Shortness of Breath

Clinical Guidelines for Medical Necessity Review

Version: V2.0
Effective Date: August 23, 2022

Important Notices

Notices & Disclaimers:

GUIDELINES SOLELY FOR COHERE'S USE IN PERFORMING MEDICAL NECESSITY REVIEWS AND ARE NOT INTENDED TO INFORM OR ALTER CLINICAL DECISION MAKING OF END USERS.

Cohere Health, Inc. (**"Cohere"**) has published these clinical guidelines to determine the medical necessity of services (the **"Guidelines"**) for informational purposes only and solely for use by Cohere's authorized **"End Users."** These Guidelines (and any attachments or linked third party content) are not intended to be a substitute for medical advice, diagnosis, or treatment directed by an appropriately licensed healthcare professional. These Guidelines are not in any way intended to support clinical decision-making of any kind; their sole purpose and intended use are to summarize certain criteria Cohere may use when reviewing the medical necessity of any service requests submitted to Cohere by End Users. Always seek the advice of a qualified healthcare professional regarding any medical questions, treatment decisions, or other clinical guidance. The Guidelines, including any attachments or linked content, are subject to change at any time without notice.

Other Notices:

Guideline Information:

Disease Area: Cardiology
Care Path Group: Diagnostic
Care Path Name: Shortness of Breath
Type: [**X**] Adult (18+ yo) | [_] Pediatric (0-17yo)

Physician author: Mary Krebs, MD (Primary Care Physician), Senthil Sundaram, MD (Cardiologist)
Peer reviewed by: Kenneth Korr, MD (Cardiologist), Carter Newton, MD FACC (Cardiologist), Russell Rotondo, MD FACC (Cardiologist); Sandeep Jauhar, MD (Cardiologist)
Literature review current through: August 10, 2022
Document last updated: August 23, 2022

Table of Contents

Important Notices **2**

Care Path Overview **6**

Care Path Clinical Discussion 6

Key Information 8

Definitions 8

Care Path Diagnostic Criteria **11**

Disease Classification 11

ICD-10 Codes Associated with Classification 11

Presentation and Etiology 14

Causes and Risk Factors 14

Clinical Presentation and Typical History Findings 15

Typical Physical Exam Findings 16

Typical Diagnostic Findings 17

Care Path Services & Medical Necessity Criteria **19**

Non-Invasive Testing 19

Service: Coronary Computed Tomography Angiogram (CCTA) 19

Medical Necessity Criteria 19

Indications 19

Non-Indications 20

Site of Service Criteria 20

Procedure Codes (HCPCS/CPT) 20

Service: Fractional Flow Reserve (CT-FFR) 21

General Guidelines 21

Medical Necessity Criteria 21

Indications 21

Non-Indications 21

Site of Service Criteria 21

Procedure Codes (HCPCS/CPT) 22

Service: Magnetic Resonance Imaging (MRI), Cardiac 23

General Guidelines 23

Medical Necessity Criteria 23

Indications 23

Non-Indications 24

Site of Service Criteria 24

Procedure Codes (HCPCS/CPT) 24

Service: Myocardial Perfusion Imaging Single Photon Emission Computed Tomography (MPI-SPECT) 26
General Guidelines 26
Medical Necessity Criteria 26
Indications 26
Non-Indications 27
Site of Service Criteria 27
Procedure Codes (HCPCS/CPT) 27
Service: Stress Echocardiogram 28
General Guidelines 28
Medical Necessity Criteria 28
Indications 28
Non-Indications 29
Site of Service Criteria 29
Procedure Codes (HCPCS/CPT) 29
Service: Cardiac Positron Emission Tomography (PET) 31
General Guidelines 31
Medical Necessity Criteria 31
Indications 31
Non-Indications 31
Normal stress test (given adequate stress) within the last year.Site of Service Criteria 32
Procedure Codes (HCPCS/CPT) 32
Service: Transthoracic Echocardiogram (TTE) 34
General Guidelines 34
Medical Necessity Criteria 34
Indications 34
Non-Indications 35
Site of Service Criteria 35
Procedure Codes (HCPCS/CPT) 35
Non-Surgical Management 36
Service: Cardiac Rehabilitation 36
General Guidelines 36
Medical Necessity Criteria 36
Indications 36
Non-Indications 37
Site of Service Criteria 37

Procedure Codes (HCPCS/CPT) 37
Surgical or Interventional Management 38
Service: Left Cardiac Catheterization 38
General Guidelines 38
Medical Necessity Criteria 38
Indications 38
Non-indications 39
Site of Service Criteria 40
Procedure Codes (HCPCS/CPT) 40
Service: Left and Right Cardiac Catheterization 41
General Guidelines 41
Medical Necessity Criteria 41
Indications 41
Non-Indications 42
Site of Service Criteria 42
Procedure Codes (HCPCS/CPT) 42
Service: Other Cardiac Catheterization 43
General Guidelines 43
Medical Necessity Criteria 43
Indications 43
Non-Indications 44
Site of Service Criteria 44
Procedure Codes (HCPCS/CPT) 44
Service: Percutaneous Coronary Intervention (PCI)/Angioplasty/Stent 45
General Guidelines 45
Medical Necessity Criteria 45
Indications 45
Non-Indications 45
Site of Service Criteria 45
Procedure Codes (HCPCS/CPT) 46
Surgical Risk Factors 48
References 51
Clinical Guideline Revision History/Information 56

Care Path Overview

Care Path Clinical Discussion

Respiratory difficulty is a common problem in the outpatient primary care setting. Respiratory difficulty may be referred to as shortness of breath or dyspnea. Shortness of breath is most commonly caused by respiratory and cardiac disorders. Other causes may be upper airway obstruction, metabolic acidosis, an anxiety disorder, or a neuromuscular condition.[1]

The initial goal of assessment is to determine the severity of the dyspnea and assess the need for oxygenation. If the patient is unstable, they should be transferred to the emergency department. In a stable patient, management depends on the underlying etiology of the dyspnea.[1] The physician must determine if the shortness of breath originates from the heart, lungs, or elsewhere.

Pertinent history findings include cough, sore throat, chest pain, edema, orthopnea, tobacco use, and occupational exposures. The physical examination should focus on vital signs and the heart, lungs, neck, and lower extremities. Diagnostic evaluation should include pulse oximetry, complete blood count, ECG, and chest x-ray.

The severity of dyspnea and rate of worsening are important determinants of the urgency and location of diagnostic testing. Additional testing may be indicated, especially when the history, physical examination, and initial testing do not provide a diagnosis. Such tests should be directed by the physician's suspicion of an underlying cause and may include a transthoracic echocardiogram, cardiac stress testing, cardiac MRI, pulmonary function testing, high-resolution non-contrast CT scan of the chest, and a ventilation-perfusion scan. If these non-invasive tests do not clarify the diagnosis, it may be appropriate to do more invasive testing, such as bronchoscopy, lung biopsy, or cardiac or pulmonary catheterization. Cardiopulmonary exercise testing may help in assessing dyspnea when it is disproportionately worse than the severity of a patient's underlying cardiac or pulmonary disease.[2]

After the underlying cause of dyspnea has been identified, the goals are to initiate appropriate treatment and to improve subjective and measurable symptoms of dyspnea. For patients who use tobacco, cessation should be encouraged.[2]

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 patient with shortness of breath may present to the office of the primary care physician or specialist. They may also present in the emergency department.
- ➢ A patient's presentation may be acute or chronic (present for more than one month.)[3]
- ➢ Shortness of breath is most commonly caused by cardiovascular and pulmonary problems.
- ➢ Initial diagnostic evaluation should include pulse oximetry, complete blood count, ECG, and chest x-ray unless the diagnosis is clear.
- ➢ The American College of Cardiology and the American Heart Association recommend echocardiography (or alternative imaging) when there is suspicion of valvular, myocardial, or pericardial disease.[3,4]
- ➢ Cardiovascular stress testing with or without imaging may clarify the likelihood of coronary ischemia.

Definitions

- **Chronic obstructive pulmonary disease (COPD):** A common pulmonary condition characterized by persistent respiratory symptoms and airflow limitation from airway or alveolar abnormalities.[1,2] It affects more than 5 percent of the population and is associated with high morbidity and mortality.[3,5] It is the fourth-ranked cause of death in the United States, killing more than 120,000 individuals each year.[6] COPD is usually caused by tobacco use or noxious substance inhalation.
- **COPD subtypes:**
  - **Chronic Bronchitis:** A chronic productive cough for three months in each of two successive years in a patient in whom other causes of chronic cough (i.e., bronchiectasis) were excluded.[7]
  - **Emphysema:** A condition describing some of the structural changes associated with COPD (e.g., abnormal and permanent enlargement of the airspaces distal to the terminal bronchioles and destruction of the airspace walls, without obvious fibrosis.[8]
  - **Asthma:** A chronic inflammatory disorder of the airways associated with hyperactive airway responsiveness. It leads to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing. These episodes are usually associated with widespread, often reversible airflow obstruction within the lung.[9]
- **Pretest Probability (of CAD):** Pretest probability of CAD is the likelihood that the patient has CAD, calculated before the test result is known.

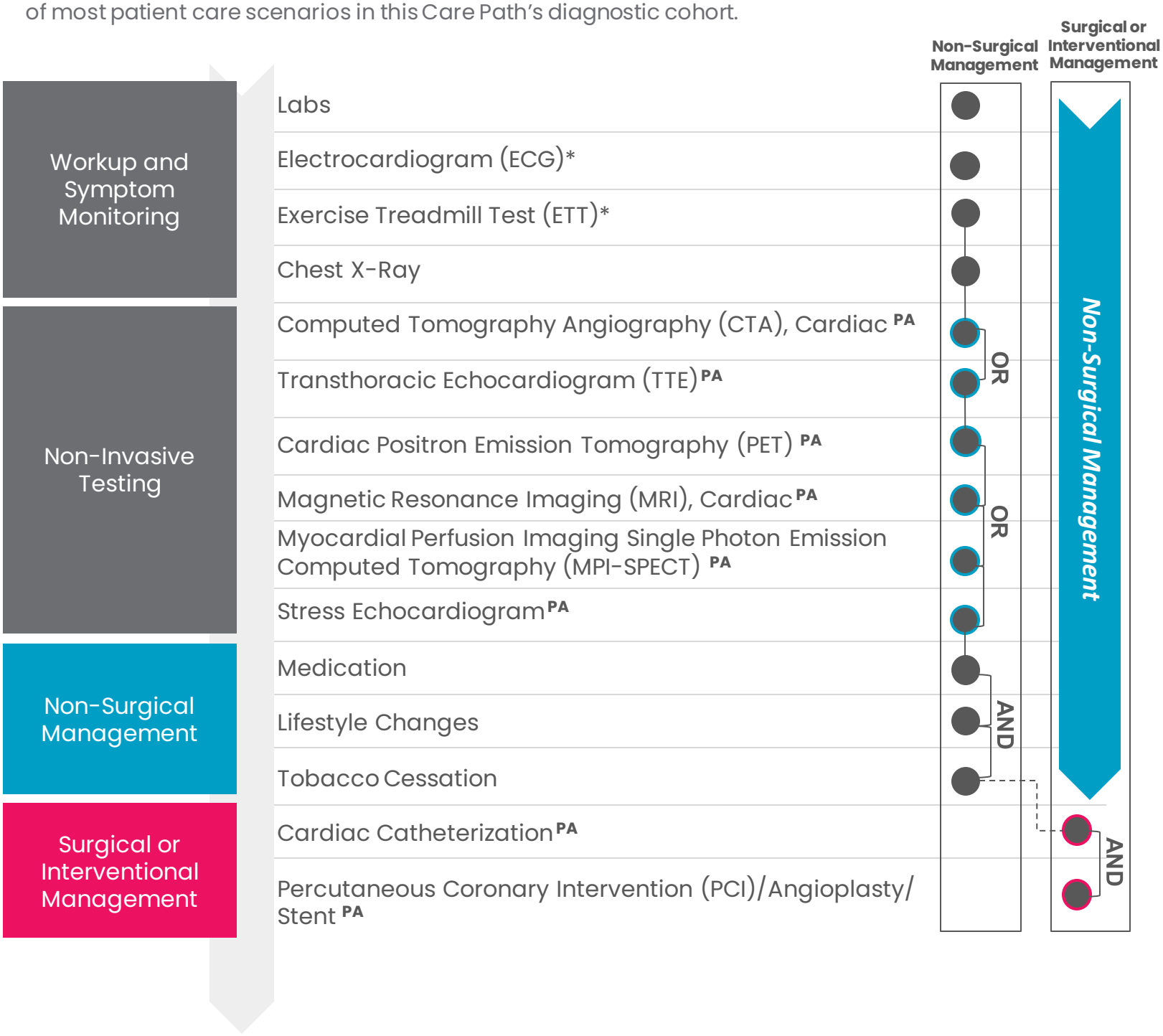
These guidelines reference the 2019 European Society of Cardiology (ESC) Guidelines for the diagnosis and management of chronic coronary syndromes model to calculate the pretest probability based on age, sex, and type of chest pain.[10]

- **CAD:** coronary artery disease
- **PAL:** prior authorization list
- **ACC:** American College of Cardiology
- **AHA:** American Heart Association
- **Canadian Cardiovascular Society grading of Angina Pectoris**:
    - Grade I: Ordinary physical activity does not cause angina, such as walking and climbing stairs. Angina with strenuous or rapid or prolonged exertion at work or recreation.
    - Grade II: Slight limitation of ordinary activity. Angina with walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals, or in cold, or inwind, or under emotional stress, or only during the few hours after awakening. Angina with alking more than two blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal conditions.
    - Grade III: Marked limitation of ordinary physical activity. Angina withalking one or two blocks on the level and climbing one flight of stairs in normal conditions and at a normal pace.
    - Grade IV: Inability to carry on any physical activity without discomfort, anginal syndrome may be present at rest.

Shortness of Breath

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

Shortness of breath

ICD-10 Codes Associated with Classification

ICD-10 Code	Code Description/Definition
R06.00	Dyspnea, unspecified
R06.01	Orthopnea
R06.02	Shortness of breath
R06.03	Acute respiratory distress
R06.09	Other forms of dyspnea
R06.82	Tachypnea, not elsewhere classified
R06.89	Other abnormalities of breathing
R06.9	Unspecified abnormalities of breathing
F17.200	Nicotine dependence, unspecified, uncomplicated
F17.201	Nicotine dependence, unspecified, in remission
F17.209	Nicotine dependence, unspecified, with unspecified nicotine-induced disorders
F17.210	Nicotine dependence, cigarettes, uncomplicated
F17.211	Nicotine dependence, cigarettes, in remission
F17.213	Nicotine dependence, cigarettes, with withdrawal
F17.219	Nicotine dependence, cigarettes, with unspecified nicotine-induced disorders
F17.290	Nicotine dependence, other tobacco product, uncomplicated
G47.30	Sleep apnea, unspecified
G47.33	Obstructive sleep apnea (adult) (pediatric)
I10	Essential Primary Hypertension
I26	Pulmonary embolism

I26.0	Pulmonary embolism with acute cor pulmonale
I26.01	Septic pulmonary embolism with acute cor pulmonale
I26.02	Saddle embolus of pulmonary artery with acute cor pulmonale
I26.09	Other pulmonary embolism with acute cor pulmonale
I26.9	Pulmonary embolism without acute cor pulmonale
I26.90	Septic pulmonary embolism without acute cor pulmonale
I26.92	Saddle embolus of pulmonary artery without acute cor pulmonale
I26.93	Single subsegmental pulmonary embolism without acute cor pulmonale
I26.94	Multiple subsegmental pulmonary emboli without acute cor pulmonale
I26.99	Other pulmonary embolism without acute cor pulmonale
I27.20	Pulmonary hypertension, unspecified
I27.21	Secondary pulmonary arterial hypertension
J43.9	Emphysema, unspecified
J44.9	Chronic obstructive pulmonary disease, unspecified
J80	Acute respiratory distress syndrome
J81.0	Acute pulmonary edema
J81.1	Chronic pulmonary edema
J90	Pleural effusion, not elsewhere classified
J96.00	Acute respiratory failure, unspecified whether with hypoxia or hypercapnia
J96.01	Acute respiratory failure with hypoxia
J96.02	Acute respiratory failure with hypercapnia
J96.10	Chronic respiratory failure, unspecified whether with hypoxia or hypercapnia
J96.11	Chronic respiratory failure with hypoxia
J96.12	Chronic respiratory failure with hypercapnia
J96.20	Acute and chronic respiratory failure, unspecified whether

	with hypoxia or hypercapnia
J96.21	Acute and chronic respiratory failure with hypoxia
J96.22	Acute and chronic respiratory failure with hypercapnia
J96.90	Respiratory failure, unspecified, unspecified whether with hypoxia or hypercapnia
J96.91	Respiratory failure, unspecified with hypoxia
J96.92	Respiratory failure, unspecified with hypercapnia
J98.19	Other pulmonary collapse
J98.4	Other disorders of lung
R09.02	Hypoxemia
R09.2	Respiratory arrest
R23.0	Cyanosis
R60.9	Edema, unspecified
R91.8	Other nonspecific abnormal finding of lung field
T65.224A	Toxic effect of tobacco cigarettes, undetermined, initial encounter
Z72.0	Tobacco use
Z82.49	Family history of ischemic heart disease and other diseases of the circulatory system
Z87.891	Personal history of nicotine dependence
I27	Other pulmonary heart diseases
I27.0	Primary pulmonary hypertension
I27.1	Kyphoscoliotic heart disease
I27.2	Other secondary pulmonary hypertension
I27.20	Pulmonary hypertension, unspecified
I27.21	Secondary pulmonary arterial hypertension
I27.22	Pulmonary hypertension due to left heart disease
I27.23	Pulmonary hypertension due to lung diseases and hypoxia
I27.24	Chronic thromboembolic pulmonary hypertension
I27.29	Other secondary pulmonary hypertension

I27.8	Other specified pulmonary heart diseases
I27.81	Cor pulmonale (chronic)
I27.82	Chronic pulmonary embolism
I27.89	Other specified pulmonary heart diseases
I27.9	Pulmonary heart disease, unspecified
I28	Other diseases of pulmonary vessels
I28.1	Aneurysm of pulmonary artery
I28.8	Other diseases of pulmonary vessels
I28.9	Disease of pulmonary vessels, unspecified

Presentation and Etiology

Causes and Risk Factors

Cardiovascular and respiratory disorders most commonly cause shortness of breath. Other causes include upper airway obstruction, metabolic acidosis, a psychogenic disorder, or a neuromuscular condition.[1]

Cardiovascular causes include congestive heart failure, coronary artery disease (CAD), acute coronary syndrome, cardiomyopathy, valve dysfunction, pericarditis, pericardial tamponade, valvular heart defect, pulmonary hypertension, cardiac arrhythmia, or intracardiac shunting.[8]

Respiratory causes may include asthma, chronic obstructive pulmonary disorder (COPD), pneumonia, pulmonary embolism, lung malignancy, pleural effusion, restrictive lung disease, pneumothorax, or aspiration.[8]

Other illnesses, such as anemia, acute renal failure, metabolic acidosis, thyrotoxicosis, cirrhosis of the liver, anaphylaxis, sepsis, angioedema, and epiglottitis, may also cause dyspnea.[8] Shortness of breath can also occur as a somatic manifestation of psychiatric disorders, including anxiety disorders.[7]

Clinical Presentation and Typical History Findings

The history should ascertain whether there are any chronic underlying cardiovascular or pulmonary problems. The physician should determine onset, character, duration, severity, periodicity, associated symptoms, progression of symptoms, aggravating and alleviating factors, and occurrence at rest or exertion for the patient. Patients with heart failure may describe air hunger or a suffocating sensation. An exacerbation of heart failure is a sensation of shortness of breath with exertion. Patients with asthma often describe a sensation of chest tightness. The sense of increased breathing effort is a common feature of conditions characterized by abnormal mechanical loads (e.g., COPD, interstitial lung disease) and neuromuscular weakness.[3]

Severe respiratory distress continuing over one to two hours should prompt evaluation for congestive heart failure or asthma. Sudden shortness of breath at rest may suggest pulmonary embolism or pneumothorax.[1] Vehicle airbag trauma or other penetrating or nonpenetrating trauma can cause pneumothorax. The physician should inquire about tobacco use, which increases the risk of pulmonary and cardiovascular problems.

Coronary or pulmonary disease can cause chest pain associated with dyspnea. Pericarditis, pulmonary embolism, pneumonia, pneumothorax, or pleuritis can cause pleuritic chest pain. Orthopnea, paroxysmal nocturnal dyspnea, and peripheral edema are prominent symptoms of congestive heart failure. Patients with spontaneous pneumothorax almost always experience chest pain, and dyspnea is the second most common symptom. Anginal chest pain accompanied by shortness of breath may signify ischemic heart disease associated with left ventricular dysfunction. Paroxysmal nocturnal dyspnea or pulmonary edema may be the only clinical presentation in ten percent of patients with myocardial infarction.[1]

A cough may indicate asthma, chronic obstructive pulmonary disease (COPD), chronic bronchitis, pneumonia, or pulmonary edema. A COPD exacerbation may cause a cough combined with a change in the character of sputum. Airway obstruction should be suspected in short of breath patients with cough or increased sputum production, especially those with a smoking history.[1]

A proper history includes other associated symptoms and recent events. A severe sore throat could indicate epiglottitis. If the patient is experiencing indigestion or dysphagia, this may indicate gastroesophageal reflux disease or gastric secretion aspiration in the lungs. The presence of fever strongly suggests an infectious etiology.[8] A history of scuba diving may suggest barotrauma.[1] Immobility, prolonged travel, or malignancy may suggest

thromboembolic disease and pulmonary embolism. Patients with intermittent symptoms may be experiencing episodes of reflux and aspiration or recurrent pulmonary emboli.

Typical Physical Exam Findings

The physical exam begins with a rapid assessment of the ABCs (airway, breathing, and circulation). Once the physician determines the patient is stable, they should perform a complete physical exam, including:

- Heart and lungs.
- Nasopharynx, oropharynx, and neck.
- Abdomen.
- Lower extremities.
- Vital signs, such as:
    - Heart rate.
    - Respiratory rate.
    - Blood pressure.
    - Temperature.
    - Oxygen saturation.
- Assessment of:
    - Respiratory effort.
    - Use of accessory muscles.
    - Ability to speak.

Engorgement of the neck veins or jugular vein distension (JVD) suggests cor pulmonale (right-sided heart failure.) This heart failure results from severe COPD or asthma, congestive heart failure, cardiac tamponade, obstructive sleep apnea, or pulmonary embolism (PE). Pulsus paradoxus - an exaggerated fall in a patient's blood pressure during inspiration - may exist in COPD, asthma, or cardiac tamponade.

Examination of the thorax may reveal an increased anteroposterior diameter suggesting COPD or spine deformities such as kyphosis or scoliosis that can cause pulmonary restriction. Percussion of the lungs helps determine the presence or absence of consolidation and effusion. Hyperresonance on percussion indicates possible pneumothorax or severe bullous emphysema. Auscultation of the lungs provides information regarding the character and symmetry of breath sounds such as rales, rhonchi, dullness, or wheezing. Absent breath sounds suggest a mass or pleural effusion. Wheezing suggests obstructive lung diseases such as asthma or COPD but may be associated with pulmonary edema or pulmonary embolism. Pulmonary edema, CHF, and pneumonia may present with rales on auscultation.[8]

A cardiovascular exam may reveal the presence of dysrhythmia, cardiac murmurs, or abnormal cardiac gallops. A rapid or irregular pulse may signify

dysrhythmia. An irregular pulse is often a sign of atrial fibrillation. An S3 gallop indicates elevated cardiac filling pressures as seen in left ventricular systolic dysfunction and congestive heart failure. An S4 gallop may suggest left ventricular diastolic dysfunction and is common in hypertension, aortic stenosis, and hypertrophic cardiomyopathy, although it can often occur in young, healthy patients. A loud P2 indicates pulmonary hypertension. Cardiac murmurs may indicate valvular dysfunction. Pericarditis may present with a characteristic cardiac friction rub on auscultation. Diminished heart sounds may indicate cardiac tamponade.[8]

Physicians should assess the lower extremities for a pulse, capillary refill time, edema, and hair growth pattern to rule out lack of peripheral perfusion.[7] Lower extremity edema is associated with CHF, and unilateral lower extremity edema suggests deep venous thrombosis that can lead to pulmonary embolism. Digital clubbing is present in some forms of lung disease (e.g., malignancy, severe COPD). Cyanosis of the extremities indicates hypoxia.[8]

On abdominal examination, ascites, hepatomegaly, and positive hepatojugular reflux may suggest CHF diagnosis.

Typical Diagnostic Findings

Laboratory testing may include a complete blood count, thyroid function testing, brain natriuretic peptide (if heart failure is suspected), cardiac enzymes, d-dimer assay (fibrin degradation), and a basic chemistry panel. These tests can help identify anemia, secondary erythrocytosis due to COPD, thyroid disease, congestive heart failure, MI, pulmonary embolism, and abnormal metabolic or renal states.[2] Levels may be abnormal due to anemia, pulmonary disease, chronic kidney disease, or an increase with age.[2] Negative test results can help exclude pulmonary embolism, CHF, or CAD (in patients with a low pretest probability) as a cause of dyspnea.[2]

ECG can identify arrhythmias and conduction abnormalities, with atrial fibrillation being the most common cause of dyspnea in such cases. The ECG may also support the diagnosis of conditions such as left ventricular hypertrophy, pericardial effusion, or ischemic heart disease.[2]

A chest radiograph is often helpful in evaluating patients with dyspnea. Characteristic findings typically occur in patients with congestive heart failure, pneumonia, and pulmonary fibrosis. The chest radiograph may also be abnormal in patients with COPD, but significant abnormalities on the chest film are often seen only in patients with advanced COPD.[3]

The American College of Cardiology and the American Heart Association recommend echocardiography (or alternative imaging) when heart failure is

suspected.[4] Echocardiography can assess the presence of valvular, myocardial, and pericardial disease. Cardiovascular stress testing with or without imaging may clarify the likelihood of coronary ischemia. Catheterization is required to confirm the diagnosis of pulmonary arterial hypertension, assess the severity of the hemodynamic impairment, and test the pulmonary circulation's vasoreactivity.

Pulmonary function tests help detect obstructive and restrictive diseases of the lung and chest wall.[3] Diagnostic bronchoscopy and biopsy may clarify infectious or interstitial lung diseases (e.g., fibrosis, sarcoidosis, malignancy).

Care Path Services & Medical Necessity Criteria

Non-Invasive Testing

Service: Coronary Computed Tomography Angiogram (CCTA)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** Clinical reason and judgment according to college and clinical practice guidelines and usage of the ACR Appropriateness Criteria.
- **Recommended Clinical Approach:** According to many members of the American College of Cardiology, coronary computed tomography angiography (CCTA) is the test of choice in most symptomatic patients with chest pain or ischemic equivalent without known coronary artery disease (CAD).[11]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **CCTA** is considered appropriate if **ANY** of the following is **TRUE** [11-17]:

- ◆ Shortness of breath (SOB) is believed to represent CAD with intermediate to high pretest probability.[18]
- ◆ History of CAD with symptoms and **ANY** of the following:
  - The patient is on optimal guideline-directed medical therapy (GDMT)
  - There is documented intolerance to GDMT.[18]
- ◆ The patient has SOB and **ANY** of the following:
  - A previously unclear or inconclusive stress test result (e.g., MPI-SPECT, stress echo).
  - An uninterpretable ECG or inability to exercise.
- ◆ The patient has uncharacterized SOB and known or suspected Congenital Heart Disease.
- ◆ There is a new onset of heart failure with an undetermined etiology.

Non-Indications

➔ **CCTA** may not be considered appropriate if **ANY** of the following is **TRUE**[19]:

- The patient has non-rate controlled atrial fibrillation.
- The patient has contrast dye hypersensitivity.
- In pregnant patients.
- The patient has impaired renal function because angiographic contrast is utilized for the study.
- The patient uses metformin.
- 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.

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

Service: Fractional Flow Reserve (CT-FFR)

General Guidelines

- **Units, Frequency, & Duration:** Single instance, must be ordered in conjunction with Coronary CTA imaging.
- **Criteria for Subsequent Requests:** For pre-intervention surveillance of coronary artery lesions or new clinical indications.
- **Recommended Clinical Approach:** Following a positive CCTA, non-invasive fractional flow reserve (FFR) may be medically necessary to guide decisions about invasive coronary angiography in patients with intermediate or high-risk coronary anatomy on imaging.[18,20] CT-FFR is not recommended in patients with complex congenital heart disease.
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **FFR** is considered appropriate if **ANY** of the following is **TRUE**[21]:
- For functional evaluation of coronary CTA lesions which are 40-90% stenosed in a proximal to a middle coronary segment on CCTA.[18]
- For evaluating multivessel disease and identifying culprit lesions causing symptoms.
- For evaluating the physiologic severity of multiple lesions in a single vessel

***FFR can only be requested with a coronary CTA, or after a recently performed coronary CTA

Non-Indications

➔ **FFR** is NOT appropriate if **ANY** of the following conditions is **TRUE**[22]:
- The original CCTA was of suboptimal quality.
- The patient is not a candidate for revascularization.
- The patient is post coronary artery bypass surgery.
- The patient has a metal intracoronary stent in the vessel to be studied.
- Coronary anatomy that is low risk (less than 40% stenosis).
- The patient has complex congenital heart disease.

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
0501T	non-invasive 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.
0502T	non-invasive 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
0503T	non-invasive 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
0504T	Non-invasive 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

Service: Magnetic Resonance Imaging (MRI), Cardiac

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** Considerations of additional phase, dynamic sequences, positioning of the patient, and use of markers at the discretion of the protocoling radiologist.
- **Recommended Clinical Approach:** Cardiac magnetic resonance imaging (MRI) has a limited role in the evaluation of patients with shortness of breath. Cardiac MRI can be useful in evaluating cardiomyopathies such as hypertrophic cardiomyopathy, arrhythmogenic RV dysplasia, sarcoidosis, amyloidosis, which may be associated with ventricular tachyarrhythmias, heart block, and other conduction abnormalities and risk of sudden cardiac death. Cardiac MRI may play a role in the decision to implant a permanent pacemaker or an implantable cardioverter-defibrillator (ICD).[12-13,23-24]
- **Exclusions:** Exclusions include contraindications of MRI (e.g., retained metal, incompatible width to bore size, claustrophobia), incompatibility with following directions (i.e., breath-hold), and renal insufficiency (eGFR less than 30 mL/min per 1.73 m^2) if gadolinium is requested.

Medical Necessity Criteria

Indications

➔ **MRI** is considered appropriate if **ALL** of the following are **TRUE**[12-13,23-24]:

- ◆ The patient had prior cardiac imaging testing and the results were **ANY** of the following:
  - Failed to characterize a cardiac basis for symptoms;
  - Revealed abnormal findings better characterized by cardiac MRI.
- ◆ The patient has ANY of the following:
  - Objective evidence of cardiomyopathy.
  - Ventricular tachyarrhythmias.
  - Heart block.
  - Congenital Heart Disease.
  - An extrathoracic disease that may involve the heart (e.g., sarcoidosis, amyloidosis, cancer).
  - Pulmonary Hypertension.
  - Congestive Heart Failure.
  - Suspected cardiac mass (e.g., thrombus, malignancy).
  - A disease of the thoracic aorta.
  - Myocarditis or pericarditis.

- History of cardiac arrest and is being considered for permanent pacemaker or ICD implantation.

Non-Indications

➔ **MRI** may not be considered appropriate if **ANY** of the following is **TRUE**[12-13,23-24]:

- ◆ MRI is the initial imaging modality.
- ◆ Non-compatible implanted devices.
- ◆ Metallic intraocular foreign bodies.
- ◆ Potential for adverse reactions to contrast media.
- ◆ Severe claustrophobia.
- ◆ Renal insufficiency (eGFR less than 30 mL/min per 1.73 m^2) and if gadolinium contrast is requested, an MRI/MRA may not be considered appropriate.

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
71551	Magnetic resonance imaging (MRI) of chest with contrast
71552	Magnetic resonance imaging (MRI) of chest with contrast material, including noncontrast images and image postprocessing, for evaluation of hilar and mediastinal lymphadenopathy
75557	Cardiac magnetic resonance imaging (MRI) without contrast material, evaluation of morphology and function
75559	Cardiac magnetic resonance imaging (MRI) with stress imaging, without contrast material, for evaluation of morphology and function
75561	Cardiac magnetic resonance imaging (MRI) without contrast material, followed by contrast material and further sequences, for evaluation of morphology and function
75563	Cardiac magnetic resonance imaging (MRI) with stress imaging, without contrast material, followed by contrast material and further sequences, for evaluation of morphology and function
S8042	Mri low field
C9762	Cardiac magnetic resonance imaging for morphology and

	function, quantification of segmental dysfunction; +strain
C9763	Cardiac magnetic resonance imaging for morphology and function, quantification of segmental dysfunction; +stress

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:** This may be appropriate for patients with symptoms of coronary artery disease (CAD) and an intermediate or high pre-test probability of CAD. An exercise stress test is recommended if the patient is able to exercise to a satisfactory workload. If the patient is unable to exercise, a drug such as adenosine will simulate exercise and may be an acceptable substitute. Resting ECG abnormalities decrease the accuracy of using the ECG to show an ischemic response, and in this situation, myocardial perfusion imaging single-photon emission computed tomography (MPI-SPECT) or echo imaging before and after exercise will help. Limitations of MPI-SPECT include cost and radiation. In addition, interpretation of MPI-SPECT can be affected by attenuation artifacts related to soft tissue overlying the heart or extracardiac radioisotope (eg, liver or gastrointestinal uptake, which may be adjacent to the heart).[12-13,21]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **MPI-SPECT** is considered appropriate if **ANY** of the following is **TRUE**:
- ◆ The patient has shortness of breath (SOB) and intermediate to high pretest probability of CAD.[18]
- ◆ The patient has SOB and **ANY** of the following:
  - ECG abnormalities that would obscure the diagnosis of ischemia (e.g., Wolff-Parkinson-White pattern, LBBB, paced ventricular rhythm, the patient takes digoxin).[25-26]
  - Inability to exercise (i.e., breathing or physical limitations) and no contraindication to vasodilators.
  - Inability to achieve the target heart rate with a standard stress test.
  - Previous non-diagnostic non-invasive stress testing needing further clarification by MPI-SPECT.

Non-Indications

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

- 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 has any unstable cardiac or pulmonary conditions.
- 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.
- The patient is pregnant.

Site of Service Criteria

Outpatient or Inpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
78451	Single-photon emission computed tomography (SPECT) myocardial perfusion imaging study at rest or with stress (exercise or pharmacologic).
78452	Multiple single-photon emission computed tomography (SPECT) myocardial perfusion imaging studies at rest and/or with stress (exercise or pharmacologic)
78453	Single planar myocardial perfusion imaging study at rest
78454	Multiple planar myocardial perfusion imaging studies with stress
78469	Planar and single photon emission computed tomography (SPECT) myocardial imaging
78481	Single planar cardiac blood pool imaging study by first pass technique with exercise and pharmacological stress, wall motion study plus ejection fraction, with quantification
78472	Planar cardiac blood pool imaging, gated equilibrium study at rest
78473	Planar cardiac blood pool imaging, gated equilibrium

	studies at rest

Service: Stress Echocardiogram

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Stress echocardiography is an option for patients with symptoms of coronary artery disease (CAD) and intermediate or high pretest probability of CAD.[18] It can be accomplished using either exercise or pharmacologic agents (predominantly dobutamine) as the stress mechanism. This test results in no radiation exposure and is typically lower cost than myocardial perfusion imaging single-photon emission computed tomography (MPI-SPECT). Other advantages of stress echo compared to MPI-SPECT include shorter patient time commitment, additional information on cardiac structures (valves, ascending aorta, pericardial space), and the test is less technically demanding than MPI-SPECT. The diagnostic accuracy of exercise and stress echocardiography is reduced in patients with limited acoustic windows.[21,25]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **Stress echo** is considered appropriate if **ANY** of the following is **TRUE**:
- ◆ The patient has SOB and an intermediate or high pretest probability of CAD.[18]
- ◆ The patient has SOB and **ANY** of the following:
  - ECG abnormalities that would obscure the diagnosis of ischemia (e.g., Wolff-Parkinson-White pattern, LBBB, paced ventricular rhythm, the patient takes digoxin).[26,4]
  - Inability to exercise (i.e., breathing or physical limitations) and no contraindication to dobutamine.
  - Inability to achieve the target heart rate with a standard stress test.
- ◆ The patient had previous non-diagnostic non-invasive stress testing needing further clarification by stress echo.

Non-Indications

- ➔ **Stress echo** is not considered appropriate for patients with **ANY** of the following:
  - ◆ Patients who are clinically unstable or have an acute medical problem including ANY of the following:
    - Acute myocardial infarction within the last 48 hours.
    - Acute pericarditis/myocarditis.
    - Symptomatic, severe aortic stenosis.
    - Uncontrolled or unstable arrhythmias.
    - Acute aortic dissection.
    - Unstable angina or heart failure.
    - Acute pulmonary embolism or pulmonary infarction.[12,27-31]:
  - ◆ The patient is unable to exercise sufficiently or tolerate pharmacologic agent to simulate exercise.
  - ◆ The patient has had another type of stress testing in the last 90 days (e.g., MPI-SPECT) with conclusive results.
- ➔ **Stress echo** may not be considered appropriate if **ANY** of the following is **TRUE** [27-31]:
  - ◆ Moderate stenotic valvular heart disease.
  - ◆ High-degree atrioventricular (AV) block.
  - ◆ Severe hypertension (greater than 180/100 mm Hg).
  - ◆ Significant electrolyte abnormalities.
  - ◆ Tachycardic or bradyarrhythmic.
  - ◆ 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.

Site of Service Criteria

Outpatient or Inpatient

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/or pharmacologically induced stress, with interpretation and report
93351	Real time transthoracic echocardiography with 2-dimensional (2D) image documentation during rest and cardiovascular stress test using treadmill, bicycle exercise

	and/or pharmacologically induced stress, with interpretation and report, including performance of continuous electrocardiographic monitoring, with physician supervision
93352	administration of contrast with a stress echocardiogram
C8928	Tte w or w/o fol w/con,stres
C8930	Tte w or w/o contr, cont ECG

Service: Cardiac Positron Emission Tomography (PET)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Positron emission tomography (PET) is a minimally invasive diagnostic imaging procedure used to evaluate metabolism in normal tissues and diseased tissues in conditions such as cancer, ischemic heart disease, and some neurologic disorders. The benefits of PET scans include greater accuracy for patients who cannot adequately exercise and less radiation exposure than single-photon emission computed tomography (SPECT). It is particularly beneficial in obese patients and others prone to SPECT attenuation artifact, in younger patients (men less than 40, women less than 50), and following equivocal or non-diagnostic testing.[27-32]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **Cardiac PET** is considered appropriate if **ALL** of the following are **TRUE**:
- ◆ The patient has shortness of breath (SOB) and **ANY** of the following:
  - Intermediate or high pre-test probability of coronary artery disease (CAD).[33]
  - Any ECG abnormalities that would obscure the diagnosis of ischemia (e.g., Wolff-Parkinson-White pattern, LBBB, paced ventricular rhythm, the patient takes digoxin).[4,26]
- ◆ The patient has **ANY** of the following[33]:
  - The patient is likely to experience attenuation artifact with SPECT imaging due to factors such as morbid obesity, large breasts, breast implants, pleural/pericardial effusion.[32]
  - A previous inconclusive MPI-SPECT or stress echo.

Non-Indications

➔ **Cardiac PET** may not be considered appropriate if **ANY** of the following is **TRUE**[33]:
- ◆ The patient has an acute myocardial infarction or unstable angina that has not been medically stabilized.

- The patient has other acute pulmonary conditions (e.g., pneumonia, pulmonary embolism) that have not been medically stabilized.
- The patient is pregnant.
- The patient has allergic reactions or intolerance to radiotracers.
- If being used to rule out ischemia, normal coronary angiogram or CCTA with no stenosis or plaque within the last two years.
- Normal stress test (given adequate stress) within the last year

Site of Service Criteria

Outpatient or Inpatient

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
78429	Single positron emission tomography (PET) myocardial imaging study for metabolic evaluation with concurrently acquired computed tomography (CT) transmission scan
78430	Single positron emission tomography (PET) myocardial perfusion imaging study with evaluation of ejection fraction, at rest or stress (exercise or pharmacologic), with concurrently acquired computed tomography (CT) transmission scan
78431	Multiple positron emission tomography (PET) myocardial perfusion imaging studies with evaluation of ejection fraction, at rest and stress (exercise or pharmacologic), with concurrently acquired computed tomography (CT) transmission scan
78432	Positron emission tomography (PET) combined myocardial perfusion imaging study and metabolic evaluation study using dual radiotracer
78433	Positron emission tomography (PET) combined myocardial perfusion imaging and metabolic evaluation study using dual radiotracer, with concurrently acquired computed tomography (CT) transmission scan
78459	Single positron emission tomography (PET) myocardial imaging study for metabolic evaluation
78491	Single positron emission tomography (PET) myocardial

	perfusion imaging study with evaluation of ejection fraction, at rest or stress (exercise or pharmacologic)
78492	Multiple positron emission tomography (PET) myocardial perfusion imaging studies with evaluation of ejection fraction, at rest and with stress (exercise or pharmacologic).
G0235	Pet not otherwise specified
G0252	Pet imaging initial dx

Service: Transthoracic Echocardiogram (TTE)

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:**
  - Single repeat TTEs are appropriate for:
    - Evaluating significant changes in signs/symptoms since the patient's last TTE.
    - Providing objective evidence of value for patients undergoing medical treatment to improve LV function.
  - A repeat TTE is appropriate for patients at various intervals with a history of:
    - Significant valve dysfunction or deformity (e.g., severe stenosis, mitral valve prolapse) with the frequency of repeat echocardiograms based on the type and severity of the valve lesion, the known rate of progression of the specific valve lesion, and the effect of the valve lesion on the affected ventricle.[34]
    - Hypertrophic, ischemic, or idiopathic dilated cardiomyopathy.[12-13,23-24]
    - Chronic pericardial effusions.[12-13,23-24]
    - Pulmonary hypertension.[12-13,23-24]
  - Repeat TTEs are **NOT** appropriate for clinically stable or asymptomatic patients with mild valvular findings, stenosis, or deformity.
- **Recommended Clinical Approach:** Transthoracic echocardiography can be useful for patients with chest pain if pericardial effusion or valvular or chamber abnormalities are suspected.[1]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **TTE** is considered appropriate if **ANY** of the following is **TRUE** [4,35]:

◆ Patient with shortness of breath (SOB) with a known or suspected cardiac origin, including but not limited to:

- Coronary Artery Disease (CAD).
- Cardiomyopathy.
- Valvular disease.
- Heart murmur.
- History of heart attack (myocardial infarction).
- Prior heart surgery.

- Abnormal cardiac test results.
- Palpitations.
- TIA or stroke.
- Peripheral embolic event.
- Pericardial disease.
- Primary myocardial disease.
- Hypertensive heart disease.
- Other suspected cardiac origin.

Non-Indications

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

◆ 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 ultrasound waves penetration.[4,36]

Site of Service Criteria

None.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
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 without spectral or color Doppler
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

Non-Surgical Management

Service: Cardiac Rehabilitation

General Guidelines

- **Units, Frequency, & Duration:** Cardiac rehabilitation is generally appropriate for 36 sessions, 60 minutes each, typically over 12 - 18 weeks. Additional sessions can be requested.[37]
- **Criteria for Subsequent Requests:** Current guidelines do not support the need for repeat cardiac rehabilitation in the absence of a new cardiac event.
- **Recommended Clinical Approach:** Cardiac rehabilitation (CR) is an evidence-based intervention that uses patient education, health behavior modification, and exercise training to improve secondary prevention outcomes and is recognized as an integral component of care for patients with cardiovascular disease.[37,38] Referral to CR is recommended within 12 months after a myocardial infarction (MI), percutaneous coronary intervention, or coronary artery bypass graft surgery or in the setting of stable angina or symptomatic peripheral arterial disease (i.e., intermittent claudication).[37] Referral to CR is also recommended after heart valve surgery or cardiac transplantation or in the setting of chronic heart failure (NYHA Class I-III) with reduced or preserved ejection fraction.[37] The effects of cardiac rehabilitation on mortality, cardiovascular events, hospitalizations, or health-related quality of life are less certain in patients with atrial fibrillation, Adult Congenital Heart Disease, and after permanent pacemaker/ICD implantation, but are described as useful by various National and International specialty societies.[39-41]
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **Cardiac Rehabilitation** is considered appropriate if **ANY** of the following are **TRUE** (within a one year period)[40-42]:

- Acute myocardial infarction
- Acute coronary artery syndrome
- Chronic stable angina
- Chronic congestive heart failure (NYHA Class I-III, including with LV assist devices)
- After coronary artery bypass surgery
- After a percutaneous coronary intervention

- After valvular surgery
- Cardiac transplantation
- Symptomatic peripheral arterial disease
- Atrial fibrillation
- Adult Congenital Heart Disease
- After permanent pacemaker/ICD implantation

Non-Indications

➔ **Cardiac Rehabilitation** may not be considered appropriate if **ANY** of the following are present[42]:

- Active unstable angina
- Decompensated cardiac failure
- Active dangerous or complex arrhythmias
- Dissecting aneurysm
- Myocarditis
- Acute pericarditis
- Severe obstruction of the left ventricular outflow tract
- Severe hypertension
- Exertional hypotension or syncope
- Severe orthopedic limitations
- Recent systemic or pulmonary embolus
- Severe or symptomatic aortic stenosis
- Previous cardiac rehabilitation in the absence of a new cardiac event.

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
S9472	Cardiac rehabilitation program, nonphysician provider, per diem
93798	Physician or other qualified healthcare professional services for outpatient cardiac rehabilitation; with continuous ECG monitoring (per session)

Surgical or Interventional Management

Service: Left Cardiac Catheterization

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** A left cardiac catheterization is invasive with more risks than other tests. Cardiac catheterization is only appropriate when there is an intermediate to high likelihood of coronary artery disease (CAD). Unless the clinical situation is an emergency or progressive, noninvasive testing such as cardiac CT angiography or stress testing (with or without accompanying echo or isotope imaging) should proceed a catheterization.[18,43]
- **Exclusions:** Non-emergent cardiac catheterization should be performed at a facility that offers coronary intervention and has the staffing and lab availability for a PCI if indicated. Unless there are objective findings at the time of catheterization that make the interventional decision such as a PCI uncertain, both procedures should be performed simultaneously.[18,43]
-

Medical Necessity Criteria

Indications

➔ **Left cardiac catheterization** is considered appropriate if **ANY** of the following is **TRUE**[18,43]:

- ◆ The patient has worsening Canadian Cardiovascular Society class II or higher angina (or ischemic equivalent) and **ANY** one of the following:
  - The patient is on two or more antianginal medications.
  - The physician can provide documentation on why the patient is not on two or more antianginal medications (i.e., contraindications or adverse effects).
- ◆ Intermediate- or high-risk non-invasive findings and **ANY** of the following:
  - Worsening or limiting ischemic symptoms (e.g., chest pain, chest tightness, chest burning, shoulder pain, left arm pain, jaw pain, shortness of breath).
  - Stable chest pain despite guideline-directed medical treatment (GDMT).[18]
- ◆ The patient has shortness of breath and **ANY** of the following:

    - A high pretest probability of CAD.
    - Patients with stable ischemic heart disease who develop symptoms and signs of heart failure.
- Stable chest pain after a negative stress test AND with a high clinical suspicion of coronary artery disease (CAD)
- Previous CABG surgery and **ALL** of the following:
    - Stable chest pain
    - Suspicion of myocardial ischemia
    - Indeterminate or nondiagnostic stress test
- Stable chest pain and obstructive CAD and **ANY** of the following:
    - Greater than or equal to 50% stenosis in the left main coronary artery, defined by CCTA
    - Obstructive CAD with fractional flow reserve (FFR) by CT less than or equal to 0.80
    - Severe stenosis (greater than or equal to 70%) in all 3 main vessels
- Chest pain (or ischemic equivalent) and high pretest probability of CAD
- High-risk ECG stress test, stress echo, or MPI SPECT results with or without symptoms
- Suspected acute coronary syndrome (ACS) and **ANY** of the following:
    - Newly diagnosed left ventricular (LV) wall motion abnormality
    - Newly diagnosed resting myocardial perfusion defect
- Ventricular fibrillation or sustained ventricular tachycardia with or without symptoms.
- Survived sudden cardiac death or potentially life-threatening ventricular arrhythmia.
- Preoperative assessment before valvular surgery.
- Suspected cardiomyopathy (LV ejection fraction (LVEF) less than 40%) of unknown etiology with symptoms.
- The patient is being considered for or has received a heart transplant.
- Patients with stable ischemic heart disease who develop symptoms and signs of heart failure.
- Depressed LV function (ejection fraction less than 40%) and moderate risk criteria on non-invasive testing with demonstrable ischemia.
- Non-invasive evaluation suggests catheterization is needed for preoperative assessment before a planned surgery.

Non-indications

➔ **Left Cardiac catheterization** may not be considered appropriate if **ANY** of the following is **TRUE**[18,43]:

- Acute or chronic kidney disease
- Coagulopathy
- Fever
- Systemic infection
- Uncontrolled arrhythmia
- Uncontrolled hypertension
- Decompensated heart failure
- Radiopaque contrast agent allergies in patients who have not been appropriately premedicated
- Pregnancy
- Normal coronary angiogram or CCTA within the last two years and with no stenosis or plaque (For certain left heart catheterization scenarios)
- Normal stress test (given adequate stress) within the last year (for certain left heart catheterization scenarios)

Site of Service Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93454	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation
93455	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with catheter placement in bypass graft, with intraprocedural injections for bypass graft angiography
93458	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with left heart catheterization, with intraprocedural injection for left ventriculography
93459	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision and interpretation, with left heart catheterization, catheter placement in bypass graft, with bypass graft angiography

Service: Left and Right Cardiac Catheterization

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** A left and right cardiac catheterization is invasive, with more risks than other tests. Thus, it should be used to provide important information that may change the treatment plan. The addition of a right cardiac catheterization to a left cardiac catheterization is frequently needed for a hemodynamic assessment when evaluating valvular heart disease, cardiomyopathies, or pericardial disease.
- **Exclusions:** Non-emergent cardiac catheterization should be performed at a facility that offers coronary intervention and has the staffing and lab availability for a percutaneous coronary intervention (PCI) if indicated. Unless there are objective findings at the time of catheterization that makes intervention uncertain, intervention should occur at the time of the catheterization.

Medical Necessity Criteria

Indications

➔ **Left and Right cardiac catheterization** is considered appropriate if **ANY** of the following is **TRUE**[18,43]:

- Preoperative assessment before valvular surgery.
- Left ventricular dysfunction out of proportion to the severity of the valvular disease.
- Pulmonary hypertension out of proportion to the severity of the valvular disease.
- Suspected or clinical uncertainty between constrictive vs. restrictive physiology.
- Suspected pericardial tamponade.
- Suspected cardiomyopathy (LV ejection fraction (LVEF) less than 40%) of unknown etiology with symptoms.
- The patient is being considered for or has received a heart transplant.
- Patients with stable ischemic heart disease who develop symptoms and signs of heart failure.

- Depressed LV function (ejection fraction less than 450%) and moderate risk criteria on noninvasive testing with demonstrable ischemia.

Non-Indications

➔ **Cardiac catheterization** may not be considered appropriate if **ANY** of the following is **TRUE**:

- Acute or chronic kidney disease
- Coagulopathy
- Fever
- Systemic infection
- Uncontrolled arrhythmia
- Uncontrolled hypertension
- Decompensated heart failure
- Radiopaque contrast agent allergies in patients who have not been appropriately premedicated
- Pregnancy
- Normal coronary angiogram or CCTA within the last two years and with no stenosis or plaque (For certain left heart catheterization scenarios)
- Normal stress test (given adequate stress) within the last year (for certain left heart catheterization scenarios)

Site of Service Criteria

Inpatient or outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93453	Combined right and left heart catheterization with intraprocedural injection for left ventriculography
93456	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with right heart catheterization
93457	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with catheter placement in bypass graft, with intraprocedural injection for bypass graft angiography and right heart catheterization

93460	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with right and left heart catheterization
93461	Catheter placement in coronary artery for coronary angiography, with intraprocedural injection for coronary angiography, imaging supervision, and interpretation, with right and left heart catheterization, catheter placement in bypass graft, with bypass graft angiography

Service: Other Cardiac Catheterization

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Cardiac catheterization is invasive, with more risks than other tests. Thus, it should be used to provide important information that may change the treatment plan. In some clinical situations, the performance of a right cardiac catheterization (hemodynamics and cardiac output) or a left heart catheterization/left ventricular angiogram alone may be needed.
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **Other Cardiac catheterization** is considered appropriate if **ANY** of the following is **TRUE**[18,43]:

- ◆ **Right cardiac catheterization: ANY** of the following are **TRUE**:
  - Pulmonary hypertension
  - Known or suspected intracardiac shunt with indeterminate shunt anatomy or shunt fraction.
  - The patient is being considered for or has received a heart transplant.
  - Indeterminate intravascular volume status
- ◆ **Left heart catheterization/left ventricular angiogram: ANY** of the following are **TRUE**:
  - Assessment of left ventricular systolic function
  - Assessment of the degree of mitral regurgitation
  - Assessment for a ventricular septal defect
  - Hemodynamic assessment of the aortic valve
  - Measurement of the left ventricular end-diastolic pressure

Non-Indications

➔ **Other Cardiac catheterization** may not be considered appropriate if **ANY** of the following is **TRUE**:

- ◆ Acute or chronic kidney disease
- ◆ Coagulopathy
- ◆ Fever
- ◆ Systemic infection
- ◆ Uncontrolled arrhythmia

- Uncontrolled hypertension
- Decompensated heart failure
- Radiopaque contrast agent allergies in patients who have not been appropriately premedicated
- Pregnancy

Site of Service Criteria

Inpatient or outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93451	Right heart catheterization
93452	Left heart catheterization with intraprocedural injection for left ventriculography

Service: Percutaneous Coronary Intervention (PCI)/Angioplasty/Stent

General Guidelines

- **Units, Frequency, & Duration:** None.
- **Criteria for Subsequent Requests:** None.
- **Recommended Clinical Approach:** Perform any percutaneous coronary intervention (PCI) during a heart catheterization for symptomatic heart disease, significant stenosis, or blockage that is refractory to optimal medical therapy.
- **Exclusions:** None.

Medical Necessity Criteria

Indications

➔ **PCI** is considered appropriate if **ANY** of the following is **TRUE** [44-46]:
- ◆ The patient has unstable angina or acute myocardial infarction.
- ◆ Refractory angina (or ischemic equivalent) and **ALL** of the following:
  - Symptoms despite medical therapy
  - Significant coronary artery stenoses as shown by **ANY** of the following:
    - ○ Significant anatomic stenosis greater than or equal to 50% left main
    - ○ Significant anatomic stenosis greater than or equal to 70% non–left main CAD
    - ○ Significant physiological stenosis: fractional flow reserve (FFR) less than or equal to 0.80
- ◆ Stable Ischemic Heart Disease (SIHD) and **ALL** of the following [44-46]:
  - Significant left main stenosis (greater than or equal to 50%)
  - PCI is expected to provide equivalent revascularization to a CABG
- ◆ Stable Ischemic Heart Disease (SIHD) and multivessel CAD.

Non-Indications

None.

Site of Service Criteria

Inpatient or outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
92920	Percutaneous transluminal coronary angioplasty into single major coronary artery
+92921	Percutaneous transluminal coronary angioplasty; each additional branch of a major coronary artery
92924	Percutaneous transluminal coronary atherectomy, with coronary angioplasty when performed; single major coronary artery or branch
+92925	Percutaneous transluminal coronary atherectomy, with coronary angioplasty when performed; each additional branch of a major coronary artery
92928	Percutaneous transcatheter insertion of stent into single major coronary artery
+92929	Percutaneous transcatheter placement of intracoronary stent(s), with coronary angioplasty when performed; each additional branch of a major coronary artery
92933	Percutaneous transluminal coronary atherectomy, with intracoronary stent, with coronary angioplasty when performed; single major coronary artery or branch
+92934	Percutaneous transluminal coronary atherectomy, with intracoronary stent, with coronary angioplasty when performed; each additional branch of a major coronary artery
92937	Percutaneous transluminal revascularization of a single coronary artery bypass graft with angioplasty
+92938	Percutaneous transluminal revascularization of or through coronary artery bypass graft (internal mammary, free arterial, venous), any combination of intracoronary stent, atherectomy and angioplasty, including distal protection when performed; each additional branch subtended by the bypass graft
92941	Percutaneous transluminal revascularization of acute total/subtotal occlusion during acute myocardial

	infarction, coronary artery or coronary artery bypass graft, any combination of intracoronary stent, atherectomy and angioplasty, including aspiration thrombectomy when performed, single vessel
92943	Percutaneous transluminal revascularization of chronic total occlusion of a single coronary artery branch with atherectomy, angioplasty, and insertion of stent
+92944	Percutaneous transluminal revascularization of chronic total occlusion, coronary artery, coronary artery branch, or coronary artery bypass graft, any combination of intracoronary stent, atherectomy and angioplasty; each additional coronary artery, coronary artery branch, or bypass graft
C9600	Perc drug-el cor stent sing
C9604	Perc d-e cor revasc t cabg s
C9607	Perc d-e cor revasc chro sin
33990	Insertion of percutaneous arterial ventricular assist device by arterial access only
33991	Insertion of percutaneous arterial ventricular assist device by arterial and venous access, with transseptal puncture, with radiological supervision and interpretation

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%		
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 clearance from HIV specialist
3- Intermediate Risk	Rheumatologic 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%		
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 CHF			
4- High Risk	Cerebrovascular disease			
4- High Risk	Uncontrolled or suspected obstructive sleep apnea (OSA)			
4- High Risk	Opioid dependence			
5- Very High Risk	Percutaneous Coronary Intervention (PCI) within 1 month			

5- Very High Risk	Cardiovascular: unstable angina, recent myocardial infarction (60 days), uncontrolled atrial fibrillation or other high-grade abnormal rhythm, severe valvular disease, decompensated heart failure			
5- Very High Risk	Primary pulmonary hypertension			Preoperative consultation with pulmonologist warranted
5- Very High Risk	Cirrhosis or severe liver disease, 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			
5- Very High Risk	Chronic Pain			

References

1. Buist AS, McBurnie MA, Vollmer WM, et al. International variation in the prevalence of COPD (the BOLD Study): a population-based prevalence study. *Lancet* 2007; 370:741.
2. Gershon AS, Warner L, Cascagnette P, et al. Lifetime risk of developing chronic obstructive pulmonary disease: a longitudinal population study. *Lancet* 2011; 378:991.
3. GBD 2015 Chronic Respiratory Disease Collaborators. Global, regional, and national deaths, prevalence, disability-adjusted life years, and years lived with disability for chronic obstructive pulmonary disease and asthma, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet Respir Med* 2017; 5:691.
4. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography. A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance Endorsed by the American College of Chest Physicians. American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR, Picard MH, Polk DM, Ragosta M, Ward RP, Weiner RB. J Am Coll Cardiol. 2011;57(9):1126.
5. Centers for Disease Control and Prevention (CDC). Chronic obstructive pulmonary disease among adults--United States, 2011. *MMWR Morb Mortal Wkly Rep* 2012; 61:938.
6. Kochanek KD, Murphy SL, Xu J, Arias E. Mortality in the United States, 2016. *NCHS Data Brief* 2017; 293. https://www.cdc.gov/nchs/data/databriefs/db293.pdf (Accessed on July 16, 2019).
7. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global Strategy for the Diagnosis, Management and Prevention of Chronic Obstructive Pulmonary Disease: 2022 Report. www.goldcopd.org (Accessed on August 9, 2022).
8. Rennard SI. COPD: overview of definitions, epidemiology, and factors influencing its development. *Chest* 1998; 113:235S.

9. Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention: 2022 update. https://www.ginasthma.org (Accessed on August 9, 2022).
10. Knuuti J, Wijns W, Saraste A, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes [published correction appears in Eur Heart J. 2020 Nov 21;41(44):4242]. Eur Heart J. 2020;41(3):407-477. doi:10.1093/eurheartj/ehz425
11. Villines TC, American College of Cardiology. Coronary CTA Should Be the Initial Test in Most Patients With Stable Chest Pain: PRO. American College of Cardiology. https://www.acc.org/latest-in-cardiology/articles/2018/05/21/06/37/coronary-cta-pro. Published May 21, 2018.
12. Expert Panel on Cardiac Imaging, Bolen MA, Bin Saeedan MN, et al. ACR Appropriateness Criteria® Dyspnea-Suspected Cardiac Origin (Ischemia Already Excluded): 2021 Update. J Am Coll Radiol. 2022;19(5S):S37-S52. doi:10.1016/j.jacr.2022.02.014
13. Expert Panel on Thoracic Imaging:, McComb BL, Ravenel JG, et al. ACR Appropriateness Criteria® Chronic Dyspnea-Noncardiovascular Origin. J Am Coll Radiol. 2018;15(11S):S291-S301. doi:10.1016/j.jacr.2018.09.015
14. Bellinge JW, Majeed K, Carr SS, Jones J, Hong I, Francis RJ, Schultz CJ. Coronary artery 18F-NaF PET analysis with the use of an elastic motion correction software. J Nucl Cardiol. 2020 Jun;27(3):952-961.
15. Sanz J. Imaging of Coronary Disease Hemodynamic Significance: And the Winner Is.... J Am Coll Cardiol. 2019 Jan 22;73(2):174-176.
16. Driessen RS, Danad I, Stuijfzand WJ, Raijmakers PG, Schumacher SP, van Diemen PA, Leipsic JA, Knuuti J, Underwood SR, van de Ven PM, van Rossum AC, Taylor CA, Knaapen P. Comparison of Coronary Computed Tomography Angiography, Fractional Flow Reserve, and Perfusion Imaging for Ischemia Diagnosis. J Am Coll Cardiol. 2019 Jan 22;73(2):161-173.
17. Cheung BMY. Coronary CT Angiography and Subsequent Risk of Myocardial Infarction. N Engl J Med. 2019 Jan 17;380(3):299-300
18. Gulati M, Levy PD, Mukherjee D, et al. 2021 AHA/ACC/ASE/Chest/Saem/SCCT/SCMR guideline for the evaluation and diagnosis of chest pain. Journal of the American College of Cardiology. October 2021. doi:10.1016/j.jacc.2021.07.053
19. Abbara S, Blanke P, Maroules CD, et al. SCCT guidelines for the performance and acquisition of coronary computed tomographic angiography: A report of the society of Cardiovascular Computed Tomography Guidelines Committee: Endorsed by the North American Society for Cardiovascular Imaging (NASCI). *J Cardiovasc Comput Tomogr*. 2016;10(6):435-449. doi:10.1016/j.jcct.2016.10.002
20. Norgaard BL, et al. Coronary CT angiography-derived fractional flow reserve testing in patients with stable coronary artery disease:

recommendations on interpretation and reporting. RSNA: Cardiothoracic Imaging. Nov 2019; 1(5): e190050.
21. Edvardsen T, Asch FM, Davidson B, et al. Non-invasive imaging in coronary syndromes: recommendations of the European Association of Cardiovascular Imaging and the American Society of Echocardiography, in collaboration with the American Society of Nuclear Cardiology, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. Eur Heart J Cardiovasc Imaging. 2022;23(2):e6-e33. doi:10.1093/ehjci/jeab244
22. FDA. De Novo Classification Request For FFRCT V. 1.4. De Novo Summary (DEN130045). Published November 26, 2014. Accessed August 3, 2022. https://www.accessdata.fda.gov/cdrh_docs/reviews/DEN130045.pdf.
23. Ho, Vincent B., et al. ACR practice guideline for the performance and interpretation of cardiac magnetic resonance imaging (MRI). J Am Coll Radiol. Revised 2021. https://www.acr.org/-/media/ACR/Files/Practice-Parameters/MR-Cardiac.pdf
24. Doherty JU, Kort S, Mehran R, et al. ACC/AATS/AHA/ASE/ASNC/HRS/SCAI/SCCT/SCMR/STS 2019 Appropriate Use Criteria for Multimodality Imaging in the Assessment of Cardiac Structure and Function in Nonvalvular Heart Disease. Journal of the American College of Cardiology. 2019;73(4):488-516. doi:10.1016/j.jacc.2018.10.038
25. Fletcher G, Ades P, Kligfield P et al. Exercise Standards for Testing and Training. Circulation. 2013;128(8):873-934. doi:10.1161/cir.0b013e31829b5b44
26. Garmel GM. Wide Complex Tachycardias: Understanding this Complex Condition Part 2 - Management, Miscellaneous Causes, and Pitfalls. West J Emerg Med. 2008;9(2):97-103.
27. Mulvagh SL, Rakowski H, Vannan MA, et al. American Society of Echocardiography Consensus Statement on the Clinical Applications of Ultrasonic Contrast Agents in Echocardiography. J Am Soc Echocardiogr. 2008;21(11):1179-1281. doi:10.1016/j.echo.2008.09.009
28. Gillam LD, Marcoff L. Stress Echocardiography. Circ Cardiovasc Imaging. 2019 Jun;12(6):e009319.
29. Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG., American Society of Echocardiography. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. J Am Soc Echocardiogr. 2007 Sep;20(9):1021-41.
30. Aggeli C, Polytarchou K, Varvarousis D, Kastellanos S, Tousoulis D. Stress ECHO beyond coronary artery disease. Is it the holy grail of cardiovascular imaging? Clin Cardiol. 2018 Dec;41(12):1600-1610.
31. Mansencal N, Mustafic H, Hauguel-Moreau M, Lannou S, Szymanski C, Dubourg O. Occurrence of Atrial Fibrillation During Dobutamine Stress Echocardiography. Am J Cardiol. 2019 Apr 15;123(8):1277-1282.

32. Subramaniam RM, Janowitz WR, Johnson GB, et al. ACR–SPR–STR Practice Parameter for the Performance of Cardiac Positron Emission Tomography - Computed Tomography (PET/CT) Imaging. Clinical Nuclear Medicine. 2017;42(12):918-927. doi:10.1097/rlu.0000000000001827
33. Ronan G, Wolk MJ, Bailey SR, et al. ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 multimodality appropriate use criteria for the detection and risk assessment of stable ischemic heart disease: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. J Nucl Cardiol. 2014;21(1):192-220. doi:10.1007/s12350-013-9841-9
34. Otto CM, Nishimura RA, Bonow RO, et al. 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease. Journal of the American College of Cardiology. 2021;77(4):25-197. doi:10.1016/j.jacc.2020.11.018
35. Rameh V, Kossaify A. Appropriate Use Criteria in Echocardiography: An Observational Institutional Study with the Perspective of a Quality Improvement Project. Clin Med Insights Cardiol. 2016;10:23-28. Published 2016 Feb 16. doi:10.4137/CMC.S36504
36. Doherty JU, Kort S, Mehran R, Schoenhagen P, Soman P. ACC/AATS/AHA/ASE/ASNC/HRS/SCAI/SCCT/SCMR/STS 2017 Appropriate Use Criteria for Multimodality Imaging in Valvular Heart Disease. Journal of the American College of Cardiology. 2017;70(13):1647-1672. doi:10.1016/j.jacc.2017.07.732
37. Thomas RJ, Beatty AL, Beckie TM, et al. Home-Based Cardiac Rehabilitation: A Scientific Statement From the American Association of Cardiovascular and Pulmonary Rehabilitation, the American Heart Association, and the American College of Cardiology. J Am Coll Cardiol. 2019;74(1):133-153. doi:10.1016/j.jacc.2019.03.008
38. Wenger NK. Current status of cardiac rehabilitation. J Am Coll Cardiol. 2008;51(17):1619-1631. doi:10.1016/j.jacc.2008.01.030
39. Taylor RS, Dalal HM, McDonagh STJ. The role of cardiac rehabilitation in improving cardiovascular outcomes [published online ahead of print, 2021 Sep 16]. Nat Rev Cardiol. 2021;1-15. doi:10.1038/s41569-021-00611-7
40. Mezzani A, Hamm LF, Jones AM, et al. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: a joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation and the Canadian Association of Cardiac

Rehabilitation. Eur J Prev Cardiol. 2013;20(3):442-467. doi:10.1177/2047487312460484
41. Stout KK, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. Circulation 2019;139(14):e698-e800. DOI: 10.1161/CIR.0000000000000603.
42. Balady GJ, Ades PA, Bittner VA, Franklin BA, Gordon NF, Thomas RJ, Tomaselli GF, Yancy CW., American Heart Association Science Advisory and Coordinating Committee. Referral, enrollment, and delivery of cardiac rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential advisory from the American Heart Association. Circulation. 2011 Dec 20;124(25):2951-60
43. Patel MR, Bailey SR, Bonow RO, et al. ACCF/SCAI/AATS/AHA/ASE/ASNC/HFSA/HRS/SCCM/SCCT/SCMR/STS 2012 appropriate use criteria for diagnostic catheterization: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, American Association for Thoracic Surgery, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. J Am Coll Cardiol. 2012;59(22):1995-2027. doi:10.1016/j.jacc.2012.03.003
44. Silber S, Albertsson P, Francisco F. Guidelines for Percutaneous Coronary Interventions: The Task Force for Percutaneous Coronary Interventions of the European Society of Cardiology. ACC Current Journal Review. 2005;14(8):49. doi:10.1016/j.accreview.2005.08.063
45. Roffi M, Patrono C, Collet JP, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). *Eur Heart J. 2*016;37(3):267-315. doi:10.1093/eurheartj/ehv320
46. Lawton JS, Tamis-Holland JE, Bangalore S, Bates ER, Beckie TM, Bischoff JM, Bittl JA, Cohen MG, DiMaio JM, Don CW, Fremes SE, Gaudino MF, Goldberger ZD, Grant MC, Jaswal JB, Kurlansky PA, Mehran R, Metkus TS Jr, Nnacheta LC, Rao SV, Sabik JF, Sellke FW, Sharma G, Yong CM, Zwischenberger BA. 2021 ACC/AHA/SCAI guideline for coronary artery revascularization: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. J Am Coll Cardiol. Dec 09, 2021. Epublished DOI: 10.1016/j.jacc.2021.09.006.

Clinical Guideline Revision History/Information

Original Date: January 28, 2022	
Review History	
January 28, 2022 (V.1)	**Physician author:** Mary Krebs, MD (Primary Care Physician), Senthil Sundaram, MD (Cardiologist) **Peer reviewed by:** Kenneth Korr, MD (Cardiologist), Carter Newton, MD FACC (Cardiologist), Russell Rotondo, MD FACC (Cardiologist) **Approving Physician:** Russell Rotondo, MD FACC (Cardiologist)
August 23, 2022 (V2.0)	**Peer reviewed by:** Sandeep Jauhar, MD (Cardiologist) **Approving physician:** Russell Rotondo, MD FACC (Cardiologist)