American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Suspected Bacterial Endocarditis**

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	9		Min
US echocardiography transesophageal	8	Clinical reference standard. Invasive test. Most useful in patients with moderate to high clinical likelihood.	None
US echocardiography transthoracic with Doppler	7		None
Cardiac catheterization with angiocardiography	6	Indicated preoperatively.	Med
CT heart function and morphology with contrast	6	Multidetector with maximal temporal and spatial resolution. Probably indicated to rule out paravalvular abscess and/or psedoaneurysm. Emerging technology.	High
US echocardiography transthoracic	6		None
MRI heart function and morphology with or without contrast	6	Probably indicated to rule out paravalvular abscess.	None
CT chest	4		Med
In-111 WBC scan heart	4		Med
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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Summary of Literature Review

Infective endocarditis has been classified as acute endocarditis and subacute endocarditis. Typically, acute endocarditis is produced by a virulent organism (such as Staphylococcus aureus) on a normal valve, while subacute endocarditis is produced by less virulent organisms (Streptococcus viridans or Staphylococcus epidermis) on an abnormal valve. Infective endocarditis can also be classified as infection of prosthetic valves. In recent years, infective endocarditis of normal right-sided valves has become frequent as a consequence of intravenous injection of illicit drugs. While acute endocarditis of left-sided cardiac valves nearly invariably causes congestive heart failure, heart failure may also occur with subacute infective endocarditis. The diagnostic work-up of patients with suspected infective endocarditis varies somewhat, depending upon the presence of congestive heart failure.

Infective endocarditis is fundamentally a clinical diagnosis based on the presence of positive blood cultures in association with characteristic symptoms and physical findings. Imaging is used to support the diagnosis by demonstration of vegetations of cardiac valves and, in complicated cases, perivalvular abscesses. Imaging is also used to assess the severity of valvular damage, identify complications, and recognize the presence and severity of heart failure.

Chest Radiograph

The chest radiograph is used to determine cardiac chamber size and the presence and severity of pulmonary venous hypertension and edema; it is necessary for the evaluation of infective endocarditis. It is used to monitor the severity of the hemodynamic consequences of valvular regurgitation caused by infective endocarditis and to assess response to treatment. Chest radiograph is also used to identify abnormal contour of the great arteries or cardiac chambers that might be indicative of perivalvular abscess. In right-sided endocarditis the chest radiograph is effective for demonstrating pulmonary infarcts and abscesses.

Cardiac Fluoroscopy

In rare occasions, cardiac fluoroscopy may be indicated for evaluating prosthetic cardiac valves afflicted with endocarditis. It is used to determine excess mobility of the valve during the cardiac cycle; this finding may be highly suggestive of valve dehiscence caused by infective endocarditis.

Transthoracic Echocardiography

Transthoracic echocardiography (TTE) plays an important role in the evaluation of infective endocarditis. It can demonstrate vegetations on cardiac valves, valvular regurgitation, and perivalvular abscess. It is the most frequently used imaging study for confirming the diagnosis of infective endocarditis. The demonstration of vegetations by echocardiography establishes the diagnosis [1].

Studies show that criteria for the diagnosis, which include the findings on TTE [2,3] and particularly transesophageal echocardiography (TEE) [4], were significantly better than traditional criteria based on clinical and bacteriologic criteria. While TEE has been shown to have significantly higher sensitivity than TTE for identifying vegetations [5], specificities were similar. The positive predictive value of echocardiography for the diagnosis has been shown to be 97%, while the negative predictive value was 94% [6].

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 [7] and adult [8-10] patients. These studies concluded that echocardiography is less indicated in patients with low probability of endocarditis. TTE is the procedure of choice for patients with intermediate or high probability of endocarditis. In right-sided endocarditis, TTE and TEE demonstrated a similar number of vegetations and frequency of tricuspid regurgitation [11].

The size and other characteristics of vegetations on echocardiography have been shown to be useful in predicting complications such as peripheral embolization. Increase or failure to decrease in size of vegetation on serial echocardiograms during antibiotic therapy has been shown to be predictive of a prolonged and/or complicated course of infective endocarditis [12].

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The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply society endorsement of the final document.

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Transesophageal Echocardiography

TEE is indicated and increasingly used in suspected infective endocarditis for demonstrating vegetations, perivalvular abscess, valvular regurgitation, and ventricular function. It is the most sensitive imaging technique for identifying vegetations, which are the hallmark for the definitive diagnosis of infective endocarditis [1,13]. Criteria for diagnosing infective endocarditis using echocardiographic features improve upon the diagnostic accuracy of using clinical criteria alone [2-4]. TEE has better sensitivity than TTE for detecting vegetations [5]. A review has claimed that in experienced hands, TEE has a greater than 90% sensitivity and specificity for detecting intracardiac lesions associated with infective endocarditis [14]. This [14] and another [15] review also concluded that a negative TEE almost always means a very low probability of infective endocarditis.

TEE has been shown to be very effective for monitoring the size and other characteristics of vegetation and for detecting complications such as perivalvular abscesses [1,5,16,17]]. TEE has improved sensitivity and accuracy compared to TTE for identifying perivalvular abscesses [16]. TEE is indicated for suspected infective endocarditis of prosthetic valves; it is significantly more accurate than TTE [10,13]. Furthermore, monitoring the size of vegetations during treatment contributes information concerning prognosis and risk of complication [12], although the usefulness of repeated TTE for altering patient management decreases with the number of repetitions [18].

In two studies, TTE was found to be the more cost effective test in patients with intermediate or high pretest probability of infective endocarditis [10,19].

TEE is indicated in many patients with suspected infective endocarditis, especially those in whom TTE is inconclusive or in patients with suspected perivalvular abscess.

Radioisotope Scanning

Radioisotope scanning is probably indicated in the evaluation of suspected infective endocarditis. Several types of radioisotope scans may be used for identifying and localizing infected vegetations and perivalvular abscesses. Gallium 67 and indium111-labeled white cells are routinely used [20]. Although these techniques are useful in isolated patients, they have a low sensitivity and add little to the usual diagnosis of infective endocarditis.

More recently, immunoscintigraphy using technetium 99m-labeled anti-NCA-95 antigranulocyte antibodies has been proposed as a method of localization [21-23]. In one study, this scan had a sensitivity of 79% and specificity of 82% compared to echocardiography, which had a sensitivity of 88% and specificity of 97% [22]. However, the combination of echocardiography and immunoscintigraphy has a sensitivity of 100% and specificity of 82%.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is probably indicated for evaluating of infective endocarditis [24,25]. However, its use should be limited to the evaluation of complications such as perivalvular and myocardial abscesses and infectious pseudoaneurysms. It is less accurate than TTE and TEE for identifying valvular vegetations. Cine MRI and velocity encoded cine MRI can be used for the semiquantification and quantification of the volume of valvular regurgitation, respectively [26].

Computed Tomography

There is limited evidence in the literature to support the use of computed tomography (CT) for the assessment of patients with suspected endocarditis. However, particularly ECG-gated multidetector-row CT is emerging as an important tool for non-invasive cardiac assessment and is probably indicated in the evaluation of complications of infective endocarditis, such as the identification of perivalvular and myocardial abscesses and infective pseudoaneurysms[27]. CT may be indicated in right-sided endocarditis for demonstrated septic pulmonary infarcts and abscesses.

CT is less accurate than TTE and TEE for identifying valvular vegetation. Consequently, the role of CT, like MRI, is for the evaluation of complicated cases of infective endocarditis.

Catheterization and Ventricular Angiography

Catheterization and ventriculography are indicated in infective endocarditis with congestive heart failure. They may be used to assess the severity of valvular dysfunction and ventricular function prior to surgery. These tests are not indicated for patients with uncomplicated endocarditis on native valves in whom surgical intervention is not contemplated. Catheterization and ventriculography may be indicated for endocarditis of prosthetic valves when echocardiographic results are equivocal.

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. 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	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Evidence table under review

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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.