

CARDIAC IMAGING GUIDELINES

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MedSolutions, Inc. Clinical Decision Support Tool for Advanced Diagnostic Imaging

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 11/30/08

ABBREVIATIONS for CARDIAC GUIDELINES

ACC	American College of Cardiology
ACS	acute coronary syndrome
AHA	American heart Association
ASCOT	Anglo-Scandinavian Cardiac Outcomes trial
ASD	atrial septal defect
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
CTCA	computed tomography coronary angiography
CTA	computed tomography angiography
EBCT	electron beam computed tomography
ECP	external counterpulsation (also known as EECP)
ECG	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)
MRA	magnetic resonance angiography
MRI	magnetic resonance imaging
mSv	millisievert (a unit of radiation exposure)
MUGA	multi gated acquisition scan
PCI	percutaneous coronary intervention (includes percutaneous coronary angioplasty (PTCA) and coronary artery stenting)
PET	positron emission tomography
PTCA	percutaneous coronary angioplasty
SPECT	single photon emission computed tomography
TEE	transesophageal echocardiogram
VSD	ventricular septal defect

GLOSSARY for CARDIAC GUIDELINES

Agatston Score: a calcium score for the coronary arteries; the only calcium score accepted by MedSolutions
Angina: principally chest discomfort, exertional (or with emotional stress) and relieved by rest or nitroglycerine (see CD- 8 Evidence Based Clinical Support Table B1 and definitions)
Anginal variants or equivalents: a manifestation of myocardial ischemia which is perceived by patients to be (otherwise unexplained) dyspnea, unusual fatigue, more often seen in women and may be unassociated with chest pain
ARVD/ARVC – Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy: a potentially lethal inherited disease with syncope and rhythm disturbances, including sudden death, as presenting manifestations
BNP: B-type natriuretic peptide, blood test used to diagnose and track heart failure (n-T-pro-BNP is a variant of this test)
Brugada Syndrome: an electrocardiographic pattern that is unique and might be a marker for significant life threatening dysrhythmias
Double product: systolic blood pressure times heart rate, generally calculated at peak exercise; over 25000 means an adequate stress load was performed
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
Optimized Medical Therapy should include (where tolerated): antiplatelet agents, calcium channel antagonists, partial fatty acid oxidase inhibitors (e.g. ranolazine), statins, short-acting nitrates as needed, long-acting nitrates up to 6 months after an acute coronary syndrome episode, beta blocker drugs (optional), angiotensin-converting enzyme (ACE) inhibitors/angiotensin receptor blocking (ARB) agents (optional)
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 <u>not</u> syncope
Takotsubo cardiomyopathy: apical dyskinesis oftentimes associated with extreme stress and usually thought to be reversible
Troponin: a marker for ischemic injury, primarily cardiac

GLOSSARY for CARDIAC GUIDELINES

Uninterpretable electrocardiogram (ECG): (for stress test purposes, this is very often NOT the same as ABNORMAL ECG), a baseline ECG that renders exercise interpretation invalid due to:

1. complete LEFT bundle branch block
2. ventricular paced rhythm
3. pre-excitation patterns such as Wolff-Parkinson-White
4. left ventricular hypertrophy with ST segment depression >1mm or any resting ST segment pattern with that change
5. patient on a digitalis preparation
6. resting heart rate <50 in patients on beta blocker and/or calcium blocker drug

Multiple other patterns may be noted (e.g. right bundle branch block, nonspecific ST or T changes, ST elevations), but other than the ECG patterns mentioned above, are considered interpretable.

Volume Score: another type of calcium score under consideration for acceptance

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CARDIAC IMAGING GUIDELINES

CD-1~GENERAL GUIDELINES

• CD-1.1 General Issues

- Prior to considering cardiac imaging, there should be recent (within 30 days) clinical evaluation or documented meaningful contact with the patient (preferably with a recent ECG and chest x-ray, if clinically relevant to the evaluation process). Vital signs, height and weight or BMI or description of general habitus is needed.
- 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.
- These guidelines are based upon using cardiac imaging to answer a specific clinical question that will affect patient management.
 - If the clinical question (e.g. does the patient have coronary artery disease?) has already been answered based upon previous clinical evaluation or imaging, then additional cardiac imaging is not indicated.
 - Cardiac imaging is not indicated if the results will not affect patient management decisions.
- 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.
 - Even some of the “appropriate” criteria are open to interpretation, since these criteria are largely consensus-based and not evidence-based.
 - “Appropriateness does not necessarily imply that the test being rated is the initial clinical approach to be taken”*

*J Am Coll Cardiol 2005;46(8):1587-1605

• CD-1.2 Transplant Patients

- Patients who are candidates for any type of organ or bone marrow transplant can undergo imaging stress testing every year (usually stress echo or MPI) prior to transplant.
- Patients who have undergone organ transplant are at increased risk for ischemic heart disease secondary to their medication.
 - MPI or stress echo can be repeated within one year of the transplant or within one year of a prior cardiac imaging study if there is evidence of progressive vasculopathy.

• CD-1.3 Stress Testing

- Whenever possible, the initial stress test should be an exercise treadmill test
 - **References:**
 - Clin Cardiol 2008;31:35-40
 - Ann Intern Med 2007;147:821-828
 - Arch Intern Med 2008;168(2):174-179

- *Cardiosource Spotlight* July 1, 2008;CS2-CS4
 - *Clin Cardiol* 2007;30:505-510
 - *Cardiac stress test supplement*. Institute for Clinical Systems Improvement. February 20, 2007. http://www.guideline.gov/summary/summary.aspx?ss=15&doc_id=10810&nbr=5635. Accessed October 23, 2008
 - *Chest* 2001;119:907-925
 - *Am Heart J* 2007;154:285-290
 - *Am J Cardiol* 2008;101:1437-1443
- **Stress testing with imaging such as stress echocardiography or MPI can be considered in the following circumstances (see CD-2.4 for specific indications for stress echo and CD-3.2 for specific indications for MPI):**
 - Recent ECG is uninterpretable due to complete left bundle branch block, ventricular paced rhythm, pre-excitation pattern such as Wolff-Parkinson-White, ST segment depression greater than 1mm, patient on digitalis preparation, resting heart rate less than 50 in patients on beta blocker and/or calcium blocker medication
 - For stress test purposes, an abnormal ECG does not necessarily mean that it is an uninterpretable ECG*
 - **Chest* 2001;119:907-925
 - Physical inability to perform treadmill or other type of exercise
 - Need to evaluate exercise-induced left ventricular dysfunction—segmental or global
 - Examples include the need to assess specific known arterial obstructive lesions, patients presenting with shortness of breath, dyspnea on exertion, unusual fatigue, or patients with hypertrophic obstructive disease.
 - Need to evaluate exercise-induced valve dysfunction such as mitral regurgitation due to papillary muscle ischemia
 - If the exercise treadmill stress test is equivocal, inconclusive, or inadequate (e.g. double product < 25,000)
- **Stress Testing with Imaging:**
 - Stress testing with stress echocardiography, MPI or cardiac MRI can be performed with maximal exercise or chemical stress (dipyridamole, dobutamine, adenosine or adenosine analogs).
 - The use of exercise versus chemical stress does not alter the CPT codes used to report these studies.
- **CD-1.4 Hybrid imaging**
 - SPECT/CT which involves SPECT (MPI) imaging and CT for optimizing location, accuracy, and attenuation correction combines functional and anatomic information.
 - There is currently no evidence-based data to formulate appropriateness criteria for these hybrid scans.

CD-2~ECHOCARDIOGRAPHY (ECHO)

CD-2.1 Transthoracic Echocardiography (TTE)

- A recent documented history consistent with a cardiac disorder (e.g. congestive heart failure), recent physical examination and/or relevant laboratory tests such as BNP elevations and worsening elevated BNP in the setting of heart failure should be considered prior to considering the need for imaging.
- The need for repeat transthoracic echocardiography (TTE) is based upon findings in the original study and documentation of the way in which repeat studies will affect patient management.
- **The following are indications for which transthoracic echocardiography (TTE) can be performed at least once:**
 - **Valve function and structure including:**
 - Mitral valve prolapse
 - Mitral regurgitation
 - Mitral stenosis
 - Aortic regurgitation
 - Aortic stenosis
 - Bicuspid aortic valve
 - Tricuspid valve regurgitation
 - Pulmonary valve regurgitation
 - If valve surgery is being considered, TTE to assess aortic, pulmonary or mitral stenosis or regurgitation can be performed once or twice a year.
 - TTE can accurately assess the severity of valve stenosis but is sometimes less accurate in assessing valve regurgitation.
 - **Ventricular function** including global and segmental wall motion for evaluating ejection fraction (EF) and coronary artery disease.
 - Echo can be performed to evaluate cardiomyopathy due to etiologies such as ischemia, alcohol, viral myocarditis, or idiopathic.
 - Echo can be performed before and after chemotherapy known to affect heart function.
 - **Ventricular structure including:**
 - Infiltrative diseases (e.g. sarcoid, amyloid)
 - Aneurysm with/without thrombus
 - Ventricular septal defect (VSD)
 - Papillary muscle rupture/dysfunction
 - Hypertrophy (including asymmetric septal hypertrophy, spade heart, hypertensive concentric hypertrophy, infiltrative hypertrophy)
 - **Evaluate atrial or ventricular chamber size** (e.g. patients with atrial fibrillation, tachyarrhythmias, or left ventricular dilatation).
 - Yearly TTE may be indicated depending on the clinical circumstance.
 - **Detection of embolic source** in patients with recent Transient Ischemic Attack (TIA), stroke, or peripheral vascular emboli.
 - Although transesophageal Echo (TEE) is more accurate in visualizing thrombus in the cardiac chambers and in visualizing the cardiac valves for

vegetations (or classic mitral valve fibrinous excrescences), TTE is non-invasive and is indicated as the initial study.

- Intravenous injected sterile saline contrast can be performed for shunt detection in cases of known or suspected atrial and/or ventricular septal defect and/or patent foramen ovale.
 - This is best assessed using TEE, especially in patients with decompression illness, although TTE is still useful in this setting.
- **Evaluation of ASD repair or other cardiac surgeries** (e.g. valve surgery)
- **Tumor evaluation including myxomas**
- **Clot detection**
- **Evaluation of right ventricular systolic pressure and pulmonary hypertension**
- **Evaluation of pericardial effusion/pericardial disease**, particularly suspected cardiac tamponade
- **Evaluation of congenital heart disease**
- **Evaluation of endocarditis**
 - **Note:** lack of visible vegetations does not eliminate the diagnosis.
 - TEE remains a more sensitive technique for identification of small vegetations.
- **Complications of pacemaker insertion** should be monitored by TTE

CD-2.2 Transesophageal Echocardiography (TEE)

- The need for repeat TEE studies is based upon findings in the original study and documentation of the way in which repeat studies will affect patient management:
- **The following are indications for which transesophageal echocardiography (TEE) can be performed at least once:**
 - Limited transthoracic echo window
 - Detection of embolic source or intracardiac shunting when TTE is inconclusive
 - **Examples:** atrial septal defect, ventricular septal defect, patent foramen ovale, aortic cholesterol plaques, thrombus in cardiac chambers, valve vegetations, tumor
 - Evaluation of cardiac valve dysfunction
 - Differentiation of tricuspid from bicuspid aortic valve
 - Congenital abnormalities
- TEE is not particularly sensitive for left ventricular assessment since this chamber lies farther from the TEE probe than in transthoracic echo
 - **Exceptions:** the base of the heart in evaluating asymmetric septal hypertrophy or membranous ventricular septal defect

CD-2.3 Frequency of Echocardiography testing

- **Annual testing can be performed for the following:**
 - Assessment of left ventricular hypertrophy progression or regression
 - Assessment of valve dysfunction
 - Assessment of cardiac chamber size in cardiomyopathy and atrial dysrhythmias

- Assessment of chronic pericardial effusions
- Assessment of left ventricular contractility/diastolic function prior to planned medical therapy for heart failure or to evaluate the effectiveness of on-going therapy
 - BNP levels are useful and may alone be sufficient for monitoring in many cases
- Assessment of aortic dissection
- Assessment of aortic root dilatation
- **Testing twice a year can be performed for the following:**
 - New (not chronic stable) pericardial effusions
 - Assessment of new/changed medical therapy for congestive heart failure
 - BNP levels are useful and may alone be sufficient for monitoring in many cases
 - Assessment of new/changed medical therapy for hypertension if left ventricular hypertrophy was present
- **New Echo can be performed for the following regardless of number of previous Echo studies:**
 - New cardiac murmurs
 - New myocardial infarction or acute coronary syndrome
 - New congestive heart failure (or new symptoms of dyspnea, orthopnea, paroxysmal nocturnal dyspnea, edema, elevated BNP)
 - New pericardial disease
 - New stroke/transient ischemic attack
 - New aortic dissection (TEE is preferred)
 - New decompression illness

CD-2.4 Stress Echocardiography (Stress Echo)

- Stress echocardiography (where feasible) has similar sensitivity and superior specificity to MPI for evaluation of ischemic heart disease and avoids radiation.*
 - *[J Am Coll Cardiol 2007;49\(2\):227-237](#)
 - *[Journal of the American Society of Echocardiography 2007;20\(9\):1021-1041](#)
- Based on evidence from the literature, these guidelines support stress echo as the initial imaging modality when stress testing with imaging is indicated.
 - **References:**
 - [Journal of the American Society of Echocardiography 2007;20\(9\):1021-1041](#)
 - [J Am Coll Cardiol 2008;51\(11\):1127-1147](#)
 - [International Journal of Cardiovascular Imaging 2001;17:339-345](#)
 - [Am J Cardiol 2007;100:536-543](#)
- **If stress testing with imaging is indicated, then stress echo is supported initially for evaluation of the following:**
 - Arrhythmias and palpitations (where there is Holter monitor or ECG data confirming significant dysrhythmia) such as supraventricular tachycardia, atrial flutter, atrial fibrillation (controlled).
 - Any chronic (not rate-related) complete bundle branch block (right or left) on ECG, or presence of ST depression >1 mm on pre-exercise ECG
 - Dyspnea on exertion

- Syncope or pre-syncope
- Edema
- Positional chest pain (e.g. pain when lying back but not when bending forward)
- Pericardial disease (where there is no evidence of hemodynamic compromise)
- Heart murmur with no known severe valvular disease
- Valvular heart disease, if not documented as severe
- Right heart dysfunction
- Diastolic dysfunction
- Systolic function if there are no resting segmental wall motion abnormalities.
- Cardiac chamber abnormalities
- Chest pain syndrome with any of the above
- ST depression and no other corroborating findings supporting ischemia on treadmill stress testing (suspected false positive) or ST depression thought to be equivocal
- Women over age 45 with ≥ 1 mm ST depression as the only suggestive finding for ischemia on exercise treadmill stress testing
- Radiation exposure concerns, especially in younger females

CD-2.5 Newer Echocardiography Modalities

- There is insufficient data currently to generate appropriateness criteria for the use of the following Echo modalities:
 - 3D, 4D, and higher Echo
 - Tissue perfusion Echo
 - Requests for these studies should be referred for Medical Director review

CD-3~NUCLEAR CARDIAC IMAGING (MPI)

CD- 3.1 General

- Prior to considering cardiac imaging, there should be recent (within 30 days) clinical evaluation or documented meaningful contact with the patient (preferably with a recent ECG and chest x-ray, if clinically relevant to the evaluation process). Vital signs, height and weight or BMI or description of general habitus is needed.
- 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.
 - Effort should be made to obtain copies of reported “abnormal” ECG studies in order to determine whether the ECG is uninterpretable.
 - The most recent stress testing and its findings should be documented.
- If a decision to perform cardiac catheterization or other angiography has already been made, there is often no need for MPI. These requests should be sent for Medical Director review.
- Stress echocardiography (where feasible) has similar sensitivity and superior

specificity to MPI for evaluation of ischemic heart disease (see CD-2.4 Stress Echocardiography) and avoids radiation.*

**J Am Coll Cardiol* 2007;49:227-237

**Journal of the American Society of Echocardiography* 2007;20(9):1021-1041

- Based on evidence from the literature, these guidelines support stress echo as the initial imaging modality when stress testing with imaging is indicated.
 - **References:**
 - *Journal of the American Society of Echocardiography* 2007;20(9):1021-1041
 - *J Am Coll Cardiol* 2008;51(11):1127-1147
 - *International Journal of Cardiovascular Imaging* 2001;17:339-345
 - *Am J Cardiol* 2007;100:536-543
- **Radiation Dose and MPI**
 - Sestamibi myocardial perfusion study (MPI): 13-16 mSv
 - Thallium myocardial perfusion study (MPI): 35-40 mSv
 - Diagnostic conventional coronary angiogram (cath): 5-10 mSv
 - Computed tomography coronary angiography (CTCA): 5-15 mSv
 - CT of Abdomen and pelvis: 8-14 mSv
 - Chest x-ray: <0.1 mSv
 - **Reference:**
 - American Association of Physicists in Medicine (AAPM) Report 96, January 2008. Report of AAPM Task Group 23, "The measurement, reporting and management of radiation dose in CT."
www.aapm.org/pubs/reports/rpt_96.pdf. Accessed December 3, 2008

CD-3.2 INDICATIONS FOR MPI:

- Evidence of ventricular tachycardia
- Ventricular paced rhythm (ventricular pacemakers create altered contraction pattern)
- Pre-excitation pattern such as Wolff-Parkinson-White
- Rate related complete left bundle branch block (not right bundle branch block)
 - Since fixed LBBB may cause false positive MPI, dobutamine stress echo may have greater accuracy in this setting, although MPI can be used if requested.
- Resting heart rate <50 due to beta-or calcium channel-blocker medications
- Severe mitral or aortic valve dysfunction
- Limited echo window documented by prior resting echo or other physician documentation
 - If a recent previous echo has been performed without problems, then arguments for limited echo window do not apply.
- Poorly controlled hypertension (both physical stress and dobutamine stress may exacerbate hypertension during stress echo)
- Poorly controlled atrial fibrillation (resting heart rate >100 bpm) or concern for exercise- or dobutamine-induced tachyarrhythmias.
- Segmental wall motion abnormalities at rest (e.g. due to cardiomyopathy, prior MI, or pulmonary hypertension)

- Assess myocardial viability in patients with ischemic ventricular dysfunction (suspected hibernating myocardium) if there is documented evidence that revascularization would not be undertaken without it.
 - MRI or PET is more accurate in that assessment, but MPI testing can be appropriate
- Inability to perform stress echo due to lack of availability of this modality or lack of expertise on the part of the technician and/or physician

CD-3.3 Patients with known CAD

- Includes patients with prior cardiac imaging showing CAD and/or patients who have had MI or coronary procedures such as PCI, stenting, or CABG.
- There should be clear documentation of the reason(s) why stress testing with imaging (i.e. all cardiac modalities other than maximal exercise treadmill stress test) is needed and how the results of the study will affect patient management.
- Patients with worsening symptoms or significantly deteriorated exercise treadmill stress test performance and parameters should be considered for cardiac catheterization rather than MPI.
- Patients with prior anatomic imaging study (coronary angiogram or CTCA) demonstrating coronary stenosis in a major coronary branch which is of uncertain functional significance can have one stress test with imaging. Stress testing should proceed based on CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI.
 - If there are stable symptoms or no symptoms and the coronary stenosis in question is not in a major coronary branch, stress testing with imaging is not indicated.
 - If stress testing is still requested, then it should proceed based on CD-1.3 Stress Testing.
- MPI is not indicated in stable patients with CAD unless there is evidence that these patients are on optimized medical therapy (to the extent tolerated) for both coronary risk factors and symptoms and optimized medical therapy has failed.^{1, 2} If optimized medical therapy has failed, consideration should be given to performing invasive imaging.
 - **Optimized Medical Therapy** should include (where tolerated): antiplatelet agents, calcium channel antagonists, partial fatty acid oxidase inhibitors (e.g. ranolazine), statins, short-acting nitrates as needed, long-acting nitrates up to 6 months after an acute coronary syndrome episode, beta blocker drugs (optional), angiotensin converting enzyme (ACE) inhibitors/angiotensin receptor blocking (ARB) agents (optional)³
 - External counterpulsation (ECP), where feasible, is a treatment that is considered part of optimal medical therapy for refractory angina.
 - ¹*Cleveland Clinic Journal of Medicine* 2007 Feb;74(2):123-126
 - ²*N Engl J Med* 2007;356:1503-1516 (COURAGE Trial)
 - ³*Am J Cardiol* 2007 Dec; 100(11):1635-1643
- Routine follow-up imaging is not indicated in the majority of patients with known CAD.
 - **Exception:** routine MPI or stress echo can be performed every 2 years if

there is documentation of previous “silent ischemia” (poor or absent anginal warning system) and prior maximal exercise treadmill stress test that did not show ischemia.

- If previous exercise treadmill stress test was positive, then follow-up studies should consist of exercise treadmill stress tests if ECG is interpretable and patient can exercise.

CD-3.4 Patients with no known CAD

- Stress testing should proceed based on CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI

CD-3.5 Routine follow-up MPI

- Routine follow-up MPI is not indicated in the majority of stable patients.
- Repeat testing for coronary artery disease before 5 years from any normal coronary disease testing should be reviewed by a Medical Director.
- Repeat testing before 5 years from any coronary artery interventional procedure should not be considered unless there is a documented clear change in the character or pattern of symptoms.
 - Stress testing should proceed based on CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI

CD- 3.6 Preoperative MPI:

- Stress testing for preoperative “clearance” is generally unnecessary except if high risk vascular surgery is planned.
 - Asymptomatic patients, who have had normal coronary angiogram, 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*
 - If previous cardiac imaging has been performed within the past two years, the results of that imaging should be obtained and the request should be sent for Medical Director review.
- Indications for preoperative MPI include:
 - Unstable angina
 - Decompensated heart failure
 - Significant valvular disease
 - Malignant arrhythmias
- If the above criteria for preoperative MPI are not fulfilled and stress testing is still requested, then stress testing should proceed based on CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI

CD- 3.7 MUGA study

- MUGA (CPT 78472 [default code] or 78494) is supported when a prior echocardiography study demonstrates impaired systolic function and there is a documented clinical need for an exact quantitative measurement of left ventricular ejection fraction (LVEF)
- If a prior imaging study shows impaired systolic function but a more recent imaging study shows improvement, MUGA is not indicated
- MUGA is not indicated to resolve differences in ejection fraction measurements between Echo and MPI studies unless there is clear documentation as to how exact quantitative measurement of LVEF will affect patient management.
- Right ventricular first pass scan (CPT 78496) may be indicated if there is clear documentation of a concern regarding right ventricular dysfunction or overload.
- If the above criteria for MUGA are fulfilled, potential indications for MUGA include:
 - Chemotherapy
 - Agents such as Adriamycin, Herceptin, mitoxantrone (Novantrone) and others are considered cardiotoxic and can result in myocardial dysfunction and cardiomyopathy*
**J Clinical Oncology 2006;24:4107-4115*
**Cancer Drugs Can Cause Heart Damage.*
Cancer and Chemotherapy. MD Anderson Cancer Center
<http://www.health.yahoo.com/topic/cancer>. Accessed November 28, 2006
 - Echocardiography is more sensitive to early left ventricular dysfunction associated with chemotherapy and is supported as the initial imaging modality.
 - Patients on active Herceptin treatment should undergo cardiac monitoring at 3, 6, and 9 months.*
**Invasive Breast Cancer. NCCN Practice Guidelines in Oncology v.2.2008*
 - AICD placement
 - MUGA may be used to determine eligibility for AICD placement if echocardiography and/or MPI give conflicting results
 - Congestive heart failure
 - MUGA may be used to measure response to cardiac medications for congestive heart failure if there is a documented clinical need for an exact measurement of left ventricular ejection fraction (LVEF) beyond what echocardiography can provide.
- Frequency of MUGA studies
 - If the indications for MUGA, including repeat MUGA studies, meet the criteria outlined above, then follow-up MUGA studies can be performed as follows:
 - Every three months during active chemotherapy
 - Every six months until stable for all other reasons unless there is a compelling clinical reason to obtain a MUGA study at a shorter interval.

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*

CD-5~CARDIAC IMAGING BASED ON CORONARY CALCIUM SCORE

- Stress testing in individuals who have undergone coronary calcium scoring should proceed based on CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI

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.
 - **EXCEPTIONS:** coronary artery anomalies (refer to CD-8.6) and Kawasaki disease are conditions where coronary MRA is considered useful.
- **CD-6.1 Cardiac MRI Coding**
 - **Cardiac MRI CPT codes:**
 - **75557** Cardiac MRI for morphology and function without contrast
 - **75558** Cardiac MRI for morphology and function without contrast; with flow/velocity quantification
 - **75559** Cardiac MRI for morphology and function without contrast materials; with stress imaging
 - **75560** Cardiac MRI for morphology and function without contrast materials; with flow/velocity quantification and stress
 - **75561** Cardiac MRI for morphology and function without contrast materials, followed by contrast material(s) and further sequences
 - **75562** Cardiac MRI for morphology and function without contrast materials, followed by contrast material(s) and further sequences; with flow/velocity quantification
 - **75563** Cardiac MRI for morphology and function without contrast materials, followed by contrast material(s) and further sequences; with stress imaging
 - **75564** Cardiac MRI for morphology and function without contrast materials, followed by contrast material(s) and further sequences; with

- flow/velocity quantification and stress
 - **Per the AMA: Only one procedure in the series 75557-75564 is appropriately reported per session.***
 - *Radiology. CPT 2008 changes: An insider's view.
Chicago, 2007, p.178
 - **Medicare Coverage:** CMS (National Coverage Determination 220.2) states that the use of MRI for blood flow measurement is “not considered reasonable and necessary.”
 - **Therefore, the cardiac MRI codes that include flow/velocity quantification (CPT 75558, 75560, 75562, 75564) are non-covered in Medicare patients.**
- **CD-6.2 Indications for cardiac MRI include:**
 - Myocardial viability study if there is documented evidence that revascularization would not be undertaken without it. Report CPT 75561.
 - Stress perfusion study if a specific clinical question is left unanswered by another recent cardiac imaging study (e.g. echo, stress echo, MPI, etc.) and the answer to the clinical question will affect management of the patient's clinical condition.
 - Report CPT 75559 (or 75563 if viability study is done as part of the procedure)
 - Report CPT 75560 (or 75564 if there is a documented indication to clarify or precisely quantitate a valve or shunt flow abnormality seen on a recent echo).
 - Assessment of global ventricular function and mass if a specific clinical question is left unanswered by another recent cardiac imaging study (e.g. echo, stress echo, MPI, etc.) and the answer to the clinical question will affect management of the patient's clinical condition.
 - Cardiac MRI is particularly useful in evaluating cardiomyopathy (ischemic,/diabetic/ hypertrophic/muscular dystrophy), noncompaction, amyloid heart disease, post cardiac transplant, hemochromatosis, hypertrophic heart disease, myocarditis, cardiac aneurysm, trauma and contusions, and in monitoring cancer chemotherapy effect on the heart (especially if accurate assessment of right ventricular function is documented as necessary).
 - Report CPT 75557 or 75561.
 - Pre- and postoperative congenital heart disease assessment (e.g. Tetralogy of Fallot, patent ductus arteriosus, platypnea, coarctation of the aorta, atrial septal defects, restrictive VSD, anomalous pulmonary arteries or veins or anomalous coronary arteries). (see CD-8.6 Other Indications for CTCA for criteria regarding anomalous coronary arteries).
 - Report CPT 75557 or 75561.
 - CPT 71555 (chest MRA) may be added if the aorta or pulmonary artery need to be visualized beyond the root.
 - Report CPT 75558 or 75562 only if there is a need to clarify findings on a recent echocardiogram and cardiac Doppler study.

- Chest MRA alone (CPT 71555) can be performed in certain situations (e.g.; suspected dissection), especially if requested by the cardiovascular specialist.
- Clinical suspicion of arrhythmogenic right ventricular dysplasia or arrhythmogenic cardiomyopathy (ARVD/ARVC) especially if patient has presyncope or syncope if the clinical suspicion is supported by established criteria for ARVD (see CD-6 Evidence Based Clinical Support) or if the patient has documented Brugada's syndrome . MRI (CPT 75557) is considered the optimal test for this disorder.*
 - * *Circulation* 2006;113:316-327
 - * *Am J Med* 1994;97:78-88
 - * *Eur Heart J* 1989;10:127-132
 - * *Circulation* 2005;112(25):3823-3832
- Pericardial disease (constrictive pericarditis versus restrictive and perimyocarditis). Report CPT 75561.
- Evaluate cardiac tumor or mass (e.g. in sarcoidosis or tuberous sclerosis). Report CPT 75561.
- Anomalous coronary arteries: Cardiac MRI (CPT 75561) or CTA (CPT 0146T) (which is still favored) is much better at detecting this than conventional angiography. (see CD-8.6 Other Indications for CTCA for criteria regarding anomalous coronary arteries).
- Fabry's disease: late enhancement MRI may predict the effect of enzyme replacement therapy on myocardial changes that occur with this disease. Report CPT 75561.
- Aortic dissection. CPT 71555 (MRA chest) can be reported and add CPT 74185 (MRA abdomen) if dissection extends beyond ascending aorta.
- Valvular disease including Libman-Sachs endocarditis, other endocarditis, and assessing valve abnormalities associated with ankylosing spondylitis. Transthoracic echo or transesophageal echo is supported initially.
 - For cardiac MRI report CPT 75562.
 - Alternatively, cardiac CT (CPT 0145T) can be reported.
- Diagnosing paravascular abscess in patients with endocarditis. Report CPT 75561.
- Pulmonary vein anatomy for planned ablation procedures in patients with supraventricular tachycardia or atrial fibrillation. (see CD-10 Pulmonary Artery and vein imaging). Report CPT 75562
- Rule out cardiac thrombus. Report CPT 75557.*
 - * *J Am Coll Radiol* 2006;3:665-676
 - * *J Am Coll Cardiol* 2006;48(7):1475-1497
- Evaluation of right ventricular function (CPT 75557 or 75558) if a recent echo has been done and there is documented need to perform cardiac MRI in order to resolve an unanswered question.
- To evaluate for shunting through a VSD (CPT 75560) if a recent echo has been done, including a bubble study, and there is documented need to perform cardiac MRI in order to resolve an unanswered question.

- **CD-6.3 The aortic root and proximal ascending aorta** can be adequately evaluated during a cardiac MRI.
 - For screening due to family history of aortic aneurysm or dissection see CH-30 Thoracic Aortic Dissection or Aneurysm in the Chest guidelines.
 - If a patient (e.g. Marfan's or Loeys-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 chest MRI code (CPT 71551) or thoracic MRA code (CPT 71555).

- **CD-6.4 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 if a specific clinical question is left unanswered by another recent imaging study and the answer to the clinical question will affect management of the patient's clinical condition
 - Cancers that can metastasize to the pericardium or myocardium and can cause a malignant effusion include lung, breast, renal cell, lymphoma and melanoma.

CD-7~CARDIAC PET SCAN

- All requests for cardiac PET scan should be sent for Medical Director review.
 - CPT 78492 should be used for stress cardiac PET scans used to determine ischemia (i.e. coronary artery disease).
 - This study uses rubidium tracer most often 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-3 Nuclear Cardiac Imaging (MPI) guidelines should be followed.
 - There are circumstances in which cardiac PET can be useful:
 - Cardiac PET is more accurate than MPI in obese patients or those with large breasts or implants in differentiating ischemia from attenuation artifact.
 - Cardiac PET can be useful in patients who have an equivocal nuclear perfusion (MPI) stress test if results of the PET will affect patient management.
 - PET demonstrated unequivocal normal perfusion in as many as 77% of a subset of women with equivocal nuclear perfusion studies.*
- * *J Nucl Med* 2005;46(suppl1):115S-127S
- * *J Am Coll Cardiol* 2006;48:1029-1039
- 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.
- Radiation exposure from cardiac PET is slightly lower than from SPECT MPI exposure although data is limited.
 - Radiation exposure from cardiac PET/CTCA (CTCA=CT coronary angiogram) is high enough to raise concerns.
 - PET/CT in which CT is used only for attenuation correction has a much lower radiation exposure. The radiation exposure is slightly higher than that of PET alone.
 - **Reference:**
 - *Circulation* 2007;116:1290-1305

CD-8~CT OF THE HEART and COMPUTED TOMOGRAPHY CORONARY ANGIOGRAPHY (CTCA)

CD-8.1 General

- Certain payers consider coronary calcium scoring and/or cardiac CT and Computed Tomography Coronary Angiography (CTCA) investigational, and their coverage policies will take precedence over MedSolutions' guidelines. Prior authorization does not guarantee payment of the study.
- Most payers require cardiac CT studies to be performed on a 64-slice CT scanner.
- Metallic interference including surgical clips, pacemaker devices, defibrillator devices and tissue expanders can also cause interference with CTCA imaging.
- Cardiac testing that does not involve exposure to ionizing radiation should be strongly considered in individuals under age 40.
- Contraindications to CTCA include:
 - Irregular heart rhythms (e.g. atrial fibrillation/flutter, frequent irregular premature ventricular contractions or premature atrial contractions, and high grade heart block)
 - Very obese patients (body mass index >40 kg/m²)
 - Elevated calcium score
 - CTCA should not be performed if there is extensive coronary calcification (calcium score >1000).
 - Renal insufficiency with creatinine greater than 1.8 mg/dl
 - Inability to follow breath holding instructions (e.g. patients with serious valve disease with marked dyspnea, patients with COPD)
 - Heart rate over 75 beats per minute
 - Allergy to iodine contrast material

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.
 - **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 CTCA in the Asymptomatic Patient

- CTCA 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>
 - 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 CTCA in the Symptomatic Patient

- The high negative predictive value (98%-99%) of CTCA in ruling out significant coronary artery disease has been found on multiple studies.
- If CTCA shows no significant coronary artery disease, then no further cardiac imaging is necessary.
- CTCA using a 64-slice or greater CT scanner can be used for the following:
 - To evaluate chest pain in patients with very low, low, or intermediate pretest probability of CAD (see Table B1 in CD-8 Evidence Based Clinical Support section) when the patient cannot perform or has contraindications to exercise and chemical stress testing (i.e. exercise treadmill stress test, stress echo, and MPI).
 - To exclude coronary artery disease in patients with low or very low pretest probability of CAD if stress test results (e.g. exercise treadmill, stress echo, or MPI) are uninterpretable, equivocal, or are felt to be falsely positive
 - To exclude coronary artery disease in patients with intermediate pretest probability of CAD (see Table B1 in CD-8 Evidence Based Clinical Support section) if recent exercise treadmill stress test or stress echo is uninterpretable or equivocal and CTCA will replace performance of MPI, cardiac PET, or coronary angiogram.
 - To exclude coronary artery disease in patients with intermediate pretest probability of CAD (see Table B1 in CD-8 Evidence Based Clinical Support section) if recent MPI is un-interpretable or equivocal and CTCA will replace performance of cardiac PET or coronary angiogram.
- Abnormal results on exercise treadmill stress test, stress echo or MPI are not

- necessarily an indication for CTCA, especially with stable patients and good performance parameters (e.g. patients going over 6 minutes on Bruce protocol).
- Patients with high risk of coronary artery disease should undergo conventional coronary angiography rather than CTCA, especially if an interventional procedure (e.g. PCI) is anticipated.
 - Any scenario where a coronary intervention is likely to be necessary is one in which CTCA should be avoided, since the patient runs the risk of undergoing two studies that require contrast and radiation exposure.
 - 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-27 Pulmonary Embolism and CH-30 Thoracic Aortic Dissection or Aneurysm in the Chest guidelines.
 - If coronary artery disease is present on CTCA and no functional stress test has been performed, exercise treadmill stress test, stress echocardiogram, or MPI is needed to determine whether the coronary artery stenosis seen on CTCA is causing functional ischemia.
 - See CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI for guidelines regarding which functional stress test would be appropriate.
 - **There is no data to support performing serial follow-up CTCA studies in symptomatic or asymptomatic patients.**
 - Serial imaging studies to evaluate for coronary artery disease should follow the guidelines in CD-3.3 Patients with known CAD and CD-3.5 Routine follow-up MPI

CD-8.5 CTCA in Patients with Previous Coronary Artery Procedures

- Detection of coronary artery disease post-revascularization (PCI and/or CABG):
 - CTCA 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 CTCA. However, **not every patient who is scheduled for re-do surgery needs a CTCA**, and there are no evidence-based data that performing CTCA in these patients improves health outcome.
 - Because accurately imaging both the native coronary arteries and bypass grafts at the same time is challenging, this application of CTCA has not yet been proven.
 - Requests for CTCA 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 CTCA 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, CTCA to follow-up stent placement cannot be recommended.*

**Circulation 2006;114:1761-1791*

<http://circ.ahajournals.org/cgi/content/full/114/16/1761>

Accessed November 29, 2006

CD-8.6 Other Indications for CTCA

- Evaluating coronary artery anomalies and other complex congenital heart disease of cardiac chambers or great vessels is an appropriate indication for CTCA.
 - Report CPT 0146T for evaluating coronary artery anomalies.
 - Report CPT 0150T for congenital heart disease
 - can add CPT 71275 (chest CTA) to evaluate great vessels
 - In cases of anomalous pulmonary venous return, can add CT abdomen and pelvis
 - The use of CTCA to rule out anomalous coronary artery(ies) should be limited to patients who need to have an anomalous coronary artery mapped prior to an invasive procedure, or who have not had a previous imaging study that clearly demonstrates an anomalous coronary artery and/or shows the anomalous artery to be patent and who are less than age 40 with a history that includes one or more of the following (cardiac MRI can also be considered to avoid radiation exposure):
 - 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-11 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 CTCA.
 - 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
 - The presence of other congenital heart disease is not a separate indication for CTCA to rule out anomalous coronary artery(ies).
- Evaluation of coronary artery status in patients with new onset heart failure is an appropriate indication for CTCA (CPT 0148T).
- Patients with dilated cardiomyopathy who have at least intermediate coronary risk can undergo CTCA.*
 - *JACC 2007 May;49:2044-2050*
- CTCA (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 CTCA will replace invasive coronary angiography.

- Vasculitis/Takayasu's/ Kawasaki's disease can be imaged with coronary CTCA (CPT 0148T).
- Cardiac trauma: chest CTA (CPT 71275) and CTCA (CPT 0148T) are useful in detecting aortic and coronary injury and can help in the evaluation of myocardial and pericardial injury.*
 - Also see CD-13 Cardiac Trauma

**Am J Cardiol 2006;98:402-406*

CD-8.7 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.
- Congenital heart disease assessment using CPT 0150T or CPT 71275 is supported in adults.
- 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-10 Pulmonary Artery and Vein Imaging).
- Cardiac CT (CPT 0145T) can be used to assess cardiac tumor or mass, pericardial mass, pericarditis/constrictive pericarditis, complications of cardiac surgery, etc., if echocardiogram is inconclusive
- Cardiac CT (CPT 0145T) can be used to evaluate cardiac thrombus in patients with technically limited echocardiogram, MRI, or TEE.
- Cardiac CT (CPT 0145T) can be used to evaluate clinical suspicion of arrhythmogenic right ventricular dysplasia or arrhythmogenic cardiomyopathy (ARVD/ARVC), especially if patient has presyncope or syncope if the clinical suspicion is supported by established criteria for ARVD (see CD-6 Evidence Based Clinical Support) or if the patient has documented Brugada's syndrome.
- Native aortic abnormalities can be investigated with cardiac CT (CPT 0145T) if echocardiogram is indeterminate.
- Cardiac CT may be helpful in the evaluation of recurrent laryngeal nerve palsy due to cardiac chamber enlargement.

CD-8.8 Unproven Uses of Cardiac CT and CTCA

- **There is insufficient data to support the routine use of cardiac CT and/or CTCA for the following:**
 - As the first test in evaluating symptomatic patients (e.g. chest pain)
 - see CD-8.4 for exceptions.
 - To evaluate chest pain in an intermediate or high risk patient when a stress test (exercise treadmill, stress echo, MPI, cardiac MRI, cardiac PET) is clearly positive or negative.
 - Preoperative assessment for non-cardiac, nonvascular surgery (see CD- 3.6 Preoperative evaluation)
 - There is no data to support performing serial follow-up CTCA studies in symptomatic or asymptomatic patients.

- Serial imaging studies to evaluate for coronary artery disease should follow the guidelines in CD-3.3 Patients with known CAD and CD-3.5 Routine follow-up MPI
- Identification of plaque composition and morphology is possible with CTCA, 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 CTCA 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>
 - 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-3.7 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-8.9 Radiation Dose and CTCA

- Radiation dosage for CTCA 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).
 - Sophisticated gating and other techniques can reduce the radiation dose of cardiac CT studies to less than 5 mSv. Application of these techniques is increasing nationwide.
 - **J Am Coll Radiol* 2005;2:471-477
 - Dual source scanners decrease radiation exposure by approximately one third.
 - Conventional coronary angiography typically delivers a radiation dose of 3 to 6 mSv*
 - **J Am Coll Cardiol* 2007;50(15):1469-1475

CD-8.10 CPT Coding

- 3D rendering (CPT 76376 or 76377) and nuclear medicine codes for ventricular function or ejection fraction should not be reported in conjunction with coding for CTCA with left ventricular function assessment.
- Coronary imaging is not included in the code definition for CPT 71275.
 - The AMA description for CPT 71275 in CPT 2008 reads: “CTA Chest (**non-coronary**), with contrast material(s), including noncontrast images, if performed, and image postprocessing.”
- 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 CTCA studies since they most accurately describe the procedures performed.*

**ACC Advocacy Weekly, July 11, 2005*

- The Category III 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 reported as a stand-alone code and **never** should be reported 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 to report 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 report imaging of the coronary arteries (e.g. for evaluating anomalous coronary arteries).
 - **0147T** CTA of coronary arteries with quantitative evaluation of coronary calcium
 - Used to report imaging of the coronary arteries and calcium scoring calculation.
 - **0148T** Cardiac structure and morphology and CTA of the of the coronaries without quantitative evaluation of coronary calcium
 - Used to report evaluation of cardiac morphology as well as coronary artery disease; calcium scoring is not included.
 - This code is a combination of 0145T and 0146T.
 - **0149T** Cardiac structure and morphology and CTA of the coronaries with quantitative evaluation of coronary calcium
 - Used to report evaluation of cardiac morphology as well as coronary artery disease; calcium scoring is included.
 - This code is a combination of 0145T and 0147T.
 - **0150T** Cardiac structure and morphology in congenital heart disease.
 - Used to report evaluation of congenital heart disease.
 - **0151T** 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 report evaluation of wall motion and ventricular function
- This is an add-on code and should **never** be reported as a stand-alone procedure. It should be used in conjunction with 0145T-0150T.

CD-9~DIAGNOSTIC LEFT HEART CATHETERIZATION

- Diagnostic left heart catheterization (cath) is an invasive procedure with morbidity of 1.5% and mortality of 0.15%.
- These guidelines apply to patients with chronic stable conditions or new but stable conditions.
 - These guidelines do not apply to patients in the acute setting (acute coronary syndrome) or patients with unstable angina. These patients should be handled as a medical emergency.
- **Indications for diagnostic left heart catheterization:**
 - Identifying disease for which invasive procedures have been shown to prolong survival:
 - Left main coronary artery disease plus right coronary artery disease plus left ventricular dysfunction.
 - Triple vessel coronary artery disease plus left ventricular dysfunction.
 - Identifying disease that is unresponsive to optimized medical therapy and for which invasive procedures are needed to provide pain relief.
 - **Optimized Medical Therapy** should include (where tolerated): antiplatelet agents, calcium channel antagonists, partial fatty acid oxidase inhibitors (e.g. ranolazine), statins, short-acting nitrates as needed, long-acting nitrates up to 6 months after an acute coronary syndrome episode, beta blocker drugs (optional), angiotensin converting enzyme (ACE) inhibitors/angiotensin receptor blocking (ARB) agents (optional)*
 - * *Am J Cardiol* 2007 Dec.;100(11):1635-1643
 - Evaluating the presence and/or extent of coronary artery disease suggested by noninvasive imaging studies if the results of catheterization will change patient management.
 - Evaluating the cause of left ventricular dysfunction (congestive heart failure) in patients suspected of having coronary artery disease that is treatable using invasive procedures.
 - Ruling out coronary artery disease prior to planned non-coronary cardiac or great vessel surgery (cardiac valve surgery, aortic dissection, aortic aneurysm, congenital disease repair such as atrial septal defect, etc.)
- **Diagnostic left heart catheterization is NOT indicated for the following where pump function has already been determined by other means:**
 - Prior to initiation of medical therapy in patients with coronary artery disease diagnosed by other means.
 - Prior to a reasonable trial of optimized medical therapy in stable patients with coronary artery disease diagnosed by other means.
 - Patients in whom catheterization will not change management decisions (e.g. patients who are unwilling or unable to proceed with invasive procedures such as angioplasty, stenting, or surgery).

- Surveillance imaging
- Screening for coronary artery disease
 - There must be objective evidence of coronary artery disease/cardiac ischemia by elevated cardiac enzymes, ECG, and/or noninvasive cardiac imaging.
- **NOTE:** A positive stress test should not automatically lead to cardiac catheterization, since angioplasty/stenting should no longer be considered first-line therapy for stable coronary artery disease.
- The printed report of the left heart catheterization should describe hemodynamics, coronary calcifications, coronary artery stenosis, aortic and mitral valve function/dysfunction, and segmental and global left ventricular wall motion.
- In appropriate cases, post left ventriculogram renal fluoroscopy may be used to assess for evidence of renovascular hypertension (see AB-41 Renovascular Hypertension in the Abdominal guidelines).

CD-10~PULMONARY ARTERY and VEIN IMAGING

- **Pulmonary artery hypertension (PAH):** CT or CTA or MRA of the pulmonary arteries (CPT 71260 or 71275 or 71555) is useful in the assessment of PAH, especially if there is suspicion for recurrent pulmonary emboli
 - In the absence of a clinical change, follow-up imaging for PAH is not indicated.
 - Also see PVD- 5 Pulmonary Artery Hypertension in the Peripheral Vascular Disease guidelines and CH- 27 Pulmonary Embolism in the Chest guidelines.
 - **Reference:**
 - [*Radiology 2007;243:70-79*](#)
- **Pulmonary vein imaging:** A preoperative cardiac MRI (CPT 75562) or cardiac CT (CPT 0145T) can be performed to evaluate anatomy of the pulmonary veins prior to an ablation procedure performed for atrial fibrillation.
 - A routine post-procedure MRI or cardiac CT 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-11~SYNCOPE

- Also see HD-32 Syncope in the Head Imaging Guidelines.
- **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, low heart rate, or serious dysrhythmias should be performed prior to considering advanced imaging or stress testing.
- Stress testing should proceed based on CD-1.3 Stress Testing, CD-2.4 Stress Echocardiography (Stress Echo), and CD-3.2 INDICATIONS FOR MPI
- Cardiac MRI (CPT 75561) or CTCA (see CD- 8.10 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-8.6 Other indications for CTCA).
- Cardiac MRI (CPT 75557) can be performed to evaluate pre-syncope or syncope in patients with suspected ARVD/ARVC if the clinical suspicion is supported by established criteria for ARVD (see CD-6 Evidence Based Clinical Support) or if the patient has documented Brugada's syndrome
- **Duchenne muscular dystrophy:** usually imaged by echocardiogram but evaluation for ischemic or cardiomyopathic changes using MPI or (typically) cardiac MRI (CPT 75557 or 75561) can be performed (see CD-6 Cardiac MRI).

CD-12~CONGESTIVE HEART FAILURE (CHF)

- Cardiac CT should not be used for evaluation of left ventricular function following myocardial infarction or in chronic heart failure mostly out of concern for radiation exposure.
 - Patients with indeterminate echocardiogram should undergo MUGA (CPT 78472 or 78494) or cardiac MRI (CPT 75557).
 - In patients with CHF undergoing CTCA for an appropriate indication (see CD-8 CT of the Heart and CTCA), 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 75557) can be used to assess patients with CHF.
 - Where there is evidence of arteriovenous fistula with "high output" heart failure, CT scans of the chest, abdomen and pelvis with contrast (CPT 71260, 74160, 72193) can be performed. Chest and/or abdominal MRA (CPT 71555 and/or 74185) may also be useful.
- Right-sided congestive heart failure can be a manifestation of pulmonary hypertension or serious lung disease.
 - 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 75557 or 75561).

CD-13~CARDIAC TRAUMA

- Echocardiographic modalities (TTE, TEE) are the fastest modalities to assess cardiac trauma.
- Cardiac MRI (CPT 75557, 75561, 75558, or 75562 depending on physician request) can be performed in stable patients.
 - CPT 71555 (chest MRA) can be added if there is suspicion of vascular trauma distal to the root of the great vessels.
- Chest CTA (CPT 71275) and CTCA (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*

EVIDENCE BASED CLINICAL SUPPORT

Evidence Based Clinical Support CD-1~GENERAL GUIDELINES

- Cardiac imaging is used for diagnostic (e.g. surveillance or risk-stratification), or treatment (e.g. in patients with known coronary disease) purposes. Surveillance and risk-stratification can often be done with non-imaging studies and these should be considered primarily in patients with known disease. Whereas imaging may have incremental prognostic value it does not make substantial enough outcome difference to be easily supportable in patients with known disease.

Evidence Based Clinical Support CD-2~ECHOCARDIOGRAPHY (ECHO)

- “A definition of an imaging test’s appropriateness must include test performance characteristics for a clinical indication, the potential negative consequences of imaging, an understanding of the implicit impact of cost on clinical decision making, and an explicit understanding of how the test results might lead to care that could improve the patient’s chances for better survival or improved health status.”¹

MedSolutions seeks to identify the most appropriate (from multiple viewpoints) test for the appropriate patient at the appropriate time. MedSolutions’ guidelines are based upon using cardiac imaging to answer a specific clinical question that affects patient management. Therefore “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.”¹

In following this philosophy, MedSolutions considers both inherent risks and downstream effects, including costs. As such, if the imaging study requested provides no significant diagnostic benefit over standard clinical judgment and care or alternative diagnostic studies, then cost considerations should contribute to deeming the procedure inappropriate. In the case of MPI versus stress echo, MedSolutions believes that the evidence from the literature^{2,3,4,5,6} supports stress echo as the initial imaging modality when stress testing with imaging is indicated. It offers higher specificity^{2,6}, versatility in that it shows a more extensive evaluation of cardiac anatomy and function, greater patient comfort (does not require intravenous access or the discomfort of nuclear imaging camera/table demands) and at a lower cost. Additionally due to its higher specificity, it reduces ‘downstream’ costs created by the need for further clarification (e.g. tissue attenuation or patient movement during imaging). Most importantly, it avoids exposing patients to ionizing radiation.

In support of standard exercise treadmill stress testing as the initial diagnostic test, MedSolutions takes into account the pre test likelihood of disease, the baseline ECG, and the question being asked. More specifically, it is determined whether the test is for the diagnosis of unknown coronary artery disease versus functional capacity determination, evaluation of dyspnea, or the evaluation of exercise induced arrhythmias. The inherent inaccuracies of this modality are also taken into account.^{8, 9, 10}

When there is the need for imaging (above standard exercise treadmill testing), MedSolutions supports the testing modality that meets the above criteria. If there are reasons that this modality cannot be utilized, approval for alternative modalities is offered. However, if all other aspects of testing are equivalent in sensitivity and specificity, availability and expertise, then patient comfort and cost containment must also be considered above and beyond the 'medical appropriateness' of society published guidelines. This leads to our guidance towards stress echocardiography.

The ultimate objective of MedSolutions' reviews is to improve patient care and health outcomes in a cost-effective manner.

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- ² *Am J Med* 2008 May;121(5):358-359
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- ⁴ *Am J Cardiol* 2007;100:1744-1749
- ⁵ *Am J Cardiol* 2007;99:1193-1195
- ⁶ *Cardiac stress test supplement*. Institute for Clinical Systems Improvement. February 20, 2007, http://www.guideline.gov/summary/summary.aspx?ss=15&doc_id=10810&nbr=5635. Accessed October 23, 2008.
- ⁷ *Radiation exposure from medical diagnostic imaging procedures: Health Physics Society fact sheet*. Health Physics Society, <http://hps.org/documents/meddiagimaging.pdf>. Accessed October 30, 2008.
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**Evidence Based Clinical Support
CD-3~NUCLEAR CARDIAC IMAGING (MPI)**

- The U.S. Preventive Services Task Force (USPSTF) found insufficient evidence to recommend for or against screening with ECG, exercise treadmill testing or EBCT for coronary artery stenosis in asymptomatic adults at increased risk for coronary heart disease events.
- Exercise treadmill stress test: Sensitivity 68% Specificity 77%
Stress Echo: Sensitivity 76% Specificity 88%
MPI: Sensitivity 88% Specificity 77%
PET: Sensitivity 91% Specificity 82%
- **Reference:**
 - *Am J Med* 2008 May;121(5):358-359

- **Positive exercise treadmill stress test (for ischemia) is defined as:**
 - ECG ST depression of >1 mm
 - **Exception:** women over age 45 may have false-positive ST depression
 - exercise-induced angina
 - drop in systolic blood pressure >10 mm Hg with exercise
 - development of ventricular tachycardia with exercise
- If a previous exercise treadmill stress test was positive and follow-up stress tests are indicated, then these follow-up studies should consist of exercise treadmill stress tests if the patient can exercise. Electrocardiographic interpretive ability is not really critical since the diagnosis of CAD has already been made. Other information obtained during the stress test such as the presence of arrhythmias, blood pressure and heart rate response, symptoms, and exercise capacity should provide sufficient prognostic and patient management data.
- From a study of 7,456 patients with normal MPI study followed for 665+/- 200 days:
 - 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.
 - 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](#)
 - 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.
- 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.
- Recent evidence reveals that instituting medical therapy such as Enalapril and Carvedilol at the beginning of chemotherapy may substantially lessen or eliminate cardiac toxicity from chemotherapy.*

- Left ventricular imaging may be indicated in patients who have both early and late troponin level elevations.*

**Rev Cardiovasc Med 2008;9(2):75-83*

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

- 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.

Evidence Based Clinical Support
CD-6~CARDIAC MRI

- 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*

- Proposed diagnostic criteria for Arrhythmogenic Right Ventricular Cardiomyopathy from the Task Force of the Working Group on Myocardial and Pericardial Disease of the European Society of Cardiology and of the Scientific Council on Cardiomyopathies of the International Society and Federation of Cardiology:
 - Family history
 - Familial disease confirmed at necropsy or surgery (Major criterion)
 - Family history of premature sudden death (<35 years old) caused by suspected ARVD (Minor criterion)
 - Family history (clinical diagnosis based on present criteria) (Minor criterion)
 - ECG depolarization/conduction abnormalities
 - Epsilon waves or localized prolongation (≥ 110 ms) of the QRS complex in the right precordial leads (V1-V3) (Major criterion)
 - Late potentials seen on signal averaged ECG (Minor criterion)
 - ECG repolarization abnormalities
 - Inverted T waves in right precordial leads (V2 and V3) in patients aged >12 y and in the absence of right bundle branch block (Minor criterion)
 - Arrhythmias
 - Sustained or nonsustained left bundle branch block type ventricular tachycardia documented on ECG or Holter monitoring, or during exercise testing (Minor criterion)
 - Frequent ventricular extrasystoles (>1000/24 h on Holter monitoring) (Minor criterion)
 - Global or regional dysfunction and structural alterations
 - Severe dilatation and reduction of RV ejection fraction with no (or only mild) LV involvement (Major criterion)
 - Localized RV aneurysms (akinetic or dyskinetic areas with diastolic bulging) (Major criterion)
 - Severe segmental dilatation of the right ventricle (Major criterion)
 - Mild global RV dilatation or ejection fraction reduction with normal left ventricle (Minor criterion)
 - Mild segmental dilatation of the right ventricle (Minor criterion)
 - Regional RV hypokinesia (Minor criterion)
 - Tissue characteristics of walls
 - Fibrofatty replacement of myocardium on endomyocardial biopsy (Major criterion)

- The diagnosis of ARVD/ARVC requires the presence of 2 major criteria or 1 major plus 2 minor or 4 minor criteria

**The American Journal of Medicine 2008;121:674-681*

- 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 can be complex. Conventional Echo gives accurate information regarding the valves and is easier to perform.
- Tuberosus 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.

Evidence Based Clinical Support
CD-8~CT of the HEART and Computed Tomography Coronary Angiography CTCA

Table B1. Pre-Test Probability of CAD by Age, Gender, and Symptoms

Age (yrs)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain	Asymptomatic
30 - 39	Men	Intermediate	Intermediate	Low	Very low
	Women	Intermediate	Very low	Very low	Very low
40 - 49	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Low	Very low	Very low
50 - 59	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Intermediate	Low	Very low
60 - 69	Men	High	Intermediate	Intermediate	Low
	Women	High	Intermediate	Intermediate	Low

High: Greater than 90% pre-test probability; **Intermediate:** Between 10% and 90% pre-test probability; **Low:** Between 5% and 10% pre-test probability; **Very Low:** Less than 5% pre-test probability.

ACCF/ASNC 2005 Appropriateness Criteria*

**J Am Coll Cardiol 2005;46(8):1587-1605*

- Angina as defined by the ACC/AHA 2002 Guideline Update for Exercise Testing:*
 - **Typical angina (definite):** 1) Substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.
 - **Atypical angina (probable):** Chest pain or discomfort that lacks one of the characteristics of definite or typical angina.
 - **Non-anginal chest pain:** Chest pain or discomfort that meets one or none of the typical angina characteristics.

**J Am Coll Cardiol 2002;40:1531-1540*

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

- 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 CTCA. In this setting, CTCA may need to be reconsidered for another imaging modality.
- Other considerations for obtaining a high quality cardiac CTCA:
 - 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 CTCA imaging and should be considered a potential contraindication for CTCA.
- Currently there is a lack of standardization of the protocols in use for coronary CTCA. 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 CTCA, 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 CTCA were 95%, 98% 87% and 99%, respectively. *

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