National Imaging Associates, Inc.*	
Clinical guideline: **CT CORONARY ANGIOGRAPHY (CCTA)**	**Original Date: October ~~6,~~ 2009**
CPT Codes: 75574	**Last Revised Date: ~~March 2021~~January 2022**
Guideline Number: NIA_CG_062	**Implementation Date: ~~January~~ TBD ~~2022~~**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CORONARY COMPUTED TOMOGRAPHIC ANGIOGRAPHY (CCTA)

(Fihn, 2012; Gulati, 2021; Montalescot, 2013; Taylor, 2010; Wolk, 2014)

Evaluation in Suspected Coronary Artery Disease (CAD)

(Cheng, 2011; Douglas, 2015; Fordyce, 2016; Newby, 2015)

- Intermediate and high pretest probability patients (Gulati, 2021) ~~in whom either exercise electrocardiogram (ECG) stress or stress echo cannot be performed (see Background section)~~
- ~~High pretest probability as an alternative to coronary angiography (can also do MPI)~~
- Exercise ECG stress test with intermediate Duke Treadmill Score (- 10 to + 4) ~~in whom stress echo cannot be performed~~
- Equivocal, borderline, or discordant stress imaging evaluation with continued symptoms concerning for CAD
- Repeat testing in patient with new or worsening symptoms since prior normal stress imaging (Taylor, 2010; Wolk, 2013)
- Asymptomatic patients without known CAD
    - Previously unevaluated ECG evidence of possible myocardial ischemia including ischemic ST segment or T wave abnormalities
    - Previously unevaluated pathologic Q waves
    - Previously unevaluated left bundle branch block

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- Newly diagnosed clinical systolic heart failure (ejection fraction [EF] < 50%) or diastolic heart failure without recent CAD evaluation, in the presence of angina or an anginal equivalent symptoms, as an alternative to invasive coronary arteriography (Patel, 2012; Patel, 2013; Taylor, 2010; Wolk, 2013)
- ~~Reduced EF (EF ≤ 40%) as an alternative to invasive coronary arteriography~~
- Before valve surgery or transcatheter intervention as an alternative to coronary angiography (Baumgartner, 2017; Chaikriangkrai, 2018; Nishimura, 2014)
- To establish the etiology of mitral regurgitation (Nishimura, 2014)
- Evaluation of coronary anomaly or aneurysm ~~(CMR favored in young patients)~~ (Bluemke, 2008; Grani, 2017; Newburger, 2016; Sachdeva, 2020)
    - Evaluation prior to planned repair
    - Evaluation due to change in clinical status and/or new concerning signs or symptoms
- Evaluation of coronary artery bypass grafts, to assess (Eisenberg, 2017; Taylor, 2010):
    - Patency and location when invasive coronary arteriography was either nondiagnostic or not performed
    - Location prior to cardiac or another chest surgery

BACKGROUND

Coronary computed tomographic angiography (CCTA) is a noninvasive imaging study that uses intravenously administered contrast material and high-resolution, rapid imaging computed tomography (CT)~~ equipment to obtain detailed volumetric images of the coronary blood vessels. Cardiac CT perfusion can be added to the CCTA, with increasing data regarding its diagnostic accuracy~~ (Nakamura, 2018; Pontone, 2018).

~~Image quality depends on keeping HR optimally < 60 bpm, a regular rhythm, limited coronary calcification, stents > 3.0 mm in diameter, ≥ 5 second breath hold, and vessels requiring imaging ≥ 1.5 mm diameter (Abbara, 2016).~~

~~Coronary artery disease (CAD) stenosis ≥ 70% is considered clinically significant or obstructive CAD. Hemodynamically or functionally significant CAD means the degree of stenosis is severe enough to cause ischemia. This is discussed in more detail in the Overview section (Fihn, 2012; Montalescot, 2013; Wolk, 2013).~~

Stable patients without known CAD fall into 2 categories (Fihn, 2012; Montalescot, 2013; Wolk, 2013):

- **Asymptomatic**, for whom global risk of CAD events can be determined from coronary risk factors, using calculators available online (see ~~Part III~~Risk Calculators in the ~~Background~~ Overview section).

- **Symptomatic,** for whom we estimate the pretest probability that their chest-related symptoms are due to clinically significant CAD.

The Three Types of Chest Pain or Discomfort:

- **Typical Angina (Definite)** is defined as including all **3** characteristics:
  - Substernal chest pain or discomfort with characteristic quality and duration
  - Provoked by exertion or emotional stress
  - Relieved by rest and/or nitroglycerin
- **Atypical Angina (Probable)** has only **2** of the above characteristics
- **Nonanginal Chest Pain/Discomfort** has only **0 - 1** of the above characteristics
- Once the type of chest pain has been established from the medical record, the Pretest Probability of significant CAD is estimated from the Diamond Forrester Table below, recognizing that additional coronary risk factors could increase pretest probability (Wolk, 2013):

Age (Years)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain
≤ 39	Men	Intermediate	Intermediate	Low
	Women	Intermediate	Very low	Very low
40 – 49	Men	High	Intermediate	Intermediate
	Women	Intermediate	Low	Very low
50 – 59	Men	High	Intermediate	Intermediate
	Women	Intermediate	Intermediate	Low
≥ 60	Men	High	Intermediate	Intermediate
	Women	High	Intermediate	Intermediate

  - **Very Low:** < 5% pretest probability of CAD
  - **Low:** 5 - 10% pretest probability of CAD
  - **Intermediate:** 10% - 90% pretest probability of CAD
  - **High:** > 90% pretest probability of CAD

OVERVIEW

The *2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain* ***has given*** a Class 1 recommendation with level of evidence of A for patients with stable and acute chest pain, who have no known coronary artery disease (CAD)(Gulati, 2021).

Patient selection and contraindications to CCTA must be considered and may be inappropriate for the following:

- Known history of severe and/or anaphylactic contrast reaction

- Inability to cooperate with scan acquisition and/or breath-hold instructions
- Pregnancy
- Clinical instability (e.g., acute myocardial infarction, decompensated heart failure, severe hypotension)
- Renal impairment as defined by local protocols
- Image quality depends on keeping HR optimally < 60 bpm, a regular rhythm, limited coronary calcification, stents > 3.0 mm in diameter, ≥ 5 second breath hold, and vessels requiring imaging ≥ 1.5 mm diameter (Abbara, 2016).

Scenarios that can additionally support ~~MPI over SE~~a CCTA over a regular exercise treadmill test in the low probability scenario
(Henzlova, 2016)

~~Poor Quality Echo Image~~

- ~~Obesity with body mass index (BMI) > 40 kg/m^2 or poor acoustic imaging window~~

Inability to Exercise

- Physical limitations precluding ability to exercise for at least 3 full minutes of Bruce protocol
- The patient has limited functional capacity (< 4 METS) **such as one** of the following:
  - Unable to take care of their activities of daily living (ADLs) or ambulate
  - Unable to walk 2 blocks on level ground
  - Unable to climb 1 flight of stairs
  - Unable to vacuum, dust, do dishes, sweep, or carry a small grocery bag

Other Comorbidities

- Prior cardiac surgery (coronary artery bypass graft or valvular)
- Left ventricular ejection fraction ≤ ~~40~~50%
- Severe chronic obstructive pulmonary disease (COPD) with pulmonary function test (PFT) documentation, severe shortness of breath on minimal exertion, or requirement of home oxygen during the day
- Poorly controlled hypertension, with systolic blood pressure (BP) > 180 or Diastolic BP > 120

ECG and Echo-Related Baseline Findings

- Pacemaker or implantable cardioverter defibrillator (ICD)
- ~~Poorly controlled atrial fibrillation/ectopy~~
- Resting wall motion abnormalities ~~that would make SE interpretation difficult~~on echocardiography
- Complete LBBB

Risk-Related

- ~~High pretest probability in suspected CAD~~
- Intermediate or high global risk in patients requiring type IC antiarrhythmic drugs
- Arrhythmia risk with exercise

ECG Stress Test Alone versus Stress Testing with Imaging

Prominent scenarios suitable for an ECG stress test WITHOUT imaging (i.e., exercise treadmill ECG test) require that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate AND has an interpretable ECG for ischemia during exercise (Wolk, 2013):

- The (symptomatic) low ~~or intermediate~~ pretest probability patient who ~~is able to~~can exercise and has an interpretable ECG (Wolk, 2014)
- The patient who is under evaluation for exercise-induced arrhythmia
- The patient who requires an entrance stress test ECG for a cardiac rehab program or for an exercise prescription
- For the evaluation of syncope or presyncope during exertion (Shen, 2017)

Duke Exercise ECG Treadmill Score (Mark, 1987)
Calculates risk from ECG treadmill alone**:**

- The equation for calculating the Duke treadmill score (DTS) is: DTS = exercise time in minutes - (5 x ST deviation in mm or 0.1 mV increments) - (4 x exercise angina score), with angina score being 0 = none, 1 = non-limiting, and 2 = exercise-limiting
- The score typically ranges from - 25 to + 15. These values correspond to low-risk (with a score of ≥ + 5), intermediate risk (with scores ranging from - 10 to + 4), and high-risk (with a score of ≤
- - 11) categories

An uninterpretable baseline ECG includes (Fihn, 2012):

- ST segment depression of 1 mm or more (not for non-specific ST - T wave changes)
- Ischemic looking T wave inversions of at least 2.5 mm
- LVH with repolarization abnormalities, WPW, a ventricular paced rhythm, or left bundle branch block
- Digitalis use with associated ST - T abnormalities
- Resting HR under 50 bpm on a beta blocker and an anticipated suboptimal workload
- Note: RBBB with less than 1 mm ST depression at rest may be suitable for EKG treadmill testing

Global Risk of Cardiovascular Disease

Global risk of CAD is defined as the probability of manifesting cardiovascular disease over the next 10 years and refers to **asymptomatic** patients without known cardiovascular disease. It should be determined using one of the risk calculators below. A high risk is considered greater than a 20% risk of a cardiovascular event over the ensuing 10 years.

High global risk by itself generally lacks scientific support as an indication for stress imaging (Cheng, 2011).

There are rare exemptions, such as patients requiring IC antiarrhythmic drugs, who might require coronary risk stratification prior to initiation of the drug, when global risk is moderate or high.

- **CAD Risk—Low**
  10 - year absolute coronary or cardiovascular risk less than 10%
- **CAD Risk—Moderate**
  10 - year absolute coronary or cardiovascular risk between 10% and 20%
- **CAD Risk—High**
  10 - year absolute coronary or cardiovascular risk of greater than 20%

Websites for Global Cardiovascular Risk Calculators*

*Patients who have already manifested cardiovascular disease are already at high global risk and are not applicable to the calculators.
(Arnett, 2019; D'Agostino, 2008; Goff, 2014; McClelland, 2015; Ridker, 2007)

Risk Calculator	Websites for Online Calculator
Framingham Cardiovascular Risk	https://reference.medscape.com/calculator/framingham-cardiovascular-disease-risk
Reynolds Risk Score Can use if no diabetes Unique for use of family history	http://www.reynoldsriskscore.org/
Pooled Cohort Equation	http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator	http://tools.acc.org/ASCVD-Risk-Estimator/
MESA Risk Calculator With addition of Coronary Artery Calcium Score, for CAD-only risk	https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx

~~**Coronary Artery Calcium Scoring**~~
~~(Arnett, 2019)~~

~~**Non-contrast** coronary computed tomography (non-contrast coronary CT) and its older technological version, electron beam computed tomography (EBCT), provide quantitative coronary artery calcium scoring, which is appropriate for further evaluation of coronary risk in asymptomatic patients without known cardiovascular disease, who are at low to intermediate or intermediate global risk for coronary or overall cardiovascular disease. Non-contrast coronary CT (computed tomography) and EBCT are supported by a separate CPT code and guideline document with references titled EBCT or Non-Contrast Coronary CT.~~

Definitions of Coronary Artery Disease
(Fihn, 2012; Lofti, 2018; Mintz, 2016; Montalescot, 2013; Patel, 2017)

- Percentage stenosis refers to the reduction in diameter stenosis when angiography is the method and can be estimated or measured using angiography or more accurately measured with intravascular ultrasound (IVUS).
- Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. It is not a diagnostic tool so much as it is a **risk stratification** tool. Its incorporation into global risk can be achieved by using the MESA risk calculator.
- Stenoses ≥ 70% are considered obstructive coronary artery disease (also referred to as clinically significant), while stenoses ≤ 70% are considered non-obstructive coronary artery disease (Patel, 2017).
- Ischemia-producing disease (also called hemodynamically or functionally significant disease, for which revascularization might be appropriate) generally implies at least one of the following:
    - Suggested by percentage diameter stenosis ≥ 70% by angiography; borderline lesions are 40 - 70% (Fihn, 2012)
    - For a left main artery, suggested by a percentage stenosis ≥ 50% or minimum luminal cross-sectional area on IVUS ≤ 6 square mm (Fihn, 2012; Lofti, 2018; Mintz, 2016)
    - FFR (fractional flow reserve) ≤ 0.80 for a major vessel (Lofti, 2018; Mintz, 2016)
    - iFR (instantaneous wave-free ratio) ≤ 0.89 for a major vessel (Davies, 2017; Gotberg, 2017; Lofti, 2018)
    - Demonstrable ischemic findings on stress testing (ECG or stress imaging), that are at least mild in degree
- A major vessel would be a coronary vessel that would be amenable to revascularization, if indicated. This assessment is made based on the diameter of the vessel and/or the extent of myocardial territory served by the vessel.
- FFR is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a significant reduction in coronary flow.

- ~~Instantaneous wave-free ratio (iFR) measures the ratio of distal coronary to aortic pressure during the wave-free period of diastole, with a value ≤ 0.89 considered hemodynamically significant (Davies, 2017; Gotberg, 2017).~~
- Newer technology that estimates FFR from CCTA images is covered under the separate NIA Guideline for FFR-CT.

Anginal Equivalent
(Fihn, 2012; Moya, 2009; Shen, 2017)

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons that symptoms other than chest discomfort are not due to other organ systems (e.g., dyspnea due to lung disease, fatigue due to anemia), by presentation of clinical data such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope per se is not an anginal equivalent.

Abbreviations

ACS	Acute coronary syndrome
CABG	Coronary artery bypass grafting surgery
CAD	Coronary artery disease
CCS	Coronary calcium score
CCTA	Coronary computed tomography angiography
ECG	Electrocardiogram
MI	Myocardial infarction
MPI	Myocardial Perfusion Imaging
PCI	Percutaneous coronary intervention
SE	Stress echocardiography
TTE	Transthoracic echocardiography

POLICY HISTORY

Date	Summary
January 2022	• Deleted the requirement for stress echocardiography. • Changed to Intermediate and High probability chest pain patients now allowable as first line testing • Intermediate DTS patients now allowable for CCTA • Removed EF < 40%, keeping the existing EF< 50% systolic dysfunction, and adding symptomatic diastolic heart failure with no prior workup

	• Added a paragraph explaining the changes, new guidelines of November 2021 with contraindications within the overview section • Added section on when CCTA is preferred over ETT in low-risk patients • Deleted the phrasing 'scenarios that support MPI over SE' as it would no longer apply here. Replaced with 'Scenarios that can additionally support a CCTA over a regular exercise treadmill test in the low probability scenario'. • Deleted statement that MPI may be supported over CCTA in Poorly controlled atrial fibrillation/ectopy • Took out the word 'intermediate' in the phrase "The (symptomatic) low pretest probability patient who is able to exercise and has an interpretable ECG" • Removed section on Coronary Artery calcium scoring
March 2021	• Deleted: Appropriate exercise ECG stress test with low Duke Treadmill Score (≥ 5) and continued symptoms concerning for CAD • Added: High pretest probability as an alternative to coronary angiography (can also do MPI) • Removed statement about low Duke treadmill score and continuing symptoms

March 2020	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review
	• Added further details for imaging of coronary anomaly or aneurysm to include the following:
	  ○ Evaluation prior to planned repair
	  ○ Evaluation due to change in clinical status and/or new concerning signs or symptoms
	• Added edits to the Coronary Artery Disease definition section
	• Updated and added references

July 2019	• CCTA can be used as an alternative to coronary angiography in appropriate patients prior to valve surgery or transcatheter intervention • Noted CMR is favored over CCTA in young patients for evaluation of coronary anomaly or aneurysm • Global Risk of Cardiovascular Disease information expanded in background section for additional clarification

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Reviewed / Approved by NIA Clinical Guideline Committee

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