American College of Radiology
ACR Appropriateness Criteria®
Syncope

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	O
Radiography chest	May Be Appropriate	☢
MRI heart function and morphology without and with IV contrast	May Be Appropriate	O
MRI heart function and morphology without IV contrast	May Be Appropriate	O
CTA chest with IV contrast	May Be Appropriate	☢☢☢
CTA coronary arteries with IV contrast	May Be Appropriate	☢☢☢
US duplex Doppler carotid artery	Usually Not Appropriate	O
US echocardiography transesophageal	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
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	☢☢☢
SPECT or SPECT/CT MPI rest only	Usually Not Appropriate	☢☢☢
SPECT or SPECT/CT MPI stress only	Usually Not Appropriate	☢☢☢
CT heart function and morphology with IV contrast	Usually Not Appropriate	☢☢☢☢
SPECT or SPECT/CT MPI rest and stress	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	☢
US duplex Doppler carotid artery	Usually Not Appropriate	O
US echocardiography transesophageal	Usually Not Appropriate	O
US echocardiography transthoracic resting	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without and with IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without IV contrast	Usually Not Appropriate	O
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	☢☢☢
CTA chest with IV contrast	Usually Not Appropriate	☢☢☢
CTA coronary arteries with 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	☢☢☢
CT heart function and morphology with IV contrast	Usually Not Appropriate	☢☢☢☢
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	☢☢☢☢

Panel Members

Seth J. Kligerman, MD[a]; Julie Bykowski, MD[b]; Lynne M. Koweek, MD[c]; Bruno Policeni, MD, MBA[d]; Brian B. Ghoshhajra, MD, MBA[e]; Michael D. Brown, MD, MSc[f]; Andrew M. Davis, MD, MPH[g]; Elizabeth H. Dibble, MD[h]; Thomas V. Johnson, MD[i]; Faisal Khosa, MD, MBA[j]; Luke N. Ledbetter, MD[k]; Steve W. Leung, MD[l]; David S. Liebeskind, MD[m]; Diana Litmanovich, MD[n]; Christopher D. Maroules, MD[o]; Jeffrey S. Pannell, MD[p]; William J. Powers, MD[q]; Todd C. Villines, MD[r]; Lily L. Wang, MBBS, MPH[s]; Samuel Wann, MD[t]; Amanda S. Corey, MD[u]; Suhny Abbara, MD[v].

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 wherein 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.

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

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

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

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

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

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

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

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

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

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

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

Variant 1: Presyncope or syncope. Clinical suspicion for cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
K. US duplex Doppler carotid artery

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

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

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

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

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

Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
B. CT heart function and morphology

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

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

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

Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
D. CTA coronary arteries

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

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

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

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

F. MRI heart function and morphology

There is no relevant literature that examines the use of cardiac MRI in this clinical scenario.

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

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

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

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

Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
K. US duplex Doppler carotid artery

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

Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
L. US echocardiography transesophageal

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

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

Variant 2: Presyncope or syncope. Low probability of cardiovascular etiology based on history, physical examination, and ECG findings. Initial imaging.
N. 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, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

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.

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 below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*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 (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies.”

References

1. Anderson TS, Thombley R, Dudley RA, Lin GA. Trends in Hospitalization, Readmission, and Diagnostic Testing of Patients Presenting to the Emergency Department With Syncope. Ann Emerg Med. 72(5):523-532, 2018 11.
2. Probst MA, Kanzaria HK, Gbedemah M, Richardson LD, Sun BC. National trends in resource utilization associated with ED visits for syncope. American Journal of Emergency Medicine. 33(8):998-1001, 2015 Aug.
3. Shen WK, Sheldon RS, Benditt DG, et al. 2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients With Syncope: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. J Am Coll Cardiol. 70(5):620-663, 2017 08 01.
4. Thiruganasambandamoorthy V, Stiell IG, Wells GA, Vaidyanathan A, Mukarram M, Taljaard M. Outcomes in presyncope patients: a prospective cohort study. Annals of Emergency Medicine. 65(3):268-276.e6, 2015 Mar.
5. Bastani A, Su E, Adler DH, et al. Comparison of 30-Day Serious Adverse Clinical Events for

Elderly Patients Presenting to the Emergency Department With Near-Syncope Versus Syncope. Annals of Emergency Medicine. 2018 Dec 07.

6. Grossman SA, Babineau M, Burke L, et al. Do outcomes of near syncope parallel syncope?. American Journal of Emergency Medicine. 30(1):203-6, 2012 Jan.

7. Albassam OT, Redelmeier RJ, Shadowitz S, Husain AM, Simel D, Etchells EE. Did This Patient Have Cardiac Syncope?: The Rational Clinical Examination Systematic Review. JAMA. 321(24):2448-2457, 2019 06 25.

8. Brignole M, Moya A, de Lange FJ, et al. 2018 ESC Guidelines for the diagnosis and management of syncope. European Heart Journal. 39(21):1883-1948, 2018 Jun 01.

9. Runser LA, Gauer RL, Houser A. Syncope: Evaluation and Differential Diagnosis. Am Fam Physician. 95(5):303-312, 2017 Mar 01.

10. Soteriades ES, Evans JC, Larson MG, et al. Incidence and prognosis of syncope. New England Journal of Medicine. 347(12):878-85, 2002 Sep 19.

11. Iacovino JR.. Mortality outcomes of various causes of syncope. Journal of Insurance Medicine (Seattle). 36(1):4-9, 2004.

12. Kapoor WN.. Evaluation and outcome of patients with syncope. [Review] [120 refs]. Medicine. 69(3):160-75, 1990 May.

13. Koene RJ, Adkisson WO, Benditt DG. Syncope and the risk of sudden cardiac death: Evaluation, management, and prevention. [Review]. Journal of Arrhythmia. 33(6):533-544, 2017 Dec.

14. Freeman R, Wieling W, Axelrod FB, et al. Consensus statement on the definition of orthostatic hypotension, neurally mediated syncope and the postural tachycardia syndrome. Clinical Autonomic Research. 21(2):69-72, 2011 Apr.

15. Bent C, Lee PS, Shen PY, Bang H, Bobinski M. Clinical scoring system may improve yield of head CT of non-trauma emergency department patients. EMERG. RADIOL.. 22(5):511-6, 2015 Oct.

16. Giglio P, Bednarczyk EM, Weiss K, Bakshi R. Syncope and head CT scans in the emergency department. Emergency Radiology. 12(1-2):44-6, 2005 Dec.

17. Goyal N, Donnino MW, Vachhani R, Bajwa R, Ahmad T, Otero R. The utility of head computed tomography in the emergency department evaluation of syncope. Internal & Emergency Medicine. 1(2):148-50, 2006.

18. Grossman SA, Fischer C, Bar JL, et al. The yield of head CT in syncope: a pilot study. Internal & Emergency Medicine. 2(1):46-9, 2007 Mar.

19. Mitsunaga MM, Yoon HC. Journal Club: Head CT scans in the emergency department for syncope and dizziness. AJR Am J Roentgenol. 204(1):24-8, 2015 Jan.

20. Mendu ML, McAvay G, Lampert R, Stoehr J, Tinetti ME. Yield of diagnostic tests in evaluating syncopal episodes in older patients. Archives of Internal Medicine. 169(14):1299-305, 2009 Jul 27.

21. Choosing Wisely. American College of Emergency Physicians. Avoid CT of the head in asymptomatic adult patients in the emergency department with syncope, insignificant trauma and a normal neurological evaluation. Available at:

http://www.choosingwisely.org/clinician-lists/acep-avoid-head-ct-for-asymptomatic-adults-with-syncope/.

22. D'Ascenzo F, Biondi-Zoccai G, Reed MJ, et al. Incidence, etiology and predictors of adverse outcomes in 43,315 patients presenting to the Emergency Department with syncope: an international meta-analysis. [Review]. International Journal of Cardiology. 167(1):57-62, 2013 Jul 15.

23. Greve Y, Geier F, Popp S, et al. The prevalence and prognostic significance of near syncope and syncope: a prospective study of 395 cases in an emergency department (the SPEED study). Deutsches Arzteblatt International. 111(12):197-204, 2014 Mar 21.

24. Morgan DJ, Dhruva SS, Wright SM, Korenstein D. 2016 Update on Medical Overuse: A Systematic Review. [Review]. JAMA Internal Medicine. 176(11):1687-1692, 2016 11 01.

25. Salmela MB, Mortazavi S, Jagadeesan BD, et al. ACR Appropriateness Criteria® Cerebrovascular Disease. J Am Coll Radiol 2017;14:S34-S61.

26. American College of Radiology. ACR Appropriateness Criteria®: Head Trauma. Available at: https://acsearch.acr.org/docs/69481/Narrative/.

27. Luttrull MD, Boulter DJ, Kirsch CFE, et al. ACR Appropriateness Criteria® Acute Mental Status Change, Delirium, and New Onset Psychosis. J Am Coll Radiol 2019;16:S26-S37.

28. Lee RK, Burns J, Ajam AA, et al. ACR Appropriateness Criteria® Seizures and Epilepsy. J Am Coll Radiol 2020;17:S293-S304.

29. Whitehead MT, Cardenas AM, Corey AS, et al. ACR Appropriateness Criteria® Headache. J Am Coll Radiol 2019;16:S364-S77.

30. Expert Panel on Neurologic Imaging:, Juliano AF, Policeni B, et al. ACR Appropriateness Criteria R Ataxia. J. Am. Coll. Radiol.. 16(5S):S44-S56, 2019 May.

31. Harvey HB, Watson LC, Subramaniam RM, et al. ACR Appropriateness Criteria® Movement Disorders and Neurodegenerative Diseases. J Am Coll Radiol 2020;17:S175-S87.

32. American College of Radiology. ACR Appropriateness Criteria®: Acute Nonspecific Chest Pain—Low Probability of Coronary Artery Disease. Available at: https://acsearch.acr.org/docs/69401/Narrative/.

33. Shah AB, Kirsch J, Bolen MA, et al. ACR Appropriateness Criteria R Chronic Chest Pain-Noncardiac Etiology Unlikely-Low to Intermediate Probability of Coronary Artery Disease. Journal of the American College of Radiology. 15(11S):S283-S290, 2018 Nov.J. Am. Coll. Radiol.. 15(11S):S283-S290, 2018 Nov.

34. Akers SR, Panchal V, et al. ACR Appropriateness Criteria® Chronic Chest Pain-High Probability of Coronary Artery Disease. J Am Coll Radiol. 2017 May;14(5S):S1546-1440(17)30141-2.

35. Batlle JC, Kirsch J, Bolen MA, et al. ACR Appropriateness Criteria® Chest Pain-Possible Acute Coronary Syndrome. J Am Coll Radiol 2020;17:S55-S69.

36. White RD, Kirsch J, Bolen MA, et al. ACR Appropriateness Criteria® Suspected New-Onset and Known Nonacute Heart Failure. J Am Coll Radiol 2018;15:S418-S31.

37. American College of Radiology. ACR Appropriateness Criteria®: Nonischemic Myocardial Disease with Clinical Manifestations (Ischemic Cardiomyopathy Already Excluded). Available

at: https://acsearch.acr.org/docs/3082580/Narrative/

38. Expert Panel on Cardiac Imaging:, Vogel-Claussen J, Elshafee ASM, et al. ACR Appropriateness Criteria R Dyspnea-Suspected Cardiac Origin. [Review]. J. Am. Coll. Radiol.. 14(5S):S127-S137, 2017 May.

39. Woodard PK, Ho VB, Akers SR, et al. ACR Appropriateness Criteria® Known or Suspected Congenital Heart Disease in the Adult. J Am Coll Radiol 2017;14:S166-S76.

40. American College of Radiology. ACR Appropriateness Criteria®: Acute Chest Pain — Suspected Aortic Dissection. Available at: https://acsearch.acr.org/docs/69402/Narrative/.

41. American College of Radiology. ACR Appropriateness Criteria®: Suspected Pulmonary Embolism. Available at: https://acsearch.acr.org/docs/69404/Narrative/.

42. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: https://gravitas.acr.org/PPTS/GetDocumentView?docId=164+&releaseId=2.

43. Prandoni P, Lensing AW, Prins MH, et al. Prevalence of Pulmonary Embolism among Patients Hospitalized for Syncope. New England Journal of Medicine. 375(16):1524-1531, 2016 10 20.

44. Badertscher P, du Fay de Lavallaz J, Hammerer-Lercher A, et al. Prevalence of Pulmonary Embolism in Patients With Syncope. J Am Coll Cardiol. 74(6):744-754, 2019 Aug 13.

45. Roncon L, Zuin M, Casazza F, Becattini C, Bilato C, Zonzin P. Impact of syncope and pre-syncope on short-term mortality in patients with acute pulmonary embolism. Eur J Intern Med 2018;54:27-33.

46. Nallamothu BK, Mehta RH, Saint S, et al. Syncope in acute aortic dissection: diagnostic, prognostic, and clinical implications. American Journal of Medicine. 113(6):468-71, 2002 Oct 15.

47. Spittell PC, Spittell JA Jr, Joyce JW, et al. Clinical features and differential diagnosis of aortic dissection: experience with 236 cases (1980 through 1990). Mayo Clinic Proceedings. 68(7):642-51, 1993 Jul.

48. Altintas S, Dinh T, Marcks NGHM, et al. Presence and extent of cardiac computed tomography angiography defined coronary artery disease in patients presenting with syncope. Netherlands Heart Journal. 25(6):376-387, 2017 Jun.

49. Basso C, Maron BJ, Corrado D, Thiene G. Clinical profile of congenital coronary artery anomalies with origin from the wrong aortic sinus leading to sudden death in young competitive athletes. [Review] [47 refs]. J Am Coll Cardiol. 35(6):1493-501, 2000 May.

50. Kramer MR, Drori Y, Lev B. Sudden death in young soldiers. High incidence of syncope prior to death. Chest. 93(2):345-7, 1988 Feb.

51. Bruder O, Wagner A, Jensen CJ, et al. Myocardial scar visualized by cardiovascular magnetic resonance imaging predicts major adverse events in patients with hypertrophic cardiomyopathy. Journal of the American College of Cardiology. 56(11):875-87, 2010 Sep 07.

52. Spirito P, Autore C, Rapezzi C, et al. Syncope and risk of sudden death in hypertrophic cardiomyopathy. Circulation. 119(13):1703-10, 2009 Apr 07.

53. Adamson P, Melton I, O'Donnell J, MacDonald S, Crozier I. Cardiac sarcoidosis: the

Christchurch experience. Intern Med J. 44(1):70-6, 2014 Jan.

54. Okada DR, Smith J, Derakhshan A, et al. Ventricular Arrhythmias in Cardiac Sarcoidosis. [Review]. Circulation. 138(12):1253-1264, 2018 09 18.

55. Kearney MT, Cotton JM, Richardson PJ, Shah AM. Viral myocarditis and dilated cardiomyopathy: mechanisms, manifestations, and management. [Review] [63 refs]. Postgraduate Medical Journal. 77(903):4-10, 2001 Jan.

56. Sagar S, Liu PP, Cooper LT Jr. Myocarditis. [Review]. Lancet. 379(9817):738-47, 2012 Feb 25.

57. Uemura A, Morimoto S, Hiramitsu S, Hishida H. Endomyocardial biopsy findings in 50 patients with idiopathic atrioventricular block: presence of myocarditis. Japanese Heart Journal. 42(6):691-700, 2001 Nov.

58. Selvanayagam JB, Hawkins PN, Paul B, Myerson SG, Neubauer S. Evaluation and management of the cardiac amyloidosis. [Review] [84 refs]. Journal of the American College of Cardiology. 50(22):2101-10, 2007 Nov 27.

59. Brembilla-Perrot B, Suty-Selton C, Beurrier D, et al. Differences in mechanisms and outcomes of syncope in patients with coronary disease or idiopathic left ventricular dysfunction as assessed by electrophysiologic testing. Journal of the American College of Cardiology. 44(3):594-601, 2004 Aug 04.

60. Klem I, Weinsaft JW, Bahnson TD, et al. Assessment of myocardial scarring improves risk stratification in patients evaluated for cardiac defibrillator implantation. Journal of the American College of Cardiology. 60(5):408-20, 2012 Jul 31.

61. Baugh CW, Sun BC, Syncope Risk Stratification Study Group. Variation in diagnostic testing for older patients with syncope in the emergency department. Am J Emerg Med. 37(5):810-816, 2019 05.

62. Wong ML, Chiu D, Shapiro NI, Grossman SA. Utility of Chest Radiography in Emergency Department Patients Presenting with Syncope. West J Emerg Med. 17(6):698-701, 2016 Nov.

63. AlJaroudi WA, Alraies MC, Wazni O, Cerqueira MD, Jaber WA. Yield and diagnostic value of stress myocardial perfusion imaging in patients without known coronary artery disease presenting with syncope. Circ Cardiovasc Imaging. 6(3):384-91, 2013 May 01.

64. Scott JW, Schwartz AL, Gates JD, Gerhard-Herman M, Havens JM. Choosing wisely for syncope: low-value carotid ultrasound use. J Am Heart Assoc. 3(4), 2014 Aug 13.

65. Schnipper JL, Ackerman RH, Krier JB, Honour M. Diagnostic yield and utility of neurovascular ultrasonography in the evaluation of patients with syncope. Mayo Clinic Proceedings. 80(4):480-8, 2005 Apr.

66. Kadian-Dodov D, Papolos A, Olin JW. Diagnostic utility of carotid artery duplex ultrasonography in the evaluation of syncope: a good test ordered for the wrong reason. Eur Heart J Cardiovasc Imaging. 16(6):621-5, 2015 Jun.

67. Sarasin FP, Junod AF, Carballo D, Slama S, Unger PF, Louis-Simonet M. Role of echocardiography in the evaluation of syncope: a prospective study. Heart. 88(4):363-7, 2002 Oct.

68. Han SK, Yeom SR, Lee SH, et al. Transthoracic echocardiogram in syncope patients with normal initial evaluation. Am J Emerg Med. 35(2):281-284, 2017 Feb.

69. Chang NL, Shah P, Bajaj S, Virk H, Bikkina M, Shamoon F. Diagnostic Yield of Echocardiography in Syncope Patients with Normal ECG. Cardiology Research & Practice. 2016:1251637, 2016.

70. Dawn B, Paliwal VS, Raza ST, Mastali K, Longaker RA, Stoddard MF. Left ventricular outflow tract obstruction provoked during dobutamine stress echocardiography predicts future chest pain, syncope, and near syncope. American Heart Journal. 149(5):908-16, 2005 May.

71. Suzuki K, Akashi YJ. Exercise stress echocardiography in hypertrophic cardiomyopathy. Journal of Echocardiography. 15(3):110-117, 2017 09.

72. Madeira CL, Craig MJ, Donohoe A, Stephens JR. Things We Do For No Reason: Echocardiogram in Unselected Patients with Syncope. Journal of Hospital Medicine (Online). 12(12):984-988, 2017 12.

73. Probst MA, Gibson TA, Weiss RE, et al. Predictors of Clinically Significant Echocardiography Findings in Older Adults with Syncope: A Secondary Analysis. J Hosp Med. 13(12):823-828, 2018 12 01.

74. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf.

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.

[a]University of California San Diego, San Diego, California. [b]University of California San Diego, San Diego, California. [c]Panel Chair, Duke University Medical Center, Durham, North Carolina. [d]Panel Chair, University of Iowa Hospitals and Clinics, Iowa City, Iowa. [e]Panel Vice-Chair, Massachusetts General Hospital, Boston, Massachusetts. [f]Michigan State University, East Lansing, Michigan; American College of Emergency Physicians. [g]The University of Chicago Medical Center, Chicago, Illinois; American College of Physicians. [h]Alpert Medical School of Brown University, Providence, Rhode Island; Commission on Nuclear Medicine and Molecular Imaging. [i]Sanger Heart and Vascular Institute, Charlotte, North Carolina; American Society of Echocardiography. [j]Vancouver General Hospital, Vancouver, British Columbia, Canada; Committee on Emergency Radiology-GSER. [k]University of California Los Angeles, Los Angeles, California. [l]Gill Heart & Vascular Institute, University of

Kentucky, Lexington, Kentucky; Society for Cardiovascular Magnetic Resonance. [m]University of California Los Angeles, Los Angeles, California; American Academy of Neurology. [n]Harvard Medical School, Boston, Massachusetts. [o]Naval Medical Center Portsmouth, Portsmouth, Virginia. [p]University of California San Diego, San Diego, California. [q]University of North Carolina School of Medicine, Chapel Hill, North Carolina; American Academy of Neurology. [r]University of Virginia Health System, Charlottesville, Virginia; Society of Cardiovascular Computed Tomography. [s]University of Cincinnati Medical Center, Cincinnati, Ohio. [t]Ascension Healthcare Wisconsin, Milwaukee, Wisconsin; American Society of Nuclear Cardiology. [u]Specialty Chair, Atlanta VA Health Care System and Emory University, Atlanta, Georgia. [v]Specialty Chair, UT Southwestern Medical Center, Dallas, Texas.