

ACR Appropriateness Criteria[®] Chronic Dyspnea-Noncardiovascular Origin

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Abstract

Chronic dyspnea may result from a variety of disorders of cardiovascular, pulmonary, gastrointestinal, neuromuscular, systemic, and psychogenic etiology. This article discusses guidelines for the initial imaging of six variants for chronic dyspnea of noncardiovascular origin: (1) Chronic dyspnea of unclear etiology; (2) Chronic dyspnea with suspected chronic obstructive pulmonary disease; (3) Chronic dyspnea with suspected central airways disease; (4) Chronic dyspnea with suspected interstitial lung disease; (5) Chronic dyspnea with suspected disease of the pleura or chest wall; and (6) Chronic dyspnea with suspected diaphragm dysfunction.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision include an extensive analysis of current medical literature from peer reviewed journals and the application of well-established methodologies (RAND/UCLA Appropriateness Method and Grading of Recommendations Assessment, Development, and Evaluation or GRADE) to rate the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where evidence is lacking or equivocal, expert opinion may supplement the available evidence to recommend imaging or treatment.

Key Words: Appropriateness Criteria, Appropriateness Use Criteria, AUC, Central airways, Chronic dyspnea, Chronic obstructive pulmonary disease, Diaphragm motion, Interstitial lung disease, Noncardiovascular dyspnea, Pleural disease

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Dr. Ackman reports a potential for royalties from Elsevier for my contribution to a Thoracic Imaging textbook, outside the submitted work. Dr. Kanne is a consultant for Parexel Informatics. Dr. Ravenel reports other from Imbio LLC, outside the submitted work. The other authors have no conflicts of interest related to the material discussed in this article.

Disclaimer: The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Variant 1. Chronic dyspnea. Unclear etiology. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☼
CT chest without IV contrast	May Be Appropriate (Disagreement)	☼☼☼
CT chest with IV contrast	May Be Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
US chest	Usually Not Appropriate	○

Variant 2. Chronic dyspnea. Suspected chronic obstructive pulmonary disease (COPD). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☼
CT chest without IV contrast	May Be Appropriate	☼☼☼
CT chest with IV contrast	May Be Appropriate	☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
US chest	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼

Variant 3. Chronic dyspnea. Suspected central airways disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☼
CT chest without IV contrast	Usually Appropriate	☼☼☼
CT chest with IV contrast	May Be Appropriate	☼☼☼
MRI chest without and with IV contrast	May Be Appropriate	○
MRI chest without IV contrast	May Be Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
US chest	Usually Not Appropriate	○

Variant 4. Chronic dyspnea. Suspected interstitial lung disease. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT chest without IV contrast	Usually Appropriate	☼☼☼
Radiography chest	Usually Appropriate	☼
CT chest with IV contrast	May Be Appropriate (Disagreement)	☼☼☼
MRI chest without and with IV contrast	Usually Not Appropriate	○
MRI chest without IV contrast	Usually Not Appropriate	○
US chest	Usually Not Appropriate	○
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼

Variant 5. Chronic dyspnea. Suspected disease of the pleura or chest wall. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☼
CT chest with IV contrast	Usually Appropriate	☼☼☼
CT chest without IV contrast	Usually Appropriate	☼☼☼
MRI chest without and with IV contrast	May Be Appropriate (Disagreement)	○
MRI chest without IV contrast	May Be Appropriate	○
US chest	May Be Appropriate (Disagreement)	○
FDG-PET/CT skull base to mid-thigh	Usually Not Appropriate	☼☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼

Variant 6. Chronic dyspnea. Suspected diaphragm dysfunction. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	Usually Appropriate	☼
Fluoroscopy chest	Usually Appropriate	☼☼☼
MRI chest without and with IV contrast	May Be Appropriate	○
MRI chest without IV contrast	May Be Appropriate	○
US chest	May Be Appropriate	○
CT chest with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without and with IV contrast	Usually Not Appropriate	☼☼☼
CT chest without IV contrast	Usually Not Appropriate	☼☼☼

Table 1. Appropriateness category names and definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Table 2. Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
⊕	<0.1	<0.03
⊕⊕	0.1-1	0.03-0.3
⊕⊕⊕	1-10	0.3-3
⊕⊕⊕⊕	10-30	3-10
⊕⊕⊕⊕⊕	30-100	10-30

Note: Relative radiation level (RRL) assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "varies."

SUMMARY OF LITERATURE REVIEW

Introduction/Background

Dyspnea is the subjective experience of breathing discomfort [1], often described as a feeling of breathlessness, or shortness of breath. The perception of dyspnea derives from the interactions of physiological, psychological, environmental, and social factors that may provoke various physiologic and behavioral responses. Clinical history and physical examination may provide insight into the cause or causes of dyspnea; however, laboratory and ancillary tests are also often necessary.

Chronic dyspnea implies shortness of breath of >1 month duration [2]. The differential diagnosis encompasses a wide variety of pathologies [3], including cardiovascular, pulmonary, gastrointestinal, neuromuscular, systemic, and psychogenic disorders. A multifactorial etiology is reported in up to a third of patients [4], with cardiovascular and pulmonary etiologies being the most common. Chronic dyspnea can be associated with a wide variety of disorders involving the airways, airspace, interstitium, pulmonary vessels, mediastinum and hila, pleura, diaphragm, and chest wall.

Asthma, bronchitis, chronic obstructive pulmonary disease (COPD), and interstitial lung disease (ILD) are frequently implicated. See the ACR Appropriateness Criteria® topic on "Dyspnea-Suspected Cardiac Origin" [5] and the ACR Appropriateness Criteria® topic on "Suspected Pulmonary Hypertension" [6] for further details.

OVERVIEW OF IMAGING MODALITIES

Radiography Chest

The workup of chronic dyspnea is influenced by its severity, the rate of worsening, and the presence or absence of risk factors and other symptoms. The initial evaluation is aimed at determining whether the cause is related to cardiovascular disease, pulmonary disease, a combination of both, or neither. A chest radiograph will typically be performed in the initial workup. The results of the chest radiograph can help guide, and sometimes eliminate the need for, further investigation. Using an algorithmic approach, the combination of chest radiograph and laboratory evaluation may result in a specific diagnosis in one-third of cases [7].

CT Chest

CT has an important role in the imaging evaluation of chronic dyspnea. It is useful when a radiographic abnormality requires further characterization or clinical findings necessitate additional imaging despite a normal radiograph [8,9]. For most routine applications, intravenous (IV) contrast is not needed, although it may be added when vascular abnormalities are in the differential diagnosis. CT protocols should be tailored to meet individual needs and may be determined based on radiographs and clinical features. For dyspnea, thin collimation of the lung parenchyma is essential. Most modern scanners allow this without additional data to be acquired. Adjuncts, such as expiratory images, prone images, and dynamic imaging of the airways, may be applied in certain clinical situations; therefore, knowledge of the suspected diagnosis is essential for planning the CT scan.

MRI Chest

MRI does not currently have a significant role in the evaluation of chronic dyspnea that is not of cardiovascular origin. However, MRI may play a role in the workup of congenital anomalies and diseases of the cardiopulmonary axis where both pulmonary imaging and cardiac imaging are desired in a single examination, and in the tissue characterization and assessment of extent of thoracic lesions.

FDG-PET/CT Skull Base to Mid-Thigh

Functional information from PET using the tracer fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)/CT can complement morphologic information derived from chest radiographs and CT. Attempts have been made to determine the efficacy of FDG-PET/CT in the behavior of inflammatory cells, extent of active lung disease, and response to therapy [10]. To date, evidence is limited to small series and has not been subjected to use in pharmacologic trials.

US Chest

Transthoracic ultrasound (US) imaging can be used for assessment of the lung periphery and pleura. Major advantages include portability, ease of use, and real-time imaging capability. US can target abnormalities and complement other imaging studies. It is particularly suited to bedside evaluation. Examples of uses in chronic dyspnea include the assessment of pleural and chest wall pathology, peripheral lung abnormalities, evaluation of

diaphragmatic function, and guidance of interventional procedures.

DISCUSSION OF PROCEDURES BY VARIANT

Variant 1: Chronic Dyspnea. Unclear Etiology. Initial Imaging

Radiography Chest. The chest radiograph should generally be the initial imaging study in chronic dyspnea. Pratter et al [11] reported that it added sufficient information to justify its routine use. In conjunction with cardiomyopathy, two-thirds of cases of chronic dyspnea in a pulmonary clinic were caused by asthma, COPD, and ILD. Pratter et al [7] later employed a prospective algorithmic approach to chronic dyspnea that used the chest radiograph as part of a Tier I evaluation. Karnani et al [2] advocated an algorithm that used the history and physical examination to guide appropriate testing, with the chest radiograph a component of a Level 1 diagnostic workup. Wahls [3] addressed the importance of the chest radiograph in the initial workup of chronic dyspnea in patients both with and without other physical examination findings.

A chest radiograph might reveal a wide variety of abnormalities in chronic dyspnea that may guide further imaging choices as outlined in subsequent variants. Examples include COPD, ILD, central airways disease, and pleural, chest wall, and diaphragmatic pathology.

CT Chest. In cases where the chest radiograph is normal or does not provide a direct answer, CT can be beneficial for documenting abnormalities not identified on a chest radiograph and guiding further workup [8,12]. In the Multi-Ethnic Study of Atherosclerosis lung study, CT imaging for parenchymal disease was considered to be the most informative imaging test [13].

MRI Chest. MRI has not been evaluated in a systematic manner for the assessment of patients with nonspecific chronic dyspnea, although it may have a role in specific clinical situations.

US Chest. Transthoracic US has good test characteristics for peripheral thoracic abnormalities, although it does not provide the comprehensive evaluation that CT does in the setting of an unspecified cause.

FDG-PET/CT Skull Base to Mid-Thigh. FDG-PET/CT has not been evaluated in a systematic manner for the assessment of patients with nonspecific chronic dyspnea, although it may have a role in specific clinical situations.

Variant 2: Chronic Dyspnea. Suspected Chronic Obstructive Pulmonary Disease (COPD). Initial Imaging

Radiography Chest. In COPD, a radiograph can help exclude alternative diagnoses and evaluate for comorbidities and complications [14]. Wallace et al [15] reported that 14% of chest radiographs ordered during COPD evaluation detected potentially treatable causes of dyspnea other than COPD and lung cancer and that 84% of radiographs assisted management.

CT Chest. CT has greater sensitivity and specificity than a chest radiograph in determining the type, extent, and distribution of emphysema and bronchial wall abnormalities [16]. CT is able to identify early changes of COPD in asymptomatic and spirometrically normal smokers [17]. It has shown that visual assessments of emphysema and airway disease are accurate and reproducible [18]. In addition, quantitative CT-derived parameters correlate with pulmonary function tests and can be used as imaging biomarkers to follow disease progression [19-23]. Findings have been shown to correlate with patient-reported measures [24-26] and to predict health status in COPD [27]. CT-based phenotypes have prognostic value in predicting future hospitalization, symptomatic decline, and mortality [28,29]. Expiratory CT has been reported to reflect airflow limitation and correlates well with levels of dyspnea [30].

MRI Chest. Numerous MRI techniques are available to evaluate COPD, including hyperpolarized helium, T1 oxygen-enhanced mapping, and equilibrium signal mapping [31-33]. While predominately the subject of research, small studies have shown good correlation with CT-derived measures and provide a rationale for the use of MRI when quantitative imaging measures are needed.

US Chest. US may have a role in defining pleural or diaphragmatic complications related to COPD, but there is no supporting evidence for its use as a diagnostic technique for this condition.

FDG-PET/CT Skull Base to Mid-Thigh. There are no primary data to support the use of FDG-PET/CT to diagnose or manage COPD.

Variant 3: Chronic Dyspnea. Suspected Central Airways Disease. Initial Imaging

Radiography Chest. Chest radiographs have the potential to identify conditions of the trachea, with accuracy

dependent on the condition to be identified. Compared to CT, radiographs have an accuracy of 89% [34]. It should be noted that radiographic findings may be normal or nonspecific. In a single-institution retrospective study of tracheal neoplasms, <50% were directly detectable by a chest radiograph [35].

CT Chest. Examples of airway conditions that may result in chronic dyspnea and can be accurately diagnosed by CT include stenoses, tumors, and end-expiratory airway collapse/tracheobronchomalacia, with strong correlations when compared with bronchoscopy [36,37]. For the last condition, expiratory images are required for diagnosis. Both dynamic airway imaging and static forced expiratory imaging are able to accurately characterize airway collapse when compared with bronchoscopy [38,39]. It has been shown that the degree of expiratory collapse is greater on dynamic studies compared to static forced expiratory images, although the clinical importance of this observation remains unclear [39,40]. Forced expiratory measurements show good reproducibility in healthy volunteers [41]. Volume acquisition of the airways allows for the production of 2-D and 3-D reformations that can better delineate the extent of abnormalities, while perspective volume rendering (virtual bronchoscopy) may be helpful in preprocedural planning.

MRI Chest. There are limited data supporting the use of MRI for the central airways in adult populations [42,43]. Some data supporting the use of MRI in pediatric populations [44,45] may be applicable in adults.

FDG-PET/CT Skull Base to Mid-Thigh. FDG-PET/CT has a supplemental role in the staging of tracheal neoplasms; however, there are no data to support its use in other tracheal conditions.

US Chest. One small study has shown that measurements obtained from US imaging of the extrathoracic trachea correlate well with MRI [46]; however, a transthoracic US technique is limited by its inability to evaluate the entire tracheobronchial tree.

Variant 4: Chronic Dyspnea. Suspected Interstitial Lung Disease. Initial Imaging

Radiography Chest. The chest radiograph may be abnormal in diffuse ILD; however, studies documenting the sensitivity of chest radiographs predate the widespread use of CT [47]. A normal chest radiograph in the setting of suspected ILD does not exclude the possibility of clinically important ILD. In subjects with diseases that

predispose them to ILD (eg, connective tissue disease), it is reasonable to consider CT rather than radiography as the primary screening modality.

CT Chest. CT is currently the preferred imaging method for evaluating ILD [48]. CT protocols should be tailored to the clinical setting and may include expiratory or prone imaging. Good correlation has been reported between extent of disease on CT and severity of dyspnea [49-53]. CT findings are often sufficient to permit either a limited differential or confident diagnosis; the latter occurs particularly in the diagnosis of usual interstitial pneumonia [54-57], although the diagnostic yield improves with multidisciplinary discussion [58,59]. There is moderate agreement across individuals in the rating of honeycomb change [60]. The presence and extent of honeycomb change and other imaging features of ILD may serve as important prognostic variables [61,62].

MRI Chest. MRI does not currently have an established clinical role in the evaluation of ILD, although small studies have shown good concordance with CT [63-65]. In general, MRI does not yet display the same level of parenchymal detail that is available with CT. A specific advantage of MRI may exist when a single examination is desired for the evaluation of both ILD and its effect on the cardiovascular system [66].

FDG-PET/CT Skull Base to Mid-Thigh. FDG-PET/CT may have a secondary role in ILD evaluation. It can be used as a marker of disease extent and severity in sarcoidosis [67], reveal inflammatory activity before morphological changes are demonstrated on CT [68], and assist in follow-up and the monitoring of treatment response [10]. Some studies show that the degree of FDG activity correlates with severity and prognosis in ILD [69-71].

US Chest. US has been evaluated as a potential ILD screening tool in high-risk populations. In scleroderma, US was concordant with CT in 83% of patients and demonstrated high sensitivity [72]. It is being used in some centers to detect chronic ILD [73,74] and is emerging as a monitoring tool [75].

Variant 5: Chronic Dyspnea. Suspected Disease of the Pleura or Chest Wall. Initial Imaging

Radiography Chest. Pleural effusion is often diagnosed by a chest radiograph, and volume can reasonably be estimated [76]. A radiograph is somewhat limited in its ability to determine the exact location of an abnormality, whether

parenchymal, pleural, or extrapleural. A chest radiograph may reveal structural abnormalities of the sternum, ribs, and thoracic spine that may predispose toward dyspnea.

CT Chest. CT is superior to radiographs in detecting and characterizing pleural disease, differentiating it from parenchymal and chest wall disease, and determining the extent of involvement [77]. CT is somewhat limited in its ability to differentiate causes of pleural effusion, although the presence of pleural thickening or enhancement may help document complex exudative and malignant effusions [78,79].

MRI Chest. MRI may provide improved characterization and assessment of the extent of pleural and chest wall abnormalities compared to CT. MRI can help distinguish components of complex fluid collections, including septations [80], and is thought to be slightly better at distinguishing benign from malignant pleural thickening [81]. Improved soft-tissue contrast allows for better demonstration of soft-tissue relationships, which can facilitate the assessment of invasion and neurovascular encasement. Small studies have shown that MRI is capable of providing diagnostic images to guide surgical chest wall reconstruction [82]. There is extensive supportive literature in pediatric populations surrounding the detection and management of pectus excavatum.

FDG-PET/CT Skull Base to Mid-Thigh. FDG-PET/CT remains a secondary test that may be used in the staging of mesothelioma and pleural metastatic disease.

US Chest. US can complement the imaging evaluation of several abnormalities. US has an established role in pleural effusion, including detection, differentiation from lung disease, characterization, and guidance of intervention. US may be more efficacious than chest radiography and CT at detecting internal septations in complex pleural effusions [83]. Pleural thickening, plaques, and masses may be identifiable on US, although US is not recommended in their workup. US is advantageous in the bedside diagnosis of pneumothorax and is most often used in acute assessment [84].

Variant 6: Chronic Dyspnea. Suspected Diaphragm Dysfunction. Initial Imaging

Radiography Chest. A static chest radiograph is useful to assess the relative position of the diaphragm and its effect on lung volumes and can provide clues to diaphragm paralysis compared to a fluoroscopic reference standard [85].

Fluoroscopy Chest. With fluoroscopic visualization, more accurate assessment of diaphragmatic motion can be made [86,87].

CT Chest. While CT can document the position of the diaphragm with multiplanar imaging and in theory can provide dynamic information, there are no data to support its use in the analysis of diaphragmatic dysfunction.

MRI Chest. Although not widely practiced, cine dynamic MRI sequences allow for the direct visualization of diaphragm motion [88]. This can result in comprehensive analysis of both the diaphragm and chest wall muscle movement in neuromuscular diseases [89].

US Chest. US findings have been found to be concordant with fluoroscopic imaging of diaphragm motion, with reproducible results [90]. Diaphragmatic excursion amplitude, thickness, and contraction can be evaluated, and paralysis may be identified as paradoxical movement during respiration [91]. There is high sensitivity and specificity for the diagnosis of neuromuscular disorders of the diaphragm [92-95]. The extent of diaphragm motion in various conditions, including neuromuscular diseases, COPD, and ILD, correlates with respiratory symptoms and lung function [96-100].

SUMMARY OF RECOMMENDATIONS

- **Variant 1:** For patients with chronic dyspnea of unclear etiology, it is usually appropriate to initially evaluate with chest radiography, which may reveal a wide variety of abnormalities and guide further imaging decisions.
- **Variant 2:** The appropriate initial imaging study for patients with chronic dyspnea with suspected COPD is usually a chest radiograph, which can evaluate for comorbidities, complications, and alternative diagnoses.
- **Variant 3:** A chest radiograph is usually appropriate for the initial imaging of patients with chronic dyspnea and suspected central airways disease. Alternatively, CT without IV contrast is also usually appropriate, particularly for the detection of airway collapse, stenosis, or tumor.
- **Variant 4:** CT without IV contrast is usually appropriate for the initial imaging of patients with chronic dyspnea and suspected ILD, especially if the patient has a disease that predisposes to ILD. Alternatively, initial imaging with chest radiography is usually appropriate, although a

normal chest radiograph does not exclude clinically important ILD.

- **Variant 5:** For patients with chronic dyspnea and suspected pleural or chest wall disease, initial imaging with chest radiography is usually appropriate. Alternatively, initial imaging by CT without or with IV contrast is usually appropriate; CT is superior in distinguishing, characterizing, and assessing the extent of pleural and chest wall abnormalities.
- **Variant 6:** It is usually appropriate to initially image patients with chronic dyspnea and suspected diaphragm dysfunction by chest radiography, which can assess diaphragm position and provide clues to the presence of paralysis. Alternatively, initial imaging by fluoroscopy is usually appropriate and provides a more accurate assessment of diaphragm motion.

SUMMARY OF EVIDENCE

Of the 101 references cited in the *ACR Appropriateness Criteria[®] Chronic Dyspnea-Noncardiovascular Origin* document, all of them are categorized as diagnostic references including 2 well-designed studies, 30 good-quality studies, and 41 quality studies that may have design limitations. There are 28 references that may not be useful as primary evidence.

The 101 references cited in the *ACR Appropriateness Criteria[®] Chronic Dyspnea-Noncardiovascular Origin* document were published from 1978 to 2017.

Although there are references that report on studies with design limitations, 32 well-designed or good-quality studies provide good evidence.

RELATIVE RADIATION LEVEL INFORMATION

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation

exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table 2). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [101].

SUPPORTING DOCUMENTS

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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