2026 Consensus Statement 4 by the IDSA and ESCMID on Transesophageal Echocardiography in the Diagnostic Evaluation of SAB

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Executive Summary

Overview

As endocarditis is a serious complication of SAB, accurate diagnosis is critical to guide clinical decision-making, including duration of therapy and surgical intervention. Due to its lower sensitivity, transthoracic echocardiography (TTE) may be insufficient to exclude endocarditis, particularly among adult patients at increased risk of endocarditis. An approach to guide the use of transesophageal echocardiography (TEE) among patients with SAB and a negative TTE is needed.

Clinical question 4

In patients with SAB and a negative TTE, should a TEE be performed?

Consensus statements for the adult population

- The panel suggests performing TEE in adults with SAB who have a negative TTE, even if the TTE is of good quality if any of the following endocarditis increased-risk features are present:
    - Intracardiac device (e.g., prosthetic heart valve, permanent pacemaker, automatic implantable cardioverter-defibrillator, left ventricular assist device)
    - Predisposing heart valve conditions including prior endocarditis
    - Positive follow-up blood cultures obtained ≥ 48 hours after the first positive blood culture
    - Embolic events
    - More than one non-contiguous focus of infection (consensus)
- The panel suggests consideration of TEE in adults with SAB with community-onset or injection drug use as an endocarditis increased-risk feature. The decision to perform TEE should be guided by TTE quality and interpretability, presence of other endocarditis increased-risk features, clinical response, and anticipated impact on management (consensus).
- The panel suggests that TEE may be unnecessary in adults with SAB who have a negative good quality TTE and are without any endocarditis increased-risk features as outlined in below Remarks and Consensus Statement 1 (consensus).

Remarks for the adult population

- Features associated with an increased risk of endocarditis include any of the following (Consensus Statement 1):
    - Intracardiac device (e.g., prosthetic heart valve, permanent pacemaker, automatic implantable cardioverter-defibrillator, left ventricular assist device)
    - Predisposing heart valve conditions, including prior endocarditis
    - Positive blood cultures obtained ≥ 48 hours after the first positive blood culture
    - Embolic events
    - More than one non-contiguous focus of infection
    - Community-onset SAB
    - Injection drug use
- There is variability in the literature regarding which patients can be safely classified as low risk for endocarditis who may not require TEE. Clinical prediction scores may help inform the decision to omit TEE but should not replace clinician judgment.

Consensus statements for the pediatric population

- The panel suggests not performing TEE in most pediatric patients with SAB and good quality TTE images. TEE has limited additional diagnostic utility over TTE for exclusion of endocarditis in most young children (consensus).
- TEE should be considered in pediatric patients when TTE is negative or indeterminate AND there is high clinical suspicion of endocarditis. (consensus).

Remarks for the pediatric population

- Decisions regarding the performance of TEE in children must consider risks associated with the procedure and anesthesia, as well as the size and age of the patient and the availability of experienced personnel. Close consultation with pediatric cardiologists is recommended.

Introduction

Background

Transesophageal echocardiography (TEE) is considered the gold standard for diagnosing endocarditis due to its superior sensitivity compared with TTE for detecting vegetations and its enhanced ability to identify intracardiac complications, such as leaflet perforation, abscess formation, and aortic pseudoaneurysm [1]. Accurate diagnosis of endocarditis is critical because it directly influences clinical management, including treatment duration and the need for surgical interventions in some cases. In adult patients, TEE has a sensitivity of 90%-100% for detecting vegetations in native valve endocarditis while TTE has a sensitivity between 50-90% [2, 3]. While TTE is valuable as an initial imaging modality in patients with SAB, a negative TTE is insufficient to rule out endocarditis when clinical suspicion remains high. TTE generally has higher sensitivity for right-sided versus left-sided endocarditis, but its diagnostic yield is limited in the setting of obesity, emphysema, or the presence of a prosthetic valves or pacemakers [4].

Previous guidelines recommend TEE as the preferred imaging modality in SAB [5]. Despite this, fewer than 20% of infectious disease (ID) specialists surveyed through the Emerging Infections Network reported performing TEE in all patients with a negative TTE [6]. TEE is an invasive procedure with a low but non-negligible risk of major complications (0.2%-0.5%) [7, 8], and its use may be constrained by resource availability in some healthcare settings.

Decision-making regarding TEE is influenced by multiple factors, including patient-specific risk factors for endocarditis, clinical course, risk-benefit assessment, and anticipated impact on management. A study evaluating ID physicians' reasoning in 221 SAB patients identified 19 distinct factors influencing the decision to obtain TEE [9]. These considerations highlight the need for a structured approach to TEE in patients with a negative TTE.

Purpose and objectives

The objective of the panel was to review the relevant literature and evidence to provide consensus statements on whether TTE should be performed in patients with SAB who have a negative TTE.

Scope

This consensus statement is intended for use by adult and pediatric healthcare professionals including physicians, advanced practice providers, and pharmacists who care for patients with SAB. The target audience includes but is not limited to infectious diseases specialists, hospitalists, emergency care clinicians, intensivists, and health systems research and policymakers.

Methods

Panel composition

The four chairs of the panel were selected by the leadership of IDSA and the European Society of Clinical Microbiology and Infectious Diseases (ESCMID). Twenty-three additional panelists comprised the full panel: Nine from IDSA, 10 from ESCMID, one from the Pediatric Infectious Diseases Society (PIDS), one from the European Society for Paediatric Infectious Diseases (ESPID), one from both IDSA and the Society for Healthcare Epidemiology of America (SHEA), and one from IDSA, the Society of Infectious Diseases Pharmacists (SIDP), and the American Society of Health-

System Pharmacists (ASHP). The panel included physicians and pharmacists with expertise in adult and pediatric infectious diseases and microbiology. Panelists were from diverse geographic distributions and years of clinical experience. IDSA staff oversaw all methodological, administrative, and logistical aspects of the guideline. The panel reviewed existing literature and brought in their professional experiences and clinical judgment.

Process

For this question, we sought studies comparing TEE to no TEE in patients with SAB who had a negative TTE.

Literature review

A medical librarian (EG) designed the literature searches and Medical Subject Headings (MeSH) terms for Medline (OVID), Embase (OVID), and Cochrane. The formal literature searches were performed in June 2021, July 2023, and January 2025. Searches were limited to studies published in English. We excluded animal studies, conference/meeting abstracts, books/chapters, editorials, or correspondence. Reference lists of related articles and guidelines were reviewed for relevance to supplement the electronic searches. Title and abstract screening was done by the methodologist (LAK) and 3 panelists (CL, AS, VL), and full-text screening was done by 3 panelists (CL, AS, VL). Search strategies are detailed in the supplementary file.

Consensus statement development

Consensus statements were developed using an iterative, structured process that incorporated input from both topic-specific subgroups and the full multidisciplinary panel. Subgroups drafted preliminary statements based on a comprehensive review of the available literature and expert clinical judgment. Draft statements were then reviewed and discussed during multiple virtual panel meetings and refined through sequential rounds of asynchronous electronic feedback. Disagreements and areas of limited agreement were systematically identified, documented, and addressed through targeted discussion and revision. Statements were modified iteratively until convergence was achieved. Final consensus for each statement was defined a priori as agreement by >75% of panel members. Consensus statements should be interpreted in the context of evolving evidence and are intended to support, not replace, individualized clinical decision making, while highlighting priorities for future SAB research. Panel members considered whether there was sufficient evidence to support the application of the same guidance to children, or whether available evidence supported development of alternative guidance.

Results

Adults' perspective

Summary of the literature review for the adult population

Diagnostic accuracy of TTE compared to TEE in SAB and impact on clinical management

We screened 1,548 titles and abstracts and identified two prospective observational studies evaluating the diagnostic performance of TEE and TTE in adult patients with SAB using modified Duke criteria as the reference standard [10, 11]. Sekar et al. assessed 119 adults with SAB who underwent both TEE and TTE, with definite endocarditis diagnosed according to the modified Duke criteria [11]. Fowler et al. studied 103 adults with SAB who had both TEE and TTE performed, with endocarditis defined by Duke criteria [10] (Table 1 in supplementary file).

TEE demonstrated a sensitivity of 86%-100% and specificity of 97%-99%, whereas TTE had sensitivity of 21%-32% and specificity of 99%-100%. In the Fowler study, 18% of TTEs were indeterminate, with TEE detecting endocarditis in 21% of these cases [10]. Sekar et al. reported that even among patients with good quality TTE images, sensitivity was only 24%, compared to 94% for TEE [11].

For patients with prosthetic valves or cardiovascular implantable electronic devices (CIEDs), TTE is often inadequate due to structural interference, with sensitivity for the detecting vegetation or valve dehiscence below 50% [1, 4] [12].

TTE quality and diagnostic accuracy

While standardized definitions of TTE quality are lacking, a good quality TTE should include adequate visualization of all valves, anatomic structures, and cardiac function without significant technical limitations [13, 14]. Operator skill as well as reader expertise are critical determinants of TTE quality. TTE quality significantly influences diagnostic reliability. In a study of 790 adult patients who underwent TTE followed by TEE (including 157 with SAB), standard TTE had a sensitivity of 43.3% (95% CI, 35.8%-51.1%) and negative predictive value (NPV) of 86.5% (95% CI, 83.7%-88.9%) [14]. Using strict criteria for negative TTE – including good image quality, normal valve anatomy, trivial regurgitation, and absence of devices – sensitivity improved to 98.1% (95% CI 94.5%-99.3%) and NPV to 97.1% (91.9-99.0%) [14].

Impact of TEE on Clinical Management

Two studies evaluated how TEE influenced management in patients with SAB and negative TTE [11, 15]. Sekar et al found that among 22 patients with negative TTE and positive TEE, 16 (73%) had their antibiotic course extended, and 4 (18%) underwent surgery. Conversely, in 91 patients with negative results on both TTE and TEE, therapy was shortened in 38 (42%) [11]. A separate study of 206 adult patients with SAB showed that 86% of management decisions were made after both TTE and TEE, primarily regarding antibiotic duration [15].

Risk Stratification of Patients for Endocarditis

Supplementary Table 2 summarizes major factors that have been associated with increased risk for endocarditis. However, there is variability in the magnitude of risk of endocarditis conferred by each of these factors and across different studies (Consensus Statement 1). Identifying patients for whom TEE should be used or can be safely avoided remains challenging. Several clinical prediction scores (e.g., VIRSTA, PREDICT, POSITIVE) have been developed to aid risk stratification, but none have reliably identified patients with < 1.1% probability of occult endocarditis with 95% confidence [16]. While VIRSTA has a high negative predictive value (NPV), false negatives occur in up to 3.4% of cases [17]. On the other hand, prediction scores may also lead to excess TEE use in those who may be less likely to benefit. For example, in one study, use of VIRSTA to define increased-risk patients would have resulted in a 45% increase in use of TEE [18].

Certain risk factors, such as prosthetic valves, intracardiac devices, predisposing heart valve conditions including prior endocarditis, positive follow-up blood cultures ≥ 48 hours, warrant TEE even if TTE is negative. For other factors (e.g., community-acquisition, injection drug use), the need for TEE should be guided by ongoing clinical assessment, considering patient-specific context. For example, while a patient with community-acquired SAB and multiple foci of infection warrants a TEE despite a negative good quality TTE, a TEE may not be necessary in a person who injects drugs with a skin abscess that has been drained, is clinically improved with negative follow-up blood cultures and good quality TTE.

Rationale for the consensus statements for the adult population

A risk-stratified approach to TEE prioritizes use among patients most likely to benefit, supports individualized decision-making based on specific risk factors, and avoids an invasive procedure in those patients with a low pretest probability of endocarditis.

Balance of benefits and harm

- TEE provides superior sensitivity with minimal risk (major complications 0.2%-0.5%) [7, 8]. On the other hand, if an endocarditis diagnosis is missed, a patient may receive suboptimal therapy and be at risk of relapsed SAB and mortality [18, 19].
- For patients with increased-risk features or high clinical suspicion for endocarditis, the benefits of TEE outweigh procedural risks.
- For carefully selected patients with increased-risk features and no clinical concern for endocarditis, it may be reasonable to forego TEE if the TTE is negative (see Practical Advice section below)
- For patients without any increased risk features, TEE may not be necessary, provided accurate risk stratification.

Costs

- TEE is considered cost-effective in SAB patients with increased-risk features for endocarditis, as it informs management decisions that reduce relapse, readmission, and mortality [20].

Feasibility

- TEE availability may be a major limitation to the feasibility of implementation at some centers.

Implementation Considerations for the adult population

Practical advice

- Routinely perform TEE in patients with SAB and risk factors such as prosthetic valves, intracardiac device, predisposing heart valve conditions including prior endocarditis [1], positive follow-up blood cultures ≥ 48 hours after first positive blood culture, embolic events, more than one non-contiguous focus of infection.
- Consider TEE in patients with other endocarditis increased-risk features such as community-onset or injection drug use. Individualize decision-making regarding TEE based on TTE quality, presence of other endocarditis increased-risk features, the patient's clinical course, and anticipated impact on patient management.
- For example, it may be reasonable to forego TEE if a good quality TTE is negative in carefully selected patients with SAB:
    - Community-onset SAB and central venous catheter-associated bacteremia in a patient with prompt catheter removal, clinical improvement, and negative follow-up blood cultures at 48 hours
    - Community-onset SAB in a patient with injection drug use and skin abscess that has been drained, clinical improvement, and negative follow-up blood cultures at 48 hours
    - Community-onset SAB without other endocarditis increased-risk features and a planned extended course of antibiotics for deep-seated infection, no clinical signs or symptoms suggestive of endocarditis or perivalvular abscess (e.g., PR interval

prolongation), and TEE findings would not change any management decisions (e.g., duration of antibiotic therapy, surgery).

- In those patients for whom TEE is indicated, perform TEE as early as reasonably possible to guide treatment decisions.
- Perform ECG in patients with SAB as PR interval prolongation is highly suggestive of perivalvular abscess and should prompt TEE.
- Use prediction scores (e.g., VIRSTA) as adjuncts but not replacements for clinical judgment.

Barriers

- Poor quality TTE may limit implementation of a risk-stratified approach to TEE. For example, the optimal approach to patients with low-risk SAB and a poor quality TTE is unknown. In such cases, a repeat TTE could be performed if factors affecting acoustic window or patient-related factors impacting quality have improved. Alternatively, a TEE may be considered or close clinical follow-up at end of treatment with low threshold to obtain FUBC if any concern for new symptoms and relapsed SAB. An individualized approach guided by infectious disease specialists should be made considering clinical suspicion for endocarditis and clinical response.
- Resources necessary for implementing TEE may not be available in all settings.
- Some patients might have contraindications to TEE (e.g., esophageal stricture or tumor, recent upper gastrointestinal surgery, severe thrombocytopenia) and alternative modalities such as cardiac Computed Tomography (CT) scan or [18F]FDG-PET/CT, or white blood cell SPECT/ CT may be considered based on local availability [1]. Others may have intolerance for such an invasive procedure and might require anesthesia.

Research needs for the adult population

- Studies using contemporary TTE technology with greater sensitivity in detecting vegetation are needed to evaluate the value of TEE among SAB patients who have a negative TTE.
- Prospective studies are needed to validate the safety of risk-stratification approaches where TEE is withheld. An ongoing randomized controlled trial evaluating echocardiography compared to no echocardiography in patients with SAB and a VIRSTA score < 3 will inform whether echocardiography can be avoided in low-risk patients [21].

Pediatrics perspective

Summary of the literature review for the pediatric population

Evidence on the diagnostic yield of TTE versus TEE in children with SAB is limited and primarily derived from single-center observational studies. Available data suggest that TTE has higher sensitivity for detecting vegetations in younger children compared to adults [22, 23]. In one small study of 39 children with definite endocarditis (per Duke criteria), participants were stratified by body weight into “pediatric-sized” (< 60 kg) and “adult-sized” (≥ 60 kg) groups [23]. TTE sensitivity was 97% in children < 60 kg versus 70% in those ≥ 60 kg. Among children < 60 kg with structurally normal hearts, no cases of endocarditis were missed by TTE; the few missed cases occurred in children with complex congenital heart disease (CHD) with or without vascular grafts/conduits. A small study of 21 children who underwent both TTE and TEE demonstrated a high level of concordance between modalities [24]. Using TEE as the reference standard, TTE had 86% sensitivity for any cardiac findings suggestive of endocarditis and 93% sensitivity for detecting vegetations.

The accuracy of TTE may be lower in children with complex CHD, particularly those with vascular conduits. In a case series of 13 children with CHD, SAB, and endocarditis, TEE detected findings missed or equivocal on TTE in 3 cases (23%), all with a history of complex cardiac repair [25].

Rationale for the remarks for the pediatric population

- Given the overall higher sensitivity of TTE in young children and the lower incidence of endocarditis in this population, routine TEE adds limited value in most cases. TEE may be indicated in selected pediatric populations, including:
    - Children with complex CHD, including those with vascular conduits that impair acoustic windows (particularly of the aortic valve) or intracardiac devices
    - Older adolescents or patients > 60kg
    - Children with obesity or large thoracic diameter
    - Cases with a high clinical suspicion for endocarditis despite a negative or equivocal TTE

Implementation considerations for the pediatric population

Practical advice

- Perform TTE as the primary imaging modality for pediatric patients with SAB and concern for endocarditis; for most pediatric patients, a negative good quality TTE is sufficient.
- Perform TEE when there is a high index of suspicion and negative or equivocal TTE.
- The decision for the performance of TEE in pediatric patients with a high index of suspicion for endocarditis should be individualized and made in consultation with experienced pediatric cardiologists/echocardiographers.

Barriers

- Practice Guidelines from the American Society for Echocardiography suggest that TEE be only performed in children with CHD by providers with experience and training in this specific population [26]. The limitations on the availability of experienced pediatric echocardiographers would restrict the ability to perform TEE in many centers.
- TEE may not be feasible in some very small children due to physical size (such as very young infants) and the limitations imposed by probe size. The need for anesthesia in young children undergoing TEE poses an additional challenge to clinical practice. However, TEE to evaluate cardiac anatomy has been successfully and safely performed in small infants in tertiary centers and thus is a diagnostic option for experienced providers when the index of suspicion for endocarditis is high [27, 28].
- Other anatomic anomalies that can co-exist in children with CHD (e.g., tracheoesophageal fistula, vascular ring, etc.) may preclude TEE in select high-risk patients. In such cases, the use of other imaging modalities (e.g., cardiac CT or MRI) may be considered.

Research needs for the pediatric population

Large, contemporary studies comparing the diagnostic utility and impact of TTE and TEE in children with SAB are lacking. Further work, including multicenter cohorts, is needed to define which children with SAB would benefit most from TEE in the evaluation of endocarditis.

Limitations

This manuscript was developed using a consensus-based methodology rather than a formal clinical practice guideline process. Although a comprehensive literature review was performed, formal systematic review methods and structured evidence grading were not required. Consensus

statements reflect a synthesis of available evidence and expert clinical judgment, particularly in areas where high-quality randomized data and systematic reviews are limited. In this SAB guideline project, where clinical presentations are heterogeneous and many management questions lack definitive trial data, this approach allows translation of imperfect but clinically relevant evidence into practical consensus statements.

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