically investigated. Thus, physicians’ practices vary widely.
Exercise EKG has repeatedly been demonstrated to be inaccurate in detecting restenosis following revascularization.

When performed six or more months following PCI, myocardial perfusion imaging reliably identifies patients most at risk for poor long-term outcomes. *

*J Am Cardiol 2004;43:328-336

Myocardial perfusion imaging: sensitivity and specificity range from 39%-100% and 46%-100%, respectively, improving with time since revascularization.

A decrease in specificity has been observed when MPI is performed within two months of PCI. This may be due to temporary impairment of regional perfusion by endothelial dysfunction and medial injury at the treated site and/or abnormal microvascular and resistive vessel function distal to the site.

A longitudinal study assessing patients with planar MPI nine days, three months and seven months following PTCA showed that 40% of defects observed early after PCI improved two to nine months later. At 7-month angiographic follow-up, no patient had restenosis. *

*J Am Coll Cardiol 2004;43:328-336

CD-4~ ULTRAFAST CT, EBCT, OR MULTIDETECTOR CT FOR CORONARY CALCIUM SCORING
Evidence Based Clinical Support

Among 1743 unselected asymptomatic men and women who were screened for coronary artery calcium and followed for a mean of 2.5 years, 30.3% subsequently reported chest pain. Coronary artery calcium was seen in 340 patients (19.5%). The proportion of patients who had coronary artery calcium were similar among those who had no chest pain, noncardiac pain, atypical pain, or cardiac chest pain.*

*Am J Cardiol 2005;96:61-63

A study evaluating coronary calcium scores from electron beam tomography scanning (EBCT) in 1,795 asymptomatic subjects from 1997 – 2000 (age range 62-85 years old) showed that the risk of coronary artery disease increased with increasing calcium score. The mean follow up was 3.3 years. The multivariate-adjusted relative risk of coronary events was 3.1 for calcium scores 101 – 400, 4.6 for calcium scores 401 to 1000 and 8.0 for calcium scores >1000 compared with calcium scores of 0 – 100. Risk prediction based on the cardiovascular risk factors improved when coronary calcification was added. The author concluded that coronary calcification is strong and independent predictor of coronary heart disease.*

*Circulation 2005;112:572-577

Publications such as the SHAPE task force advocate using imaging such as coronary calcium scoring for general population screening, since current risk assessment tools are imperfect. There is no current outcome data to confirm the cost-effectiveness of this approach.
The task force also recommends carotid intimal-media thickness measurement which is performed with ultrasound, does not require radiation, and is much less expensive to perform.

It is currently unclear whether either of these modalities adds to screening effectiveness for vascular disease or coronary disease. However, with lower radiation exposure and cost of coronary calcium scoring, calcium scoring or carotid intimal-media thickness measurement may become more acceptable for screening purposes.

**CD-6~CARDIAC MRI**
Evidence Based Clinical Support

- Contrast-enhanced cardiac MRI is an excellent imaging study to determine the extent of cardiac damage following a myocardial infarction (MI). Hyper enhancement on T1-weighted delayed contrast-enhanced MRI only occurs in necrotic, irreversibly injured myocardium, irrespective of the age of the infarct. The regional extent of hyper enhancement across the left ventricular wall has been shown to predict functional improvement of stunned or hibernating myocardium, with the likelihood of functional improvement decreasing with increasing segmental extent of hyper enhancement.

- Viability study: In instances in which segments of LV demonstrated decreased wall motion (i.e. stunned or hibernating myocardium), but are shown to have viable myocardium that involves at least 50% of wall thickness, studies have demonstrated that these segments are likely to benefit from revascularization with full recovery of cardiac function.* Thus, MRI is very good at determining whether there has been a subendocardial MI versus a transmural MI. In this respect, MRI is being used to replace both nuclear cardiac stress testing and PET scan for myocardial viability imaging.

  *J Am Coll Cardiol 2003;42:895-901

- SSFP cine MRI provides an excellent assessment of valvular morphology and motion. Semi-quantitative assessment of gradients and regurgitation is increasingly being assessed by cine CMR.

- Cardiac MRI can reveal myocarditis in specific ways and can help differentiate this from other processes such as MI.

- The degree of valvular calcification is not easily evaluated with MRI.

- Transesophageal echocardiography (TEE) is best for demonstrating valve vegetations in endocarditis.

- MRI is useful in diagnosing paravalvular abscesses associated with endocarditis. These paravalvular abscesses are difficult to demonstrate by echocardiogram.

- Patients with prosthetic valves can be imaged safely in high-field magnets.

- Patients with coronary stents can safely undergo MRI.

- MRI can quantify many aspects of cardiac function, including ventricular volumes, ejection fraction, cardiac output, shunt ratio, valvular pressure gradients, and regurgitation fractions. However, measuring valve function with
velocity studies by MRI (CPT code 75556) can be complex. Conventional Echo
gives accurate information regarding the valves and is easier to perform.

- Tuberous sclerosis involves benign tumors of the heart and other organs.
  Usually these are best assessed using cardiac MRI although cardiac CT can also
  be used.

**CD-8—CT OF THE HEART and CTA of the CORONARY ARTERIES**
**Evidence Base Clinical Support**

- Coronary artery disease remains the leading cause of death in Western nations.
  One-third of all conventional coronary angiograms in the U.S. are performed in
  conjunction with an interventional procedure, while the rest are performed only
  for verification of the presence and degree of coronary artery disease.
  Therefore, development of a reliable noninvasive imaging study of the coronary
  arteries for detection of coronary artery disease is a high priority.

- In reality, there still is no “gold standard” for the evaluation of coronary disease.

- CT coronary angiography is emerging as a potentially useful imaging study with a
  variety of applications. However, the standard of reference for diagnosis of
  coronary artery disease remains conventional coronary angiography.*
  Conventional coronary angiography gives high spatial resolution and the option
  of direct performance of interventions such as balloon dilatation or coronary stent
  placement.

  *Radiology 2004;232:18-37

- Noninvasive imaging of the coronary arteries is complex due to their small size,
  tortuosity, and cardiac motion. The overall diagnostic quality of noninvasive CT
  coronary angiography is largely dependent on spatial resolution, the patient’s
  heart rate during the exam, the choice of appropriate reconstruction time points
  in the cardiac cycle, calcium interference, and contrast enhancement.

- Spatial resolution at image acquisition is a crucial factor, and 16-detector row CT
  scanners or higher provide high spatial resolution.

- Heart rate greater than 70-75 bpm, or variation of heart rate during scanning,
  consistently induces motion artifact and produces less consistent and
  reproducible imaging results. It is recommended that the heart rate of patients
  with persistently irregular heart rates (such as atrial fibrillation) result in interscan
  discontinuities that prohibit evaluation of CT angiographic images for coronary
  artery stenosis.*

  *Radiology 2004;232:18-37

- Heart rates greater than 70 bpm that do not respond to heart rate slowing
  medicines limit the accuracy of CTA. In this setting, CTA may need to be
  reconsidered for another imaging modality.

- Other considerations for obtaining a high quality cardiac CTA:
  - Patients must be able to hold still for a number of minutes and follow
    breathing instructions closely.
  - Patients should be able to take Nitroglycerin and have no medications that
    would contraindicate their taking Nitroglycerin
- Erectile dysfunction drugs are a contraindication to taking Nitroglycerin
  - Patients should not have an iodine allergy or should be prepped for possible allergy reaction to contrast
  - Patients should be able to lift both arms above their shoulders.
  - Any of the above considerations place an obvious limitation on CTA imaging and should be considered a potential contraindication for CTA.

- Currently there is a lack of standardization of the protocols in use for coronary CTA. The consistent and reproducible visualization of the right coronary artery, the circumflex coronary artery, and the small side branches is difficult because of these vessels’ complex motion during the cardiac cycle. For optimal visualization retrospective reconstruction (rendering) data of different coronary arteries is recommended.*
  *Radiology 2004;232:7-17
  *J Am Coll Radiol 2006;3(9):677-685

- Knowledge of imaging techniques regarding multiplanar reformation (MPR), oblique MPR, maximum-intensity projection, shaded surface display, and direct volume rendering is necessary. Different clinical examinations such as stent evaluation, stenosis evaluation and bypass evaluation, require different visualization techniques. Errors such as findings of false stenoses can be avoided by means of accurate and appropriate use of software features. Training regarding the capabilities of the software and the background of the different techniques and their possible pitfalls is necessary.*
  *Cardiol Clin 2003;21(4):549-559

- Careful custom tailoring of the contrast bolus for achieving adequate, consistent, and homogeneous contrast attenuation over the entire course of the coronary arteries in order to facilitate imaging is needed. Optimal contrast attenuation within the vessel is high enough to allow lesion detection but not so high that it obscures calcified coronary artery wall lesions.*
  *Radiology 2004;232:18-37

- High risk patients, if they receive CTA, may be running an unacceptably high risk of having to have angiography which results in double contrast and essentially double radiation dose which is a major reason to avoid this test in those patients.

- A prospective, single center study evaluating 1,384 coronary artery segments in 103 patients showed that, compared with invasive coronary angiography for detection of significant lesions (>50% stenosis), segment-based sensitivity, specificity, and positive and negative predictive values of 16-slice CTA were 95%, 98% 87% and 99%, respectively. *
  *JAMA 2005;293:2471-2478

- A study of 72 patients scheduled for invasive coronary angiography because of suspected CAD who also underwent CTA on a 16-slice CT scanner showed sensitivity, specificity, and positive and negative predictive values of 82%, 98%, 87% and 97%, respectively for CTA. *
  *J Am Coll Cardiol 2005;45:123-127
CARDIAC GUIDELINE REFERENCES

CD-1~General Guidelines

CD-2~Nuclear Cardiac Imaging (MPI)
CD-2.2~Asymptomatic Patient or Patient with Stable Symptoms

CD-2.3~Symptomatic Patient

CD-2.4~Preoperative evaluation

CD-2.5~MUGA Study
- *Invasive Breast Cancer. NCCN Practice Guidelines in Oncology v.2.2006*

CD-4~Ultrafast CT, EBCT, or Multidetector CT for Coronary Calcium Scoring

CD-6~Cardiac MRI


**CD-7~Cardiac PET Scan**


**CD-8~CT of the Heart and CTA of the Coronary Arteries**

**CD-8.2~CT Used For Coronary Calcium Scoring**


**CD-8.3~Coronary CTA in the Asymptomatic Patient**


**CD-8.6~Coronary CTA in Patients with Previous Coronary Artery Procedures**


**CD-8.7~Other Indications for Coronary CTA**

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tomographic coronary angiography for the diagnosis of anomalous coronary arteries.

**CD-8.9~Unproven Uses of Cardiac CT and Coronary CTA**
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**CD-8.10~Radiation Dose and Coronary CTA**
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**CD-8.11~CPT Coding**

**CD-10~Syncope**
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**CD-2~Nuclear Cardiac Imaging (MPI), Evidence Based Clinical Support**
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diabetic patients who are candidates for screening stress single-photon emission
CD-3~Nuclear Cardiac Imaging After Percutaneous Coronary Intervention (PCI) or Coronary Surgery, Evidence Based Clinical Support


CD-4~Ultrafast CT, EBCT, or Multidetector CT for Coronary Calcium Scoring, Evidence Based Clinical Support


CD-6~Cardiac MRI, Evidence Based Clinical Support


CD-8~CT of the Heart and CTA of the Coronary Arteries, Evidence Based Clinical Support