Preoperative Evaluation: Non-Cardiac Surgery

Clinical Guidelines for Medical Necessity Review

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Important Notices

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Other Notices:

Guideline Information:

Disease Area: Cardiology
Care Path Group: General Cardiology
Care Path Name: Preoperative Evaluation
Type: [**X**] Adult (18+ yo) | [_] Pediatric (0-17yo)

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Care Path Overview

Care Path Clinical Discussion

Preoperative assessment of cardiac risk prior to noncardiac surgery is an important area of concern for clinicians evaluating all patients, especially those with a history of cardiovascular disease or significant cardiac risk factors. Major adverse cardiovascular and cerebrovascular events have been a significant source of perioperative morbidity and mortality following non-cardiac surgery. They tend to occur most frequently in patients undergoing vascular, thoracic, abdominal, and transplant surgeries.[1]

Patients with underlying atherosclerotic cardiovascular disease (ASCVD)[i.e., coronary artery disease (CAD), cerebrovascular disease (CVD) and peripheral arterial disease (PAD)], have an increased risk of perioperative cardiac complications than patients without clinical atherosclerosis.[2,3] These patients have a higher incidence of significant coronary artery disease and left ventricular systolic dysfunction (left ventricular ejection fraction less than or equal to 40%).

In addition, there are a variety of physiologic factors associated with surgery for patients predisposed to myocardial ischemia. Increased myocardial oxygen demand from elevations in heart rate and blood pressure during surgery and recovery, volume shifts and blood loss, and increased postoperative platelet reactivity are all contributory. These surgical stresses have more pronounced consequences in patients with underlying coronary disease and left ventricular dysfunction.[4]

Despite the increased risk in this population, perioperative MI and death rates have decreased over time. This decrease is likely the result of improved recognition of individual patient risk, goal-directed medical therapy, including the use of perioperative beta-blockers, and enhancements in the provision of anesthesia services. Since the mid-1990s, the preoperative evaluation of cardiac patients has trended increasingly towards testing based solely on patients' symptoms and not routinely in the absence of urgent or untreated signs and symptoms Routine preoperative testing may not improve clinical outcomes and imposes unnecessary delays while significantly increasing costs.[4]

The information contained herein gives a general overview of the pathway of this specific diagnosis, beginning with the initial presentation, recommended assessments, and treatment options as supported by the medical literature and existing guidelines. It should be noted that the care of patients can be

complex. The information below is meant to support clinical decision-making in adult patients. It is not necessarily applicable to every case, as the entire clinical picture (including comorbidities, history, etc.) should be considered.

Key Information

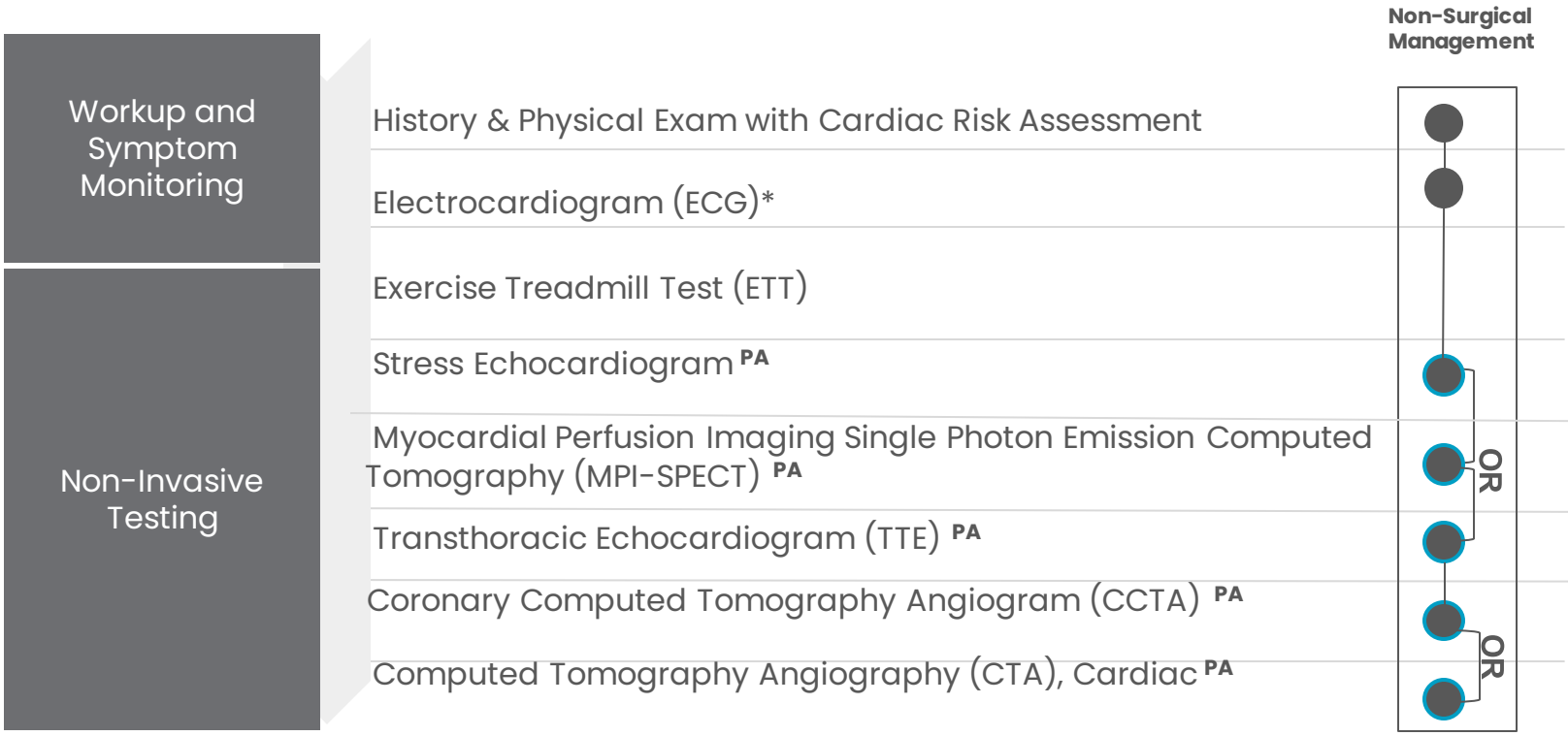
- ➢ A fundamental part of the preoperative evaluation before non-cardiac surgery, the initial history and physical examination should include an evaluation of cardiac symptoms and any history of prior cardiovascular disease.
- ➢ Include a cardiac risk assessment in the initial evaluation. Base the assessment on individual patient risk factors, surgical procedural risk, and whether the surgery is emergent, urgent, or elective.
- ➢ Obtain a 12-lead ECG before non-cardiac surgery.
- ➢ Base further diagnostic testing on the patient's symptoms; do not perform further testing just because the patient is having surgery. The physician should consider whether the diagnostic test results will significantly change management.

Definitions

- **Non-Cardiac Surgery:** Includes all surgical procedures not involving the heart or the ascending aorta (i.e., CABG, valve replacement, or repair) and not requiring cardiopulmonary bypass. See the table in Causes and Risk Factors for examples of non-cardiac surgeries.
- **Myocardial Perfusion Imaging Single Photon Emission Computed Tomography (MPI-SPECT):** A nuclear stress test involving the injection of radiopharmaceuticals during exercise or pharmacologic stress to assess the presence and extent of myocardial ischemia. Compared to stress echo, it is more costly, more time-consuming, and exposes the patient to radiation equivalent to a chest x-ray.
- **Pretest Probability (of CAD):** Pretest probability of coronary artery disease (CAD) is the likelihood that the patient has CAD, calculated before the test result is known. These guidelines reference the 2019 European Society of Cardiology (ESC) Guidelines for the diagnosis and management of chronic coronary syndromes model to calculate the pretest probability based on age, sex, and type of chest pain.[5-6]
- **Metabolic Equivalents of Task (MET):** An objective measurement used during exercise testing that compares a person's energy expenditure during exercise to their energy expenditure at rest. One MET is the energy expenditure at complete rest (i.e., bed rest, sitting).

Preoperative Evaluation: Non-Cardiac Surgery

What is a "Cohere Care Path"?
These Care Paths organize the services typically considered most clinically optimal and likely to be automatically approved. These service recommendations also include the suggested sequencing and quantity or frequency determined clinically appropriate and medically necessary for the management of most patient care scenarios in this Care Path's diagnostic cohort.



Key

PA = Service may require prior authorization
★ = Denotes preferred service
AND = Services completed concurrently
OR = Services generally mutually exclusive

= Non-surgical management prior authorization group of services
= Surgical management prior authorization group of services
= Subsequent service
= Management path moves to a different management path

Care Path Diagnostic Criteria

Disease Classification

Preoperative cardiovascular evaluation

ICD-10 Codes Associated with Classification

ICD-10 Code	Code Description/Definition
R94.31	Abnormal electrocardiogram [ECG]
Z01.810	Encounter for preprocedural cardiovascular examination
Z01.818	Encounter for other preprocedural examination

Presentation and Etiology

Causes and Risk Factors

In general, low-risk patients with an estimated risk of death or MI of less than 1% require no additional cardiovascular testing. Intermediate-high risk patients with an estimated risk of death or MI of 1% or higher and frequently with a history of known CAD or valvular disease may require additional testing or cardiology consultation.[7-8]

Different cardiac risk scores and indices are available based on a combination of individual patient risk factors and surgical procedural risk. Lee et al. proposed 6 independent predictors of major cardiac complications to include in a Revised Cardiac Risk Index (RCRI) as follows[8-10]:

- High-risk type of surgery (vascular surgery and any open intraperitoneal or intrathoracic procedures).
- History of ischemic heart disease (prior MI, a positive exercise test, active complaint of chest pain, ECG with pathologic Q waves).
- History of congestive heart failure.
- History of cerebrovascular disease.
- History of diabetes requiring treatment with insulin.
- Preoperative serum creatinine greater than 2.0 mg/dL.

The risk of major cardiac complications (cardiac death, nonfatal MI, nonfatal cardiac arrest, postoperative cardiogenic pulmonary edema, complete heart block) varies according to the number of risk factors as follows[8,11]:

- No risk factors – 0.4% risk of major cardiac complication
- 1 risk factor – 1% risk of major cardiac complication
- 2 risk factors – 2.4% risk of major cardiac complication

- 3 or more risk factors – 5.4% risk of major cardiac complication

Atrial fibrillation and obesity are additional important patient-related risk factors that are not currently included in standard risk assessment tools but probably add to overall risk.[12]

Surgeries with Low, Intermediate, and High Cardiovascular Risk[7,13-14]

Low Risk (rates of cardiac death or nonfatal MI less than 1%)	Intermediate Risk (rates of cardiac death or nonfatal MI between 1-5%)	High Risk (rates of cardiac death or nonfatal MI greater than 5%)
breast surgery	carotid endarterectomy	aortic, major intra abdominal vascular, and peripheral artery surgeries
cataract surgery	head and neck surgery	Whipple procedure
laparoscopic cholecystectomy or appendectomy	prostate surgery (e.g., TURP and bladder resection)	open cholecystectomy
rotator cuff repair	orthopedic surgery (e.g., total hip arthroplasty)	total abdominal colectomy with ileostomy (open or laparoscopic)
	open appendectomy	open ventral hernia repair
		emergency surgery*

***Emergency surgery carries particularly high risk (2-5 fold increase in risk of cardiac complications compared to elective surgery). Emergency surgery is outside of the scope of these guidelines.**

Clinical Presentation

Patients planning to undergo non-cardiac surgeries should present for cardiovascular perioperative risk assessment to improve the success and safety of the procedure. The patient's background health and the nature of the surgery should drive the appropriate testing.[7]

Testing should be based on symptoms. Stress testing in intermediate-high (combined clinical/surgical) risk patients can further stratify the risk of an adverse perioperative event.[15] Standard exercise stress testing without imaging may be appropriate if the patient has unknown functional capacity

,can seemingly exercise to a satisfactory workload, and has a normal baseline ECG (see Typical Physical Exam Findings). Standard exercise testing is beneficial for the assessment of functional capacity if not attainable by history and physical exam. Standard exercise testing is limited by a higher incidence of false-positive studies, especially in lower-risk patients, and its sensitivity and specificity for detection of ischemia and CAD is lower than stress echo or MPI-SPECT.[13]

Typical History Findings

Patients With Pre-Existing Cardiovascular Disease

Patients with pre-existing cardiovascular disease, including peripheral artery disease or stroke, have an increased risk of perioperative cardiac complications than patients without clinical atherosclerosis.[2,3,16-17] These patients have a higher incidence of significant coronary artery disease and left ventricular systolic dysfunction (ejection fraction less than or equal to 40%).[7]

Patients With Pre-Existing Valvular Heart Disease

As a general rule, the decision to proceed with or postpone non-cardiac surgery in patients with pre-existing valvular heart disease depends on the chronicity and severity of the valvular disease. For patients with moderate or more significant valvular stenosis or regurgitation, complete echocardiography before the elective surgery is recommended if there has been either 1) no prior echocardiography within 1 year or 2) a significant change in clinical status or physical examination since the last evaluation. AHA/ACC recommendations are as follows[19]:

- Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe aortic stenosis (AS).
- Elevated-risk elective noncardiac surgery using appropriate intraoperative and postoperative hemodynamic monitoring may be reasonable in asymptomatic patients with severe mitral stenosis if valve morphology is not favorable for percutaneous mitral balloon commissurotomy.
- Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe MR.
- Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe aortic regurgitation (AR) and a normal LVEF.

- In patients who meet clinical indications for valve replacement or repair based on symptoms and disease severity, valve surgery should be performed before elective non-cardiac surgery if it will significantly reduce perioperative risk. This decision also depends on the urgency and risk of the non-cardiac surgical procedure.

Typical Physical Exam Findings

Physicians should consider the patient's functional capacity during the preoperative cardiovascular evaluation in patients undergoing non-cardiac surgery. In general, patients who can perform greater than 4 metabolic equivalents of task (METs) of activity do not require additional testing. For those whose functional capacity is unknown or is lower than 4 METs, additional testing may be appropriate if it will influence perioperative care.[7-8,18-19]

In 2014, the American College of Cardiology (ACC) and the American Heart Association (AHA) jointly published extensive clinical practice guidelines on the Perioperative Cardiovascular Evaluation and Management of Patients Undergoing non-cardiac Surgery. Their recommendations are as follows[7,19]:

- Class IIa: Benefit-to-Risk Ratio is favorable
    - Patients with elevated risk and excellent (greater than 10 METs) functional capacity: forgo further exercise testing with cardiac imaging and proceed to surgery.
- Class IIb: Benefit-to-Risk Ratio is favorable but weaker
    - Patients with elevated risk and moderate (4-10 METs: climbing a flight of stairs or walking up a hill, walking on level ground at 4 mph, and performing heavy work around the house) functional capacity: forgo further exercise testing with cardiac imaging and proceed to surgery.
    - Patients with elevated risk and poor (less than 4 METs: slow ballroom dancing, golfing with a cart, playing a musical instrument, and walking at approximately 2 mph to 3 mph) or unknown functional capacity: perform exercise testing with cardiac imaging to assess for myocardial ischemia if it will change management.
- Class III: No Benefit
    - Routine screening with noninvasive stress testing is not beneficial for patients at low risk for non-cardiac surgery.

Care Path Services & Medical Necessity Criteria

Non-Invasive Testing

Service: Stress Echocardiogram

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Stress echocardiography is one of a number of modalities considered appropriate for the perioperative cardiac assessment in patients with an elevated (intermediate to high) risk for surgery if the test results will substantially change patient management.[19-20]
    - Use either exercise or pharmacologic agents (predominantly dobutamine (DSE)) as the stress mechanism.[21-22]
    - This test results in no radiation exposure and is typically lower cost than myocardial perfusion imaging (MPI-SPECT).[22]
    - Other advantages of stress echo compared to MPI-SPECT include shorter patient time commitment, and additional information on cardiac structures (e.g., left ventricular (LV) function, valves, ascending aorta, pericardial space). The test is technically less demanding than MPI-SPECT.[20]
- **Exclusions:** Exercise and stress echocardiography are less diagnostically accurate in patients with limited acoustic windows. Echocardiography may have limited benefit in patients at the extremes of adult body weight because a thick chest wall (in markedly obese patients) or overcrowded ribs (in severely underweight patients) may limit the penetration of ultrasound waves.[23]

Medical Necessity Criteria

Indications

➔ **Stress echo** is considered appropriate if **ANY** of the following is **TRUE**:

- ◆ For patients with an elevated non-cardiac surgery risk and poor or unknown functional capacity, it may be reasonable to perform stress testing (treadmill or pharmacologic) with cardiac imaging to assess for myocardial ischemia.[10,19]

Non-Indications

➔ **Stress echo** is not considered appropriate as part of a pre-operative evaluation if **ANY** of the following is **TRUE**:

- The patient has a contraindication to dobutamine use for a requested DSE
- Normal coronary angiogram or CCTA within the last two years and no stenosis or plaque
- Normal stress test (given adequate stress) within the last year.
- The patient is at low risk for non-cardiac surgery.
- The patient has moderate to good (greater than 4 METs to 10 METs) or excellent (greater than 10 METS) functional capacity.[7-8,18]
- Surgery is emergent

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93350	Real time transthoracic echocardiography with 2-dimensional (2D) image documentation during rest and cardiovascular stress test using treadmill and pharmacologically induced stress, w/ interpretation & report
93351	Real time transthoracic echocardiography with 2-dimensional (2D) image documentation during rest and cardiovascular stress test using treadmill, bicycle exercise and pharmacologically induced stress, with interpretation and report, including performance of continuous electrocardiographic monitoring, with physician supervision

Service: Myocardial Perfusion Imaging Single Photon Emission Computed Tomography (MPI-SPECT)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Myocardial perfusion imaging single-photon emission computed tomography (MPI-SPECT) is typically appropriate for the perioperative cardiac risk assessment in patients with an elevated (intermediate to high) risk for surgery if the test results will substantially change patient management.[19]
    - If the patient is unable to exercise or has ECG abnormalities that interfere with the interpretation of an ECG during exercise, then pharmacologic MPI-SPECT or stress echo should be considered.
    - Limitations of MPI-SPECT include cost and radiation. Interpretation of MPI-SPECT can also be affected by attenuation artifacts related to soft tissue overlying the heart or extracardiac radioisotope (e.g., liver or gastrointestinal uptake adjacent to the heart).
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **MPI-SPECT** is considered appropriate if **ANY** of the following is **TRUE**:

- For patients with elevated non-cardiac surgery risk and poor or unknown functional capacity, it may be reasonable to perform exercise testing with cardiac imaging to assess for myocardial ischemia.[10]
- It is reasonable for patients at elevated risk for non-cardiac surgery with a poor functional capacity to undergo either DSE or pharmacologic MPI if it will change management.[7-8,21]

Non-Indications

➔ **MPI-SPECT** may not be considered appropriate if **ANY** of the following is **TRUE**:

- The patient is pregnant.
- The patient is clinically stable with no known cardiac disease.
- The patient is at low risk for non-cardiac surgery.
- The patient has moderate to good (greater than 4 METs to 10 METs) or excellent (greater than 10 METS) functional capacity.[7-8,18]
- Normal coronary angiogram or CCTA within the last two years and no stenosis or plaque

- Normal stress test (given adequate stress) within the last year.
- Vasodilators (i.e., adenosine, regadenoson, and dipyridamole) are contraindicated in patients with hypotension, sinus node dysfunction, high-degree atrioventricular (AV) block (in the absence of back up pacemaker capability), and reactive airway disease.

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
78451	Single-photon emission computed tomography (SPECT) myocardial perfusion imaging study with stress
78452	Multiple single-photon emission computed tomography (SPECT) myocardial perfusion imaging studies with stress
78494	Cardiac blood pool single photon emission computed tomography (SPECT) imaging, gated equilibrium study, at rest, with wall motion study plus ejection fraction

Service: Transthoracic Echocardiogram (TTE)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Transthoracic echocardiography (TTE) is generally not indicated in the preoperative patient. TTE could be appropriate for patients experiencing symptomatic HF, valvular heart disease, or arrhythmias. TTE could also help confirm other findings (e.g., heart murmur, abnormal ECG).[7]
- **Exclusions:** Echocardiography has no contraindications. Echocardiography may have limited benefit in patients at the extremes of adult body weight because a thick chest wall (in markedly obese patients) or overcrowded ribs (in severely underweight patients) may limit the penetration of ultrasound waves.[23]

Medical Necessity Criteria

Indications

➔ ***Transthoracic Echocardiogram (TTE)*** is considered appropriate if **ANY** of the following is **TRUE**[24-25]:

- ◆ The patient has moderate or severe valvular heart disease and no prior echo in the past year.
- ◆ The patient has valvular heart disease or left ventricular (LV) dysfunction and a recent worsening of symptoms.
- ◆ The patient has new or uncategorized signs or symptoms (e.g., new murmur, ECG change, arrhythmias, shortness of breath or other signs or symptoms of heart failure) or recent worsening symptoms with a suspected cardiac origin.

Non-Indications

➔ **TTE** is not considered appropriate if **ANY** of the following is **TRUE**:

- ◆ The patient is asymptomatic with no known cardiac disease.
- ◆ The patient is at low risk for non-cardiac surgery.
- ◆ A routine preoperative evaluation of LV function.
- ◆ Surgery is emergent

Site of Service Criteria

Outpatient

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93303	Complete transthoracic echocardiography for congenital cardiac anomalies
93304	Follow-up transthoracic echocardiography for congenital cardiac anomalies
93306	Real time transthoracic echocardiography with 2-dimensional (2D) image documentation, M-mode recording with spectral Doppler echocardiography, and color flow Doppler echocardiography
93307	Complete real time transthoracic echocardiography with 2-dimensional (2D) image documentation
93308	Follow-up real time transthoracic echocardiography with 2-dimensional (2D) image documentation
C8921	Tte w or w/o fol w/cont, com
C8922	Tte w or w/o fol w/cont, f/u
C8923	2d tte w or w/o fol w/con,co
C8924	2d tte w or w/o fol w/con,fu
C8929	Tte w or wo fol wcon,doppler

Service: Computed Tomography Angiography (CTA), Cardiac

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** Clinical reason and judgement according to academic medical society and clinical practice guidelines and usage of the ACR Appropriateness Criteria.
- **Recommended Clinical Approach:** As part of the preoperative evaluation before non-cardiac surgery, cardiac computed tomography angiography (CTA) may be indicated for the evaluation of new or worsening dyspnea/shortness of breath not explained by stress testing or transthoracic echocardiography or due to known or suspected pulmonary disease.[26]
- **Exclusions:** Patients with renal failure for contrast exams (eGFR less than 30 ml/min) who are not on dialysis, a history of anaphylactic reaction to iodinated contrast, or other allergic reactions that may require premedication. Patients who cannot cooperate with exam requirements (i.e., breath-holding) are also excluded.[7]

Medical Necessity Criteria

Indications

➔ **Cardiac CTA** is considered appropriate if **ANY** of the following is **TRUE**[26-30]:

- ◆ The patient has dyspnea (shortness of breath) not explained by prior diagnostic testing (e.g., cardiac PET, stress testing, TTE).
- ◆ The patient has new or worsening dyspnea and known or suspected pulmonary disease.
- ◆ The patient has a cardiothoracic disease (e.g., cancer, sarcoidosis, amyloidosis).
- ◆ The patient had previous inconclusive or abnormal imaging.

Non-Indications

➔ **Cardiac CTA** may not be considered appropriate if **ANY** of the following is **TRUE**[31]:

- ◆ The patient has contrast dye hypersensitivity.
- ◆ In pregnant patients.
- ◆ The patient has impaired renal function because angiographic contrast is utilized for the study.[7]
- ◆ The patient uses metformin.

- The patient has non-rate-controlled atrial fibrillation.
- The patient is asymptomatic with no known cardiac disease.
- The patient is at low risk for non-cardiac surgery.
- Surgery is emergent

Site of Service Criteria

Outpatient or Inpatient

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
75572	Computed tomography (CT) of heart with contrast material for evaluation of cardiac structure and morphology, including 3-dimensional (3D) image postprocessing, assessment of cardiac function, and evaluation of venous structures
75573	Computed tomography (CT) of heart with contrast material for evaluation of cardiac structure and morphology in congenital heart disease

Service: Coronary Computed Tomographic Angiogram (CCTA)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** As part of the preoperative evaluation before non-cardiac surgery, a coronary computed tomography angiogram (CCTA) may help assess the presence and severity of ischemic coronary artery disease (CAD).[32-36] The referring clinician should provide appropriate clinical documentation based on pretest probability and clinical decision-making. Considerations of additional phases, dynamic sequences, positioning of the patient, and use of markers are at the discretion of the protocoling radiologist. If FFR-CT is available, the attending radiologist and cardiologist should decide whether or not to include FFR. The radiologist should protocol the examination before the patient's arrival.
- **Exclusions:** CCTA is contraindicated in known or suspected allergy to contrast media or kidney failure (where contrast agents could worsen the kidney function). CCTA may not be appropriate for patients who cannot adequately cooperate with exam requirements (e.g., breath-holding).[7]

Medical Necessity Criteria

Indications

➔ **CCTA** is considered appropriate if **ANY** of the following is **TRUE**[32-38]:

- ◆ The patient has **ALL** of the following
  - **ANY** of the following[19,39]:
    - Undergoing an intermediate or high-risk surgery
    - Intermediate or high clinical risk for surgery
  - **ANY** of the following:
    - Poor (less than 4 METS) or unknown functional capacity and Is unable to have either exercise or complete a pharmacologic stress test[7-8,18]
    - Previous functional or structural CAD testing (e.g., stress test) with abnormal or inconclusive results.[7]
- ◆ An intermediate to high pretest probability of CAD and **ANY** of the following[19,32-36,38]:
  - Unexplained congestive heart failure.
  - Ventricular tachycardia.

- Segmental wall motion abnormalities at rest (e.g., cardiomyopathy, recent MI).
- Chest pain.

Non-Indications

➔ **CCTA** may not be appropriate if **ANY** of the following is **TRUE**[31]:

- Contrast dye hypersensitivity.
- In pregnant patients.
- Impaired renal function because angiographic contrast is utilized for the study.[7]
- The patient uses metformin.
- Uncontrolled rapid atrial fibrillation.
- Clinically stable with no known cardiac disease.
- Low risk for non-cardiac surgery.
- Moderate to good (greater than 4 METs to 10 METs) or excellent (greater than 10 METS) functional capacity.[7-8,18]
- Normal coronary angiogram or CCTA within the last two years and no stenosis or plaque
- Normal stress test (given adequate stress) within the last year
- Surgery is emergent

Site of Service Criteria

Outpatient or Inpatient

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
75574	Computed tomographic angiography (CTA) of coronary arteries and bypass grafts, with contrast material and 3-dimensional (3D) image postprocessing

Surgical Risk Factors

Patient Medical Risk Stratification

Patient Risk Score	Patient Characteristic	Min Range	Max Range	Guidance
1- Very Low Risk	No known medical problems			
2- Low Risk	Hypertension		180/110 mm Hg	
2- Low Risk	Asthma	peak flow >80% of predicted or personal best value		
2- Low Risk	Prior history of alcohol abuse			Screen for liver disease and malnutrition
2- Low Risk	Prior history of tobacco use			
3- Intermediate Risk	Asthma	peak flow <80% of predicted or personal best value		
3- Intermediate Risk	Active alcohol abuse			
3- Intermediate Risk	Age	65	75	
3- Intermediate Risk	History of treated, stable coronary artery disease (CAD)			
3- Intermediate Risk	Stable atrial fibrillation			
3- Intermediate Risk	Diabetes mellitus	HbA1C >7%		Consider preoperative consultation with endocrinologist
3- Intermediate Risk	Morbid obesity	BMI 30	BMI 40	
3- Intermediate Risk	Anemia	hemoglobin <11 (females), <12 (males)		Workup to identify etiology
3- Intermediate Risk	HIV	CD4 <200 cells/mm3		Get evaluation from HIV specialist
3- Intermediate Risk	Rheumatologic/autoimmune disease			Preoperative consultation with rheumatologist re: perioperative medication management
3- Intermediate Risk	Peripheral vascular disease or history of peripheral vascular bypass	ankle-brachial pressure index (ABPI)		Preoperative consultation with vascular surgeon

		<0.9		
3- Intermediate Risk	History of venous thromboembolism (VTE)			
3- Intermediate Risk	Well-controlled obstructive sleep apnea			
3- Intermediate Risk	Malnutrition	transferrin <200 mg/dL albumin <3.5 g/dL prealbumin <22.5 mg/dL total lymphocyte count <1200-1500 cell/mm3 BMI <18		Preoperative consultation with nutritionist
3- Intermediate Risk	Active tobacco Use			Enroll patient in smoking cessation program
3- Intermediate Risk	Known allergy or hypersensitivity to medication needed for procedure			
4- High Risk	Advanced Renal Disease (Creatinine > 2)			
4- High Risk	Diabetes mellitus with complications	HbA1c >8%		Consider Preoperative consultation with endocrinologist
4- High Risk	Age	76	85	
4- High Risk	Oxygen dependent pulmonary disease			
4- High Risk	Sickle cell anemia			
4- High Risk	Obesity	BMI 40		
4- High Risk	Cirrhosis, history of hepatic decompensation or variceal bleeding			
4- High Risk	Impaired cognition; dementia			
4- High Risk	Compensated HF			
4- High Risk	Cerebrovascular disease			
4- High Risk	Uncontrolled or suspected obstructive sleep apnea (OSA)			
4- High Risk	Renal insufficiency	serum creatinine >1.5 mg/dL or creatinine clearance		

		<100 mL/min		
4- High Risk	Opioid dependence			Consider enrollment in a substance abuse disorder program
5- Very High Risk	Percutaneous Coronary Intervention (PCI) within 1 month			
5- Very High Risk	Cardiovascular: unstable angina, recent myocardial infarction (60 days), uncontrolled arrhythmias, severe valvular disease, decompensated heart failure			
5- Very High Risk	Pulmonary hypertension			Consider preoperative consultation with pulmonologist
5- Very High Risk	Severe cirrhosis or severe liver disease, recent history of hepatic decompensation or variceal bleeding			
5- Very High Risk	Severe frailty, dependence for ADLs, or history of 3 or more falls in last 6 mos			
5- Very High Risk	Obesity		BMI >50	
5- Very High Risk	Age		>85	
5- Very High Risk	History of VTE with CI to anticoagulation, failure of anticoagulation, cessation of anticoagulation therapy secondary to bleeding			Preoperative consultation with hematologist or internist
5- Very High Risk	Renal failure requiring dialysis			
5- Very High Risk	Immunosuppression, history of solid organ, heart, or lung transplant			Consider preoperative consultation with specialist
5- Very High Risk	Chronic Pain			

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Clinical Guideline Revision History/Information

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Review History	
February 4, 2022 (V.1)	**Physician author:** Kenneth Korr, MD (Cardiologist, Internist) **Peer reviewed by:** Islam M. Othman, MD (Interventional Cardiologist), Carter Newton, MD FACC (Cardiologist), Russell Rotondo, MD FACC (Cardiologist) **Approving Physician:** Russell Rotondo, MD FACC (Cardiologist)
October 3, 2022 (V.2)	**Peer reviewed by:** Ankeet Bhatt, MD (Cardiologist) **Approving Physician:** Russell Rotondo, MD FACC (Cardiologist)