CLINICAL GUIDELINES

Cardiac Imaging Guidelines

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eviCore healthcare Clinical Decision Support Tool Diagnostic Strategies:This tool addresses common symptoms and symptom complexes. Imaging requests for individuals with atypical symptoms or clinical presentations that are not specifically addressed will require physician review. Consultation with the referring physician, specialist and/or individual's Primary Care Physician (PCP) may provide additional insight.

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Abbreviations for Cardiac Imaging 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
CCTA	coronary computed tomography angiography
CTA	computed tomography angiography
EBCT	electron beam computed tomography
ECP	external counterpulsation (also known as EECP)
ECG	electrocardiogram
ECP	external counterpulsation
ETT	exercise treadmill stress test
FDG	Fluorodeoxyglucose, a radiopharmaceutical used to measure myocardial metabolism
HCM	hypertrophic cardiomyopathy
IV	intravenous
LAD	left anterior descending coronary artery
LDL-C	low density lipoprotein cholesterol
LHC	left heart catheterization
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) equal to an effective dose of a joule of energy per kilogram of recipient mass
MUGA	multi gated acquisition scan of the cardiac blood pool
PCI	percutaneous coronary intervention (includes percutaneous coronary angioplasty (PTCA) and coronary artery stenting)
PET	positron emission tomography
PTCA	percutaneous coronary angioplasty
RHC	right heart catheterization
SPECT	single photon emission computed tomography
TEE	transesophageal echocardiogram
TIA	Transient Ischemic Attack
VSD	ventricular septal defect

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Glossary

Agatston Score: a nationally recognized calcium score for the coronary arteries based on Hounsfield units and size (area) of the coronary calcium
Angina: principally chest discomfort, exertional (or with emotional stress) and relieved by rest or nitroglycerin
Anginal variants or equivalents: a manifestation of myocardial ischemia which is perceived by individuals 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 (Rate Pressure Product)**:** an index of cardiac oxygen consumption, is the 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
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 not syncope
Takotsubo cardiomyopathy: apical dyskinesis oftentimes associated with extreme stress and usually thought to be reversible
Troponin: a marker for ischemic injury, primarily cardiac

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CD-1: General Guidelines

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Practice Estimate of Effective Radiation Dose chart for Selected Imaging Studies

Imaging Study	Estimate of Effective Radiation Dose
Sestamibi myocardial perfusion study (MPI) PET myocardial perfusion study: Rubidium-82 NH3	9-12 mSv 3 mSv 2 mSv
Thallium myocardial perfusion study (MPI)	22-31 mSv
Diagnostic conventional coronary angiogram (cath)	5-10 mSv
Computed tomography coronary angiography (CTCA) (with prospective gating)	5-15 mSv Less than 5 mSv
CT Abdomen and Pelvis	8-14 mSv
Chest x-ray	<0.1 mSv

CD-1.0: General Guidelines

- A current clinical evaluation (within 60 days) is required prior to considering advanced imaging, which includes:
  - Relevant history and physical examination and appropriate laboratory studies and non-advanced imaging modalities, such as recent ECG (within 60 days), chest x-ray or ECHO/ultrasound, after symptoms started or worsened.
    - Effort should be made to obtain copies of reported “abnormal” ECG studies in order to determine whether the ECG is uninterpretable for ischemia on ETT
    - Most recent previous stress testing and its findings should be obtained
    - Other meaningful contact (telephone call, electronic mail or messaging) by an established individual can substitute for a face-to-face clinical evaluation.
  - Vital signs, height and weight, or BMI, or description of general habitus is needed.
  - Clinical question to be answered by advanced imaging that will affect management of the individual’s clinical condition.
- Cardiac imaging is not indicated if the results will not affect clinical management decisions. If a decision to perform cardiac catheterization or other angiography has already been made, there is often no need for imaging stress testing
- Assessment of ischemic symptoms can be determined by **Table-1**:

Clinical pre-test probability of CAD in individuals with stable chest pain symptoms

- Clinical pre-test probability of CAD is a statistical tool used in the initial assessment of stable chest pain syndromes to estimate the likelihood that the symptoms are caused by obstructive coronary artery disease using the individual’s description of the symptoms, their age, and sex assigned at birth. The pre-test probability for obstructive coronary artery disease as the cause of the symptoms is categorized as the following:
  - **High** >85% pre-test probability
  - **Intermediate/high** between 66-85% pre-test probability
  - **Intermediate** between 15-65% pre-test probability
  - **Low** <15% pre-test probability

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Table-1

Clinical pretest probability of CAD in individuals with stable chest pain symptoms				
Age (years)	Sex at birth	Type of symptoms		
		Cardiac	Possibly cardiac	Noncardiac
30-39	Men	Intermediate	Intermediate	Intermediate
	Women	Intermediate	Low	Low
40-49	Men	Intermediate/High	Intermediate	Intermediate
	Women	Intermediate	Low	Low
50-59	Men	Intermediate/High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
60-69	Men	Intermediate/High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Intermediate
70-79	Men	High	Intermediate/High	Intermediate
	Women	Intermediate/High	Intermediate	Intermediate
>80	Men	High	Intermediate/High	Intermediate
	Women	Intermediate/High	Intermediate	Intermediate

- For purposes in this guideline ischemic symptoms can be defined as the following:
  - **Cardiac chest pain** (typical angina):
    - Angina pectoris is classified as typical when all of the following are present:
      - Retrosternal chest discomfort (generally described as pressure, heaviness, burning, constriction, squeezing, or tightness)
      - Brought on by exertion or emotional stress
      - Relieved by rest or nitroglycerin
    - May radiate to the left arm or jaw
    - When clinical information is received indicating that an individual is experiencing chest pain that is "exertional" or "due to emotional stress" and relieved with rest, this meets the cardiac chest pain (typical angina) definition under the Pre-Test Probability Grid. No further description of the chest pain is required (location within the chest is not required).
    - The Clinical pretest probability of CAD (**Table-1**) is based on age, sex, and symptoms. All factors must be considered in order to approve for stress testing with imaging using the Pre-Test Probability Grid.
  - **Possibly cardiac chest pain** (atypical angina):
    - Chest pain or discomfort (arm or jaw pain) that lacks one of the characteristics of cardiac chest pain.
    - DOE can be considered
  - **Noncardiac chest pain**:
    - Chest pain or discomfort that meets one or none of the possibly cardiac characteristics.
  - Anginal equivalents:
    - Symptoms consistent with individual's known angina pattern in an individual with a history of CABG or PCI.

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- Other signs and symptoms suggestive of potential cardiac etiology:
  - Dyspnea
  - Orthopnea
  - Paroxysmal nocturnal dyspnea
  - Heartburn unrelated to meals/nausea and vomiting
  - Palpitations
  - Syncope
  - Heart failure
- Chest pain remains the predominant symptom reported by women among those diagnosed with an acute coronary syndrome.
- For the purpose of this guideline, evidence documenting the presence of obstructive CAD includes any of the following:
  - Prior heart catheterization or CCTA revealing any of the following:
    - ≥40% stenosis of the left main coronary artery
    - ≥50% stenosis for other coronary arteries
    - Significant stenosis defined by an FFR of <0.80
  - History of a prior PCI or CABG
- For the purpose of this guideline, evidence documenting the presence of **non-obstructive CAD** includes prior heart catheterization or CCTA revealing any of the following:
  - <40% stenosis of the left main coronary artery
  - <50% stenosis for other coronary arteries
  - FFR >0.8
- For the purposes of this guideline, evidence documenting a prior MI includes any of the following:
  - Presence of diagnostic Q waves on an ECG
  - A fixed perfusion defect on MPI
  - Akinetic or dyskinetic wall motion on echocardiogram
  - Area of Late Gadolinium Enhancement (LGE) on cardiac MRI suggesting scar
- Findings that may alter the ECG changes during exercise or are uninterpretable for ischemia on a stress test:
  - Complete Left Bundle Branch Block (bifasicular block involving right bundle branch and left anterior hemiblock does not render ECG uninterpretable for ischemia)
  - Ventricular paced rhythm
  - Pre-excitation pattern such as Wolff-Parkinson-White
  - Greater or equal to 1.0 mm ST segment depression (NOT nonspecific ST/T wave changes)
  - LVH with repolarization abnormalities, also called LVH with strain (NOT without repolarization abnormalities or by voltage criteria)
  - T wave inversion in the inferior and/or lateral leads. This includes leads II, AVF, V5 or V6. (T wave inversion isolated in lead III or T wave inversion in lead V1 and V2 are not included).
  - Individual on digitalis preparation

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CD-1.2: Stress Testing without Imaging – Procedures

The Exercise Treadmill Test (ETT) is without imaging.

- Necessary components of an ETT include:
  - ECG that can be interpreted for ischemia.
  - Individual capable of exercise to achieve target heart rate on a treadmill or similar device (5 METs or greater; see functional capacity below). Target heart rate is calculated as 85% of the maximum age predicted heart rate (MPHR). MPHR is estimated as 220 minus the individual's age.
- An abnormal ETT (exercise treadmill test) includes any one of the following:
  - ST segment depression (usually described as horizontal or downsloping, ≥1.0 mm below baseline)
  - Development of chest pain
  - Significant arrhythmia (especially ventricular arrhythmia)
  - Hypotension during exercise
- Functional capacity ≥5 METs equates to the following:
  - Can walk four blocks without stopping
  - Can walk up a hill
  - Can climb one flight of stairs without stopping
  - Can perform heavy work around the house
  - Can walk 4mph at a brisk pace

Practice Note

An observational study found that, compared with the Duke Activity Status Index, subjective assessment by clinicians generally underestimated exercise capacity

CD-1.3: Stress Testing with Imaging – Procedures

- Imaging Stress Tests include any one of the following:
  - Stress Echocardiography see **CD-2.6: Stress Echocardiography (Stress Echo) – Coding**
  - SPECT MPI see **CD-3.1: Myocardial Perfusion Imaging (MPI) – Coding**
  - Stress perfusion MRI see **CD-5.3: Cardiac MRI – Indications for Stress MRI**
  - PET Perfusion see **CD-6.2: Cardiac PET-Perfusion-Indications**
- Stress testing with imaging can be performed with maximal exercise or chemical stress (adenosine, dipyridamole, dobutamine, or regadenoson) and does not alter the CPT® codes used to report these studies.

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CD-1.4: Stress Testing with Imaging – Indications

- Stress echo, SPECT MPI or stress MRI, can be considered if there are **new, recurrent, or worsening** symptoms consistent with ischemia **and any** of the following:
  - Intermediate-high or High pretest probability (>66% probability of CAD) per **Table-1**
  - A history of obstructive CAD as defined in **CD-1.0: General Guidelines**
  - Evidence of ventricular tachycardia
  - High suspicion of ventricular tachycardia such as unheralded syncope (not near syncope)
  - Age 40 years or greater and known diabetes mellitus
  - Coronary calcium score ≥100
  - Poorly controlled hypertension defined as systolic BP ≥180mmhg, if provider feels strongly that CAD needs evaluation prior to BP being controlled.
  - ECG is uninterpretable for ischemia due to any one of the following:
    - Complete Left Bundle Branch Block (bifasicular block involving right bundle branch and left anterior hemiblock does not render ECG uninterpretable for ischemia)
    - Ventricular paced rhythm
    - Pre-excitation pattern such as Wolff-Parkinson-White
    - Greater or equal to 1.0 mm ST segment depression (NOT nonspecific ST/T wave changes)
    - LVH with repolarization abnormalities, also called LVH with strain (NOT without repolarization abnormalities or by voltage criteria)
    - T wave inversion in the inferior and/or lateral leads. This includes leads II, AVF, V5 or V6. (T wave inversion isolated in lead III or T wave inversion in lead V1 and V2 are not included).
    - Individual on digitalis preparation
  - Continuing symptoms in an individual who had a normal or submaximal exercise treadmill test and there is suspicion of a false negative result.
  - Individuals with recent equivocal, borderline, or abnormal stress testing where ischemia remains a concern. See **CD-1.2: Stress Testing without Imaging – Procedures.**
  - Heart rate <50 bpm in individuals, including those on beta blocker, calcium channel blocker, or amiodarone, where it is felt that the individual may not achieve an adequate workload for a diagnostic exercise study.
  - Inability to safely use a treadmill or exercise bicycle, for example, the need for ambulatory assistance (wheelchair, cane, walker, etc.) or significant neurologic or orthopedic issue
  - ETT inadequate due to one of the following:
    - Physical (musculoskeletal or neurological) inability to achieve target heart rate- 85% MPHR (220-age). See **CD-1.2: Stress Testing without Imaging – Procedures** for necessary components for ETT
    - History of false positive exercise treadmill test: a false positive ETT is one that is abnormal however the abnormality does not appear to be due to macrovascular CAD.

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- Stress echo, SPECT MPI or stress MRI, can be considered regardless of symptoms for **any** of the following:
  - One imaging stress test can be performed within 3 months of an acute coronary syndrome (e.g. ST segment elevation MI [STEMI], unstable angina, non-ST segment elevation MI [NSTEMI]), to evaluate for inducible ischemia if ALL of the following related to the most recent acute coronary event apply:
    - Individual is hemodynamically stable
    - No recurrent chest pain symptoms and no signs of heart failure
    - No prior coronary angiography or imaging stress test since the current episode of symptoms
  - Assessing myocardial viability in individuals with significant ischemic ventricular dysfunction (suspected hibernating myocardium) and persistent symptoms or heart failure such that revascularization would be considered.
    - MRI, cardiac PET, SPECT MPI, or Dobutamine stress echo can be used to assess myocardial viability depending on physician preference.
    - See **CD-6.4: Cardiac PET – Metabolic – Indications**.
  - Asymptomatic individual with an uninterpretable ECG as decribed in **CD 1.0: General Guidelines** that either:
    - Has never been evaluated
    - Is a new uninterpretable change
  - Individual with an elevated cardiac troponin.
  - One routine study 2 years or more after a stent
    - Except with a left main stent where it can be done at 1 year.
  - One routine study at 5 years or more after CABG, without cardiac symptoms.
  - Every 2 years if there was documentation of previous “silent ischemia” on the imaging portion of a stress test but not on the ECG portion.
  - To assess for CAD prior to starting a Class IC antiarrhythmic agent (flecainide or propafenone) and annually while taking the medication.
  - Prior to starting Interleukin-2
  - Prior anatomic imaging study (coronary angiogram or CCTA) demonstrating coronary stenosis in the proximal or mid-portion of a major coronary branch, which is of uncertain functional significance, can have one stress test with imaging.
- Evaluating new, recurrent, or worsening left ventricular systolic dysfunction
- Cardiac perfusion PET (CPT® 78430, 78431, 78491, 78492) can be considered in place of stress echo, SPECT MPI, or stress MRI when any of the above indications for stress testing with imaging have been met **and** there is documentation of **one** of the following:
  - Individual is severely obese (for example BMI ≥40 kg/m^2) or
  - Individual has large breasts or implants
  - Individual incapable of exercise due to physical (musculoskeletal or neurological) inability to achieve target heart rate. Target heart rate is calculated as 85% of the maximum age predicted heart rate (MPHR). MPHR is estimated as 220 minus the individual’s age.
    - See **CD-6.2: Cardiac PET – Perfusion – Indications** for additional indications for cardiac PET perfusion

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CD-1.5: Stress Testing with Imaging – Preoperative

- There are **2** steps that determine the need for imaging stress testing in (stable) pre-operative individuals:
  - Step1: Would the individual qualify for imaging stress testing independent of planned surgery?
    - If yes, proceed to stress testing guidelines **CD-1.4: Stress Testing with Imaging – Indications**
    - If no, go to step 2
  - Step 2: Is the surgery considered high, moderate or low risk? (see **Table-2**) If high or moderate-risk, proceed below. If low-risk, there is no evidence to determine a need for preoperative cardiac testing.
    - **High Risk Surgery**: All individuals in this category should receive an imaging stress test if there has not been an imaging stress test within 1 year* unless the individual has developed new cardiac symptoms or a new change in the EKG since the last stress test.
    - **Intermediate Surgery**: One or more risk factors and unable to perform an ETT per guidelines if there has not been an imaging stress test within 1 year* unless the individual has developed new cardiac symptoms or a new change in the EKG since the last stress test.
    - **Low Risk**: Preoperative imaging stress testing is not supported.
  - Clinical Risk Factors (for cardiac death & non-fatal MI at time of non-cardiac surgery)
    - Planned high-risk surgery (open surgery on the aorta or open peripheral vascular surgery)
    - History of ischemic heart disease (previous MI, previous positive stress test, use of nitroglycerin, typical angina, ECG Q waves, previous PCI or CABG)
    - History of compensated previous congestive heart failure (history of heart failure, previous pulmonary edema, third heart sound, bilateral rales, chest x-ray showing heart failure)
    - History of previous TIA or stroke
    - Diabetes Mellitus
    - Creatinine level > 2 mg/dL

*Time interval is based on consensus of eviCore executive cardiology panel.

Table-2

Cardiac Risk Stratification List		
High Risk (> 5%)	**Intermediate Risk (1-5%)**	**Low Risk (<1%)**
➢ Open aortic and other major open vascular surgery ➢ Open peripheral vascular surgery	➢ Open intraperitoneal and/or intrathoracic surgery ➢ Open carotid endarterectomy ➢ Head and neck surgery ➢ Open orthopedic surgery ➢ Open prostate surgery	➢ Endoscopic procedures ➢ Superficial procedures ➢ Cataract surgery ➢ Breast surgery ➢ Ambulatory surgery ➢ Laparoscopic and endovascular procedures that are unlikely to require further extensive surgical intervention

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CD-1.6: Transplant

- Stress Testing in individuals for Non-Cardiac Transplant
  - Individuals who are candidates for any type of organ, bone marrow, or stem cell transplant can undergo imaging stress testing every year (usually stress echo or MPI) prior to transplant.
  - Individuals who have undergone organ transplant are at increased risk for ischemic heart disease secondary to their medication. Risk of vasculopathy is 7% at one year, 32% at five years and 53% at ten years. An imaging stress test can be repeated annually after transplant for at least two years or within one year of a prior cardiac imaging study if there is evidence of progressive vasculopathy.
  - After two consecutive normal imaging stress tests, repeated testing is not supported more often than every other year without evidence for progressive vasculopathy or new symptoms.
  - Stress testing after five years may proceed according to normal patterns of consideration.
- Post-Cardiac transplant assessment of transplant CAD:
  - One of the following imaging studies may be performed annually:
    - SPECT MPI
    - Stress ECHO
    - Stress MRI
    - Cardiac PET perfusion

CD-1.7: Non-imaging Heart Function and Cardiac Shunt Imaging

- Procedures reported with CPT® 78414 and CPT® 78428 are essentially obsolete and should not be performed in lieu of other preferred modalities.
- Echocardiogram is the preferred method for cardiac shunt detection, rather than the cardiac shunt imaging study described by CPT® 78428.
- Ejection fraction can be obtained by echocardiogram, SPECT MPI, MUGA study, cardiac MRI, cardiac CT, or cardiac PET depending on the clinical situation, rather than by the non-imaging heart function study described by CPT® 78414.

CD-1.8: Genetic lab testing in the evaluation of CAD

- Corus® CAD genetic expression score – refer to lab management program guidelines

CD-1.9: CAD Risk factor modification

- Risk factor modification
  - Statins remain the mainstay of medical treatment for cardiovascular risk reduction with an abundance of scientific evidence regarding their efficacy.
  - PCSK9 drugs are a new addition to the treatment of hyperlipidemia
    - Refer to specialty drug coverage criteria for these drugs.

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CD-2: Echocardiography (ECHO)

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CD-2.1: Transthoracic Echocardiography (TTE) – Coding

TTE CODES		
Transthoracic Echocardiography		**CPT®**
TTE for congenital cardiac anomalies, complete		**93303**
TTE for congenital cardiac anomalies, follow-up or limited		**93304**
TTE with 2-D, M-mode, Doppler and color flow, complete		**93306**
TTE with 2-D, M-mode, without Doppler or color flow		**93307**
TTE with 2-D, M-mode, follow-up or limited		**93308**
Doppler Echocardiography		**CPT®**
Doppler echo, pulsed wave and/or spectral display		**+93320***
Doppler echo, pulsed wave and/or spectral display, follow-up or limited study		**+93321***
Doppler echo, color flow velocity mapping		**+93325**
*CPT® 93320 and CPT® 93321 should not be requested or billed together		
3D Echocardiography		**CPT®**
3D echocardiographic imaging and postprocessing during transesophageal echocardiography, or during transthoracic echocardiography for congenital cardiac anomalies, for the assessment of cardiac structure(s) (eg, cardiac chambers and valves, left atrial appendage, interatrial septum, interventricular septum) and function, when performed (List separately in addition to code for echocardiographic imaging) Code with (**93303**-**93304**, **93312**, **93314**, **93315**, **93317**, **93350**-**93351**)		**93319**
Transthoracic Echocardiography		**CPT®**
C8921	TTE for congenital cardiac anomalies, complete	**93303**
C8922	TTE for congenital cardiac anomalies, follow-up or limited	**93304**
C8929	TTE with 2-D, M-mode, Doppler and color flow, complete	**93306**
C8923	TTE with 2-D, M-mode, without Doppler or color flow	**93307**
C8924	TTE with 2-D, M-mode, follow-up or limited	**93308**
C codes are unique temporary codes established by CMS. C codes were established for contrast echocardiography. Each echocardiography C code corresponds to a standard echo code (Class I CPT code) The C code and the matching CPT® code should not both be approved.		
Myocardial strain imaging		
Myocardial strain imaging using speckle tracking-derived assessment of myocardial mechanics (List separately in addition to codes for echocardiography imaging)		**+93356**
Investigational Codes		
0439T	Myocardial contrast perfusion echocardiography, at rest or with stress, for assessment of myocardial ischemia or viability	Investigational

CD-2.1.1: Transthoracic Echocardiography (TTE) – Coding - General Information

- Complete transthoracic echocardiogram with spectral and color flow Doppler (CPT® 93306).
  - CPT® 93306 includes the Doppler exams, so CPT® codes 93320-93325 should **not** be assigned together with CPT® 93306.
  - Doppler codes (CPT® 93320, CPT® 93321, and CPT® 93325) are 'add-on codes' (as denoted by the + sign) and are assigned in addition to code for the primary procedure.
- For a 2D transthoracic echocardiogram without Doppler, report CPT® 93307.

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- Limited transthoracic echocardiogram should be billed if the report does not "evaluate or document the attempt to evaluate" all of the required structures.
  - A limited transthoracic echocardiogram is reported with CPT® 93308.
  - CPT® 93321 (not CPT® 93320) should be reported with CPT® 93308 if Doppler is included in the study. CPT® 93325 can be reported with CPT® 93308 if color flow Doppler is included in the study.
  - A limited congenital transthoracic echocardiogram is reported with CPT® 93304.
- Doppler echo may be used for evaluation of the following:
  - Shortness of breath
  - Known or suspected valvular disease
  - Known or suspected hypertrophic obstructive cardiomyopathy
  - Shunt detection

Practice Notes

- Providers performing echo on a pediatric individual, may not know what procedure codes they will be reporting until the initial study is completed.
- If a congenital issue is found on the initial echo, a complete echo is reported with codes CPT® 93303, CPT® 93320, and CPT® 93325 because CPT® 93303 does NOT include Doppler and color flow mapping.
- If no congenital issue is discovered, then CPT® 93306 is reported alone and includes 2-D, Doppler, and color flow mapping.
- Since providers may not know the appropriate code/s that will be reported at the time of the pre-authorization request, they may request all 4 codes (CPT® 93303, CPT® 93320, CPT® 93325, and CPT® 93306).
- CPT® 76376 and CPT® 76377 are not unique to 3D Echo. These codes also apply to 3D rendering of MRI and CT studies, see **CD-2.8: 3D Echocardiography – Coding**
- CPT® 93325 may also be used with fetal echocardiography.
- CPT® 93319 3D echo imaging postprocessing of TEE or TTE to evaluate congenital cardiac abnormalities. see **CD-2.8: 3D Echocardiography – Coding**

CD-2.2: Transthoracic Echocardiography (TTE) – Indications/initial evaluation

Asymptomatic individuals

- TTE can be approved for screening of an individual when there is documentation of any of the following:
  - First-degree relative with an inherited cardiomyopathy-an initial screening echocardiogram can be approved at the time an inherited cardiomyopathy is diagnosed in a first degree relative
  - First-degree relative with bicuspid aortic valve
  - First degree relative with known thoracic aortic aneurysm or dissection (may repeat every two years if negative). See **PVD-6.2: Thoracic Aortic Aneurysm**, **PVD-6.7: Aortic Dissection and Other Aortic Conditions**, **PVD-2.3: Screening for TAA** in individuals with bicuspid aortic valves in the Peripheral Vascular Disease Imaging Guideline

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- TTE can be approved for the initial evaluation of an individual for any of the following documented conditions:
  - Known or suspected connective tissue disease or a genetic condition that predisposes to an aortic aneurysm or dissection to evaluate the ascending aorta (may repeat every two years if negative). See **PVD-2.2: Screening for Vascular related genetic connective tissue Disorders** in the Peripheral Vascular Disease Imaging Guidelines
  - Genotype positive individual with inherited cardiomyopathy including any of the following:
    - HCM
    - Non compaction cardiomyopathy
    - Familial Dilated Cardiomyopathy
    - Arrhythmogenic Cardiomyopathy (e.g., ARVC)
  - Prior to solid organ transplant or hematopoietic stem cell transplant (HSCT)
  - Prior to exposure to medications or radiation that could result in cardiotoxicity/heart failure. See **CD-12.1: Oncologic Indications for Cancer Therapeutics-Related Cardiac Dysfunction (CTRCD)**
  - Suspected pulmonary arterial hypertension (PAH) in an individual with documented high risk for developing PAH including **any** of the following conditions:
    - Scleroderma
    - Lupus
    - Mixed connective tissue disease
  - Cardiac mass, suspected tumor, or thrombus seen on other imaging (i.e., chest CT, chest MRI, CXR) when further assessment is needed for alteration in treatment or therapy
  - Newly diagnosed or strongly suspected cerebral ischemia or peripheral embolic event- initial evaluation
- Suspected cardiac injury due to blunt chest trauma
- Post myocardial infarction (MI) can be approved once in follow-up ≥6 weeks after the MI
- Evaluation of adult congenital heart disease see **CD-11: Adult Congenital Heart Disease** and **PEDCD-2: Congenital Heart Disease** in the Pediatric Cardiology imaging guidelines

Symptomatic individuals

- TTE can be approved to evaluate an individual when there is documentation of **any** of the following new or worsening clinical signs and symptoms of heart disease:
  - Chest pain
  - New or changing heart murmur
  - Newly diagnosed RBBB or LBBB
  - Frequent VPCs without other evidence of heart disease (Frequent VPCs is defined as Ventricular premature contractions occurring more frequently than 30 times per hour or occurring in a pattern of bigeminy, trigeminy, or runs of ventricular tachycardia)
  - Non sustained or sustained ventricular tachycardia (VT)
  - Ventricular fibrillation (VF)
  - Newly diagnosed atrial fibrillation/flutter

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- Palpitations
- Dependent lower extremity edema
- Presyncope/Syncope
- Dyspnea/shortness of breath, or hypoxemia
- Suspected hypertensive heart disease (initial evaluation)
- Suspected endocarditis when there is documentation of any
  - Fever
  - Positive blood cultures indicating bacteremia
  - A new murmur

CD-2.3: Frequency of Echocardiography Testing

- Repeat routine echocardiograms are not supported (annually or otherwise) for evaluation of clinically stable syndromes
- A repeat echo is allowed **every three years**, without a change in clinical status, when there is a documented history of:
  - Bicuspid aortic valve
  - Mild aortic or mitral stenosis
  - Prosthetic heart valve
  - Aortic sclerosis without stenosis
  - A first degree relative with a diagnosis of Hypertrophic Cardiomyopathy
  - A first degree relative with a diagnosis of Familial Dilated Cardiomyopathy or Idiopathic cardiomyopathy
  - Genotype positive for Familial Dilated Cardiomyopathy
- First degree relative with known thoracic aortic aneurysm or dissection a repeat echo is allowed every **two years** when **both:**
  - Prior aortic imaging (echo, CT, MR) is negative
  - Last aortic imaging was ≥2 years
- A repeat echocardiogram is allowed every six months for asymptomatic, **severe** mitral regurgitation
- A repeat echo is allowed **once** a year (when no change in clinical status), when there a history of:
  - Significant valve dysfunction either:
    - Moderate or severe regurgitation
    - Moderate or severe stenosis
  - Significant valve deformity regardless of extent of regurgitation or stenosis when there is documentation of either:
    - Thickened myxomatous valve
    - Bileaflet prolapse
  - Hypertrophic cardiomyopathy- see also: **CD-2.2: Transthoracic Echocardiography (TTE) – Indications**, **CD-2.7: Stress Echocardiography – Indications, other than ruling out CAD**
  - Chronic pericardial effusions when findings would potentially alter therapy
  - Left ventricular systolic dysfunction to evaluate the effectiveness of on-going therapy
  - Aortic root dilatation that has not yet been repaired, see also **CD-11.2.9: Congenital Valvular Aortic Stenosis** and for post-repair see **PVD-6.8: Post Aortic Endovascular/Open Surgery Surveillance Studies** in the Peripheral Vascular Disease Imaging Guideline
  - Systemic Sclerosis or Scleroderma

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- Valve Surgery
  - If valve surgery is being considered can have TTE **twice a year**
  - Post-surgery (repair or prosthetic valve implantation):
    - 6 weeks post surgery to establish baseline
    - One routine study (surveillance) every 3 years after valve repair or replacement.
  - TAVR follow-up:
    - A baseline post-op TTE is usually performed within one week after surgery. This baseline study may also be approved as an outpatient if not performed in the hospital prior to discharge
    - 1 month post procedure
    - 1 year post-procedure
    - Annually thereafter
    - See also **CD-4.8: Transcatheter Aortic Valve Replacement (TAVR)**
  - Mitral valve clip:
    - 1 month post procedure
    - 6 months post-procedure
    - 1 year post-procedure
    - See also **CD-13.5: Percutaneous Mitral Valve Repair (mitral valve clip)**
- PFO closure (for ASD closure see **CD 11.2.1 ASD-Atrial septal defects**)
  - Preoperative evaluation for closure of PFO
  - Postprocedural evaluation of PFO repair
  - 6 month follow-up post PFO repair
  - Annually if there is a residual shunt
- Left Atrial Appendage Occlusion- TTE with 3D imaging can be approved as part of the preprocedural evaluation
- Pulmonary hypertension
  - Anytime, without regard for the number or timing of previous ECHO studies to evaluate either:
    - Change in therapy
    - Change in clinical findings or symptoms
  - Surveillance- regardless of symptoms
    - Annually- if known to be at least moderate in severity
    - Mild- repeat imaging is not indicated in absence of new clinical signs or symptoms
- Cardiac device therapy
  - Re-evaluation is indicated **three months** after revascularization or maximally tolerated optimal medical therapy to determine either:
    - Candidacy for device therapy
    - Optimal choice of device
  - Evaluation prior to ICD/CRT placement, while establishing 3 months of optimal medical therapy

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- Repeat echocardiogram is indicated anytime, without regard for the number or timing of previous ECHO studies, if there is a change in clinical status, or new signs and symptoms with documentation of **any** of the following:
  - Cardiac murmurs
  - Myocardial infarction or acute coronary syndrome
  - Congestive heart failure (new or worsening)
    - New symptoms of dyspnea
    - Orthopnea
    - Paroxysmal nocturnal dyspnea
    - Elevated BNP
  - Pericardial disease
  - Stroke/transient ischemic attack
  - Decompression illness
  - Prosthetic valve dysfunction or thrombosis
  - Cardiac transplant
  - Individuals with Left Ventricular Assist Device (LVAD)
- Anytime, without regard for the number or timing of previous ECHO studies when there is a history of cardiac transplant per transplant center protocol
- For re-evaluation in an individual previously or currently undergoing therapy with cardiotoxic agents or radiation therapy, see **CD-12.1: Oncologic Indications for Cancer Therapeutics-Related Cardiac Dysfunction (CTRCD)**

Practice note

- Decisions regarding routine echocardiographic follow-up should not be based on the degree of regurgitation alone, but should take into account associated structural valvular and cardiac abnormalities. For example: a structurally normal mitral valve with moderate mitral regurgitation by color flow Doppler and normal left atrial size, does not generally require routine echocardiographic follow-up. However, a thickened, myxomatous appearing mitral valve with bi-leaflet prolapse and only trivial or mild mitral regurgitation, should be followed echocardiographically at routine intervals.

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CD-2.4: Transesophageal Echocardiography (TEE) – Coding

Transesophageal Echocardiography	CPT®
TEE with 2-D, M-mode, probe placement, image acquisition, interpretation and report	**93312**
TEE probe placement only	**93313**
TEE image acquisition, interpretation, and report only	**93314**
TEE for congenital anomalies with 2-D, M-mode, probe placement, image acquisition, interpretation and report	**93315**
TEE for congenital anomalies, probe placement only	**93316**
TEE for congenital anomalies, image acquisition, interpretation and report only	**93317**
TEE for monitoring purposes, ongoing assessment of cardiac pumping function on an immediate time basis	**93318**
Doppler Echocardiography	**CPT®**
Doppler echo, pulsed wave and/or spectral display	**+93320**
Doppler echo, pulsed wave and/or spectral display, follow-up or limited study	**+93321**
Doppler echo, color flow velocity mapping	**+93325**
Doppler echo, if performed, may be reported separately in addition to the primary TEE codes: CPT® 93312, CPT® 93314, CPT® 93315, and CPT® 93317.	

CPT®	Transesophageal Echocardiography	
93312	TEE with 2-D, M-mode, probe placement, image acquisition, interpretation and report	**C8925**
93315	TEE for congenital anomalies with 2-D, M-mode, probe placement, image acquisition, interpretation and report	**C8926**
93318	TEE for monitoring purposes, ongoing assessment of cardiac pumping function on an immediate time basis	**C8927**

- **The complete transesophageal echocardiogram** service, including both (1) probe (transducer) placement and (2) image acquisition/interpretation, is reported with CPT® 93312.
  - Probe placement only is reported with CPT® 93313.
  - The image acquisition/interpretation only is reported with CPT® 93314.
- Physicians assign codes CPT® 93312, CPT® 93313, and/or CPT® 93314 to report professional services if the test is performed in a hospital or other facility where the physician cannot bill globally.
  - Modifier -26 (professional component) is appended to the appropriate code
  - CPT® 93313 and CPT® 93314 should never be used together. If both services are provided, CPT® 93312 is reported.
- Hospitals should report TEE procedures using CPT® 93312 (the complete service). CPT® 93313 and CPT® 93314 are not used for hospital billing.
- Monitoring of individuals undergoing cardiac surgery is CPT® 93318.

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CD-2.5: Transesophageal Echocardiography (TEE) – Indications

- Limited transthoracic echo window when further information is needed to guide management (e.g. suspected or confirmed endocarditis, suspected intracardiac mass, etc.)
- Assessing valvular dysfunction, especially mitral regurgitation, when TTE is inadequate and intervention is being considered to repair/replace valve.
- Evaluation of cardiac mass, suspected tumor or thrombus
- Preprocedure assessment of PFO/ASD
- 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 vegetation, tumor
- Embolic events when there is an abnormal TTE or a history of atrial fibrillation
  - Clarify atria/atrial appendage, aorta, mitral/aortic valve beyond the information that other imaging studies have provided
- Cardiac valve dysfunction
  - Differentiation of tricuspid from bicuspid aortic valve in setting of aortic enlargement or significant stenosis or significant regurgitation
  - Congenital abnormalities
- Assessing for left atrial thrombus prior to cardioversion of atrial fibrillation or atrial flutter.
- Prior to planned atrial fibrillation ablation/pulmonary vein isolation procedure.
- For initial imaging of ascending and descending thoracic aortic aneurysms.
- For repeat imaging or established thoracic aneurysms, TEE is indicated **only** when imaging with CT or MR is contraindicated.
- Left atrial appendage (LAA) Closure device (e.g., WATCHMAN®)
  - Preprocedural evaluation with or without 3D imaging
  - Repeat TEE 45 days post procedure
  - 1 year post procedure
  - See also **CD-13.5: Percutaneous Mitral Valve Repair (mitral valve clip)**

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CD-2.6: Stress Echocardiography (Stress Echo) – Coding

Stress ECHO Procedure Codes	
Stress Echocardiography	**CPT®**
Echo, transthoracic, with (2D), includes M-mode, during rest and exercise stress test and/or pharmacologically induced stress, with report;*	**93350**
Echo, transthoracic, with (2D), includes M-mode, during rest and exercise stress test and/or pharmacologically induced stress, with report: *including performance of continuous electrocardiographic monitoring, with physician supervision**	**93351**
Doppler Echocardiography	**CPT®**
Doppler echo, pulsed wave and/or spectral display**	**+93320**
Doppler echo, pulsed wave and/or spectral display, follow-up/limited study	**+93321**
Doppler echo, color flow velocity mapping**	**+93325**
*CPT® 93350 and CPT® 93351 do not include Doppler studies	
**Doppler echo (CPT® +93320 and CPT® +93325), if performed, may be reported separately in addition to the primary SE codes: CPT® 93350 or CPT® 93351.	

CPT®	Stress Echocardiography	
93350	Echo, transthoracic, with (2D), includes M-mode, during rest and exercise stress test and/or pharmacologically induced stress, with report;*	**C8928**
93351	Echo, transthoracic, with (2D), includes M-mode, during rest and exercise stress test and/or pharmacologically induced stress, with report: *including performance of continuous electrocardiographic monitoring, with physician supervision**	**C8930**

CD-2.7: Stress Echocardiography–Indications, other than ruling out CAD

- See: **CD-1.4: Stress Testing with Imaging – Indications**.
- In addition to the evaluation of CAD, stress echo can be used to evaluate the following conditions:
  - Dyspnea on exertion (specifically to evaluate pulmonary hypertension)
  - Right heart dysfunction
  - Valvular heart disease, especially when the outcome would affect a therapeutic or interventional decision
  - Pulmonary hypertension, when the outcome will measure response to therapy and/or prognostic information
  - Hypertrophic cardiomyopathy
    - In an individual with a history of hypertrophic cardiomyopathy who has been previously evaluated with a stress echo, another stress echo may be appropriate if there are worsening symptoms or if there has been a therapeutic change (for example: change in medication, surgical procedure performed).
- In general, spectral Doppler (CPT® 93320 or 93321) and color-flow Doppler (CPT® 93325) are necessary in the evaluation of the above conditions and can be added to the stress echo code.

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CD-2.8: 3D Echocardiography – Coding

- CPT® 93319 with one of the following (CPT® 93303, 93304, 93312, 93314, 93315, or 93317) for congenital cardiac abnormalities
- The procedure codes used to report 3D rendering for echocardiography are not unique to echocardiography and are the same codes used to report the 3D post-processing work for CT, MRI, ultrasound, and other tomographic modalities.
  - **CPT® 76376**, not requiring image post-processing on an independent workstation, is the most common code used for 3D rendering done with echocardiography
  - **CPT® 76377** requires the use of an independent workstation

CD-2.9: 3D Echocardiography – Indications

Echocardiography with 3-dimensional (3D) rendering is becoming universally available, yet its utility remains limited based on the current literature.

- 3D Echo may be indicated when a primary echocardiogram is approved and **one** of the following is needed:
  - Left ventricular volume and ejection fraction assessment when measurements are needed for treatment decision (e.g. implantation of ICD, alteration in cardiotoxic chemotherapy)
  - Mitral valve anatomy specifically related to mitral valve stenosis
  - Preprocedural evaluation of left atrial appendage occlusion (e.g., WATCHMAN®)
  - Guidance of transcatheter procedures such as:
    - Mitral valve clipping
    - TAVR
    - Left atrial appendage closure device (e.g., WATCHMAN®)

CD-2.11: Myocardial contrast perfusion echocardiography (CPT® 0439T)

- Investigational see **CD-2.1: Transthoracic Echocardiography (TTE) – Coding**

CD-2.12: Myocardial strain imaging (CPT® 93356)

- Myocardial strain imaging (CPT® 93356, speckle tracking longitudinal strain) is indicated for the initial evaluation of LVH, in addition to the primary echocardiogram, when there is documentation of **both**:
  - Unclear etiology
  - Concern for infiltrative cardiomyopathy
- Myocardial strain imaging (CPT® 93356) can be approved in addition to the primary echocardiogram in individuals receiving therapy with cardiotoxic agents for **any** of the following:
  - Initial evaluation-prior to treatment with (either):
    - Medications that could result in cardiotoxicity/heart failure
    - Radiation that could result in cardiotoxicity/heart failure
  - Re-evaluation in an individual previously or currently undergoing therapy with cardiotoxic agents as per echocardiogram parameters. See **CD-12.1: Oncologic Indications for Cancer Therapeutics – Related Cardiac Dysfunction (CTRCD)**
  - Periodic re-evaluation in a patient undergoing therapy with cardiotoxic agents and worsening symptoms

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CD-3: Nuclear Cardiac Imaging

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CD-3.1: Myocardial Perfusion Imaging (MPI) – Coding

Nuclear Cardiac Imaging Procedure Codes	
Myocardial Perfusion Imaging (MPI)	**CPT®**
MPI, tomographic (SPECT) (including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); single study, at rest or stress (exercise or pharmacologic)	**78451**
MPI, tomographic (SPECT) (including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); multiple studies, at rest and/or stress (exercise or pharmacologic) and/or redistribution and/or rest reinjection	**78452**

- The most commonly performed myocardial perfusion imaging are single (at rest or stress, CPT® 78451) and multiple (at rest and stress, CPT® 78452) SPECT studies.
  - Evaluation of the individual's left ventricular wall motion and ejection fraction are routinely performed during MPI and are included in the code's definition.
  - First pass studies, (CPT® 78481 and CPT® 78483), MUGA, (CPT® 78472 and CPT® 78473) and SPECT MUGA (CPT® 78494) should not be reported in conjunction with MPI codes.
  - Attenuation correction, when performed, is included in the MPI service by code definition. No additional code should be assigned for the billing of attenuation correction.
- **Multi-day Studies:** In the absence of written payer guidelines to the contrary, it is not appropriate to bill separately for the rest and stress segments of MPI even if performed on separate calendar dates. A single code is assigned to define the entire procedure on the date all portions of the study are completed.
- 3D rendering, (CPT® 76376/CPT® 76377), should not be billed in conjunction with MPI.
- Separate codes for such related services as treadmill testing (CPT® 93015 - CPT® 93018) and radiopharmaceuticals should be assigned in addition to MPI. These services are reimbursed according to each individual payer policy.

CD-3.2: SPECT MPI – Indications

- See: **CD-1.4: Stress Testing with Imaging – Indications**

CD-3.3: MUGA – Coding

Cardiac blood pool imaging, or radionuclide ventriculography, can be used to evaluate ventricular function. Cardiac blood pool imaging includes first pass studies (CPT® 78481 and 78483) as well as gated equilibrium studies (CPT® 78472, 78473, 78494, and +78496).

Gated equilibrium studies can also be referred to as multi-gated acquisition (MUGA) scan or equilibrium radionuclide angiography (ERNA). Imaging for gated equilibrium studies can be planar or three-dimensional (single photon emission computed tomography, SPECT).

Of note, all cardiac blood pool imaging is synchronized with electrographic RR interval (EKG-gated); thus, regular rhythm is required for accurate LV assessment.

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Gated Equilibrium Studies – Planar	CPT®
Cardiac blood pool imaging, gated equilibrium; planar, ***single study*** at rest *or* stress, wall motion study plus ejection fraction, with or without quantitative processing	**78472**
Cardiac blood pool imaging, gated equilibrium; planar, ***multiple*** studies, wall motion study plus ejection fraction, ***at rest and stress***, with or without additional quantification	**78473**
Gated Equilibrium Studies - SPECT	**CPT®**
Cardiac blood pool imaging, gated equilibrium, SPECT, at rest, wall motion study plus ejection fraction, with or without quantitative processing	**78494**
First Pass studies	**CPT®**
Cardiac blood pool imaging (planar), first pass technique; ***single*** study, at rest or with stress (exercise and/or pharmacologic), wall motion study plus ejection fraction, with or without quantification	**78481**
Cardiac blood pool imaging (planar), first pass technique; ***multiple*** studies, at rest and with stress (exercise and/or pharmacologic), wall motion study plus ejection fraction, with or without quantification	**78483**
Cardiac blood pool imaging, gated equilibrium, ***single study***, at rest, with ***right ventricular ejection fraction*** by first pass technique (List separately in addition to code for primary procedure) This CPT code is an add-on code to 78472.	**+78496**

- The technique employed for a MUGA service guides the code assignment.
  - CPT® 78472 is used for a planar MUGA scan at rest or stress
  - CPT® 78473 for planar MUGA scans, multiple studies at rest and stress.
- Planar MUGA studies (CPT® 78472 and CPT® 78473) should not be reported in conjunction with:
  - SPECT MPI (CPT® 78451 - CPT® 78454)
  - First pass studies (CPT® 78481- CPT® 78483)
  - SPECT MUGA (CPT® 78494).
- CPT® +78496 is assigned only in conjunction with CPT® 78472.

CD-3.4: MUGA Study – Cardiac Indications

MUGA (Multi Gated Acquisition) – Blood Pool Imaging Indications

- Echocardiography is the preferred method of following left ventricular systolic function.
- MUGA may be appropriate when a recent ECHO, as indicated in **CD 2.2 Transthoracic Echocardiography (TTE) – Indications** and/or **CD 2.3 Frequency of Echocardiography Testing**, was technically limited and prevented accurate assessment of left ventricular function.
- MUGA may be appropriate when there is a significant discrepancy between LVEF assessment by ECHO and another modality (i.e., one study reports normal LVEF and the other, a reduced LVEF) AND there is clear documentation as to how quantitative measurement of LVEF will affect individual management (e.g., implantation of an ICD, alteration in cardiotoxic chemotherapy, etc.).

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- MUGA may be performed in place of an ECHO in the following circumstances:
  - To determine candidacy for ICD/CRT and/or to determine optimal choice of device in individuals who meet criteria for ICD based on ejection fraction and other criteria.
  - When previously or currently undergoing therapy with potentially cardiotoxic agents, including chemotherapy and radiation, AND a history of previous low LV ejection fraction (LVEF <50%). See **CD-12.1: Oncologic Indications for Cancer Therapeutics – Related Cardiac Dysfunction (CTRCD)**
- MUGA is **not** indicated when requested simply to compare LVEF by the same modality, a prior MUGA is not a reason to approve another MUGA.

Right ventricular first pass study

- (CPT® 78472 and 78496) may be performed when ECHO is technically limited and prevents accurate assessment of RV function AND when further information about RV function is needed to guide management (e.g. established/diagnosed pulmonary hypertension, suspected or confirmed pulmonary embolus).

First pass studies

- First pass studies (CPT® 78481 and CPT® 78483) may be approved in place of MUGA when indications are met for MUGA and/or there is need for information that cannot be obtained by MUGA.
- First pass studies, (CPT® 78481 and CPT® 78483), MUGA (CPT® 78472 and CPT® 78473) and SPECT MUGA (CPT® 78494) should not be reported in conjunction with MPI codes.

CD-3.5: MUGA Study – Oncologic Indications for Cancer Therapeutics-Related Cardiac Dysfunction (CTRCD)

- See **CD-12.1: Oncologic Indications for Cancer Therapeutics – Related Cardiac Dysfunction (CTRCD)**

CD-3.6: Myocardial Sympathetic Innervation Imaging in Heart Failure

- In heart failure, the sympathetic nervous system is activated in order to compensate for the decreased myocardial function. Initially, this is beneficial, however, long-term this compensatory mechanism is detrimental and causes further damage.
- Markers have been developed, using radioactive iodine, in an attempt to image this increased myocardial sympathetic activity. Currently, AdreView™ (Iodine-123 meta-iodobenzylguanidine), is the only FDA-approved imaging agent available for this purpose. eviCore currently considers AdreView to be experimental and investigational.
- The AMA has established the following set of Category III codes to report these studies:
  - **0331T** - Myocardial sympathetic innervation imaging, planar qualitative and quantitative assessment
  - **0332T** - Myocardial sympathetic innervation imaging, planar qualitative and quantitative assessment; with tomographic SPECT.

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CD-3.7: Myocardial Tc-99m Pyrophosphate Imaging

Myocardial Tc-99m Pyrophosphate Imaging	
MUGA (Multi Gated Acquisition) – Blood Pool Imaging	**CPT®**
Myocardial Imaging, infarct avid, planar, qualitative or quantitative	**78466**
Myocardial Imaging, infarct avid, planar, qualitative or quantitative with ejection fraction by first pass technique	**78468**
Myocardial Imaging, infarct avid, planar, qualitative or quantitative tomographic SPECT with or without quantification	**78469**
Radiopharmaceutical Localization Imaging Limited area	**78800**
Radiopharmaceutical Localization Imaging SPECT Note: When reporting CPT® 78803, planar imaging of a limited area or multiple areas should be included with the SPECT	**78803**
Radiopharmaceutical localization of tumor, inflammatory process or distribution of radiopharmaceutical agent(s) (includes vascular flow and blood pool imaging, when performed); tomographic (SPECT) with concurrently acquired computed tomography (CT) transmission scan for anatomical review, localization and determination/detection of pathology, single area (e.g., head, neck, chest, pelvis), single day imaging	**78830**

- Historically this method of imaging the myocardium was used to identify recent infarction, hence, the term "infarct-avid scan." Although still available, the sensitivity and specificity for identifying infarcted myocardial tissue are variable and the current use for this indication is limited. See **CD-5: Cardiac MRI**.

CD-3.8: Cardiac Amyloidosis

- Tc-99m pyrophosphate imaging (CPT® 78803 or 78830) may be used to identify cardiac amyloidosis. Chest SPECT and planar imaging may be used, as well as whole-body imaging for identification of systemic ATTR (transthyretin) amyloidosis. See **CD-3.7: Myocardial Tc-99m Pyrophosphate Imaging** for coding information
- For a single planar imaging session alone (without a SPECT study), report CPT® 78800 Radiopharmaceutical Localization Imaging Limited area
- Tc-99m pyrophosphate imaging can be pursued for diagnosis of ATTR amyloidosis after screening for presence of a monoclonal light chain to exclude AL amyloidosis:
  - Serum kappa/lambda free light chain ratio (not SPEP)
    - Abnormal if ratio is <0.26 or >1.65
  - Serum and urine immunofixation electrophoresis (IFE)
    - Abnormal if monoclonal protein detected
- Tc-99m pyrophosphate imaging may also be used for the following:
  - Diagnosis of cardiac ATTR in individuals with cardiac MRI or echocardiography findings consistent with or suggestive of cardiac amyloidosis.
  - Individuals with suspected cardiac ATTR amyloidosis and contraindications to CMR such as renal insufficiency or an implantable cardiac device.

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Practice Note

- The following conditions would raise high index of suspicion:
  - Left ventricular hypertrophy but low voltage on ECG
  - Heart failure with preserved ejection fraction and an increase in left ventricular wall thickness.
  - Unexplained heart failure with preserved ejection fraction and concomitant right heart failure in an individual over the age of 60
  - Individuals, especially elderly males, with signs/symptoms of heart failure and any of the following:
    - lumbar spinal stenosis
    - spontaneous biceps tendon rupture
    - bilateral carpal tunnel syndrome
    - atrial arrhythmias in the absence of usual risk factors
  - Known or suspected familial amyloidosis.
  - Low flow, low gradient aortic stenosis

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CD-4: Cardiac CT, Coronary CTA, and CT for Coronary Calcium (CAC)

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CD-4.1: Cardiac CT and CTA – General Information and Coding

Cardiac Imaging Procedure Codes	
Cardiac CT	**CPT®**
CT, heart, without contrast, with quantitative evaluation of coronary calcium	**75571**
The code set for Cardiac CT and CCTA (CPT® 75572-CPT® 75574), include quantitative and functional assessment (for example, calcium scoring) if performed	
CPT® 75571 describes a non-contrast CT of the heart with calcium scoring and should be reported only when calcium scoring is performed as a stand-alone procedure. ➢ Can be used to report a preliminary non-contrast scan which indicates an excessive amount of calcium such that the original scheduled study must be discontinued. ➢ CPT® 75571 should not be reported in conjunction with any of the contrast CT/CTA codes (CPT® 75572- CPT® 75574).	
Cardiac CT and CCTA	**CPT®**
CT, heart, with contrast, for evaluation of cardiac structure and morphology (including 3D image post-processing, assessment of cardiac function, and evaluation of venous structures, if performed).	**75572**
CT, heart, with contrast, for evaluation of cardiac structure and morphology *in the setting of congenital heart disease* (including 3D image post-processing, assessment of cardiac function, and evaluation of venous structures, if performed).	**75573**
CTA, heart, coronary arteries and bypass grafts (when present), with contrast, including 3D image post-processing (including 3D image post-processing, assessment of cardiac function, and evaluation of venous structures, if performed).	**75574**
Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; data preparation and transmission, analysis of fluid dynamics and simulated maximal coronary hyperemia, generation of estimated FFR model, with anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report	**0501T**
Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; data preparation and transmission	**0502T**
Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; analysis of fluid dynamics and simulated maximal coronary hyperemia, and generation of estimated FFR model	**0503T**
Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report	**0504T**

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Cardiac Imaging Procedure Codes	
Automated quantification and characterization of coronary atherosclerotic plaque to assess severity of coronary disease, using data from coronary computed tomographic angiography; data preparation and transmission, computerized analysis of data, with review of computerized analysis output to reconcile discordant data, interpretation and report	0623T
Automated quantification and characterization of coronary atherosclerotic plaque to assess severity of coronary disease, using data from coronary computed tomographic angiography; data preparation and transmission	0624T
Automated quantification and characterization of coronary atherosclerotic plaque to assess severity of coronary disease, using data from coronary computed tomographic angiography; computerized analysis of data from coronary computed tomographic angiography	0625T
Automated quantification and characterization of coronary atherosclerotic plaque to assess severity of coronary disease, using data from coronary computed tomographic angiography; review of computerized analysis output to reconcile discordant data, interpretation and report	0626T

- The high negative predictive value (98%-99%) of CCTA in ruling out significant coronary artery disease has been confirmed in multiple studies.
- 3D rendering, (CPT® 76376/CPT® 76377), should not be billed in conjunction with Cardiac CT and CCTA.
- Only one code from the set: CPT® 75572 - CPT® 75574 can be reported per encounter.
- CPT® 75574 includes evaluation of cardiac structure and morphology when performed; therefore, additional code/s should not be assigned.
- Automated quantification and characterization of coronary atherosclerotic plaque (CPT® 0623T, 0624T, 0625T, 0626T) is a service in which coronary computed tomographic angiography (CCTA) data are analyzed using computerized algorithms to assess the extent and severity of coronary artery disease. The use of automated quantification and characterization of coronary atherosclerotic plaque is considered investigational and experimental at this time.

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CD-4.2: CT for Coronary Calcium Scoring (CPT® 75571)

CD-4.2.1: CT Calcium Scoring-Asymptomatic and for CAD Screening

- Coronary calcium scoring is not indicated in someone with known CAD.
- Coronary artery calcium score (CPT® 75571) can be approved when there is documentation of **all** of the following:
  - The results will impact risk-based decisions for preventive interventions
  - The individual is an adult age 40-75
  - The 10-year ASCVD risk including pooled cohort equation is between 5.0% to 19.9%
  - There is no documented CAD
  - Individual is not currently on a statin
  - Individual is not a smoker
  - There is no history of diabetes
  - There is no family history of premature CAD
  - There has been no calcium score performed in the previous 5 years
  - There has been no prior calcium score > 0

State mandates

- Texas Heart Attack Preventive Screening Law (HR 1290) mandates that insurers in Texas cover either a calcium scoring study (CPT® 75571 or HCPCS S8092) **or** a carotid intima-media thickness study (ultrasound—Category III code 0126T) every five years for certain populations. To qualify, the following must apply:
  - Must be a Texas resident.
  - Must be a member of a fully-insured Texas health plan.
  - Must be a man age 45 to 75 or a woman age 55 to 75.
  - Must have either diabetes or a Framingham cardiac risk score of intermediate or higher (10% or higher).
  - Must not have had a calcium scoring study or a carotid intima-media thickness study within the past 5 years.
- New Mexico House Bill 126 Coverage for Health Artery Calcium Scan
  - Coverage may apply per state mandate as stated in House Bill 126. See https://www.nmlegis.gov for guidance on specific application.
  - Coronary calcium scan can be approved every 5 years to be used as a clinical management tool when all the following apply:
    - Prior CT calcium was >5 years ago
    - Prior CT calcium scan had a calcium score of zero
    - The individual is between the ages of 45 and 65
  - The individual has an intermediate risk of developing CAD determined by a health care provider based on a 10 year risk algorithm including pooled cohort equation.

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CD-4.2.2: CT Calcium Scoring Indications Symptomatic Symptoms concerning for cardiac ischemia

- Individuals with new, recurrent or worsening symptoms concerning for cardiac ischemia, who have a 'low' pretest probability of CAD*, see **Table 1** in **CD-1.0: General guidelines** for definition of low pretest probability of CAD

Low gradient aortic stenosis

- Coronary artery calcium score (CPT® 75571) can be approved in low gradient aortic stenosis when symptomatic, severe aortic stenosis is suspected. Low gradient aortic stenosis is defined as an AVA ≤1 and a mean gradient <40mmHg.

CD-4.3: CCTA – Indications for CCTA (CPT® 75574)

- New, recurrent or worsening symptoms concerning for cardiac ischemia in individuals who have:
  - An intermediate or intermediate-high pretest probability of CAD*, see **Table-1** in **CD-1.0: General guidelines**
  - Persistent symptoms in individuals with a low, intermediate, or intermediate-high pre-test probability of coronary disease after a normal stress test
  - Equivocal, borderline, abnormal or discordant prior noninvasive evaluation where obstructive coronary artery disease remains a concern (<90 days)
  - Abnormal rest ECG findings, such as a new LBBB, or T-wave inversions, when ischemia is a concern
  - A prior CABG when **only** graft patency is a concern
- Evaluation of an individual under the age of 40 for suspected anomalous coronary artery(ies) or for treatment planning when there is a history of one or more of the following:
  - Syncopal episodes during strenuous activities
  - Persistent chest pain brought on by exertion or emotional stress, and normal stress test
  - Full sibling(s) with history of sudden death syndrome before age 40 or with documented anomalous coronary artery
  - Resuscitated sudden death and contraindications for conventional coronary angiography
  - Prior nondiagnostic coronary angiography in determining the course of the anomalous coronary artery in relation to the great vessels, origin of a coronary artery or bypass graft location (any):
    - Anomalies of origin:
      - LCA or the RCA arising from the pulmonary artery;
      - Interarterial course between the pulmonary artery and the aorta of either the RCA arising from the left sinus of Valsalva or the LCA arising from the right sinus of Valsalva
    - Anomalies of course:
      - Myocardial bridging
    - Anomalies of termination:
      - Coronary artery fistula

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- Initial imaging study in individuals with hypertrophic cardiomyopathy and stable anginal symptoms.
  - Chest discomfort is common in individuals with hypertrophic cardiomyopathy. The incidence of false positive myocardial perfusion imaging abnormalities is higher in these individuals, whereas the incidence of severe coronary artery stenosis is low.
- Individuals who have recovered from unexplained sudden cardiac arrest in lieu of invasive coronary angiography (both):
  - Confirm the presence or absence of ischemic heart disease
  - Exclude the presence of an anomalous coronary artery.

CD-4.4: CCTA – Regardless of symptoms (CPT® 75574)

- Evaluation of newly diagnosed congestive heart failure or cardiomyopathy (all).
  - No prior history of coronary artery disease, the ejection fraction is less than 50 percent, and low or intermediate risk on the pre-test probability assessment, and
  - No contraindications to cardiac CT angiography.
  - No cardiac catheterization, SPECT, cardiac PET, or stress echocardiogram has been performed since the diagnosis of congestive heart failure or cardiomyopathy.
- Unclear coronary artery anatomy despite conventional cardiac catheterization
- Re-do CABG
  - Assess bypass graft patency
  - Evaluate the location of the left internal mammary artery (LIMA) and or right internal mammary artery (RIMA) prior to repeat bypass surgery
- Follow-up Left main stent one time at 6-12 months
- Evaluate coronary artery anomalies and other complex congenital heart disease of cardiac chambers or great vessels.
  - Report CPT® 75574 for evaluating coronary artery anomalies.
  - Report CPT® 75573 for congenital heart disease.
  - To evaluate the great vessels, CTA Chest (CPT® 71275) can be performed instead of CCTA or in addition to CCTA.
  - For anomalous pulmonary venous return, can add CT Abdomen and Pelvis with contrast (CPT® 74177).
- When CCTA will replace conventional invasive coronary angiography for any of the following:
  - Ventricular tachycardia (6 beat runs or greater)
  - Delayed presentation or retrospective evaluation of suspected Takotsubo syndrome (stress cardiomyopathy)
  - Preoperative assessment of the coronary arteries in planned surgery for any of the following:
    - Aortic dissection
    - Aortic aneurysm
    - Valvular surgery

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- To assess for coronary involvement in individuals with systemic vasculitis (e.g. Giant Cell Arteritis,Takayasu's, Kawasaki's disease) when there are clinical features suggestive of underlying vasculitis including:
  - Unexplained elevated cardiac markers (erythrocyte sedimentation rate, C-reactive protein)
  - Constitutional symptoms (fever, chills, night sweats, weight loss)
  - Multiple visceral infarcts in the absence of embolic etiology

- **Cardiac Trauma:** CTA Chest (CPT® 71275) and CCTA (CPT® 75574) are useful in detecting aortic and coronary injury and can help in the evaluation of myocardial and pericardial injury see **CD-10.1: Cardiac Trauma – Imaging**

CD-4.5: Fractional Flow Reserve by Computed Tomography

- Fractional flow reserve (FFR) is typically measured using invasive techniques. FFR can be obtained noninvasively from coronary computed tomography angiography data (FFR-CT).
- Indications for FFR-CT
  - To further assess CAD seen on a recent CCTA that is of uncertain physiologic significance

CD-4.6: CT Heart – Indications (CPT® 75572)

- Cardiac vein identification for lead placement in individuals needing left ventricular pacing.
- Pulmonary vein isolation procedure (ablation) for atrial fibrillation
  - MRI Cardiac (CPT® 75557 or CPT® 75561), MRV Chest (CPT® 71555), CTV Chest (CPT® 71275), or CT Cardiac (CPT® 75572) can be performed to evaluate the anatomy of the pulmonary veins prior to an ablation procedure performed for atrial fibrillation.
  - Study may be repeated post-procedure between 3-6 months after ablation because of a 1%-2% incidence of asymptomatic pulmonary vein stenosis
  - See **CD-8.2: Pulmonary Vein Imaging – Indications**
- If echocardiogram is inconclusive for:
  - Cardiac or pericardial tumor or mass
  - Cardiac thrombus
  - Pericarditis/constrictive pericarditis
  - Complications of cardiac surgery
- In place of MRI when there is clinical suspicion of arrhythmogenic right ventricular dysplasia or arrhythmogenic cardiomyopathy (ARVD/ARVC) if the clinical suspicion is supported by established criteria for ARVD-see **CD-5.2: Cardiac MRI – Indications (excluding Stress MRI)**
- Recurrent laryngeal nerve palsy due to cardiac chamber enlargement.

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- CT Cardiac (CPT® 75572) can be performed instead of TEE for assessment of left atrial appendage (LAA) occlusion device or to assess for thrombus, see: **CD-2.5: Transesophageal Echocardiography (TEE) – Indications**
- Coronary imaging is not included in the code definition for CPT® 71275.
  - The AMA definition for CPT® 71275 reads: "CTA Chest (non-coronary), with contrast material(s), including non-contrast images, if performed, and image post-processing."

CD-4.7: CT Heart for Congenital Heart Disease (CPT® 75573)

- Coronary artery anomaly evaluation
  - A cardiac catheterization was performed, and not all coronary arteries were identified.
- Thoracic arteriovenous anomaly evaluation
  - A MRI Cardiac or CT angiogram Chest was performed and suggested congenital heart disease.
- Complex adult congenital heart disease evaluation
  - No CT Cardiac or MRI Cardiac has been performed, and there is a contraindication to MRI Cardiac.
  - A CT Cardiac or MRI Cardiac was performed one year ago or more.
- See also section **CD-11: Adult Congenital Heart Disease**

CD-4.8: Transcatheter Aortic Valve Replacement (TAVR)

- Once the decision has been made for aortic valve replacement, the following may be used to determine if an individual is a candidate for TAVR:
  - CTA Chest (CPT® 71275), Abdomen and Pelvis (combination code CPT® 74174) are considered appropriate, and
  - CT Cardiac (CPT® 75572) may be considered to measure the aortic annulus or
  - Coronary CTA (CCTA CPT® 75574) may be considered to both measure the aortic annulus and assess the coronary arteries in lieu of heart catheterization.
- Post TAVR- TTE follow-up is indicated at:
  - A baseline post-op TTE is indicated within one week after surgery if not performed in the hospital prior to discharge.
  - 1 month
  - One year post-procedure
  - Then annually thereafter.
- A repeat diagnostic left heart catheterization is not medically necessary when the individual is undergoing a transcatheter aortic valve replacement (TAVR).

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CD-5: Cardiac MRI

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CD-5.1: Cardiac MRI – Coding

Cardiac Imaging Procedure Codes	
Cardiac MRI	**CPT®/HCPCS**
Cardiac magnetic resonance imaging for morphology and function without contrast	**75557**
Cardiac magnetic resonance imaging for morphology and function without contrast; with stress imaging	**75559**
Cardiac magnetic resonance imaging for morphology and function without and with contrast and further sequences	**75561**
Cardiac magnetic resonance imaging for morphology and function without and with contrast and further sequences; with stress imaging	**75563**
Cardiac magnetic resonance imaging for velocity flow mapping (List separately in addition to code for primary procedure)	**+75565**
Cardiac magnetic resonance imaging for morphology and function, quantification of segmental dysfunction; with strain imaging	**C9762**
Cardiac magnetic resonance imaging for morphology and function, quantification of segmental dysfunction; with stress imaging	**C9763**

- Only one procedure code from the set (CPT® 75557- CPT® 75563) should be reported per session.
- Only one flow velocity measurement (CPT® +75565) should be reported per session when indicated.
- C9762--Cardiac magnetic resonance imaging for morphology and function, quantification of segmental dysfunction; with strain imaging. The use of CMR strain imaging for the quantification of segmental dysfunction is considered investigational and experimental at this time.
- C9763--Cardiac magnetic resonance imaging for morphology and function, quantification of segmental dysfunction; with stress imaging. The use of stress CMR for the quantification of segmental dysfunction is considered investigational and experimental at this time.

CD-5.2: Cardiac MRI and MRA Chest – Indications (excluding Stress MRI)

- Assess myocardial viability (to differentiate hibernating myocardium from scar) when necessary to determine if revascularization should be performed (CPT® 75561)
- Assessment of global ventricular function, myocardial composition, and mass if a specific clinical question is left unanswered by a recent echocardiogram and results will affect individual management (CPT® 75557 or CPT® 75561). Particularly useful in evaluating:
  - Cardiomyopathy (ischemic, diabetic, hypertrophic, or muscular dystrophy)
  - Noncompaction
  - Infiltrative heart disease such as amyloid, iron overload cardiomyopathy (hemosiderosis, hemochromatosis)
  - Post cardiac transplant
  - Hypertrophic cardiomyopathy
  - Suspected acute myocarditis, cardiac aneurysm, trauma, and contusions
  - Monitoring cancer chemotherapy effect on the heart (especially if an accurate assessment of right ventricular function is documented as necessary).

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- Pre and postoperative congenital heart disease assessment see **CD-11: Adult Congenital Heart Disease** for defect specific indications (CPT® 75557 or CPT® 75561).
  - MRA Chest (CPT® 71555) may be added if the aorta or pulmonary artery need to be visualized beyond the root.
  - May add CPT® +75565 in conjunction with CPT® 75557 or CPT® 75561, only if there is a need to clarify findings on a recent echocardiogram and cardiac Doppler study when there is documentation of **either** of the following:
    - Significant valvular disease that may require intervention
    - Intracardiac flow disturbances (e.g., ASD, VSD)
- MRA Chest (CPT® 71555) may be indicated for the following:
  - Thoracic aortic dissection see **PVD-6.7: Aortic Dissection and Other Aortic Conditions** in the Peripheral Vascular Disease Imaging Guidelines
  - Coarctation of the aorta see:
    - **CD-11.3.2: Coarctation of the Aorta** for adults
    - **PEDCD-2.4.11: Aortic Coarctation and IAA (interrupted aortic arch)** for infants and children in the Pediatric Cardiac Imaging Guideline
  - Thoracic aortic aneurysm see **PVD-6.2: Thoracic Aortic Aneurysm (TAA)** in the Peripheral Vascular Disease Imaging Guidelines
- Coarctation of the aorta
  - Follow-up (surveillance) imaging after repair of coarctation:
    - Adults: see **CD-11.3.2: Coarctation of the Aorta**
    - Infants and children: see **PEDCD-2.4.11: Aortic Coarctation and IAA (interrupted aortic arch)** in the Pediatric Cardiac Imaging Guideline
- Arrhythmogenic right ventricular dysplasia or arrhythmogenic right ventricular cardiomyopathy (ARVD/ARVC) suspicion (CPT® 75557 or CPT® 75561)—must have one of the following:
  - Nonsustained or sustained VT of LBBB morphology OR >500 PVC's over 24 hours on event recorder or Holter monitor.
  - ARVD/ARVC confirmed in a first degree relative either by criteria, autopsy, pathogenic genetic mutation or sudden death <35 years of age with suspected ARVD/ARVC.
  - Inverted T waves in right precordial leads (V1, V2 and V3) or beyond in individuals >14 years of age in the absence of complete RBBB
  - Right ventricular akinesis, dyskinesis or aneurysm noted on echo or RV angiography.
- Differentiate constrictive pericarditis from restrictive cardiomyopathy (CPT® 75561).
- Evaluate cardiac tumor or mass when echocardiogram is inconclusive.
- Evaluate valvular heart disease when echocardiogram is inconclusive:
  - CPT® 75557 **or** CPT® 75561
  - May add CPT® 75565 when there is documentation of either of the following:
    - Significant valvular disease that may require intervention
    - Intracardiac flow disturbances (e.g., ASD, VSD)

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- MRI Cardiac (CPT® 75557 or CPT® 75561) *or* chest MRV (CPT® 71555), but not both, for pulmonary vein anatomy for planned ablation procedures in individuals with atrial fibrillation. See **CD-8: Pulmonary Artery and Vein Imaging** for guidelines on follow-up imaging after ablation procedure.
- Suspected cardiac thrombus when echocardiogram is inconclusive (CPT® 75557).
- Right ventricular function evaluation (CPT® 75557 in conjunction with CPT® +75565) if a recent ECHO has been done, and there is documented need to perform Cardiac MRI in order to resolve an unanswered question about flow dynamics.
- Shunting through a VSD (CPT® 75557 in conjunction with CPT® +75565) 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 about flow dynamics.
- Conditions that would **not** require an echo prior to an MRI:
  - Anomalous coronary arteries: Cardiac MRI (CPT® 75561) or CCTA (CPT® 75574) is much better at detecting this than conventional angiography.
  - Assess coronary arteries in Kawasaki's disease.
  - Fabry disease
    - Late enhancement MRI may predict the effect of enzyme replacement therapy on myocardial changes that occur with this disease (CPT® 75561).
  - Initial evaluation for cardiac sarcoidosis.

CD-5.3: Cardiac MRI – Indications for Stress MRI

- For indications for Stress MRI see **CD-1.4: Stress Testing with Imaging – Indications**.
- If a nuclear perfusion (MPI) stress test was performed and was equivocal, a stress MRI is appropriate.

CD-5.4: Cardiac MRI – Aortic Root and Proximal Ascending Aorta

- See- **PVD-6.2: Thoracic Aortic Aneurysm (TAA)** in the Peripheral Vascular Disease imaging guidelines

CD-5.5: Cardiac MRI – Evaluation of Pericardial Effusion or Diagnosis of Pericardial Tamponade

- Contrast-enhanced cardiac MRI (CPT® 75561) is useful for evaluating pericarditis, neoplastic and other effusion, tamponade or myocardial infiltration if a specific clinical question is left unanswered by echocardiogram or another recent imaging study.

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CD-5.6: Cardiac MRI – Myocarditis

Cardiac MRI is indicated for suspected myocarditis even in the absence of an echocardiogram in the presence of **all** of the following:

- New onset or persisting symptoms suggestive of myocarditis (dyspnea, chest pain, palpitations, or effort intolerance), and
- Evidence for recent or ongoing myocardial injury documented by (any) of the following:
  - Ventricular dysfunction noted on any cardiac imaging study, or
  - New or persisting ECG abnormalities suspicious for myocarditis
    - New ST changes, T wave changes, Q waves, or
    - New conduction abnormalities, such as LBBB or AV block, or
    - VT or VF
  - Elevated troponin
- Strong suspicion for viral etiology of myocardial injury (both)
  - Recent systemic viral disease or prior myocarditis, and
  - No evidence of coronary ischemia, such as
    - Lack of risk factors for CAD, or
    - Age under 35 years, or
    - Negative imaging study, such as MPI, CCTA, cath

CD-5.7: Cardiac MRI – Duchenne Muscular Dystrophy (DMD)

Cardiac MRI (CPT® 75557 or 75561-does not include 75565 or 71555 unless otherwise indicated)

- Asymptomatic individual with documented DMD can have annual surveillance cardiac MRI starting at 6 years old (yearly echo is recommended prior to age 6)
- Asymptomatic, documented carrier of DMD can have cardiac MRI every 3 years starting at 18

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CD-6: Cardiac PET

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CD-6.1: Cardiac PET – Coding

Cardiac Imaging Procedure Codes	
Cardiac PET	**CPT®**
Myocardial imaging, positron emission tomography (PET), metabolic evaluation study (including ventricular wall motion[s] and/or ejection fraction[s], when performed), single study	**78459**
Myocardial imaging, positron emission tomography (PET), perfusion study (including ventricular wall motion[s] and/or ejection fraction[s], when performed); single study at rest or stress (exercise or pharmacologic)	**78491**
Myocardial imaging, positron emission tomography (PET), perfusion study (including ventricular wall motion[s] and/or ejection fraction[s], when performed); multiple studies at rest and stress (exercise or pharmacologic)	**78492**
Myocardial imaging, positron emission tomography (PET), metabolic evaluation study (including ventricular wall motion[s] and/or ejection fraction[s], when performed), single study; with concurrently acquired computed tomography transmission scan	**78429**
Myocardial imaging, positron emission tomography (PET), perfusion study (including ventricular wall motion[s] and/or ejection fraction[s], when performed); single study, at rest or stress (exercise or pharmacologic), with concurrently acquired computed tomography transmission scan	**78430**
Myocardial imaging, positron emission tomography (PET), perfusion study (including ventricular wall motion[s] and/or ejection fraction[s], when performed); multiple studies at rest and stress (exercise or pharmacologic), with concurrently acquired computed tomography transmission scan	**78431**
Myocardial imaging, positron emission tomography (PET), combined perfusion with metabolic evaluation study (including ventricular wall motion[s] and/or ejection fraction[s], when performed), dual radiotracer (e.g., myocardial viability);	**78432**
Myocardial imaging, positron emission tomography (PET), combined perfusion with metabolic evaluation study (including ventricular wall motion[s] and/or ejection fraction[s], when performed), dual radiotracer (e.g., myocardial viability); with concurrently acquired computed tomography transmission scan	**78433**
Absolute quantitation of myocardial blood flow (AQMBF), positron emission tomography (PET), rest and pharmacologic stress (List separately in addition to code for primary procedure)	**+78434**
Positron emission tomography (PET) with concurrently acquired computed tomography (CT) for attenuation correction and anatomical localization imaging; skull base to mid-thigh	**78815**

- 3D rendering, (CPT® 76376/CPT® 76377), should not be billed in conjunction with PET.
- Separate codes for such related services as treadmill testing (CPT® 93015-CPT® 93018) and radiopharmaceuticals should be assigned in addition to perfusion PET. These services are paid according to each individual payer.

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CD-6.2: Cardiac PET – Perfusion – Indications

CPT® 78430, CPT® 78431, CPT® 78491 and CPT® 78492

- Meets all of the criteria for an imaging stress test in **CD-1.4: Stress Testing with Imaging – Indications** and additionally any one of the following:
  - Individual is severely obese (for example BMI >40 kg/m^2) or
  - Individual has large breasts or implants
  - Individual incapable of exercise due to physical (musculoskeletal or neurological) inability to achieve target heart rate. Target heart rate is calculated as 85% of the maximum age predicted heart rate (MPHR). MPHR is estimated as 220 minus the individual's age
- Equivocal nuclear perfusion (SPECT MPI) stress test
- Routine use in post heart transplant assessment of transplant CAD

CD-6.3: Cardiac PET – Absolute quantitation of myocardial blood flow (AQMBF)

CPT® 78434

Performance of quantitation of myocardial blood flow by Cardiac PET is currently non-standardized between different vendor products.

- Absolute quantitation of myocardial blood flow is considered experimental, investigational and/or unproven (EIU).

CD-6.4: Cardiac PET – Metabolic – Indications

- Cardiac PET Metabolic (CPT® 78459 or CPT® 78429)
  - To determine myocardial viability when a previous study has shown significant left ventricular dysfunction when under consideration for revascularization
  - To monitor response to therapy for established cardiac sarcoid
- Cardiac PET Metabolic and Perfusion (MPI SPECT CPT® 78451 and CPT® 78459, or CPT® 78432, or CPT® 78433)
  - To identify established or strongly suspected cardiac sarcoid.
- Full body PET/CT (CPT® 78815) is not indicated for the diagnosis or monitoring response to therapy of cardiac sarcoid. It may be considered to assist in diagnosis and/or treatment options in some instances of pulmonary sarcoid. See **CH-15.1: Sarcoid** in the Chest Imaging Guidelines

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CD-6.5: FDG PET/CT for infections

- FDG PET/CT (CPT® 78815 or CPT® 78429) is indicated in the assessment of suspected prosthetic heart valve endocarditis when there is documentation of **both** of the following:
  - TTE and/or TEE are equivocal or non-diagnostic
  - Suspicion for prosthetic heart valve endocarditis remains high (all):
    - C-reactive protein ≥40 mg/L
    - No evidence of prolonged antibiotic therapy
- The implantation was ≥3 months ago and there is no evidence of surgical adhesives used during the valve implantationFDG PET/CT for LVAD driveline infection (CPT® 78815 or 78429)
  - Early infection detection for LVAD drivelines is desirable, since once the infection extends to the cannula and pump pocket, eradication becomes difficult. CT findings are nonspecific and metal device artifacts of the driveline itself affects sensitivity.
  - FDG PET/CT can be approved for suspected LVAD infection if other studies and examination remain inconclusive.

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CD-7: Diagnostic Heart Catheterization

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CD-7.1: Diagnostic Heart Catheterization – Code Sets

Cardiac Catheterization Procedure Codes	
Cardiac Cath Procedures	**CPT®**
Congenital Heart Disease Code "Set"	93593-93597
Right heart catheterization for congenital heart defect(s) including imaging guidance by the proceduralist to advance the catheter to the target zone; normal native connections	93593
Right heart catheterization for congenital heart defect(s) including imaging guidance by the proceduralist to advance the catheter to the target zone; abnormal native connections	93594
Left heart catheterization for congenital heart defect(s) including imaging guidance by the proceduralist to advance the catheter to the target zone, normal or abnormal native connections	93595
Right and left heart catheterization for congenital heart defect(s) including imaging guidance by the proceduralist to advance the catheter to the target zone(s); normal native connections	93596
Right and left heart catheterization for congenital heart defect(s) including imaging guidance by the proceduralist to advance the catheter to the target zone(s); abnormal native connections	93597
Anomalous coronary arteries, patent foramen ovale, mitral valve prolapse, and bicuspid aortic valve	93451-93464, 93566-93568
RHC without LHC or coronaries	93451
LHC without RHC or coronaries	93452
RHC and retrograde LHC without coronaries	93453
Native coronary artery catheterization;	93454
with bypass grafts	93455
with RHC	93456
with RHC and bypass grafts	93457
with LHC	93458
with LHC and bypass grafts	93459
with RHC and LHC	93460
with RHC and LHC and bypass grafts	93461
LHC by trans-septal or apical puncture	+93462
Angiography of non-coronary arteries and veins performed as a distinct service	Select appropriate codes from the Radiology and Vascular Injection Procedures sections.

- CPT® 93593 to 93597 are appropriate for invasive evaluation of congenital heart disease. See specific conditions in **CD-11: Adult Congenital Heart Disease**

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CD-7.2: Diagnostic Heart Catheterization – Coding Notes

Cardiac catheterization (CPT® 93451-CPT® 93461) includes all "road mapping" angiography necessary to place the catheters, including any injections and imaging supervision, interpretation, and report.
Cardiac catheterization (CPT® 93452-CPT® 93461) (for all conditions other than congenital heart disease) includes contrast injections, imaging supervision, interpretation, and report for imaging typically performed.
Catheter placements in native coronaries or bypass grafts (CPT® 93454-CPT® 93461) include intraprocedural injections for bypass graft angiography, imaging supervision, and interpretation.
Injection codes CPT® 93563-CPT® 93565 should not be used in conjunction with CPT® 93452-CPT® 93461.
Codes CPT® 93451-CPT® 93461 do not include contrast injections and imaging supervision, interpretation, and report for imaging that is separately identified by the following specific procedure codes: CPT® 93566, CPT® 93567 and CPT® 93568.
➢ Separate diagnostic cardiac catheterization codes should only be assigned in conjunction with interventional procedures in the following circumstances: ◆ No prior or recent diagnostic catheterization is available to guide therapy ◆ Individual's condition has significantly changed since the last diagnostic cath ◆ The treatment plan may be affected ◆ Other vessels may be identified for treatment ◆ Further establishment of a diagnosis from a non-invasive study is necessary

CD-7.3: Diagnostic Left Heart Catheterization (LHC)

CD-7.3.1: LHC – Unstable/Active Coronary Artery Syndromes

Diagnostic Left Heart Catheterization (LHC) is indicated for individuals in acute settings or with **active** unstable angina and should be handled as medical emergencies.

These guidelines apply to individuals with **stable** conditions and who are **not** in the acute setting (acute coronary syndrome or unstable angina).

- LHC may be indicated for new onset, accelerating, or worsening ischemic symptoms suggestive of acute coronary syndrome (ACS) occurring at rest, or with minimal exertion resolving with rest, including:
  - Cardiac chest pain (typical angina) with or without new onset, evolving ischemic EKG changes
  - Symptoms consistent with the known angina pattern in an individual with a history of CABG or PCI
- Left and right heart cath may be indicated in place of a left heart cath if the above criteria has been met and there is documentation of any of the following:
  - The major component of the individual's symptoms is dyspnea
  - Newly diagnosed or worsening cardiomyopathy
  - For surgical planning prior to valve surgery or congenital heart defect repair

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CD-7.3.2: LHC – Stable Established Coronary Artery Disease

- Diagnostic Left Heart Catheterization (LHC) is indicated to identify 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.
- Optimal medical therapy (OMT) includes **all** of the following:
  - Anti-platelet therapy
  - Statin and/or other lipid-lowering therapy
  - Anti-anginal therapy implemented to pursue a goal heart rate of 60 beats per minute or less
  - Anti-hypertensive therapy as may be indicated to pursue a goal systolic blood pressure (SBP) of less than 140 mmHg and a goal diastolic blood pressure (DBP) of less than 90 mmHg
- LHC may be indicated irrespective of OMT for symptomatic individuals who have BOTH established CAD and high-risk findings on non-invasive stress testing including any of the following:
  - Cardiac chest pain induced by exercise treadmill testing or dobutamine stress testing
  - Myocardial perfusion imaging with ≥10% reversible ischemic burden
  - Stress echo with at least 3 segments of inducible ischemia
  - Exercise treadmill testing inducing at least 2.5 mm downsloping ST-depression or 3 mm horizontal ST-depression in at least two contiguous leads
  - Ventricular tachycardia of at least 3 consecutive beats induced by an exercise treadmill test
- Left and right heart cath may be indicated in place of a left heart cath if the above criteria has been met and there is documentation of any of the following:
  - The major component of the individual's symptoms is dyspnea
  - Newly diagnosed or worsening cardiomyopathy
  - For surgical planning prior to valve surgery or congenital heart defect repair

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CD-7.3.3: Stable Symptomatic Suspected or Established Coronary Artery Disease

- Diagnostic left heart catheterization to screen for coronary artery disease (CAD) in asymptomatic individuals who are not anticipating other cardiac procedures is **not** medically necessary
- LHC with coronary arteriography is indicated when there is documentation of one of the following:
  - New onset, persistent, or worsening of cardiac chest pain (typical angina) and either:
    - Symptomatic failure of a 12 week trial of OMT including as tolerated all of the following:
      - Anti-platelet therapy
      - Statin and/or other lipid-lowering therapy
      - Anti-anginal therapy implemented to pursue a goal heart rate of 60 beats per minute or less
      - Anti-hypertensive therapy as may be indicated to pursue a goal systolic blood pressure (SBP) of less than 140 mmhg and a goal diastolic blood pressure (DBP) of less than 90 mmHg
    - Worsening of cardiac chest pain (typical angina) during 12 week trial of OMT
  - New onset, persistent, or worsening of cardiac chest pain (typical angina) and documentation of both of the following:
    - High pretest probability of CAD see **CD-1.1: General Issues – Cardiac, Pre-Test Probability Grid (Table 1)**
    - Cardiac chest pain (typical angina) at a low level of exercise or at rest despite optimal medical therapy
- LHC may be indicated irrespective of OMT for symptomatic individuals with any pre-test probability for coronary artery disease (CAD) who also have high-risk findings on Coronary CT Angiography (**See CD-4.3: CCTA – Indications for CCTA (CPT® 75574)**), to include any of the following:
  - Left main coronary artery stenosis ≥40%
  - Proximal or mid left anterior descending coronary artery stenosis ≥70%
  - Proximal or mid double-vessel coronary artery stenosis ≥60%
  - Proximal or mid triple-vessel coronary artery stenosis ≥50%
  - CT-FFR measured to be ≤0.8 in the proximal or mid segment of any coronary artery irrespective of degree of stenosis

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- LHC may be indicated irrespective of OMT for symptomatic individuals who have BOTH high pretest probability of CAD see **CD-1.0: General Issues**, **Pre-Test Probability Grid (Table 1)** and high-risk findings on non-invasive stress testing including any of the following:
  - Cardiac chest pain induced by exercise treadmill testing or dobutamine stress testing
  - Myocardial perfusion imaging with ≥10% reversible ischemic burden
  - Stress echo with at least 3 segments of inducible ischemia
  - Exercise treadmill testing inducing at least 2.5 mm downsloping ST-depression or 3 mm horizontal ST-depression in two leads
  - Ventricular tachycardia of at least 3 consecutive beats induced by an exercise treadmill test
- Left and right heart cath may be indicated in place of a left heart cath if the above criteria has been met and there is documentation of any of the following:
  - The major component of the individual's symptoms is dyspnea
  - Newly diagnosed or worsening cardiomyopathy
  - For surgical planning prior to valve surgery or congenital heart defect repair

Practice note

- In addition to OMT, physician-guided behavioral modification therapy (BMT) is recommended including all of the following:
  - Mediterranean diet
  - Moderate intensity physical activity for at least thirty minutes per day at least five times per week as possible
  - Attempts at smoking cessation to include at least one of the following:
    - Cognitive behavioral therapy
    - Nicotine withdrawal replacement therapy
    - Varinicline or bupropion therapy

CD-7.3.4: Exclusion of significant coronary artery disease involvement in other cardiac pathology

- LHC may be indicated when the etiology is unclear for **any** of the following:
  - New or worsened left ventricular dysfunction or congestive heart failure if coronary artery disease is suspected
  - Ventricular fibrillation or sustained ventricular tachycardia
  - Unheralded syncope (not near syncope)
  - Suspected myocarditis
- Left and right heart cath may be indicated in place of a left heart cath if the above criteria has been met and there is documentation of any of the following:
  - The major component of the individual's symptoms is dyspnea
  - Newly diagnosed or worsening cardiomyopathy
  - For surgical planning prior to valve surgery or congenital heart defect repair

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CD-7.3.5: Evaluation of structural heart disease

- Evaluation prior to planned surgery
  - Ruling out coronary artery disease prior to planned non-coronary cardiac or great vessel surgery (i.e. cardiac valve surgery, aortic dissection, aortic aneurysm, congenital disease repair such as atrial septal defect, etc.).
  - Pre-organ transplant (non-cardiac). Some institutions perform a heart cath as part of their initial evaluation protocol. Others use an imaging stress test for evaluation. Either is appropriate and can be approved but **NOT** both.
- Valvular heart disease when either:
  - There is a discrepancy between the clinical findings (history, physical exam, and non-invasive test results)
  - Valvular surgery is being considered.
- Suspected pericardial disease.
- Previous cardiac transplant:
  - Per transplant center protocol
  - To assess for accelerated coronary artery disease associated with cardiac transplantation.
- Left and right heart cath may be indicated in place of a left heart cath if the above criteria has been met and there is documentation of any of the following:
  - The major component of the individual's symptoms is dyspnea
  - Newly diagnosed or worsening cardiomyopathy
  - For surgical planning prior to valve surgery or congenital heart defect repair

CD-7.4: Right Heart Catheterization (RHC)

CD-7.4.1: General information RHC (CPT® 93451)

- It is performed most commonly from the femoral vein, less often through the subclavian, brachial, or internal jugular vein and inter-atrial septal puncture approach.
- It includes a full oximetry for detection and quantification of shunts.
- Pressure measurements are made and are done simultaneously with aortic and left ventricular pressures.
- Cardiac outputs are calculated by several techniques including the Fick thermodilution.

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CD-7.4.2: Diagnostic Right Heart Catheterization – Indications

- Diagnostic Right heart cath is indicated when results will impact the diagnosis and management of **any** of the following:
  - Atrial septal defect (ASD) including shunt detection and quantification
  - Ventricular septal defect (VSD) including shunt detection and quantification
  - Patent foramen ovale (PFO)
  - Anomalous pulmonary venous return
  - Congenital defects including persistent left vena cava
  - Pulmonary hypertension
  - Pericardial diseases (constrictive or restrictive pericarditis)
  - Valvular disease
  - Right heart failure
  - Left heart failure
  - Newly diagnosed or worsening cardiomyopathy
  - Preoperative evaluation for valve surgery
  - During a left heart cath where the etiology of the symptoms remains unclear
  - Pre-lung transplant to assess pulmonary pressures
  - Uncertain intravascular volume status with an unclear etiology
  - Assessment post-cardiac transplant
    - For routine endomyocardial biopsy
    - Assess for rejection
    - Assess pulmonary artery pressure
    - Can be done per the institution protocol or anytime organ rejection is suspected and biopsy is needed for assessment
  - Evaluation of right ventricular morphology.
  - Suspected arrhythmogenic right ventricular dysplasia.

CD-7.5: Combined Right and Left Heart Catheterization Indications

- Preoperative evaluation for valve surgery
- The indications for **CD-7.3: Diagnostic Left Heart Catheterization (LHC)** are met and any of the following are present:
  - The major component of the individual's symptoms is dyspnea
  - The indications are met according to **CD-7.4: Right Heart Catheterization (RHC)**
  - Newly diagnosed or worsening cardiomyopathy

CD-7.6: Planned (Staged) Coronary Interventions

- The CPT® codes for percutaneous coronary interventions (PCI) include the following imaging services necessary for the procedure(s):
  - Contrast injection, angiography, 'road-mapping', and fluoroscopic guidance
  - Vessel measurement
  - Angiography following coronary angioplasty, stent placement, and atherectomy
- Separate codes for these services should not be assigned in addition to the PCI code/s because the services are already included.
- A repeat diagnostic left heart catheterization is not medically necessary when the individual is undergoing a planned staged percutaneous coronary intervention.

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CD-8: Pulmonary Artery and Vein Imaging

CD-8.1: Pulmonary Arterial Hypertension (PAH) – Indications	**64**
CD-8.2: Pulmonary Vein Imaging – Indications	**64**

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CD-8.1: Pulmonary Arterial Hypertension (PAH) – Indications

Pulmonary arterial hypertension (PAH) is a complex, chronic disease that requires extensive evaluation, including ECG (right ventricular hypertrophy with/without strain, right atrial dilatation); chest x-ray; arterial blood gas, PFT's, CT angiography or V/Q scan. Imaging is based on suspected etiology.

- Transthoracic echocardiogram (TTE) (CPT® 93306) should be performed initially as it can help determine the probability of pulmonary hypertension. Echo may be accompanied by:
  - Stress echocardiogram (CPT® 93350 or CPT® 93351), especially in the setting of concomitant valvular disease to assess for treatment
  - Left and/or right heart catheterization for direct measurement of pressures
  - High-resolution CT Chest (CPT® 71250) to rule out restrictive lung disorders such as pulmonary fibrosis in the setting of hypoxemia
- For suspected acute and/or chronic pulmonary embolism one of the following:
  - CTA Chest (CPT® 71275)
  - MRA Chest (CPT® 71555)
  - V/Q scan (CPT® 78580-Pulmonary Perfusion Imaging CPT® 78582-Pulmonary Ventilation (e.g., Aerosol or Gas) and Perfusion Imaging). If requested can add to V/Q scan one of the following:
    - SPECT imaging (CPT® 78803)
    - SPECT/CT imaging (CPT® 78830)
- See also in specific subsections:
  - **CD-2.3: Frequency of Echocardiography Testing**, **CD-7.4: Right Heart Catheterization (RHC)**, **CD-11.3.12: Severe Pulmonary artery hypertension (PHT) and Eisenmenger syndrome** in the Cardiac Imaging Guidelines
  - **PEDCD-2.3: Congenital Heart Disease Modality Considerations**, **PEDCD-7: Pediatric Pulmonary Hypertension - General** in the Pediatric Cardiac Imaging Guidelines
  - **CH-25: Pulmonary Embolism (PE)** in the Chest Imaging Guidelines.

CD-8.2: Pulmonary Vein Imaging – Indications

- MRI Cardiac (CPT® 75557 or CPT® 75561), MRV Chest (CPT® 71555), CTV Chest (CPT® 71275), or CT Cardiac (CPT® 75572) to evaluate anatomy of the pulmonary veins:
  - Prior to an ablation procedure performed for atrial fibrillation.
  - Post-procedure between 3-6 months after ablation because of a 1% to 2% incidence of asymptomatic pulmonary vein stenosis.
    - If no pulmonary vein stenosis is present, no further follow-up imaging is required.
    - If pulmonary vein stenosis is present on imaging following ablation and symptoms of pulmonary vein stenosis (usually shortness of breath) are present, can be imaged at 1, 3, 6, and 12 months.
  - The majority (81%) of pulmonary vein stenosis remain stable over 1 year. Progression occurs in 8.8% and regression occurs in a small percentage.

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CD-9: Congestive Heart Failure

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CD-9.1: CHF – Imaging

- Congestive heart failure (CHF), including post-cardiac transplant failure:
  - Echocardiogram is the first study after the clinical evaluation for suspected CHF.
  - MUGA, cardiac MRI or cardiac CT may be indicated if the ECHO is limited or does not completely answer the question.
  - Stress test to assess for CAD may be indicated. Follow stress testing guideline: **CD-1.4: Stress Testing with Imaging – Indications**
- Arteriovenous fistula with "high output" heart failure:
  - CT Chest with contrast (CPT® 71260) and/or CT Abdomen and/or CT Pelvis with contrast (CPT® 74160 or CPT® 72193 or CPT® 74177) **OR**
  - CTA Chest (CPT® 71275) and/or CTA Abdomen and/or CTA Pelvis (CPT® 74175 or CPT® 72191 or CPT® 74174) **OR**
  - MRI Chest and/or MRI Abdomen and/or MRI Pelvis without and with contrast (CPT® 71552 and/or CPT® 74183 and/or CPT® 72197) **OR**
  - MRA Chest and/or MRA Abdomen and/or MRA Pelvis (CPT® 71555 and/or CPT® 74185 and/or CPT® 72198)
- Right-sided congestive heart failure can be a manifestation of pulmonary hypertension or serious lung disease.
  - CT Chest (CPT® 71260) or CTA Chest (CPT® 71275) to evaluate for recurrent pulmonary embolism

CD-9.2: Palliative Care in individuals with heart failure

- There are currently no widely accepted published guidelines regarding end of life care for end-stage heart failure in individuals who are not candidates for advanced heart failure treatments such as left ventricular assist devices, heart pumps or heart transplantation. Consideration for palliative care services should be given to such individuals.

CD-9.3: Myocardial Sympathetic Innervation Imaging

- In heart failure, the sympathetic nervous system is activated in order to compensate for the decreased myocardial function. Initially, this is beneficial, however, long-term this compensatory mechanism is detrimental and causes further damage.
- Markers have been developed, using radioactive iodine, in an attempt to image this increased myocardial sympathetic activity. Currently, AdreView™ (Iodine-123 meta-iodobenzylguanidine), is the only FDA-approved imaging agent available for this purpose. eviCore currently considers AdreView™ to be experimental and investigational.
- The AMA has established the following set of Category III codes to report these studies:
  - **0331T** - Myocardial sympathetic innervation imaging, planar qualitative and quantitative assessment
  - **0332T** - Myocardial sympathetic innervation imaging, planar qualitative and quantitative assessment, with tomographic SPECT.

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CD-9.4: Left ventricular assist devices (LVAD)

Left ventricular assist devices (LVAD) are implantable devices used in individuals with advanced heart failure refractory to medical therapy, often as a bridge to transplantation.

- Echocardiograms (TTE) are obtained frequently for surveillance following implantation:
  - Post implant-generally at 2 weeks
  - Then as follows at:
    - One month
    - Three months
    - Six months
    - Twelve months
    - Every 6 months thereafter

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CD-10: Cardiac Trauma

CD-10.1: Cardiac Trauma – Imaging

- Any of the following can be used to evaluate cardiac or aortic trauma:
  - Echocardiogram (TTE, TEE)
  - MRI Cardiac (CPT® 75557, CPT® 75561, and CPT® 75565)
  - CT Cardiac (CPT® 75572)
  - CCTA (CPT® 75574)
  - CTA Chest (CPT® 71275)
  - CT Chest (CPT® 71260, CPT® 71270)

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CD-11.1: Congenital heart disease – General Information

- This section covers adult congenital heart disease (CHD), for other associated disorders please see the condition specific sections
  - Marfan Syndrome
  - Hypertrophic cardiomyopathy (HCM)
  - Bicuspid aortic valve (BAV)

CD-11.1.1: Definitions

- Physiological stages (A, B, C, D)
  - Each congenital heart lesion is divided into 4 physiological stages (A, B, C, D)

Characteristics	*Physiological stage*			
	A	*B*	*C*	*D*
NYHA functional class	**I**	**II**	**III**	**IV**
Hemodynamic or anatomic sequelae	None	Mild ventricular enlargement of dysfunction, small shunt	Moderate or greater, ventricular dysfunction. Any venous or arterial stenosis	Moderate or greater, ventricular dysfunction. Any venous or arterial stenosis
Valvular	None	Mild	Moderate or greater	Moderate or greater
Aortic enlargement	None	Mild	Moderate	Severe
Exercise capacity limitation	Normal	Abnormal objective cardiac limitation	Moderate	Severe
Renal hepatic pulmonary dysfunction	None		Mild but responsive to medication	Refractory to treatment
Cyanosis/ hypoxemia	None		Mild	Severe
Arrhythmias	None	Arrhythmia not requiring treatment	Needs rx	Refractory to rx
Pulmonary hypertension	None		Mild to moderate	Severe or Eisenmenger

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- CHD Anatomic classification
  - Class I-Simple
    - Native disease
      - Isolated small ASD
      - Isolated small VSD
      - Mild isolated pulmonic stenosis
    - Repaired conditions
      - Previously ligated or occluded ductus arteriosus
      - Repaired secundum ASD or sinus venosus defect without significant residual shunt or chamber enlargement
      - Repaired VSD without significant residual shunt or chamber enlargement
  - Class II-Moderate Complexity
    - Repaired or unrepaired conditions
      - Aorto-left ventricular fistula
      - Anomalous pulmonary venous connection, partial or total
      - Anomalous coronary artery arising from the pulmonary artery
      - Anomalous aortic origin of a coronary artery from the opposite sinus
      - AVSD (partial or complete, including primum ASD)
      - Congenital aortic valve disease
      - Congenital mitral valve disease
      - Coarctation of the aorta
      - Ebstein anomaly (disease spectrum includes mild, moderate, and severe variations)
      - Infundibular right ventricular outflow obstruction
      - Ostium primum ASD
      - Moderate and large unrepaired secundum ASD
      - Moderate and large persistently patent ductus arteriosus
      - Pulmonary valve regurgitation (moderate or greater)
      - Pulmonary valve stenosis (moderate or greater)
      - Peripheral pulmonary stenosis
      - Sinus of Valsalva fistula/aneurysm
      - Sinus venosus defect
      - Subvalvular aortic stenosis (excluding HCM; HCM not addressed in these guidelines)
      - Supravalvular aortic stenosis
      - Straddling atrioventricular valve
      - Repaired tetralogy of Fallot
      - VSD with associated abnormality and/or moderate or greater shunt

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- Class III- Great Complexity (or Complex)
  - Cyanotic congenital heart defect (unrepaired or palliated, all forms)
  - Double-outlet ventricle
  - Fontan procedure
  - Interrupted aortic arch
  - Mitral atresia
  - Single ventricle (including double inlet left ventricle, tricuspid atresia, hypoplastic left heart, any other anatomic abnormality with a functionally single ventricle)
  - Pulmonary atresia (all forms)
  - TGA (classic or d-TGA; CCTGA or l-TGA)
  - Truncus arteriosus
  - Other abnormalities of atrioventricular and ventriculoarterial connection (i.e., crisscross heart, isomerism, heterotaxy syndromes, ventricular inversion)

CD-11.1.2: Modalities

- Echocardiogram- transthoracic (TTE) or transesophageal (TEE)
  - Transthoracic echocardiography (TTE) is an indispensable tool in the initial and serial follow-up evaluation to identify abnormalities and changes that commonly influence management decisions.
- Cardiac MRI (CMR)
  - CMR plays a valuable role in assessment of RV size and function, because it provides data that are reproducible and more reliable than data obtained with alternative imaging techniques
  - For intracardiac congenital heart disease, CMR will typically include flow velocity mapping for shunts and flow assessment.
  - Imaging that only requires aortic arch imaging, does not require intracardiac CMR, only MRA Chest.
- Cardiac Computed Tomography (CCT) and Cardiac Computed Tomography Angiography (CCTA)
  - The most important disadvantage of CCT (including CT angiography) as an imaging technique is the associated exposure to ionizing radiation.
- Cardiac catheterization
  - (hemodynamic and/or angiographic) in individuals with adult CHD AP classification II and III, or interventional cardiac catheterization in individuals with adult CHD AP classification I to III should be performed by, or in collaboration with, cardiologists with expertise in adult CHD
- Exercise Testing
  - Exercise test does not imply stress imaging
- Stress Imaging
  - Includes-MPI, stress echo, stress MRI
  - PET stress may be included as per **CD-6: Cardiac PET**

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- Circumstances where CMR, CCT, TEE, and/or Cardiac Catheterization may be Superior to TTE
  - Assessment of RV size and function in repaired Tetralogy of Fallot (TOF), systemic right ventricles, and other conditions associated with right ventricular (RV) volume and pressure overload
  - Identification of anomalous pulmonary venous connections
  - Serial assessment of thoracic aortic aneurysms, especially when the dilation might extend beyond the echocardiographic windows
  - Accurate assessment of pulmonary artery (PA) pressure and pulmonary vascular resistance
  - Assessment for re-coarctation of the aorta
  - Sinus venosus defects
  - Vascular rings
  - Evaluation of coronary anomalies
  - Quantification of valvular regurgitation

CD-11.1.3: Coding

Modality	CPT®
Echocardiogram	
Transthoracic echocardiogram (TTE)	
TTE for congenital cardiac anomalies; complete	93303
TTE for congenital cardiac anomalies; limited study	93304
TTE (2D) m-mode recording, complete, with spectral and color flow doppler echocardiography	93306
TTE (2D) with or without m-mode recording; complete	93307
TTE (2D) with or without m-mode recording; limited study	93308
Transesophageal echocardiogram (TEE)	
TEE (2D) including probe placement, imaging, interpretation, and report	93312
TEE for congenital cardiac anomalies; including probe placement, imaging, interpretation, and report	93315
MRI	
cardiac (CMR)	
Cardiac MRI for morphology and function without contrast	75557
Cardiac MRI for morphology and function without and with contrast	75561
MRI Chest	
MRI Chest without contrast	71550
MRI Chest with contrast	71551
MRI Chest with & without contrast	71552
MRI Angiography (MRA) MRA Chest	
MRA Chest (excluding myocardium) with or without contrast	71555
CT	
cardiac (CCT)	
CT, Heart, with contrast material, for evaluation of cardiac structure and morphology	75572
CT, Heart, with contrast material, for evaluation of cardiac structure and morphology in the setting of congenital heart disease	75573

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Modality	CPT®
CT Angiography-cardiac (CCTA)	
CTA Heart, coronary arteries and bypass grafts (when present), with contrast, including 3D image post processing	75574
CT-chest	
CT Thorax without contrast	71250
CT Thorax with contrast	71260
CT Thorax without & with contrast	71270
CT Angiography-chest (CTA Chest)	
CTA Chest without and with contrast	71275
Stress Imaging (echo, MRI, MPI)	
Stress echo	
Echocardiography (TTE), (2D), with or without m-mode, during rest and cardiovascular stress, with interpretation and report	93350
Echocardiography (TTE), (2D), m-mode, during rest and cardiovascular stress test using treadmill, bicycle exercise and/or pharmacologically induced stress, with interpretation	93351
Stress MRI	
Cardiac MRI for morphology and function without contrast, with stress imaging	75559
Cardiac MRI for morphology and function without and with contrast, with stress imaging	75563
Myocardial perfusion imaging (MPI)	
MPI, tomographic (SPECT) including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); single study, at rest or stress (exercise or pharmacologic)	78451
MPI, tomographic (SPECT) (including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); multiple studies, at rest and/or stress (exercise or pharmacologic) and/or redistribution and/or rest reinjection	78452
Pulmonary perfusion imaging	
Pulmonary perfusion imaging (e.g., particulate)	78580
Pulmonary ventilation (e.g., aerosol or gas) and perfusion imaging	78582
Quantitative differential pulmonary perfusion, including imaging when performed	78597
Quantitative differential pulmonary perfusion and ventilation (e.g., aerosol or gas), including imaging when performed	78598

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CD-11.2: Congenital Heart Disease Imaging Indications

- The following sections are based on the congenital heart lesion. Requests for imaging based on other cardiac conditions, such as CAD, HCM, acquired valvular lesions, should follow the adult cardiac guidelines for those conditions.

CD-11.2.1: ASD-Atrial septal defects

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram at time of diagnosis
    - CMR, CCT (CPT® 75573), and/or TEE are useful if echo (TTE) is suboptimal and either:
      - ASD is suspected
      - To evaluate pulmonary venous connections in known ASD
    - MRA Chest or CTA Chest may be indicated if echo shows pulmonary venous anomalies
      - If normal, repeat pulmonary vein imaging is not required.
  - Transesophageal echocardiogram (TEE) is recommended to guide percutaneous ASD closure
  - Diagnostic cath is indicated when there is either:
    - Evidence of pulmonary hypertension
    - Unanswered questions on CMR/CCT for venous drainage.
- TTE is indicated post ASD device placement:
  - 6 months to evaluate for erosion
  - 1 week (if amplazter)
  - 1 month
  - 6 months
  - 12 months
  - then every 1-2 years
- Due to low risk of erosion in PFO devices- PFO device closure requires follow-up at 6-12 months. No additional evaluation unless PFO not closed
- Stress imaging and coronary artery imaging would be based on **CD-1.4: Stress Testing with Imaging – Indications**

Follow-up ASD if surgically closed or if no interventions

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	A	B	C	D
TTE	36	24	12	12

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CD-11.2.2: Anomalous Pulmonary Venous Connections

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram at time of diagnosis
    - CMR and/or MRA Chest, or CT Cardiac and/or CTA Chest at time of diagnosis if any issues with pulmonary veins or RV volume.
    - Cardiac Cath at time of diagnosis for hemodynamic data and issues not answered on other imaging
  - Routine stress imaging or coronary artery imaging not required.
  - Echo, CMR, CT, per cardiology request for clinical changes
    - Diagnostic heart catheterization if questions unanswered on imaging

Follow-up Anomalous Pulmonary Venous Connections

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	36	24	12	12

CD-11.2.3: Ventricular Septal Defect (VSD)

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echo (TTE) at time of diagnosis
    - CMR or CCT can be performed if questions are unanswered on echo
    - Catheterization at time of diagnosis for hemodynamics if pulmonary hypertension (PHT) or shunt size is a question

Long term follow-up VSD

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	36	24	12	12

CD-11.2.4: Atrioventricular Septal Defect (AV Canal, AVSD, endocardial cushion defect)

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echo (TTE) at time of diagnosis
    - CMR or CT Cardiac at time of diagnosis if there are unanswered questions on echo
    - Cardiac cath at time of diagnosis when CMR and TTE leave questions unanswered that affect individual management
  - Stress imaging per **CD-1.4: Stress Testing with Imaging – Indications**

Long term follow-up -AVSD

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	24	24	12	12

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CD-11.2.5: Patent Ductus Arteriosus (PDA)

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echo at time of diagnosis
    - MR Chest or CT Chest if there are questions left unanswered by echo
    - Cardiac Cath for hemodynamics (if planned device closure, diagnostic cardiac cath is not indicated as it is included in the procedure code)
  - Stress imaging per **CD-1.4: Stress Testing with Imaging – Indications**

Long term follow-up PDA

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	36	24	12	12

CD-11.2.6: Cor Triatriatum

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
    - CMR and/or MRA Chest or CT Cardiac and/or CTA Chest may be approved
    - Diagnostic cath may be approved if additional information is required for medical management
  - Long term follow-up
    - Stress imaging per **CD-1.4: Stress Testing with Imaging – Indications**

CD-11.2.7: Congenital Mitral Stenosis

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis

Long term follow-up congenital mitral stenosis

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	24	24	12	12

CD-11.2.8: Subaortic Stenosis (SAS)

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - Stress imaging (stress echo or stress MRI) for any of the following:
    - Once at the time of diagnosis
    - New or changed signs or symptoms of ischemia
    - Changes in cardiac function
    - If cardiac intervention is being considered
    - Any signs or symptoms allowed in **CD-1.4: Stress Testing with Imaging – Indications**

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Long term follow-up SAS

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	24	24	12	12
Stress imaging		24	24	12

CD-11.2.9: Congenital Valvular Aortic Stenosis

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - TEE may be required if TTE limited or equivocal
  - MRA Chest or CTA Chest if one of the following:
    - Suspicion of Coarctation based on exam and echocardiogram
    - Proximal ascending aorta not well visualized on TTE

Routine follow-up Congenital Valvular Aortic Stenosis

Modality	Physiological stage / intervals for routine imaging			
Stage (valvular AS)	Progressive (stage B) **Mild** Vmax 2.0-2.9 m/s	Progressive (stage B) **Moderate** Vmax 3.0-3.9 m/s	**Severe** (stage C) ≥4.0 m/s	Aortic root dilation >4.5 cm
echo (TTE)	3 years	1 years	6 months	12 months
MRA Chest or CTA				if ascending allowed yearly

Degree of aortic stenosis (AS) severity			
	Mild AS	Moderate AS	Severe AS
Vmax (m/s)[a] maximum Doppler velocity	2.0-2.9	3.0-3.9	≥4.0
Mean gradient (mmHg)[a]	<30	30-49	≥50
AVA (cm^2) aortic valve area	>1.5	1.0-1.5	<1.0
AVAi (cm^2/m^2 BSA) indexed aortic valve area	≥1.0	0.6-0.9	<0.6
[a]At normal transvalvular flow, BSA= body surface area			

Adapted from: ESC Guidelines for the management of grown-up congenital heart disease (new version 2010): The Task Force on the Management of Grown-up Congenital Heart Disease of the European Society of Cardiology (ESC).

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CD-11.2.10: Aortic disease in Turner Syndrome

- Dissection more common for a given aortic diameter. Mid-ascending aortic disease more common and may not be reliably seen on echocardiogram
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - MRA Chest or CTA Chest to rule out mid ascending aortic aneurysm if mid aorta was not seen on echocardiogram.
- Surveillance
  - Echocardiogram (TTE) yearly
    - MRA Chest or CTA if mid ascending aorta not visualized
  - For documented thoracic aortic aneurysm (TAA) ≤ 4cm
    - Routine MRA Chest or CTA yearly
  - For documented thoracic aortic aneurysm (TAA) > 4cm
    - MRA Chest or CTA every 6 months.

CD-11.3: Aortopathies with CHD

- Dilated aortic arches are not uncommon with several congenital heart diseases and postoperative procedures including- Aortic stenosis, Ross repair, Tetralogy of Fallot, Transposition of the great arteries (TGA), Pulmonary atresia, hypoplastic left heart syndrome (HLHS), Truncus Arteriosis, single ventricle.

CD-11.3.1: Supravalvular Aortic Stenosis

- Supravalvular aortic stenosis is a relatively rare condition overall but is seen commonly in individuals with Williams syndrome or homozygous familial hypercholesterolemia.
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - MRA Chest or CTA Chest
  - Cardiac MRI or CTA Cardiac to assess coronary ostea
  - Cardiac cath for any individuals pre cardiac intervention for coronary arteries
- New cardiac symptoms-any of the following:
  - CT Cardiac or cardiac MR
  - CTA Chest or MRA Chest
  - Stress imaging as per **CD-1.4: Stress Testing with Imaging – Indications**

Routine follow-up supravalvular AS

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	24	24	12	12
CMR or CCT	36	36	36	36

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CD-11.3.2: Coarctation of the Aorta

- Coarctation is suspected based on clinical findings:
  - BP higher in upper extremities than in the lower extremities
  - Absent femoral pulses
  - Continuous murmur
  - Abdominal bruit
  - Berry aneurysm with hemorrhage
  - Rib notching on x-ray
  - Abnormal thoracic aortic imaging and blood pressures
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
    - No further imaging is required if echocardiogram (TTE), blood pressure, and exam rule out Coarctation.
    - If echo and exam are equivocal or positive one of the following is indicated:
      - CTA Chest
      - MRA Chest
    - Individuals with Coarctation of the aorta do not require intracardiac MR unless issue cannot be resolved on echocardiogram.
    - Screening for intracranial aneurysm by MRA or CTA of head is allowed
  - ETT for diagnosis of exercise induced hypertension does not require imaging
  - Cardiac MR not required unless issues unresolved by echo for intracardiac anatomy
  - Diagnostic cath can be approved prior to stenting of the coarctation
  - Stress imaging, TEE, Cardiac MR or CT, Coronary imaging not routine
- Symptomatic
  - Individuals with Coarctation are at risk for dissection. When individual has new or worsening symptoms any of the following:
    - Echocardiogram (TTE)
    - MRA Chest or CTA.
  - For exertional symptoms, one of the following:
    - Stress imaging-per **CD-1.4: Stress Testing with Imaging – Indications**
    - Cardiac MRI or CT Cardiac

Routine follow-up Coarctation of the Aorta

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	24	24	12	12
MRA Chest or CTA Chest	36	36	12	12

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CD-11.3.3: Valvular Pulmonary Stenosis

- Overview Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - For issues affecting management not well visualized on TTE
    - Cardiac MRI or CT Cardiac
    - MRA Chest or CTA Chest
- Valvular PS routine follow-up and testing.
  - Echocardiogram-stages
    - Mild PS – peak gradient <36 mmHg (peak velocity < 3m/s)
    - Moderate PS- peak gradient 36-64 mmHg (peak velocity 3-4 m/s)
    - Severe PS- peak gradient >64 mmHg (peak velocity > 4 m/s); or mean gradient >35 mmHg.
  - Routine stress imaging is not required
  - Routine chest or cardiac or ischemia workup not required.

Valvular PS routine imaging

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	36	24	12	12

Isolated Pulmonary regurgitation after PS repair-Echo and CMR at same interval as TOF

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	24	12	12	12
CMR	36	24	12	12

CD-11.3.4: Branch and Peripheral pulmonary stenosis

- Overview
  - Can be seen in newborns as a normal variant in the first 6 months of life
  - Can be seen in surgeries of right ventricular outflow (TOF)
    - Noonan
    - Alagille
    - Williams
    - Maternal rubella exposure
    - Keutel syndrome
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - Baseline MRA Chest or CTA Chest
  - Cath may be considered if other advanced imaging is not adequate for management
  - VQ scan or MRA Chest for differential blood flow

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Routine follow-up branch and peripheral pulmonary stenosis

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	24	24	12	12
Cardiac MRI or CT Cardiac	36	36	24	24
MRA Chest or CTA Chest	36	36	24	24

CD-11.3.5: Double chambered RV

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis

Routine follow-up double chambered right ventricle (RV)

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	24	24	12	12

CD-11.3.6: Ebstein Anomaly

- Overview Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - TEE if either:
    - TTE is not adequate
    - If surgery/intervention planned
  - Cardiac MRI or CT Cardiac at time of Diagnosis

Routine follow-up Ebstein Anomaly

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	12	12	12	12
Cardiac MRI or CT Cardiac	60	36	24	12

CD-11.3.7: Tetralogy of Fallot (TOF, VSD with PS)

- Includes TOF with pulmonary atresia, VSD PA
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - Cardiac MR or CTA Cardiac at time of diagnosis
  - MRA Chest or CTA Chest at time of diagnosis
  - Cardiac catheterization if other advanced imaging leaves unanswered questions

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- Prior to cardiac intervention or surgery
  - Repeat imaging Echo/MR/CT
  - Cath prior to surgery or intervention
    - If planned Catheter Pulmonary Valve replacement, procedure includes diagnostic cath and hemodynamics and diagnostic cath is not billed separately
- New or worsening symptoms
  - Repeat advanced imaging
    - New or worsening symptoms
    - New EKG changes
  - Stress imaging (stress echo, stress MRI, or SPECT MPI) allowed for typical chest pain, even if intermediate pretest probability at atypical symptoms in individuals with known or undefined coronary artery (CA) anatomy or CA pathology
  - VQ scan or MRA chest for left/right perfusion abnormality

Routine Follow-up Tetralogy of Fallot (TOF)

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	24	12	12	12
Cardiac MRI or CCTA	36	24	12	12
CTA Chest or MRA	36	24	12	12

CD-11.3.8: Right Ventricle-to-Pulmonary Artery Conduit

- Initial studies-Diagnosis, clinical changes, consideration of surgery. Surgical repair for many lesions such as TOF/Truncus/Pulmonary atresia
  - Echocardiogram (TTE) at time of diagnosis
  - Cardiac MRI or CTA Cardiac
  - MRA Chest or CTA Chest
  - Prior to interventions or surgery may repeat any of the above imaging
  - Cath allowed for new symptoms or with new imaging findings as needed for management
  - Stress imaging (stress echo, stress MRI or MPI) as requested for symptoms

Routine follow-up Right Ventricle–to-Pulmonary Artery Conduit

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	12	12	12	12
CMR or CCTA	36	36	12	12
MRA Chest or CTA Chest	36	36	12	12

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CD-11.3.9: Transposition of the great arteries (TGA)

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - Baseline Cardiac MRI or CCTA
  - Baseline MRA Chest or CTA
  - Stress imaging as requested for symptoms or signs of ischemia
  - V/Q scan for left to right PA perfusion or MRA Chest
  - Symptomatic individuals should be offered stress physiological imaging and repeat anatomic imaging considered if symptoms are suggestive of coronary ischemia (regardless of diamond forester pretest probability category)
  - Cath right and left heart when issues not elucidated on advanced imaging

Routine follow-up TGA

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE	12	12	12	12
CMR or CCTA	36	24	12	12
MRA Chest or CTA Chest	36	24	12	12

CD-11.3.10: Congenitally corrected TGA

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis
  - Baseline CMR and MRA Chest
  - CMR and/or Echo for changes in clinical status

Routine follow-up congenitally corrected TGA

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	12	12	12	12
CMR or CCTA	36	36	12	12
CTA Chest or MRA Chest	36	36	12	12

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CD-11.3.11: Fontan Palliation of Single Ventricle Physiology

- Including Tricuspid Atresia and Double Inlet Left Ventricle, HLHS, HRHS, PA, Mitral atresia, AVC unbalanced, single ventricle, DIRV, pulmonary atresia, HLHS, Glen procedure, TA, double outlet right ventricle (DORV), and single ventricle physiology
- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE) at time of diagnosis and with any new symptoms
  - CMR or CCTA can be done annually (vs. based on below chart) on individuals who have prior issues that were equivocal on echo, and the data is required (i.e. very poor windows)
    - Cardiac catheterization prior to surgical interventions
  - Echo/CMR or CCTA/MRA Chest or CTA Chest/cath with any new signs or symptoms
  - V/Q scan or MRA for lung perfusion left vs. right

Routine follow-up Fontan Palliation of Single Ventricle Physiology

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
Echo (TTE)	12	12	12	12
CMR or CT Cardiac	36	24	24	24
CTA Chest or MRA	36	24	24	24

CD-11.3.12: Severe Pulmonary artery hypertension (PHT) and Eisenmenger syndrome

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echo (TTE)
    - Initial diagnosis
    - With new signs or symptoms
  - Cardiac cath
    - Echo (TTE) results suggest PHT
    - New signs or symptoms with PHT

Long term follow-up Severe Pulmonary artery hypertension (PHT) and Eisenmenger syndrome

Modality	Physiological stage / intervals for routine imaging (months)			
Physiological stage	**A**	**B**	**C**	**D**
TTE			12	12
CMR or CCT			As needed	As needed
MRA Chest or CTA Chest			As needed	As needed
Cath			As needed	As needed

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CD-11.3.13: Coronary artery anomalies

- Initial studies-Diagnosis, clinical changes, consideration of surgery
  - Echocardiogram (TTE)
    - At baseline
    - Any signs or symptoms
  - Coronary CT/MR/Cath for initial evaluation
  - CA from wrong sinus-baseline stress imaging regardless of symptoms
  - Stress imaging for any cardiac signs or symptoms
  - For Kawasaki GL regarding echo, Stress imaging, coronary imaging, see pediatric GL: **PEDCD-6: Kawasaki Disease**

CD-11.4: Pregnancy – Maternal Imaging

- Overview
  - World Health Organization (WHO) classification:
    - WHO classification I: no detectable increased risk of maternal mortality and no/mild increase in morbidity.
      - Uncomplicated small or mild pulmonary stenosis
      - Patent Ductus Arteriosus (PDA)
      - Mitral valve prolapse
      - Successfully repaired simple lesions (atrial or ventricular septal defect, patent ductus arteriosus, anomalous pulmonary venous connection)
    - WHO classification II: small increase in maternal risk mortality or moderate increase in morbidity.
      - Unrepaired atrial or ventricular septal defect
      - Repaired tetralogy of Fallot
    - WHO classification II–III (depending on individual)
      - Mild left ventricular impairment
      - Native or tissue valvular heart disease not considered WHO I or IV
      - Marfan syndrome without aortic dilation
      - Aorta <45 mm in association with bicuspid aortic valve disease
      - Repaired coarctation
    - WHO classification III: significantly increased risk of maternal mortality or severe morbidity. Expert counseling required. If pregnancy is decided upon, intensive specialist cardiac and obstetric monitoring needed throughout pregnancy, childbirth and the puerperium.
      - Mechanical valve
      - Systemic right ventricle
      - Fontan circulation
      - Unrepaired cyanotic heart disease
      - Other complex congenital heart disease
      - Aortic dilation 40–45 mm in Marfan syndrome
      - Aortic dilation 45–50 mm in bicuspid aortic valve disease

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- WHO classification IV: extremely high risk of maternal mortality or severe morbidity; pregnancy contraindicated. If pregnancy occurs, termination should be discussed. If pregnancy continues, care as for WHO class III.
  - Pulmonary arterial hypertension from any cause
  - Severe systemic ventricular dysfunction (LVEF <30%, NYHA functional class III–IV)
  - Severe mitral stenosis; severe symptomatic aortic stenosis
  - Marfan syndrome with aorta dilated >45 mm
  - Aortic dilation >50 mm in aortic disease associated with bicuspid aortic valve
  - Native severe coarctation of the aorta

Adapted from: Elkayam U, Goland S, Pieper PG, Silversides CK. High-Risk Cardiac Disease in Pregnancy. Journal of the American College of Cardiology.

- Congenital heart disease imaging in pregnancy
  - Echocardiogram (TTE) when planning pregnancy
  - TEE if TTE equivocal
  - CMR can be performed prior to planning pregnancy in those lesions where CMR would be routinely performed at some later date
  - CTA Chest or MRA Chest of arch if known disease with aortic involvement or if known dilation
  - Repeat echocardiogram and MR (can be without gad) can be performed based on the II, III, IV, or other risk factors
  - Severe complex CHD, may require echo monthly, or even weekly (every two weeks) (major physiological changes)-may be best as often as needed (Pulmonary hypertension, changes in function, can guide delivery after 24 weeks)
  - Echo can be performed if new signs or symptoms during pregnancy
  - Post-partum first year can have more frequent imaging
  - Stress imaging pre/during pregnancy for individuals with known Coronary artery anomaly, pulmonary hypertension, LVOT obstruction, cardiac dysfunction, single ventricle.
  - WHO II, III, IV, can have echo/MR/CT/stress imaging prior to pregnancy
  - WHO I- one echocardiogram during pregnancy
  - WHO II- one echocardiogram per trimester during pregnancy
  - WHO II/III- echocardiogram every 2 months during pregnancy
  - WHO III/IV- echocardiogram monthly during pregnancy
    - Individuals may require more (even weekly) if treatment decision, delivery is considered.

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- Syndromes that allow cardiac imaging at the time of diagnosis if not previously done. This list is not exhaustive
  - DiGeorge (velocardiofacial)
  - (22q11.2)
  - Down syndrome (trisomy 21)
  - Holt Oram (TBX5)
  - Klinefelter syndrome (47 XXY)
  - Noonan (PTPN11, KRAS, SOS1 RAF1, NRAS, BRAF, MAP2K1)
  - Turner (45X)
  - Williams (7q11.23 deletion)
  - Any syndrome associated with congenital heart disease.
- Echocardiogram at time of diagnosis (either genetic testing or clinical features)
- CMR or CCTA if arch involved in disease.

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CD-12: Cancer Therapeutics-Related Cardiac Dysfunction (CTRCD)

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CD-12.1: Oncologic Indications for Cancer Therapeutics – Related Cardiac Dysfunction (CTRCD)

- Echocardiogram to determine LV function in individuals on cardiotoxic chemotherapeutic drugs:
  - The time frame should be determined by the provider, but no more often than baseline and at every 6 weeks.
  - May repeat every 4 weeks if cardiotoxic chemotherapeutic drug is withheld for significant left ventricular cardiac dysfunction
  - If the LVEF is <50% on echocardiogram follow up can be done with MUGA at appropriate intervals.
- Echocardiography vs. MUGA for Determining Left Ventricular Ejection Fraction (LVEF) in Individuals on Cardiotoxic Chemotherapy Drugs:
  - eviCore guidelines support using **echocardiography rather than MUGA** for the determination of LVEF and/or wall motion EXCEPT in one of the circumstances described previously in **CD-3.4: MUGA Study – Cardiac Indications**.
- Echocardiogram is recommended for cancer survivors with a history of chest radiotherapy or anthracycline exposure who are pregnant or planning to become pregnant as follows:
  - Baseline exam
  - Once in the first trimester
  - Once in the third trimester
  - Study can be repeated for any symptoms at any other time as needed during or immediately following pregnancy
- For adults who received anthracyclines in childhood see **PEDONC-19.2**

Practice Note

- Advantages of Echocardiography in comparison to MUGA in individuals on cardiotoxic chemotherapy:
  - No ionizing radiation
  - No IV access required when echo contrast is not used
  - Allows view of the pericardium to look for effusion
  - Allows estimate of pulmonary pressure
  - May allow visualization of a clot or tumor in the Inferior Vena Cava (IVC) and/or the right heart

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CD-12.2: Myocardial Strain Imaging

- Myocardial strain imaging (CPT® 93356) in addition to the primary echocardiogram in individuals receiving therapy with cardiotoxic agents for ANY of the following:
  - Initial evaluation-prior to treatment with EITHER:
    - Medications that could result in cardiotoxicity/heart failure
    - Radiation that could result in cardiotoxicity/heart failure
  - Re-evaluation of an individual previously or currently undergoing therapy as per echocardiogram parameters. See **CD-12.1: Oncologic Indications for Cancer Therapeutics – Related Cardiac Dysfunction (CTRCD)**
  - Re-evaluation of an individual undergoing therapy with worsening symptoms

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CD-13: Pre-Surgical Cardiac Testing

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CD-13.1: Pre-Surgical Cardiac Testing – General Information

- It is important to differentiate requests for preoperative CT imaging before cardiac surgery according to type of procedure planned:
  - Primary cardiac operation—individuals who have not had prior heart surgery
  - Redo procedures-individuals who have had a prior procedure (it is important to determine the type of procedure as this may impact which modality is most appropriate for the pre-operative assessment)
  - Minimally invasive procedures, such as minimally invasive aortic valve operations, minimally invasive or robotic mitral operations, TAVR, MitraClip™ or other percutaneous valve procedures (such as valve in valve aortic or mitral, percutaneous tricuspid and TMVR which will be increasing in the future)
- In re-operative cardiac surgery, the benefit of preoperative CT is to assess for aortic calcifications, to evaluate the anatomic relationships in the mediastinum, such as the location of the various cardiac chambers and great vessels and proximity to the sternum, and to assess for the location of prior bypass grafts. Information can then be used to change the operative strategy including non-midline approach, peripheral vascular exposure, and alternative cannulation sites and for establishing cardiopulmonary bypass before re-sternotomy. These techniques can result in decreased incidence of intraoperative injury to heart, great vessels and prior bypass grafts and lower rates of postoperative stroke. IV contrast is necessary with these studies to delineate the anatomic structures. However, in individuals with renal insufficiency, the provider might choose to forgo the contrast if does not want to contrast load the individual prior to placing them on the heart-lung machine.
- Aortic atherosclerosis is recognized as the single most important determinant of postoperative stroke. There is evidence to support that preoperative CT is associated with lower postoperative stroke rates and mortality after primary cardiac surgery.
  - CT Chest without contrast (CPT® 71250) can be performed pre-operatively to allow the surgeon to:
    - Visualize the extent and location of aortic atherosclerosis
    - Change the operative strategy such as those problematic areas are avoided

CD-13.2: Primary Cardiac Surgery – No Previous Cardiac Surgery

- CT Chest without contrast (CPT® 71250) to evaluate for the presence of ascending aortic calcifications may be indicated prior to primary cardiac surgery when there is documented high risk for aortic calcification including any of the following:
  - Aortic calcification on chest x-ray or other diagnostic test (TEE, fluoroscopy, etc.)
  - Calcific aortic stenosis
  - End stage renal disease (dialysis)

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CD-13.3: Re-operative cardiac surgery

- Individuals undergoing re-operative cardiac surgery may undergo **one** of the following tests for preoperative assessment:
  - CT Chest with contrast
  - CTA Chest
  - CCTA only if prior CABG (this might be in addition to CT with contrast as CCTA will not show the extent of the thoracic aorta that needs to be visualized)
  - CT Heart usually does not provide the necessary information, and should not be approved routinely.

CD-13.4: Minimally Invasive Valve Surgery

- See **CD-4.8: Transcatheter Aortic Valve Replacement (TAVR)**
- For an individual undergoing minimally invasive aortic valve surgery and minimally invasive or robotic mitral valve surgery, ONE of the following for preoperative assessment of an individual's suitability for the approach and for subsequent procedure planning:
- CTA Chest, CTA Abdomen and Pelvis
- CT Chest and CT Abdomen and Pelvis with contrast

CD-13.5: Percutaneous Mitral Valve Repair (mitral valve clip)

- Percutaneous treatment of mitral regurgitation can be accomplished using venous access to apply a clip device (e.g., MitraClip™ currently FDA approved) to provide edge-to-edge mitral leaflet coaptation, approximating opposing sections of the anterior and posterior mitral valve leaflets. FDA approved indications include treatment for individuals with symptomatic, moderate to severe or severe primary mitral regurgitation whose surgical risks are prohibitive, as well as symptomatic moderate to severe or severe secondary mitral regurgitation who have failed optimal medical therapy. This therapy should include, if indicated, cardiac resynchronization therapy.
- The following imaging may be used to determine if an individual is eligible for the procedure:
  - Transthoracic echo with or without 3D rendering
  - Transesophageal echo with or without 3D rendering
  - Heart catheterization, including right heart cath if requested
- Because this is a venous approach, CTA of Abdomen, Chest, and/or Pelvis **is not** indicated.
- Post procedure transthoracic echo (TTE) can be performed at the following intervals:
  - One month
  - Six months
  - One year

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