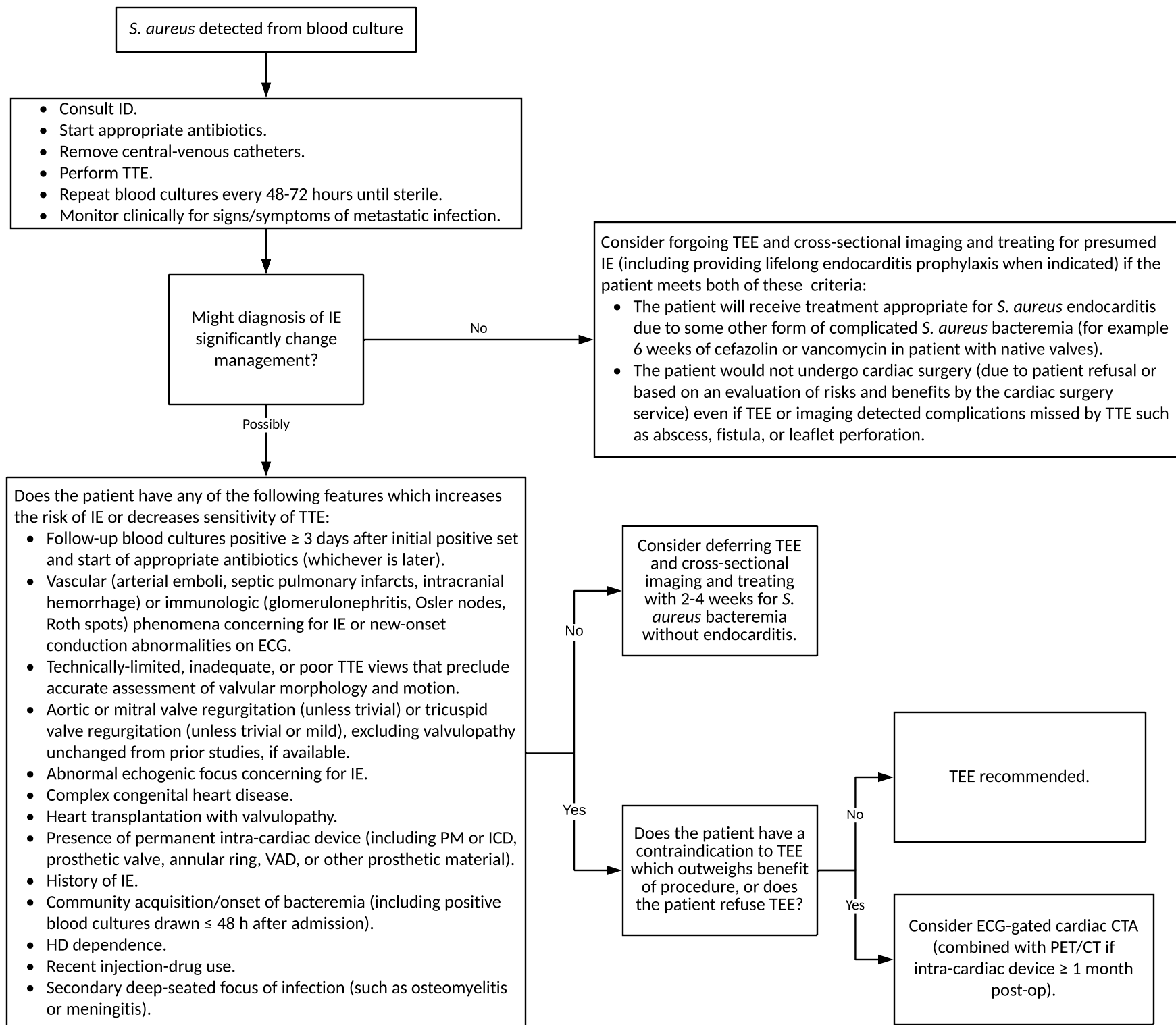


Recommendations for echocardiography in patients with *S. aureus* bacteremia

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Introduction

In almost all cases, a transthoracic echocardiogram (TTE) should be the initial echocardiographic study to be performed in patients with *S. aureus* bacteremia [1]. Compared to a transesophageal echocardiogram (TEE), a TTE can be performed more quickly, is less resource-intensive, and is not associated with any significant complications. However, even with contemporary echocardiographic techniques, and even among patients with adequate-quality TTE images, TEE is substantially more sensitive than TTE for detecting infective endocarditis (IE) [2, 3]. *S. aureus* bacteremia is unique in its association with endocarditis and adverse clinical outcomes, and warrants particular consideration for aggressive diagnosis of IE and other complications [4].

Indications for TEE

TEE is strongly recommended in most patients with persistent *S. aureus* bacteremia, signs or symptoms strongly suggestive of IE, high-risk TTE features, or high-risk cardiac conditions (as defined below) since the pretest probability for IE is increased in these cases or the sensitivity of TTE is limited [3-10].

- Persistent *S. aureus* bacteremia is reasonably defined as follow-up blood cultures positive 3 days or later after the initial positive set and initiation of appropriate antimicrobial therapy (whichever occurs later)
- Clinical signs or symptoms suggestive of IE include vascular phenomena (such as arterial emboli, septic pulmonary infarcts, and intracranial hemorrhage) and immunologic phenomena (such as glomerulonephritis, Osler nodes, and Roth spots); presence of new-onset conduction abnormalities on an electrocardiogram (ECG) can also sometimes reflect IE
- High-risk TTE features include:
 - Technically-limited, inadequate, or poor views that preclude accurate assessment of valvular morphology and motion
 - Aortic valve or mitral valve regurgitation (unless trivial), or tricuspid valve regurgitation (unless trivial or mild), excluding valvulopathy unchanged from prior studies, if available
 - Abnormal echogenic focus concerning for IE
- High-risk cardiac conditions include:
 - Complex congenital heart disease
 - Heart transplantation with valvulopathy
 - Presence of a permanent intra-cardiac device (including permanent pacemakers or implantable cardioverter-defibrillators, prosthetic valves, annular rings, ventricular assist devices, or other prosthetic material)

In other patients who do not have one of these high-risk criteria, TEE is still recommended for most patients in the presence of one of the following risk factors, which significantly increase the pretest probability of IE [4-10]:

- History of IE
- Community acquisition/onset of *S. aureus* bacteremia (including positive blood cultures drawn within the first 48 hours of hospital admission)
- Hemodialysis dependence

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- Recent injection-drug use
- Secondary deep-seated focus of infection (such as osteomyelitis or meningitis)

Timing of TEE

For patients with a particularly high risk for IE, such as those with prosthetic heart valves or clinical or echocardiographic features highly suggestive of IE, a TEE should be performed as soon as the study can be safely and practicably arranged, preferably within 24 hours [1, 6]. For other patients, a TEE can potentially be deferred for several days depending on the patient's individual risk factors and clinical condition [1, 6].

TEE contraindications or alternatives

In some cases, TEE will not significantly change clinical management and can be potentially deferred or avoided.¹ These cases include patients who meet both of the following criteria [4-9]:

- The patient will receive an extended course of parenteral antibiotics for other forms of complicated *S. aureus* infection, such as osteomyelitis, that are also appropriate for treatment of *S. aureus* endocarditis (such as cefazolin, nafcillin, vancomycin, or daptomycin in a patient with native heart valves).
- Even if TEE would reveal complications potentially missed by TTE (such as abscesses, fistulas, or leaflet perforations), cardiac surgery would not be performed due to patient refusal or based on an evaluation of risks and benefits by the cardiac surgery service.

The patient should be assessed for absolute or relative contraindications to TEE, which would affect the risk-benefit ratio of the procedure [11]:

- Absolute contraindications
 - Perforated viscous
 - Esophageal stricture, tumor, laceration, or diverticulum
 - Active upper gastrointestinal (GI) bleed
- Relative contraindications
 - History of radiation to the neck and mediastinum
 - History of GI surgery
 - Recent upper GI bleed
 - Barrett's esophagus
 - History of dysphagia
 - Restriction of neck mobility due to severe cervical arthritis or atlantoaxial joint disease
 - Symptomatic hiatal hernia
 - Esophageal varices
 - Coagulopathy or thrombocytopenia
 - Active esophagitis or peptic ulcer disease

If a TEE is otherwise indicated but unable to be performed, consider ECG-gated cardiac computed tomography angiography (CTA) with a dedicated endocarditis protocol (and, in patients with intra-cardiac devices who are at least 1 month out from cardiac surgery, positron emission tomography/computed tomography [PET/CT]) [12].

¹ Patients diagnosed with IE should also receive antimicrobial prophylaxis for many procedures involving the aerodigestive tract and other sites. However, some patients (such as heart transplant recipients with valvulopathy) would receive prophylaxis regardless. Furthermore, it is unclear if a TEE should be performed solely to inform decisions about future antimicrobial prophylaxis.

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Appendix 1: Charges and costs associated with selected studies

Pending

Appendix 2: References

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