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ONE MINUTE CONSULT

BRIEF ANSWERS TO SPECIFIC CLINICAL QUESTIONS

Q: When does *S aureus* bacteremia require transesophageal echocardiography?

A: *Staphylococcus aureus* is the most common infective agent in native and prosthetic valve endocarditis, and 13% to 22% of patients with *S aureus* bacteremia have infective endocarditis.[1]

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Transthoracic echocardiography (TTE) is a good starting point in the workup of suspected infective endocarditis, but transesophageal echocardiography (TEE) plays a key role in diagnosis and is indicated in patients with a high pretest probability of infective endocarditis, as in the following scenarios:

- Clinical picture consistent with infective endocarditis
- Presence of previously placed port or other indwelling vascular device
- Presence of a prosthetic valve or other prosthetic material
- Presence of a pacemaker
- History of valve disease
- Injection drug use
- Positive blood cultures after 72 hours despite appropriate antibiotic treatment
- Abnormal TTE result requiring better visualization of valvular anatomy and function and confirmation of local complications
- Absence of another reasonable explanation for *S aureus* bacteremia.

Forgoing TEE is reasonable in patients with normal results on TTE, no predisposing risk factors, a reasonable alternative explanation for *S aureus* bacteremia, and a low pretest probability of infective endocarditis.[1] TEE may also be unnecessary if there is another disease focus requiring extended treatment (eg, vertebral infection) and there are no findings suggesting complicated infective endocarditis, eg, persistent bacteremia, symptoms of heart failure, and conduction abnormality.[1]

TEE also may be unnecessary in patients at low risk who have identifiable foci of bacteremia due to soft-tissue infection or a newly placed vascular catheter and whose bacteremia clears within 72 hours of the start of antibiotic therapy. These patients may be followed clinically for the development of new findings such as metastatic foci of infection (eg, septic pulmonary emboli, renal infarction, splenic abscess or infarction), the new onset of heart failure or cardiac conduction abnormality, or recurrence of previously cleared *S aureus* bacteremia. If these should develop, then a more invasive study such as TEE may be warranted.

TEE is usually not needed in patients with a low pretest probability of infective endocarditis

INFECTIVE ENDOCARDITIS: EPIDEMIOLOGY AND MICROBIOLOGY

The US incidence rate of infective endocarditis has steadily increased, with an estimated 457,052 hospitalizations from 2000 to 2011. During that period, from 2000 to 2007, there was a marked increase in valve replacement surgeries.[2] This trend is likely explained by an increase in the at-risk population—eg, elderly patients, patients with opiate dependence or diabetes, and patients on hemodialysis.

Although *S aureus* is the predominant pathogen in infective endocarditis,[2–5] *S aureus* bacteremia is often observed in patients with skin or soft-tissue infection, prosthetic device infection, vascular graft or catheter infection, and bone and joint infections. *S aureus* bacteremia necessitates a search for the source of infection.

S aureus is a major pathogen in bloodstream infections, and up to 14% of patients with *S aureus* bacteremia have infective endocarditis as the primary source of infec-

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TABLE 1

Modified Duke criteria for infective endocarditis

MAJOR CRITERIA

Positive microbiologic findings

Two separate blood cultures positive for typical microorganisms causing infective endocarditis: *Staphylococcus aureus*, *Viridans*-group streptococci, *Streptococcus gallolyticus*, enterococci, and "HACEK-group" organisms (*Haemophilus* species, *Aggregatibacter* species, *Cardiobacterium hominis*, *Eikenella corrodens*, and *Kingella* species)

Persistently positive blood cultures: ie, 2 cultures at least 12 hours apart positive for typical pathogens, and at least 3 of 4 cultures positive for pathogens commonly considered as skin contaminants (*Staphylococcus epidermidis*)

A single blood culture positive for *Coxiella burnetii*, or an immunoglobulin G titer > 1:800

Echocardiographic findings

Valvular vegetation, abscess, dehiscence of prosthetic valve, or new valvular regurgitation

MINOR CRITERIA

Clinical predisposition: intravenous drug use, presence of a prosthetic heart valve or material, history of valvular disease

Microbiologic findings: positive findings on microbiologic study other than those in the major criteria

Body temperature ≥ 38.0 °C (100.4 °F)

Vascular findings: embolization, mycotic aneurysm, conjunctival hemorrhage, Janeway lesions

Immunologic findings: glomerulonephritis, Osler nodes, Roth spots, positive rheumatoid factor

Based on information in reference 7.

Infective endocarditis can present subtly, as a nonspecific infectious syndrome, or with overt cardiac manifestations or extracardiac organ damage

tion.[3] The pathogenesis of *S aureus* infective endocarditis is thought to be mediated by cell-wall factors that promote adhesion to the extracellular matrix of intravascular structures.[3]

A new localizing symptom such as back pain, joint pain, or swelling in a patient with *S aureus* bacteremia should trigger an investigation for metastatic infection.

Infectious disease consultation in patients with *S aureus* bacteremia is associated with improved outcomes and, thus, should be pursued.[3]

A cardiac surgery consult is recommended early on in cases of infective endocarditis caused by vancomycin-resistant enterococci, *Pseudomonas aeruginosa*, and fungi, as well as in patients with complications such as valvular insufficiency, perivalvular abscess, conduction abnormalities, persistent bacteremia, and metastatic foci of infection.[6]

RISK FACTORS

Risk factors for infective endocarditis include injection drug abuse, valvular heart disease, congenital heart disease (unrepaired, repaired with residual defects, or fully repaired within the past 6 months), previous infective endocarditis, prosthetic heart valve, and cardiac transplant.[2–4,6] Other risk factors are poor dentition, hemodialysis, ventriculoatrial shunts, intravascular devices including vascular grafts, and pacemakers.[2,3] Many risk factors for infective endocarditis and *S aureus* bacteremia overlap.[3]

DIAGNOSTIC PRINCIPLES

The clinical presentation of infective endocarditis can vary from a nonspecific infectious syndrome, to overt organ failure (heart failure, kidney failure), to an acute vascular catastrophe (arterial ischemia, cerebrovascular accidents, myocardial infarction). Patients may

present with indolent symptoms such as fever, fatigue, and weight loss,[6] or they may present at an advanced stage, with fulminant acute heart failure due to valvular insufficiency or with arrhythmias due to a perivalvular abscess infiltrating the conduction system. Extracardiac clinical manifestations may be related to direct infective metastatic foci such as septic emboli or to immunologic phenomena such as glomerulonephritis or Osler nodes.

Thus, a thorough review of systems is important to screen for signs of complications (eg, edema, changes in urine output and appearance) and metastatic infection (eg, splenic infarction, splenic abscess, psoas muscle abscess, vertebral infection).

The diagnosis of infective endocarditis does not rely solely on echocardiographic findings or other imaging studies; it is a clinical diagnosis based on the modified Duke criteria, which incorporate clinical, laboratory and microbiologic findings (**Tables 1 and 2**).[7] Most patients with infective endocarditis have both clinical and imaging evidence of it.

ECHOCARDIOGRAPHY'S ROLE IN DIAGNOSIS

TTE plays an important role in diagnosis and risk stratification of infective endocarditis.[6] TTE is usually done first because of its low cost, wide availability, and safety; it has a sensitivity of 70% and a specificity over 95%.[8] While a normal result on TTE does not completely rule out infective endocarditis, completely normal valvular morphology and function on TTE make the diagnosis less likely.[8,9]

If suspicion remains high despite a normal study, repeating TTE at a later time may result in a higher diagnostic yield because of growth of the suspected vegetation. Otherwise, TEE should be considered.

TEE provides a higher spatial resolution and diagnostic yield than TTE, especially for detecting complex pathology such as pseudoaneurysm, valve perforation, or valvular abscess. TEE has a sensitivity and specificity of approximately 95% for infective endocarditis.[8] It should be performed early in patients with preexisting valve disease, prosthetic cardiac material (eg, valves), or a pacemaker or implantable cardioverter-defibrillator.[6,7]

TABLE 2

Applying the Duke criteria for infective endocarditis

Definite infective endocarditis:
Confirmed by pathology studies
Meets 2 major Duke criteria
Meets 1 major and 3 minor criteria
Meets 5 minor clinical criteria

Possible infective endocarditis:
Meets 1 major and 1–2 minor criteria
Meets 3–4 minor criteria

Rules out infective endocarditis:
Pathology studies negative
An alternative diagnosis is present
Rapid clinical improvement within 4 days of starting antibiotic treatment

Detecting valve vegetation provides answers about the cause of *S aureus* bacteremia with its complications (eg, septic emboli, mycotic aneurysm) and informs decisions about the duration of antibiotic therapy and the need for surgery.[3,6]

As with any diagnostic test, it is important to compare the results of any recent study with those of previous studies whenever possible to differentiate new from old findings.

WHEN TO FORGO TEE IN *S AUREUS* BACTEREMIA

Because TEE is invasive and requires the patient to swallow an endoscopic probe,[10] it is important to screen patients for esophageal disease, cervical spine conditions, and baseline respiratory insufficiency. Complications are rare but include esophageal perforation, esophageal bleeding, pharyngeal hematoma, and reactions to anesthesia.[10]

As with any diagnostic test, the clinician first needs to consider the patient's pretest probability of the disease, the diagnostic accuracy, the associated risks and costs, and the implications of the results.

While TEE provides better diagnostic images than TTE, a normal TEE study does not exclude the diagnosis of infective endocarditis: small lesions and complications such as paravalvular abscess of a prosthetic aortic valve may still be missed. In such patients, a

Before TEE, screen patients for esophageal disease, cervical spine conditions, and respiratory insufficiency

repeat TEE examination or additional imaging study (eg, gated computed tomographic angiography) should be considered.[6]

Noninfective sterile echodensities, valvular tumors such as papillary fibroelastomas, Lambl excrescences, and suture lines of prosthetic valves are among the conditions and factors that can cause a false-positive result on TEE. ■

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