Evaluating Appropriateness for Cardiac Computed Tomography

OVERVIEW

The purpose of this document is to specifically identify the appropriate selection of patients for cardiac computed tomographic (CCT) imaging.

BACKGROUND

- In an effort to guide physicians in the appropriate use of CCT the ACCF/SCCT/ACR/AHA/ASE/ASNC/SCAI/SCMR updated and published the *2010 Appropriate Use Criteria for Cardiac Computed Tomography* (1).
- CCT appropriate use criteria (AUC) support a primary principle of radiation risk reduction advocated by the FDA Center for Devices and Radiological Health: **right exam, for the right reason, at the right time.**
- These criteria promote optimal CCT utilization in the setting of increased use and limited financial resources.

DEFINITION OF AN APPROPRIATE STUDY

An appropriate imaging study is one from which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.

The technical panel scores each indication as follows:

- **Appropriate test for specific indication** (test **is** generally acceptable and **is** a reasonable approach for the indication).
- **Uncertain for specific indication** (test **may be** generally acceptable and **may be** a reasonable approach for the indication). (Uncertainty also implies that more research and/or patient information are needed to classify the indication definitively.)
- **Inappropriate test for specific indication** (test **is not** generally acceptable and **is not** a reasonable approach for the indication).

DETERMINING PRE-TEST RISK ASSESSMENT FOR RISK STRATIFICATION

- ***Pre-test Probability of Obstructive /Significant CAD in Symptomatic (Ischemic Equivalent) Patients:*** In the presence of ischemic equivalent symptoms, the AUC

Table A. **Pre-test Probability of Obstructive/Significant CAD for Symptomatic (Ischemic Equivalent Patients)**

Age (Years)	Sex	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Nonanginal Chest Pain	Asymptomatic
< 39	Men	Intermediate	Intermediate	Low	Very low
	Women	Intermediate	Very low	Very low	Very low
40 - 49	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Low	Very low	Very low
50 - 59	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Intermediate	Low	Very low
> 60	Men	High	Intermediate	Intermediate	Low
	Women	High	Intermediate	Intermediate	Low

Very Low pre-test probability: <5%; **Low pre-test probability:** <10%;
Intermediate pre-test probability: Between 10% and 90%; **High pre-test probability:** >90%

for CCT requires the assessment of the pre-test probability of CAD as shown in Table A (2- 3)

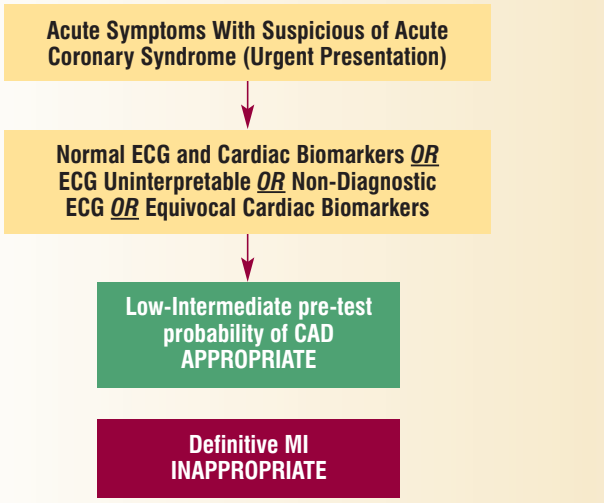
CCT INDICATIONS CATEGORY

This document addresses 97 common clinical scenarios in which CCT may be considered, defining each as Appropriate, Inappropriate, or Uncertain. This document attempts to summarize these criteria and provide a guide to the appropriate selection of patients for CCT in the following clinical scenarios.

DETECTION OF CAD IN SYMPTOMATIC PATIENTS WITHOUT KNOWN HEART DISEASE (SYMPTOMATIC ACUTE PRESENTATION)

In patients with acute symptoms suspicious of acute coronary syndrome (See Figure 1):

Figure 1. **Detection of CAD in Symptomatic Patients Without Known Heart Disease (Symptomatic Acute Presentation)**



APPROPRIATE INDICATIONS

- In the presence of normal electrocardiogram (ECG) and cardiac biomarkers (low and intermediate pre-test probability of CAD)
- ECG uninterpretable (low and intermediate pre-test probability of CAD)
- Equivocal cardiac biomarkers (low and intermediate pre-test probability of CAD)

INAPPROPRIATE INDICATIONS

- Definitive myocardial infarction (MI)

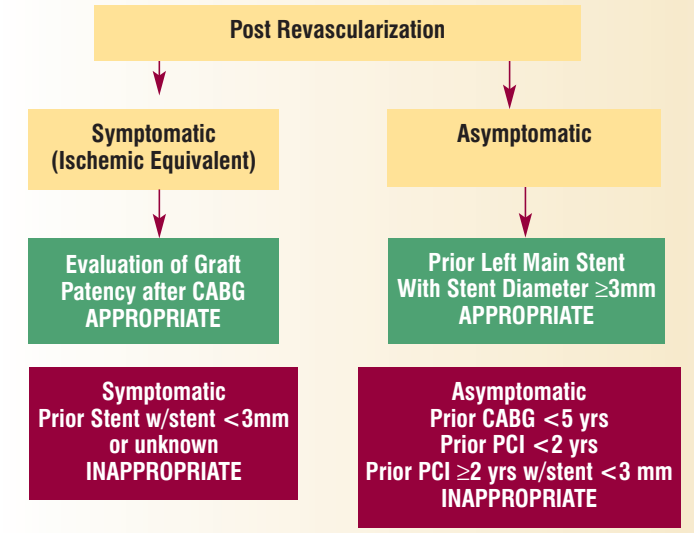
UNCERTAIN INDICATIONS:

- In the presence of normal ECG and cardiac biomarkers (high pre-test probability of CAD)
- ECG uninterpretable (high pre-test probability of CAD)
- Equivocal cardiac biomarkers (high pre-test probability of CAD)
- Persistent ST segment elevation following exclusion MI
- "Triple rule out"

RISK ASSESSMENT POST REVASCULARIZATION (PCI OR CABG)

In patients with prior revascularization, PCI, or CABG (See Figure 2):

Figure 2. **Risk Assessment Post Revascularization (PCI or CABG)**



APPROPRIATE INDICATIONS

- Evaluation of graft patency in symptomatic (ischemic equivalent)
- Prior left main coronary stent with stent diameter ≥ 3mm (asymptomatic)

INAPPROPRIATE INDICATIONS

- Prior coronary stent with stent diameter < 3mm or not known in symptomatic (ischemic equivalent)
- Prior coronary artery bypass grafting surgery (CABG) < 5 years (asymptomatic)

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- Prior percutaneous coronary intervention (PCI) < 2 years (asymptomatic)
- Prior PCI ≥ 2 years with stent diameter < 3 mm (asymptomatic)

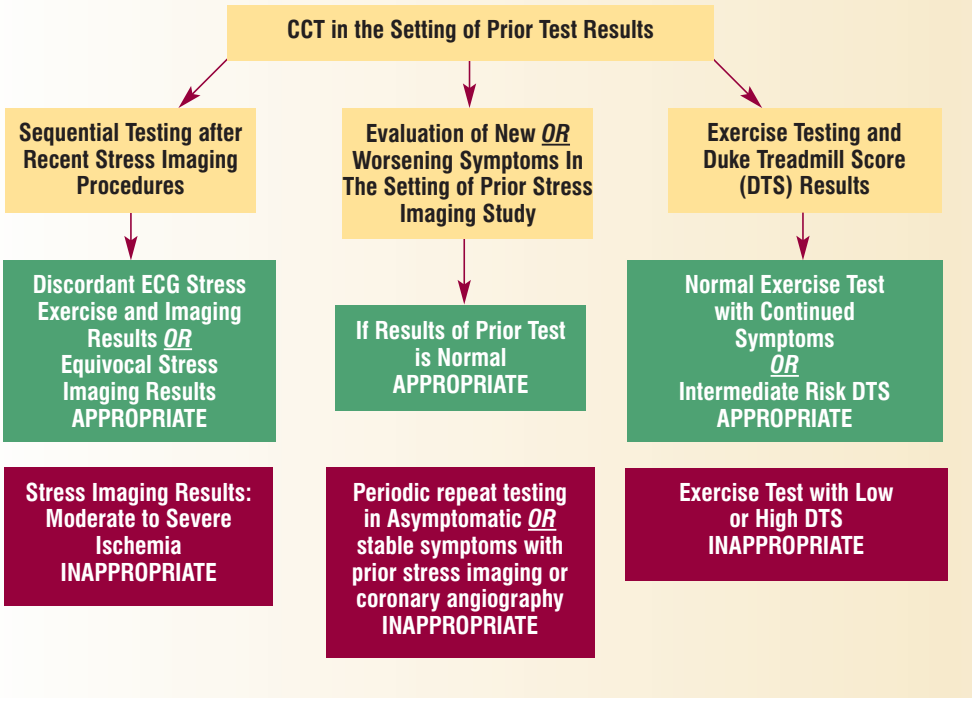
UNCERTAIN INDICATIONS

- Prior coronary stent with stent diameter ≥ 3mm (symptomatic)
- Prior CABG ≥ 5 years (asymptomatic)
- Prior PCI ≥ 2 years with stent diameter ≥ 3 mm (asymptomatic)

USE OF CCT IN THE SETTING OF PRIOR TEST RESULTS

The results of prior stress testing, exercise imaging testing impact the appropriateness of a subsequent CCT (See Figure 3):

Figure 3. **CCT in the Setting of Prior Test Results**



APPROPRIATE INDICATIONS

- Sequential stress imaging with discordant ECG exercise and imaging results
- Sequential stress imaging with equivocal stress imaging
- Evaluation of worsening symptoms in the setting of a prior normal stress imaging
- Normal exercise test with continued symptoms
- Exercise testing (Intermediate Duke Treadmill Score)
- Diagnostic impact of coronary calcium on the decision to perform contrast CT angiography in symptomatic patients (coronary calcium score ≤ 400)

INAPPROPRIATE INDICATIONS

- Prior stress imaging results consistent with moderate to severe ischemia
- Periodic repeat testing in asymptomatic ***OR*** stable symptoms with prior stress imaging or coronary angiography
- Exercise testing (Low or High Duke Treadmill Score)

UNCERTAIN INDICATIONS

- Sequential testing after recent stress imaging with mild ischemia
- Evaluation of worsening symptoms in the setting of a prior abnormal stress imaging
- Diagnostic impact of coronary calcium on the decision to perform contrast CCT in symptomatic patients (coronary calcium score 400-1000)

DETECTION OF CAD IN SYMPTOMATIC PATIENTS WITHOUT KNOWN HEART DISEASE (SYMPTOMATIC NON-ACUTE PRESENTATION)

In patients with non-acute symptoms possibly representing ischemic equivalent (See Figure 4):

APPROPRIATE INDICATIONS

- ECG interpretable and able to exercise (intermediate pre-test probability of CAD)
- ECG uninterpretable ***OR*** unable to exercise (low-intermediate pre-test probability of CAD)

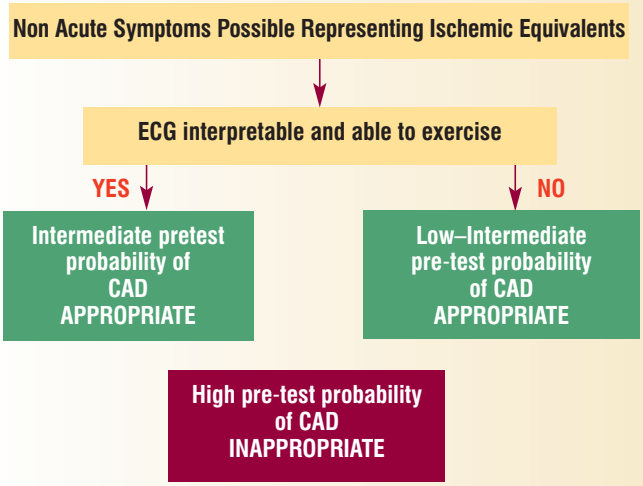
INAPPROPRIATE INDICATIONS

- ECG interpretable and able to exercise (high pre-test probability of CAD)

UNCERTAIN INDICATIONS

- ECG interpretable and able to exercise (low pre-test probability of CAD)
- ECG uninterpretable ***OR*** unable to exercise (high pre-test probability of CAD)

Figure 4. **Detection of CAD in Symptomatic Patients Without Known Heart Disease (Symptomatic —Non acute Presentation)**



DETECTION OF CAD IN OTHER CLINICAL SCENARIOS

Please see Table B for appropriate and inappropriate indications for CCT in other clinical scenarios referenced in the *2010 Appropriate Use Criteria for Cardiac Computed Tomography.*

Table B. **Detection of CAD in Other Clinical Scenarios**

Detection of CAD in Other Clinical Scenarios	
Appropriate indications	**Inappropriate indications**
New onset heart failure in patients with no prior CAD who have reduced ejection fraction (low and intermediate pre-test probability of CAD)	Evaluation of CAD in patients with new-onset (ongoing) atrial fibrillation
Preoperative coronary assessment prior to noncoronary cardiac surgery (intermediate pre test probability of CAD)	Preoperative coronary assessment prior to noncoronary cardiac surgery in high risk patients

UNCERTAIN INDICATIONS

- New onset heart failure in patients with no prior CAD who have normal LV ejection fraction
- New onset heart failure in patients with no prior CAD who have reduced ejection fraction (high pre-test probability of CAD)
- Preoperative coronary assessment prior to noncoronary cardiac surgery (low pre-test probability of CAD)
- Syncope ***OR*** non-sustained ventricular tachycardia
- Elevated troponin of uncertain clinical significance

EVALUATION OF CARDIAC STRUCTURE AND FUNCTION: EVALUATION OF INTRA- AND EXTRA-CARDIAC STRUCTURES

Please see Tables C, D, and E for CCT appropriate and inappropriate indications in the evaluation of ventricular morphology and function (Table C), adult congenital heart disease (Table D), and evaluation of intra- and extra-cardiac structures (Table E).

Table C. **Evaluation of Ventricular Morphology and Function**

Evaluation of Ventricular Morphology and Systolic Function	
Appropriate indications	**Inappropriate indications**
Evaluation of LV function following acute MI or in HF patients; if inadequate images from other methods	Initial evaluation of LV function following acute MI or in HF patients
Quantitative evaluation of RV function.	--------
Assessment of RV morphology in suspected arrhythmogenic right ventricular dysplasia	--------

Table D. **Adult Congenital Heart Disease**

Adult Congenital Heart Disease	
Appropriate indications	**Inappropriate indications**
Assessment of anomalies of coronary arteries.	--------
Assessment of complex congenital heart disease	--------

Table E. **Evaluation of Intra- and Extra-cardiac Structures**

Evaluation of Intra- and Extracardiac Structures	
Appropriate indications	**Inappropriate indications**
Characterization of native or prosthetic cardiac valves; if inadequate images from other noninvasive methods	--------
Evaluation of cardiac mass (suspected tumor or thrombus); if inadequate images from other noninvasive methods	Initial evaluation of cardiac mass (suspected tumor or thrombus)
Evaluation of pericardial anatomy	--------
Evaluation of pulmonary vein anatomy prior to radiofrequency ablation	--------
Noninvasive coronary vein mapping prior to placement of biventricular pacemaker	--------
Localization of coronary bypass grafts and other retrosternal anatomy prior to preoperative chest or cardiac surgery	--------

DETECTION OF CAD/RISK ASSESSMENT IN ASYMPTOMATIC INDIVIDUALS WITHOUT KNOWN CAD

- Asymptomatic patients should have coronary heart disease (CHD) risk determined by the National Heart, Lung, and Blood Institute report on "Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (4). This report defines CHD Risk in terms of Low (a 10-year absolute CHD risk of 10%), Intermediate (a 10-year absolute CHD risk between 10% to 20%), and High (a 10-year absolute CHD risk of 20%).
- Since risk scores may be miscalibrated in certain populations (e.g., women, younger men), clinical judgment should be applied in selecting categorical risk thresholds. Among women and younger men, an expanded intermediate risk range of 6% to 20% may be appropriate.
- Coronary calcium score (CCS) (non-contrast CT) is considered **appropriate** among asymptomatic individuals with no prior history of CAD who have intermediate risk as well as those who have a low risk but a family history of premature CHD.

- The use of CCT among low or intermediate risk asymptomatic individuals is considered **inappropriate**.
- The use of either CTA or CCS has an uncertain level of appropriateness among asymptomatic high risk individuals. **An uncertain level of appropriateness** is considered in the following:
  - The use of either CCT or CCS among asymptomatic high risk individuals
  - Repeat CCS with zero CCS > 5 y ago
  - The use of CCT for routine evaluation of coronary arteries following heart transplantation

SUMMARY OF CURRENT UTILIZATION OF CCT UTILIZATION

In a 2010 study of CCT utilization, the top four inappropriate indications (6), that accounted for of all Inappropriate studies were:

- **Detection of CAD in asymptomatic patient with low CHD risk (30%)**
- **Detection of CAD in asymptomatic patient less than 5 years after CABG for evaluation of bypass grafts and coronary anatomy (21%)**
- **Detection of CAD in asymptomatic patient greater than 5 years after CABG for evaluation of bypass grafts and coronary anatomy (13%)**
- **Detection of CAD in symptomatic patient with high pretest probability of CAD (9%)**

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ASNC thanks the following members for their contributions to this document: Maria Sciammarella, MD (Chair); Ron Blankstein, MD; Jamieson Bourque, MD; and Saurabh Malhotra, MD. The authors have indicated they have no relevant financial relationships with any commercial interest that produces health care goods or services related to the content of this document.

The 2011 Practice Points program is supported by Astellas Pharma US, Inc., Bracco Diagnostics Inc., Covidien-Mallinckrodt, GE Healthcare, and Lantheus Medical Imaging.

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Last updated: November 2011

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