

# ACR Appropriateness Criteria<sup>®</sup>

## Syncope

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Dr Abbara reports personal fees from Elsevier outside the submitted work. Dr Bykowski serves on the medical advisory board for Spinal Therapeutics. Dr Liebeskind reports other support from Cerenovus, Genentech, Medtronic, and Stryker, outside the submitted work. The other authors state that they have no conflict of interest related to the material discussed in this article. Dr Wann is self-employed. The other authors are non-partner/non-partnership track employees.

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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.

## Abstract

Syncope and presyncope lead to well over one million emergency room visits in the United States each year. Elucidating the cause of syncope or presyncope, which are grouped together given similar etiologies and outcomes, can be exceedingly difficult given the diverse etiologies. This becomes more challenging as some causes, such as vasovagal syncope, are relatively innocuous while others, such as cardiac-related syncope, carry a significant increased risk of death. While the mainstay of syncope and presyncope assessment is a detailed history and physical examination, imaging can play a role in certain situations. In patients where a cardiovascular etiology is suspected based on the appropriate history, physical examination, and ECG findings, resting transthoracic echocardiography is usually considered appropriate for the initial imaging. While no imaging studies are considered usually appropriate when there is a low probability of cardiac or neurologic pathology, chest radiography may be appropriate in certain clinical situations.

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, Appropriate Use Criteria, AUC, Cardiovascular, Echocardiogram, Neurologic, Presyncope, Radiography

J Am Coll Radiol 2021;18:S229-S238. Copyright © 2021 American College of Radiology

ACR Appropriateness Criteria® Syncope. [Variants 1 and 2](#) and [Tables 1 and 2](#).

**Variant 1.** Presyncope or syncope. Clinical suspicion for cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US echocardiography transthoracic resting	Usually Appropriate	○
CTA chest with IV contrast	May Be Appropriate	⦿⦿⦿
Radiography chest	May Be Appropriate	⦿
CTA coronary arteries with IV contrast	May Be Appropriate	⦿⦿⦿
MRI heart function and morphology without and with IV contrast	May Be Appropriate	○
MRI heart function and morphology without IV contrast	May Be Appropriate	○
CT heart function and morphology with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
US echocardiography transesophageal	Usually Not Appropriate	○
CT head with IV contrast	Usually Not Appropriate	⦿⦿⦿
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	⦿⦿⦿⦿
US echocardiography transthoracic stress	Usually Not Appropriate	○
CT head without and with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT head without IV contrast	Usually Not Appropriate	⦿⦿⦿
MRI head without and with IV contrast	Usually Not Appropriate	○
MRI head without IV contrast	Usually Not Appropriate	○
SPECT or SPECT/CT MPI rest only	Usually Not Appropriate	⦿⦿⦿
SPECT or SPECT/CT MPI stress only	Usually Not Appropriate	⦿⦿⦿
US duplex Doppler carotid	Usually Not Appropriate	○

**Variant 2.** Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	May Be Appropriate	⦿
CT head with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT head without and with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT head without IV contrast	Usually Not Appropriate	⦿⦿⦿
CT heart function and morphology with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CTA chest with IV contrast	Usually Not Appropriate	⦿⦿⦿
CTA coronary arteries with IV contrast	Usually Not Appropriate	⦿⦿⦿
MRI head without and with IV contrast	Usually Not Appropriate	○
MRI head without IV contrast	Usually Not Appropriate	○
MRI heart function and morphology without and with IV contrast	Usually Not Appropriate	○
MRI heart function and morphology without IV contrast	Usually Not Appropriate	○
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	⦿⦿⦿⦿
SPECT or SPECT/CT MPI rest only	Usually Not Appropriate	⦿⦿⦿
SPECT or SPECT/CT MPI stress only	Usually Not Appropriate	⦿⦿⦿
US duplex Doppler carotid	Usually Not Appropriate	○
US echocardiography transesophageal	Usually Not Appropriate	○
US echocardiography transthoracic resting	Usually Not Appropriate	○
US echocardiography transthoracic stress	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
⊕	<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

Syncope, the transient and abrupt loss of consciousness with spontaneous recovery, is the estimated cause of 1.2 to 1.8 million adult emergency department visits each year [1,2]. Presyncope or near syncope, defined as the sudden onset of symptoms of light-headedness, dizziness, sweating, nausea, abnormal visual sensations such as “tunnel vision” without loss of consciousness, is often considered a separate entity [3,4]. Three large prospective studies have shown that both the short-term serious outcomes and deaths in patients with syncope and presyncope are extremely similar [4-6]. Management and risk stratification of patients with syncope or presyncope should mirror one another, a concept endorsed by various medical societies [7-9].

Elucidating the underlying cause of a syncopal or presyncopal episode can be challenging. There are numerous potential cardiovascular or neurologic etiologies, many of which rely on appropriate imaging for identification and classification; these include coronary artery disease, aortic disease, and cardiomyopathies. Although the etiology is never discovered in one-third of patients [10], and some causes such as vasovagal syncope are relatively innocuous, others, such as cardiac-related syncope, carry a significant increased risk of death [10-13]. The mainstay of syncope and presyncope assessment is a detailed history and physical examination. The assessment should include measurement of postural changes in blood pressure to diagnose orthostatic-related syncope and a detailed neurologic history and physical examination to exclude symptoms or signs of a separate neurologic process, which would require a different course of evaluation [14]. In addition to a detailed cardiac examination assessing for structural heart disease, certain patient characteristics are associated with an increased risk of cardiac-related syncope and include

the following: age >60 years, male gender, known underlying congenital or acquired cardiac disease, palpitations or other cardiac-related symptoms prior to syncopal episode, syncope during exertion, syncope in supine position, low number of prior syncopal episodes, and family history of sudden cardiac death [3].

Studies have shown that patients with syncope and presyncope have a low yield of 5% to 6.4% of an acute abnormality on head CT, nearly all with external evidence of head trauma or a focal neurological deficit on examination [15-19]. Increasing age has been associated with higher odds for a CT abnormality compared with younger patients with syncope, however, the age cutoffs of >55 [15] or 60 and older [19] have not been validated across studies as independent predictive factors in absence of trauma or neurologic deficit [20]. There is a consensus across multidisciplinary task forces, clinical guidelines, and the ACR *Choosing Wisely* review that brain CT and MRI should be avoided in uncomplicated syncope [3,8,21]. Cohort studies and a meta-analysis of 12 additional studies reported <1% occurrence of new neurological diagnosis (including stroke) within 30 days from original presentation of syncope or presyncope [4,18,22,23].

Although there is conflicting data regarding its utility, multisociety guidelines suggest a resting 12-lead electrocardiogram (ECG) for all patients to detect arrhythmias or abnormality indicative of higher risk for arrhythmia (eg, prolonged QT interval) [7-9,11]. Although additional laboratory, physiologic, and image-based testing can be performed, it is recommended that testing be limited to select patients based on clinical assessment. In most instances, nonfocused additional testing in a patient with syncope or presyncope does not improve diagnostic yield, however, it does increase the hospitalization rate and

significantly increases cost, and therefore is not endorsed by any major medical society [3,8,9,20,24].

Therefore, it is important to acknowledge that head CT and/or head MRI is useful when patients with syncope present with other conditions referenced in independent ACR Appropriateness Criteria® documents, not based solely on syncope. To avoid delay of appropriate care, any patient with signs or symptoms suggesting transient ischemic attack or stroke should undergo imaging guided by the ACR Appropriateness Criteria® topic on “Cerebrovascular Disease” [25]. Similarly, if trauma occurs because of or leads to a syncopal episode, imaging should be guided by the ACR Appropriateness Criteria® topic on “Head Trauma” [26]. Please refer to additional ACR Appropriateness Criteria® topics, including “Acute Mental Status Change, Delirium and New Onset Psychosis” [27], “Seizures and Epilepsy” [28], “Headache” [29], “Ataxia” [30], and “Movement Disorders and Neurodegenerative Diseases” [31], to guide imaging rather than symptoms of syncope.

If a patient has syncope or presyncope with cardiac symptoms (eg, chest pain, congenital or acquired cardiac pathology, coronary artery pathology, nonspecific chest pain, infiltrative heart disease, aortic dissection, pulmonary embolism [PE]), please refer to the relevant ACR Appropriateness Criteria® topics on “Acute Nonspecific Chest Pain—Low Probability of Coronary Artery Disease” [32], “Chronic Chest Pain-Noncardiac Etiology Unlikely-Low to Intermediate Probability of Coronary Artery Disease” [33], “Chronic Chest Pain-High Probability of Coronary Artery Disease” [34], “Chest Pain-Possible Acute Coronary Syndrome” [35], “Suspected New-Onset and Known Nonacute Heart Failure” [36], “Nonischemic Myocardial Disease With Clinical Manifestations (Ischemic Cardiomyopathy Already Excluded)” [37], “Dyspnea-Suspected Cardiac Origin” [38] “Known or Suspected Congenital Heart Disease in the Adult” [39], “Acute Chest Pain—Suspected Aortic Dissection” [40] or “Suspected Pulmonary Embolism” [41], to guide imaging, rather than due to symptoms of syncope.

### Special Imaging Considerations

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [42]:

*CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3-D renderings.*

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the CMS has applied to the Current Procedural Terminology codes.

### Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously in which each procedure provides unique clinical information to effectively manage the patient’s care).

## DISCUSSION OF PROCEDURES BY VARIANT

**Variant 1: Presyncope or syncope. Clinical suspicion for cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging**

**CT Head.** Serial studies of patients with syncope or presyncope have shown that head CT does not influence treatment management in this clinical scenario [15–19].

**CT Heart Function and Morphology.** There is no relevant literature that examines the use of ECG-gated CT heart in this clinical scenario. CT heart can identify hypertrophic cardiomyopathy and thrombus in the cardiac chambers.

**CTA Chest.** There is conflicting evidence regarding the use of CTA of the chest in cases of presyncope and syncope to evaluate for aortic and or pulmonary arterial disease. In an Italian trial with 560 patients, the prevalence of PE was 17.3% in hospitalized patients who had presented to the emergency department with their first episode of syncope [43]. However, in a larger United States and Canadian trial with 9,091 patients, only 0.6% of patients with syncope were diagnosed with PE [43]. Similarly, in a recent prospective trial of 1,397 patients from 13 hospitals across



8 countries, only 1.4% of patients were diagnosed with PE [44]. Importantly, no patients who were categorized as having a low pretest probability (612 patients), had negative imaging during initial workup (88 patients), or were treated for PE (19 patients) were diagnosed with PE or experienced cardiovascular death over 2-year follow-up. Interestingly, a subgroup analysis from this study in patients presenting to the emergency department who were subsequently hospitalized revealed a PE incidence of 2.3%, much lower than the 17.3% in the Italian trial. Nonetheless, all-cause short-term mortality has been shown to be significantly higher in patients with PE who present with syncope or presyncope [45]. Please refer to the ACR Appropriateness Criteria® topic on “Suspected Pulmonary Embolism” [41] to guide imaging.

Syncope or presyncope can occur in the setting of acute aortic dissection. Similar to PE, syncope in the setting of acute aortic dissection is associated with a higher mortality [46,47]. Although cardiac tamponade and neurologic insult (ie, stroke, spinal cord ischemia, etc) are the most common cause of syncope in the setting of dissection, about half of patients have no explanation for their loss of consciousness. In rare instances, syncope or presyncope can be the only symptom associated with an acute aortic dissection. Please refer to the ACR Appropriateness Criteria® topic on “Acute Chest Pain—Suspected Aortic Dissection” [40] to guide imaging.

**CTA Coronary Arteries.** One small retrospective study found that patients with cardiac-related syncope or presyncope had a greater extent and severity of coronary artery disease by coronary CTA (CCTA) compared with those with noncardiac-related syncope and matched patients with chest pain and no syncope [48]. Additionally, anomalous coronary arteries can be a cause of exercise-induced syncope or presyncope, especially in younger patients [49,50]. However, there are no prospective or large retrospective studies assessing the utility of CCTA in patients with syncope or presyncope as the only presenting finding.

**MRI Head.** There is no relevant literature to support the use of head MRI in this clinical scenario.

**MRI Heart Function and Morphology.** There is no relevant literature that examines the use of cardiac MRI in this clinical scenario. MRI heart can provide detailed analysis of cardiac function, morphology, and physiology. MRI is a valuable tool in the diagnosis of infiltrative cardiomyopathies that can manifest with episodes of syncope and presyncope including hypertrophic cardiomyopathy [51,52], sarcoid [53,54], myocarditis [55-57], amyloid [58], arrhythmogenic right ventricular dysplasia [58], and nonischemic dilated cardiomyopathy [58,59]. In both

ischemic and nonischemic cardiomyopathies, MRI can assess for areas of scarring, which can serve as an arrhythmogenic focus and can lead to syncope or sudden cardiac death [60]. Although not routinely utilized as an initial imaging tool, cardiac MRI could be utilized in stable patients as an alternative to echocardiography when image quality is not diagnostic or optimal.

**Radiography Chest.** There are no prospective studies that examine the use of chest radiographs in patients with syncope or presyncope. In one large retrospective multi-institution study evaluating syncope and presyncope in 3,686 patients >60 years of age, 2,767 (75.1%) had a chest radiograph performed [61]. Of those, 182 (6.6%), had a radiograph interpreted as abnormal. In a smaller retrospective study performed at a single institution, only 4.5% of patients with syncope had an abnormal chest radiograph. However, patients with syncope or presyncope who had abnormal chest radiographs were more likely to have serious adverse events compared with those with normal radiographs [62].

**SPECT or SPECT/CT MPI Rest and Stress.** There is no relevant literature to support the routine use of a Tc-99m single-photon emission CT (SPECT) or SPECT/CT myocardial perfusion imaging (MPI) rest and stress in most patients with syncope. Limited data from one large retrospective study assessing the use of MPI in 700 patients with syncope of any cause and no known coronary artery disease concluded there was no significant utility for rest and stress testing [63].

**SPECT or SPECT/CT MPI Rest Only.** There is no relevant literature that examines the use of Tc-99m SPECT or SPECT/CT MPI rest only study in this clinical scenario. If a patient has acute chest pain associated with syncope or presyncope and likely has symptoms related to coronary artery pathology based on detailed history and physical examination along with corresponding ECG and targeting laboratory studies, please refer to the ACR Appropriateness Criteria® topic on “Chest Pain—Possible Acute Coronary Syndrome” [35] to guide imaging.

**SPECT or SPECT/CT MPI Stress Only.** There is no relevant literature that examines the use of Tc-99m SPECT or SPECT/CT MPI stress only study in this clinical scenario.

**US Duplex Doppler Carotid.** Multiple studies have shown no benefit of carotid Doppler ultrasound (US) in patients with syncope or presyncope in the absence of neurologic findings or carotid bruit [20,64-66].

**US Echocardiography Transesophageal.** There is no relevant literature to support the use of a transesophageal

echocardiography in the evaluation of syncope or presyncope. Transesophageal echocardiography can further elucidate abnormal findings visualized on transthoracic echocardiogram.

### **US Echocardiography Transthoracic Resting.**

Transthoracic resting echocardiography provides a noninvasive assessment of cardiac structure and function. In patients with an abnormal ECG or findings on history or physical examination suggesting a cardiac etiology of syncope or presyncope, transthoracic echocardiography can be used to assess for structural heart disease or to help identify risk factors for malignant arrhythmias and is validated by multiple studies and supported by numerous societies [3,8,67-69]. Possible etiologies include various cardiomyopathies, valvular disease, pericardial disease, and tumors.

**US Echocardiography Transthoracic Stress.** There are no prospective studies that examine the use of transthoracic stress echocardiography in patients with cardiac etiology for syncope or presyncope. Stress echocardiography can be used to assess for left ventricular outflow obstruction in patients with left ventricular hypertrophy and hypertrophic cardiomyopathy. In both of these populations, outflow tract obstruction is associated with increased future episodes of presyncope and syncope [70,71].

## **Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging**

**CT Head.** Serial studies of patients with syncope or presyncope have shown that CT head does not influence treatment management in this clinical scenario [15-19].

**CT Heart Function and Morphology.** There is no relevant literature that examines the use of ECG-gated CT heart in this clinical scenario.

**CTA Chest.** There is no relevant literature that examines the use of CTA of the chest in this clinical scenario.

**CTA Coronary Arteries.** There is no relevant literature that examines the use of ECG-gated CCTA in this clinical scenario.

**MRI Head.** There is no relevant literature to support the use of head MRI in this clinical scenario.

**MRI Heart Function and Morphology.** There is no relevant literature that examines the use of cardiac MRI in this clinical scenario.

**Radiography Chest.** There are no prospective studies that examine the use of chest radiographs in patients with syncope or presyncope. In one large retrospective multi-institution study evaluating syncope and presyncope in 3,686 patients >60 years of age, 2,767 (75.1%) had a chest radiograph performed [61]. Of those, 182 (6.6%), had a radiograph interpreted as abnormal. In a smaller retrospective study performed at a single institution, only 4.5% of patients with syncope had an abnormal chest radiograph. However, patients with syncope or presyncope who had abnormal chest radiographs were more likely to have serious adverse events compared with those with normal radiographs [62].

**SPECT or SPECT/CT MPI Rest and Stress.** There is no relevant literature to support the routine use of a Tc-99m SPECT or SPECT/CT MPI rest and stress in most patients with syncope. Limited data from one large retrospective study assessing the use of MPI in 700 patients with syncope of any cause and no known coronary artery disease concluded there was no significant utility for testing [63].

**SPECT or SPECT/CT MPI Rest Only.** There is no relevant literature that examines the use of Tc-99m SPECT or SPECT/CT MPI rest only study in this clinical scenario.

**SPECT or SPECT/CT MPI Stress Only.** There is no relevant literature that examines the use of Tc-99m SPECT or SPECT/CT MPI stress only study in this clinical scenario.

**US Duplex Doppler Carotid.** Multiple studies have shown no benefit of carotid Doppler US in patients with syncope or presyncope in the absence of neurologic findings or carotid bruit [20,64-66].

**US Echocardiography Transesophageal.** There is no relevant literature that examines the use of transesophageal echocardiography in this clinical scenario.

**US Echocardiography Transthoracic Resting.** There is no relevant literature that examines the use of transthoracic resting echocardiography in this clinical scenario, especially if a patient who has syncope or presyncope in the setting of a normal ECG and low probability of a cardiac cause of symptoms [66,69,72,73].

**US Echocardiography Transthoracic Stress.** There is no relevant literature that examines the use of transthoracic stress echocardiography in this clinical scenario.

## **SUMMARY OF RECOMMENDATIONS**

- **Variant 1:** US echocardiography transthoracic resting is usually appropriate for the initial imaging of a

presyncope or syncope patient with clinical suspicion for cardiovascular etiology based on history, physical examination, and ECG findings.

■ **Variant 2:** Radiography chest may be appropriate for the initial imaging of a presyncope or syncope patient with low probability of cardiovascular etiology based on history, physical examination, and ECG findings.

## SUPPORTING DOCUMENTS

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

## 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 [74].

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