American College of Radiology
ACR Appropriateness Criteria®
Infective Endocarditis

Variant: 1 Suspected infective endocarditis. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US echocardiography transthoracic resting	Usually Appropriate	O
Radiography chest	Usually Appropriate	☢
CT heart function and morphology with IV contrast	Usually Appropriate	☢☢☢☢
US echocardiography transesophageal	May Be Appropriate (Disagreement)	O
CTA chest with IV contrast	May Be Appropriate	☢☢☢
CTA coronary arteries with IV contrast	May Be Appropriate	☢☢☢
Fluoroscopy heart	Usually Not Appropriate	☢☢
Arteriography coronary	Usually Not Appropriate	☢☢☢
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 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	☢☢☢
FDG-PET/CT heart	Usually Not Appropriate	☢☢☢☢
WBC scan heart	Usually Not Appropriate	☢☢☢☢

Variant: 2 Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

Procedure	Appropriateness Category	Relative Radiation Level
US echocardiography transesophageal	Usually Appropriate	O
US echocardiography transthoracic resting	Usually Appropriate	O
CT heart function and morphology with IV contrast	Usually Appropriate	☢☢☢☢
Radiography chest	May Be Appropriate	☢
Fluoroscopy heart	May Be Appropriate (Disagreement)	☢☢
Arteriography coronary	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
CT chest with IV contrast	May Be Appropriate	☢☢☢
CT chest without and with IV contrast	May Be Appropriate	☢☢☢
CT chest without IV contrast	May Be Appropriate	☢☢☢
CTA chest with IV contrast	May Be Appropriate	☢☢☢
CTA coronary arteries with IV contrast	May Be Appropriate	☢☢☢
FDG-PET/CT heart	May Be Appropriate	☢☢☢☢
WBC scan heart	May Be Appropriate	☢☢☢☢

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Summary of Literature Review

Introduction/Background

Infective endocarditis can involve a normal, abnormal, or prosthetic cardiac valve. In recent years, infective endocarditis of normal right-sided valves has become more frequent because of intravenous (IV) injection of illicit drugs, indwelling IV catheters, and implantable cardiac devices [1-3]. In patients with implanted cardiac devices, it has become increasingly important to consider infections of the device leads, device generator, and device pocket [4]. The clinical presentation of endocarditis is heterogeneous, with patients often presenting with acute heart failure due to severe valve destruction, but many presenting insidiously. The physical examination often reveals a new heart murmur, most commonly due to valvular insufficiency, and evidence of heart failure or a myriad of potential embolic and inflammatory/immune-mediated sequelae. At the first clinical suspicion of infective endocarditis, the workup typically includes serial blood cultures and transthoracic echocardiography (TTE) [5,6].

Although infective endocarditis is typically diagnosed clinically with persistently positive blood cultures in association with characteristic symptoms and physical findings [5,7], and then further evaluated by echocardiography, blood cultures may be negative in the setting of antibiotic use. Imaging is used to support the diagnosis by demonstrating vegetations of cardiac valves and, in complicated cases, paravalvular abscesses affecting native [8] and prosthetic [9] valves. Imaging is also used to assess the severity of valvular damage, identify complications, recognize the presence and severity of heart failure, and inform the next steps in patient management [7,10].

The term "suspected" in the variant description may imply a combination of symptoms, findings on clinical examination, laboratory results, and those found on imaging performed for other reasons. The term "initial imaging" refers to the imaging step after suspicion has been established. This document has 2 variants. The first variant represents initial imaging; namely, that none of the studies in Variant 1 have been performed. Recognizing that a small set of variants are unable to fully encompass the diverse set of clinical presentations, whereas the second variant considers patients for whom an initial imaging study has been performed.

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) [11]:

> "*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 (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (i.e., 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: Suspected infective endocarditis. Initial imaging.

Variant 1: Suspected infective endocarditis. Initial imaging.
A. Arteriography Coronary

There is limited evidence in the literature for the use of catheterization for assessing patients with suspected infective endocarditis. The primary indication is for presurgical evaluation of the coronary arteries [12].

Variant 1: Suspected infective endocarditis. Initial imaging.
B. CT Chest

There is limited evidence in the literature for the use of CT chest to assess patients with suspected infective endocarditis. The primary role of CT chest is in evaluating pulmonary complications of infective endocarditis and can be particularly helpful in right-sided endocarditis for demonstrating septic pulmonary infarcts and abscesses [13,14].

Variant 1: Suspected infective endocarditis. Initial imaging.
C. CT Heart Function and Morphology

CT is less accurate than TTE and transesophageal echocardiography (TEE) for identifying valvular vegetation. Consequently, the primary role of CT is in evaluating complications of infective endocarditis such as paravalvular and myocardial abscesses and pseudoaneurysms [15-20]. In depicting aortic valve pseudoaneurysms, one study showed a sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 100%, 87.5%, 91.7%, and 100%, respectively [18]. The primary weakness of CT is in detecting native aortic valve vegetations <1 cm in size for which the NPV was 55.5%. However, the sensitivity, specificity, PPV, and NPV were all 100% for vegetations >1 cm in size [18]. One study also showed CT to lack sensitivity for detecting valve perforations when compared with TEE [17]. Compared with echocardiography, CT may be superior in both detecting and visualizing the full extent of a paravalvular abscess,

pseudoaneurysm, or fistula, particularly in patients with prosthetic valves [7,10,20-23]. CT may be equivalent or superior to echocardiography in identifying vegetations and valve dehiscence in suspected prosthetic valve endocarditis [7,22,24]. CT may also be utilized to assess for abnormalities in the mobility of mechanical heart valves [24].

Variant 1: Suspected infective endocarditis. Initial imaging.
D. CTA Chest

There is limited evidence in the literature for the use of CTA chest for assessing patients with suspected infective endocarditis. The primary role of CTA chest is in evaluating complications of infective endocarditis such as septic pulmonary infarcts and abscesses as well as paravalvular abscess, depending on CTA acquisition technique [13,14].

Variant 1: Suspected infective endocarditis. Initial imaging.
E. CTA Coronary Arteries

There is limited evidence in the literature for the use of coronary CTA (CCTA) for assessing patients with suspected infective endocarditis. CCTA has a role in preoperative planning and assessment of coronary artery disease before surgery [15,17], wherein the risks of selective coronary angiography may be considerable. Given the well-established high NPV of CCTA, its use for the presurgical assessment of significant coronary artery disease allows for a noninvasive alternative to cardiac catheterization [15,25,26]. Although the use of CCTA and CT-derived fractional flow reserve has not been studied in a patient population with suspected infective endocarditis, extrapolating from the available literature suggests that selective CT-derived fractional flow reserve in patients found to have coronary artery disease on CCTA may play a role in guiding treatment decisions [27,28].

Variant 1: Suspected infective endocarditis. Initial imaging.
F. FDG-PET/CT Heart

There is limited evidence in the literature for the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT in suspected infective endocarditis. One prospective study showed a low sensitivity of 39% for diagnosing infective endocarditis when compared with the modified Duke criteria [29]. Another retrospective study showed a sensitivity of 0% for diagnosing native valve endocarditis when compared with the modified Duke criteria [30].

Some recent studies have shown potential clinical value of FDG-PET/CT in infective endocarditis [31]. A prospective study with 72 patients showed that adding abnormal FDG uptake around a prosthetic valve to the modified Duke criteria at admission increased the sensitivity for the diagnosis of prosthetic valve endocarditis from 70% to 97% [32]. Another smaller prospective study showed that adding PET/CT to the modified Duke criteria in patients with an intermediate probability of infective endocarditis and an implantable cardiac device increased diagnostic accuracy [33]. However, when looking at a cohort of patients with native and prosthetic valves, one study showed a relatively low sensitivity of 39% for the diagnosis of infectious endocarditis [29]. Another retrospective study showed a sensitivity of 0% for diagnosing native valve endocarditis when compared with the modified Duke criteria [30].

In patients with congenital heart disease and intravascular or intracardiac prosthetic material, one prospective study showed that the use of PET/CT in addition to the modified Duke criteria, increased the diagnostic accuracy from 61.2% to 85.1% [34].

Variant 1: Suspected infective endocarditis. Initial imaging.
G. Fluoroscopy Heart

There are no data to support the use of cardiac fluoroscopy in suspected infective endocarditis. On rare occasions, cardiac fluoroscopy may be indicated for evaluating mechanical prosthetic cardiac valves afflicted with endocarditis [35]. Valve fluoroscopy is used to detect excess mobility of the mechanical prosthetic valve during the cardiac cycle (a finding highly suggestive of valve dehiscence due to infective endocarditis) or to detect immobility of mechanical prosthetic valve leaflets secondary to infected pannus or thrombus.

Variant 1: Suspected infective endocarditis. Initial imaging.
H. WBC Scan Heart

White blood cells (WBCs) may be labeled with either indium-111 (In-111), Tc-99m, or gallium-67 (Ga-67) [36]. There is limited evidence in the literature for the use of WBC scans in suspected infective endocarditis. One center reported a sensitivity of 0% for the detection of valvular vegetations by In-111 WBC in 7 patients with known vegetations seen by TEE [37].

Variant 1: Suspected infective endocarditis. Initial imaging.
I. MRI Heart Function and Morphology

There is limited evidence in the literature for the use of MRI of the heart in suspected infective endocarditis. One study showed that MRI was able to detect 14 out of 16 (87.5%) valvular vegetations > 7 × 9.5 mm in patients with suspected infective endocarditis when compared with echocardiography [38]. One vegetation was not visualized because of an artifact from a prosthetic valve.

Variant 1: Suspected infective endocarditis. Initial imaging.
J. Radiography Chest

The chest radiograph is used to determine cardiac chamber size and the presence and severity of pulmonary venous hypertension and edema. It is also used to monitor the severity of the hemodynamic consequences of valvular regurgitation caused by infective endocarditis and to assess the response to treatment. In right-sided endocarditis, the chest radiograph may be effective in demonstrating pulmonary infarcts and abscesses as sequelae of septic emboli.

Variant 1: Suspected infective endocarditis. Initial imaging.
K. US Echocardiography Transthoracic Resting

TTE resting plays an important role in the evaluation of infective endocarditis and is currently the only imaging criterion included in the modified Duke criterion used for a diagnosis of infective endocarditis [39]. It can demonstrate vegetations on cardiac valves, valvular regurgitation, and paravalvular abscess. It is the most frequently used imaging study for confirming the diagnosis of infective endocarditis. The demonstration of vegetations by echocardiography is 1 of the 2 major modified Duke criteria required for the diagnosis of a definite endocarditis [39,40].

Studies show that criteria for the diagnosis, which include the findings on TTE [40,41], were significantly better than traditional criteria based on clinical and bacteriologic criteria.

Several studies evaluated the diagnostic value of TTE and TEE in relation to the pretest probability of infective endocarditis based on clinical assessment in pediatric [42] and adult [43] patients. These studies concluded that TTE has a lower yield in patients with low probability of endocarditis. TEE is the procedure of choice for patients with intermediate or high probability of endocarditis.

In right-sided endocarditis, TTE and TEE performed comparably, demonstrating similar numbers of

vegetations and frequency of tricuspid regurgitation [1,44].

In left-sided native valve *Staphylococcus aureus* endocarditis, the presence of an intracardiac abscess and left ventricular ejection fraction <40% on echocardiography have been shown to be independent predictors of in-hospital mortality [45]. In this same group of patients, intracardiac abscess and valve perforation on echocardiography have been shown to be independent predictors of 1-year mortality [45].

One large retrospective study has shown that in low- to intermediate-risk patients using a strict negative criterion on TTE beyond the absence or presence of valvular vegetations increases the sensitivity and NPV of TTE (sensitivity: 98% versus 43%; NPV: 97% versus 87%) [46].

Variant 1: Suspected infective endocarditis. Initial imaging.
L. US Echocardiography Transesophageal

TEE plays an important role in the evaluation of infective endocarditis [39]. It is used in suspected infective endocarditis to directly identify or exclude valvular vegetations, paravalvular abscess, and valvular regurgitation [47,48]. It is the most sensitive imaging technique for identifying vegetations, the presence of which is the hallmark for a definitive diagnosis of infective endocarditis [40]. Ultrasound (US) diagnosis of infective endocarditis provides better diagnostic accuracy than using clinical criteria alone [41]. TEE has been shown to have up to a 98.6% NPV in suspected infective endocarditis [49]. TEE has better sensitivity than TTE for detecting vegetations [40]. TEE has better sensitivity and accuracy than TTE for identifying paravalvular abscesses [40]. TEE is indicated for suspected infective endocarditis of prosthetic valves; it is significantly more accurate than TTE [40]. Authors of a review in 2010 noted that TEE has sensitivity and specificity of >90% for detecting intracardiac lesions associated with infective endocarditis [40].

Several studies evaluated the diagnostic value of TTE and TEE in relation to the pretest probability of infective endocarditis based on clinical assessment in pediatric [42] and adult [43] patients. These studies concluded that TTE has a lower yield in patients with low probability of endocarditis. TEE is the procedure of choice for patients with intermediate or high probability of endocarditis. Although TEE has been shown to have significantly higher sensitivity than TTE for identifying vegetations [40], specificities were similar at 91% to 100% for TEE and 91% to 98% for TTE.

In right-sided endocarditis, TTE and TEE performed comparably, demonstrating similar numbers of vegetations and frequency of tricuspid regurgitation [1,44].

The size and other characteristics of vegetations on echocardiography have been shown to be useful in predicting complications such as peripheral embolization [50]. In left-sided native valve *S. aureus* endocarditis, the presence of an intracardiac abscess and left ventricular ejection fraction <40% on echocardiography has been shown to be independent predictors of in-hospital mortality [45]. In this same group of patients, intracardiac abscess and valve perforation on echocardiography have been shown to be independent predictors of 1-year mortality [45].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
A. Arteriography Coronary

The primary role of catheterization is for the presurgical evaluation of the coronary arteries [7,12]. It may be used to assess the severity of valvular dysfunction and ventricular function, but this use has largely been replaced by echocardiography [12].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
B. CT Chest

The primary role of CT chest is in evaluating complications of infective endocarditis after a diagnosis has been made. Routine CT chest can be helpful in right-sided endocarditis for demonstrating septic pulmonary infarcts and abscesses, osteomyelitis, and for preoperative assessment and surgical planning [25].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
C. CT Heart Function and Morphology

The primary role of CT heart is in evaluating complications of infective endocarditis such as paravalvular and myocardial abscesses and pseudoaneurysms [15-20,51]. In depicting aortic valve pseudoaneurysms, one study showed a sensitivity, specificity, PPV, and NPV of 100%, 87.5%, 91.7%, and 100%, respectively [18]. Compared with echocardiography, CT may be superior in both detecting and visualizing the full extent of a paravalvular abscess, pseudoaneurysm, or fistula, particularly in patients with prosthetic valves [7,10,20-23]. CT may be equivalent or superior to echocardiography in identifying vegetations and valve dehiscence in suspected prosthetic valve endocarditis [7,22,24]. CT may also be utilized to assess for abnormalities in the mobility of mechanical heart valves and to identify causes of mechanical valve dysfunction that are missed on echocardiography and fluoroscopy [24].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
D. CTA Chest

The primary role of CTA chest is in evaluating complications of infective endocarditis such as septic pulmonary infarcts and abscesses, paravalvular abscess depending on CTA acquisition technique [13,14], and aortic pseudoaneurysms. CTA chest can also be helpful for preoperative assessment of vasculature and surgical planning [25].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
E. CTA Coronary Arteries

CCTA has a role in preoperative planning and assessment of coronary artery disease before surgery [15,17], where the risks of selective coronary angiography may be considerable. Given the well-established high NPV of CCTA, its use for the presurgical assessment of significant coronary artery disease allows for a noninvasive alternative to cardiac catheterization [15,25,26]. Although the use of CCTA and CT-derived fractional flow reserve has not been studied in a patient population with suspected infective endocarditis, extrapolating from the available literature suggests that selective CT-derived fractional flow reserve in patients found to have coronary artery disease on CCTA may play a role in guiding treatment decisions [27,28].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.
F. FDG-PET/CT Heart

Some recent studies have shown potential clinical value of FDG-PET/CT in infective endocarditis [31]. One study showed that FDG-PET/CT detected clinically unsuspected sites of extracardiac infection in up to 24% of cases [52]. Several single-center studies have shown promise in identifying cardiovascular implantable electronic device infections using FDG-PET/CT with sensitivities ranging from 60% to 100% and specificities ranging from 86% to 100% [4,53-55]. In cases in which TTE and TEE were normal or equivocal, 2 studies showed that FDG-PET/CT was able to detect periprosthetic abscesses [56,57], which has been shown to occur in nearly 30% of cases [47].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

G. Fluoroscopy Heart

Cardiac fluoroscopy may be indicated for evaluating mechanical prosthetic cardiac valves afflicted with endocarditis [35]. Valve fluoroscopy is used to detect excess mobility of the mechanical prosthetic valve during the cardiac cycle (a finding highly suggestive of valve dehiscence due to infective endocarditis) or to detect immobility of mechanical prosthetic valve leaflets secondary to infected pannus or thrombus.

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

H. WBC Scan Heart

WBCs may be labeled with either In-111, Tc-99m, or Ga-67 [36]. This may be used for identifying and localizing infected vegetations and paravalvular abscesses [39,58]. When echocardiography is inconclusive in suspected prosthetic valve endocarditis, a WBC scan has been shown to have a lower sensitivity than FDG-PET/CT (64% versus 93%, respectively) but a higher specificity (100% versus 71%, respectively) for the diagnosis of endocarditis [39,59].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

I. MRI Heart Function and Morphology

MRI may have a role in evaluating complications of endocarditis such as paravalvular and myocardial abscesses, pseudoaneurysms, fistulas, and endothelial inflammation before morphological changes develop [60,61]. It is less accurate than TTE and TEE for identifying valvular vegetations [38] but may serve as an additional study to evaluate for native valve vegetations when echocardiography is inconclusive or nondiagnostic. MRI can be helpful to quantify valvular regurgitation—a feature that may be used to help determine prognosis and guide management—in cases where echocardiography is suboptimal, shows discordance between anatomic and Doppler findings, or in cases with eccentric jets, which can be harder to accurately quantify by echocardiography [62].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

J. Radiography Chest

The chest radiograph is used to determine cardiac chamber size and the presence and severity of pulmonary venous hypertension and edema. It is also used to monitor the severity of the hemodynamic consequences of valvular regurgitation caused by infective endocarditis and to assess the response to treatment. In right-sided endocarditis, the chest radiograph may be effective in demonstrating pulmonary infarcts and abscesses as sequelae of septic emboli.

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

K. US Echocardiography Transthoracic Resting

After the diagnosis of infective endocarditis is made, echocardiography can be used to make an informed decision for surgical treatment and play an important role in prognostication. Echocardiography is an excellent tool to evaluate for heart failure, which is a strong indication for valve surgery in several clinical scenarios [39].

The size and other characteristics of vegetations on echocardiography have been shown to be useful in predicting complications such as peripheral embolization [50]. Vegetation's increase or failure to decrease in size on serial echocardiograms during antibiotic therapy has been shown to be predictive of a prolonged or complicated course of infective endocarditis [40,44,63]. However, the usefulness of repeated TTE for altering patient management decreases with the number of repetitions [64]. Other echocardiographic findings that can guide prognosis include periannular complications, severe valvular regurgitation, low ejection fraction, pulmonary hypertension, severe prosthetic valve dysfunction, and premature mitral valve closure (a sign of elevated diastolic pressures) [7].

In left-sided native valve *S. aureus* endocarditis, the presence of an intracardiac abscess and left ventricular ejection fraction <40% on echocardiography have been shown to be independent predictors of in-hospital mortality [45]. In this same group of patients, intracardiac abscess and valve perforation on echocardiography have been shown to be independent predictors of 1-year mortality [45].

Variant 2: Known or suspected infective endocarditis. Additional imaging to direct patient management or treatment.

L. US Echocardiography Transesophageal

After the diagnosis of infective endocarditis is made, echocardiography can be used to make an informed decision for surgical treatment and play an important role in prognostication. Echocardiography is an excellent tool to evaluate for heart failure, which is a strong indication for valve surgery in several clinical scenarios [39].

The size and other characteristics of vegetations on echocardiography have been shown to be useful in predicting complications such as peripheral embolization [50]. Vegetation's increase or failure to decrease in size on serial echocardiograms during antibiotic therapy has been shown to be predictive of a prolonged or complicated course of infective endocarditis [40,44,63]. Other echocardiographic findings that can guide prognosis include periannular complications, severe valvular regurgitation, low ejection fraction, pulmonary hypertension, severe prosthetic valve dysfunction, and premature mitral valve closure (a sign of elevated diastolic pressures) [7].

In left-sided native valve *S. aureus* endocarditis, the presence of an intracardiac abscess and left ventricular ejection fraction <40% on echocardiography have been shown to be independent predictors of in-hospital mortality [45]. In this same group of patients, intracardiac abscess and valve perforation on echocardiography have been shown to be independent predictors of 1-year mortality [45].

Summary of Recommendations

- **Variant 1**: US echocardiography transthoracic resting, radiography chest, or CT heart function and morphology with IV contrast is usually appropriate for the initial imaging of suspected infective endocarditis. Radiography chest should be performed in addition to US echocardiography transthoracic resting or CT heart function and morphology with IV contrast. The panel did not agree on recommending US echocardiography transesophageal for the initial imaging of suspected infective endocarditis. There is insufficient medical literature to conclude whether or not these patients would benefit from US echocardiography transesophageal for this clinical scenario. US echocardiography transesophageal in this patient population is controversial but may be appropriate.
- **Variant 2**: US echocardiography transesophageal, US echocardiography transthoracic resting, or CT heart function and morphology with IV contrast is usually appropriate for additional imaging to direct patient management or treatment of known or suspected infective endocarditis. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending fluoroscopy heart for additional imaging to direct patient management or treatment of known or suspected infective endocarditis. There is insufficient medical literature to conclude whether or not these patients would benefit from fluoroscopy heart for this clinical scenario. Fluoroscopy heart in this patient population is controversial but may be appropriate.

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.”

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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.

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