2026 Clinical Practice Guidelines by the Infectious Diseases Society of America (IDSA) and European Society of Clinical Microbiology and Infectious Diseases (ESCMID) on Staphylococcus aureus Bacteremia: Risk Stratification, Diagnostic Evaluation, and Management of Adults and Children

Consensus Statement 5 on Whole Body Imaging in the Diagnostic Evaluation of Patients with *Staphylococcus aureus* Bacteremia

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Executive Summary

Overview
Identification of deep-seated and metastatic foci of infection is essential to management of *Staphylococcus aureus* bacteremia (SAB), guiding source control interventions and duration of

therapy. As deep-seated and metastatic foci of infection can be occult and clinically silent at presentation, the potential role of whole-body imaging in the diagnostic evaluation of SAB is discussed in this consensus statement.

Clinical question 5
In patients with *Staphylococcus aureus* bacteremia (SAB) at increased risk for deep-seated or metastatic foci of infection and with an unknown focus after appropriate initial evaluation, should whole-body imaging (e.g., [18F]FDG-PET/CT) be performed?

Consensus statements for the adult population

- In adult patients with SAB at increased risk for deep-seated or metastatic foci of infection and with an unknown focus after appropriate initial evaluation, the panel suggests performing either:
    - Whole-body imaging (WBI) (e.g., [18F]FDG-PET/CT) **OR**
    - Combinations of imaging modalities (e.g., thoracic/ abdominal CT, duplex venous ultrasound, etc.) that evaluate the most likely sites of infectious foci (consensus)

Remarks for the adult population

- This consensus statement assumes initial diagnostic evaluation including follow-up blood cultures, echocardiography, and symptom/exam-directed imaging (e.g. MRI spine in patient with back pain) has been performed based on risk stratification and as clinically indicated. Please refer to the Executive Summary and Consensus Statements 1, 2, 3, and 4 for additional details regarding risk stratification and diagnostic evaluation.
- Key risk factors for deep-seated or metastatic foci of infection include (1) community-onset, (2) positive blood culture obtained ≥48 hours after the first positive blood culture, and (3) intracardiac device. Please refer to Consensus Statement 1 for additional risk factors.
- Existing evidence for whole-body imaging in the diagnostic evaluation of SAB is limited to observational studies of [18F]FDG-PET/CT, which suggest [18F]FDG-PET/CT may enable earlier detection of occult infectious foci and can inform subsequent treatment modifications. Knowledge gaps exist including:
    - Impact of [18F]FDG-PET/CT on outcomes such as mortality and relapse of infection when compared to symptom/exam-directed imaging or multimodal imaging approaches (e.g. combinations of imaging modalities that evaluate the most likely sites of infectious foci)
- Decisions regarding imaging approach should be guided by the patient's clinical condition and availability of each imaging modality.

Consensus statement for the pediatric population

- In pediatric patients with SAB without a focus after appropriate initial evaluation, whole-body imaging (e.g., [18F]FDG-PET/CT or other modality or combination of modalities) should be considered in carefully selected situations (e.g., ongoing SAB and no identifiable focus despite targeted evaluation) (consensus).

Remarks for the pediatric population

- It is relatively rare for children to have clinically unsuspected foci of infection associated with SAB.
- Decisions about the choice of imaging in infants and children should be made based on patient age, size, comorbidities, current clinical condition, and availability of each imaging modality.

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- There is insufficient evidence to recommend whole-body imaging using [18F]FDG-PET/CT over a combination of other imaging modalities that evaluate the most likely sites of infectious foci. Whole-body imaging using [18F]FDG-PET/CT should be considered in select pediatric patients with SAB if other diagnostic evaluation is unrevealing, taking into consideration the availability of resources.
- Neonates and very young infants in particular have potential for wide dissemination of disease and may require a more cautious approach. Consideration of whole-body imaging may be warranted in neonates with persistent SAB as resources and clinical condition allow.

Introduction

Background

Staphylococcus aureus bacteremia (SAB) is often associated with deep-seated infection and metastatic seeding, leading to distant foci of infection. Due to the propensity of *Staphylococcus aureus* to attach to tissue surfaces and foreign bodies, multiple foci may occur in a single patient. The reported prevalence of metastatic infection varies widely—from 5% to 75%—depending on the diagnostic evaluation performed and primary focus, with the highest rates among those with endocarditis, followed by those with arteriovenous grafts and bone/joint infections [1, 2].

A thorough history and physical exam, follow-up blood cultures, and transthoracic echocardiography are essential components of risk stratification and the initial diagnostic evaluation of SAB, with symptom/ exam-directed evaluation guided by clinical assessment to detect deep-seated and metastatic foci of infection (Consensus Statement 1). However, many cases of metastatic seeding are clinically silent at presentation and may not become apparent for weeks. Notably, 15–20% of SAB cases have no identifiable focus of infection [3, 4], a finding strongly associated with increased mortality [3, 5, 6]. These cases may represent patients with undiagnosed deep-seated and metastatic foci of infection.

Timely and accurate identification of deep-seated and metastatic foci of infection is critical for optimal SAB management, informing both source control and appropriate treatment duration, and could thereby improve outcomes. Whole-body imaging—particularly with modalities like [18F]FDG-PET/CT—has emerged as a promising tool to detect otherwise occult infections. Unlike sequential use of multiple regional imaging studies, these techniques allow for detection of hypermetabolic foci and comprehensive, one-session imaging of the entire body.

Purpose and objectives

The objective of the panel was to review the relevant literature and evidence to provide consensus statements concerning whether whole-body imaging (e.g., [18F]FDG-PET/CT) should be performed in patients with SAB at increased risk for deep-seated or metastatic infection and with an unknown focus after appropriate initial evaluation.

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

We considered studies evaluating the use of whole-body imaging, including [18F]FDG-PET/CT, in adult and pediatric patients with SAB, including those at increased risk or high risk for deep-seated or metastatic foci of infection. Outcomes of interest included mortality, relapse, treatment modification, and incidental findings leading to additional interventions.

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 July 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 three panellists (CL, AS, and HC) and the methodologist (LAK). Full-text screening was done by one panelist (CL). The search strategies are reported 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. The consensus statements were also developed considering the balance of benefits and harms, feasibility, and resource use, while also providing practical advice for implementation and identifying key research gaps. 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

We screened 1216 titles and abstracts and identified five observational studies in adult patients with SAB that compared whole-body imaging versus no whole-body imaging, evaluating mortality and relapse outcomes [7-11]. In all five studies, the whole-body imaging modality used was [18F]FDG-PET/CT. Two studies included only patients with increased-risk SAB [7, 8], two studies reported on all patients with SAB, as well as the subset of patients with increased-risk SAB [9], and one study evaluated all patients with SAB (without risk stratification) [11].

Mortality

Three studies found that [18F]FDG-PET/CT was associated with a lower mortality rate among patients with SAB at increased risk for deep-seated or metastatic foci of infection [7-9]. The term "high-risk SAB" was used in each study with some variation in the definition used across studies (Supplementary Table 1).

- Berrevoets 2017[7]: In a retrospective study of 148 patients with high-risk SAB, 90-day mortality was significantly lower among those who had [18F]FDG-PET/CT performed compared to those who did not (32.7% vs. 12.4%, p-value =0.003; multivariate adjusted odds ratio (aOR 0.20, 95% CI 0.07-0.62). This study did not adjust for immortal time bias.
- Yildiz 2019 [8]: In a retrospective study of 102 patients with high-risk SAB, overall mortality was lower in patients who had [18F]FDG-PET/CT performed compared to those who did not (16.6% vs. 44.4%, p-value =0.002). Similar results were found by Kaplan-Meier analysis with survival at 30 days (p-value=0.001; multivariate adjusted hazard ratio (aHR) 6.14, 95% CI 2.29-16.49), at 90 days (p-value=0.004; multivariate aHR 3.94, 95% CI 1.63-9.51), and at 1 year (p-value=0.002, multivariate aHR 4.12, 95% CI 1.82-9.39). This study did not adjust for immortal time bias.
- Ghanem-Zoubi 2021 [9]: In a prospective matched cohort study including 139 patients with high-risk SAB, 90-day mortality was lower in patients who had [18F]FDG-PET/CT performed compared to those who did not (17.9% vs. 32.7%, p-value = 0.044). On multivariate analysis, [18F]FDG-PET/CT was independently associated with reduced mortality at 90 days (aHR 0.45, 95% CI 0.24-0.85). Similar observations were observed among those with low-risk SAB. Adjustments for immortal time bias were made by matching with a hierarchical approach, but selection bias is possible as consent was required among those who had [18F]FDG-PET/CT.

One retrospective cohort study found that [18F]FDG-PET/CT was associated with lower mortality among 315 patients with SAB (no risk stratification) at each time point measured (7 days, 30 days, 90 days, 1 year, and at 1.5 years, p<0.0001) even after adjusting for confounders and immortal time bias (aHR 0.43, (95% CI 0.30-0.63, p<0.0001) [11].

A prospective, multicenter cohort study of 476 patients with SAB found that while [18F]FDG-PET/CT was associated with lower 90-day all-cause mortality (confounder-adjusted HR 0.50, 95% CI, 0.34-0.74), the effect was no longer observed after adjusting for immortal time bias (confounders

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and immortal time bias-adjusted HR: 1.00, 95% CI 0.68-1.48) [10]. Similarly, among the subgroup of 236 patients with high-risk SAB, while [18F]FDG-PET/ CT was associated with lower 90-day all-cause mortality (confounder-adjusted HR 0.47, 95% CI, 0.28-0.77), the effect was no longer observed after adjusting for immortal time bias (confounders and immortal time bias-adjusted HR, 1.07, 95% CI 0.63-1.83).

Relapse

Three studies evaluated the effect of [18F]FDG-PET/CT on relapse of SAB:

- Two studies demonstrated no effect of [18F]FDG-PET/CT on recurrent infection or relapse. Berrevoets 2017 [7] found similar rates of recurrent infection at 3 months (3% vs 0%, p-value =0.56) and Ghanem-Zoubi 2021 [9] found similar rates of relapse at 6 months (3.3% vs. 2.6%, p-value =0.735).
- Briol 2024 [11] found a higher rate of relapse at 3 months (7.6% vs 2.2%, p <0.0001) among those who received [18F]FDG-PET/CT, which the authors attributed to a higher rate of osteoarticular infections in this group.

Treatment modifications

Three studies reported treatment modifications among those who underwent [18F]FDG-PET/CT compared to those who did not.

- Ghanem-Zoubi 2021 [9] found that [18F]FDG-PET/CT led to extended durations of therapy (42 vs 19 days, p-value=0.0001) and higher rates of source control interventions (21.9% vs 11.9%, p-value =0.021) compared to those who did not receive [18F]FDG-PET/CT.
- van der Vaart 2023 [10] found prolonged durations of therapy (42 vs 16 days, p-value <0.001) and increased frequency of source control interventions (44.3% vs 33.6%, p-value =0.02) among those who received [18F]FDG-PET/CT.
- Briol (2024) also found that those who had [18F]FDG-PET/CT had longer treatment durations (47 vs 23 days, p-value <0.001).

Three studies reported treatment modifications among either patients who underwent [18F]FDG-PET/CT without a control group or compared to a different population:

- Berrevoets 2017 [7] reported that treatment modifications were made among 74.7% of patients who underwent [18F]FDG-PET/CT, including extension or shortening of therapy and source control intervention.
- Berrevoets 2019 [12] conducted a case-control study comparing patients with increased-risk SAB (but no evidence of metastatic infection on [18F]FDG-PET/CT and normal echocardiography) to patients with low-risk SAB. Both groups had similar treatment durations (15.9 vs. 15.4 days, p-value = 0.34), 90-day mortality (19.4% vs. 15%, p-value =0.64), and relapse (2.5% vs. 5%, p-value =1.00).
- Kouijzer 2021[13] performed a retrospective cohort study comparing patients with SAB and evidence of metastatic foci of infection (but no endovascular involvement by [18F]FDG-PET/CT and echocardiography) who were transitioned to oral therapy at two weeks, to patients who received prolonged intravenous therapy. No significant differences were observed in relapse (0% in both groups) and 3-month mortality (13.3% vs. 6.6%, p-value = 0.242).

Rationale for the consensus statement for the adult population

Balance of benefits and harm

While patients with low-risk SAB are unlikely to benefit from routine diagnostic imaging [14], whole-body imaging with [18F]FDG-PET/CT among increased-risk patients with an unknown focus may facilitate early detection of metastatic infection, thereby guiding duration of therapy and timely source control interventions. However, it is unknown whether similar diagnostic yield and outcomes could be achieved by combinations of imaging modalities (e.g., thoracoabdominal CT, duplex venous ultrasound, etc.). To date, no studies have evaluated [18F]FDG-PET/CT in comparison to other imaging strategies such as symptom/ exam-directed imaging, combinations of imaging modalities, or whole-body MRI.

It is unclear whether [18F]FDG-PET/CT directly improves patient important outcomes. Findings of mortality benefit associated with [18F]FDG-PET/CT in several studies are limited by observational study design, failure to adjust for immortal time bias, and the potential for residual confounding; one study found no mortality benefit after adjustment for immortal time bias. Notably, no significant effect on relapse of SAB at 3 months or 6 months was observed, with one study finding a higher rate of relapse among those who received [18F]FDG-PET/CT.

Potential harms include exposure to ionizing radiation and risks associated with the transfer of a clinically unstable patient to a PET scanner, which may be off-site at some centers. Whole-body imaging could lead to the identification of incidental findings and unnecessary interventions or extended durations of treatment. One study reported that irrelevant findings were found in eight of 105 patients who underwent [18F]FDG-PET/CT, leading to additional procedures without a clear diagnosis [7].

Costs and Feasibility

A cost-utility analysis suggests that use of [18F]FDG-PET/CT among patients with increased-risk SAB is more cost-effective compared to routine diagnostic workup [15]. However, decisions regarding the use of [18F]FDG-PET/CT should be made based on local availability and cost and considered in the context of alternative imaging modalities. Globally, there is significant geographic variability in the use of [18F]FDG-PET/CT due to differences in access and insurance coverage. In an international survey, 78% of European respondents indicated that PET/CT was readily available compared to 49%, 47%, and 29% of respondents from North America, Asia, and South America, respectively [16].

Implementation Considerations for the adult population

Practical advice

- Initial diagnostic evaluation of all patients with SAB should include a careful history and physical exam, follow-up blood cultures (Consensus Statement 2), and transthoracic echocardiogram (Consensus Statement 3). Prior to considering whole-body imaging approaches, patients should undergo a tailored evaluation with symptom and exam-directed imaging to identify deep-seated or metastatic foci of infection (Consensus Statement 1), along with a risk-stratified approach to transesophageal echocardiography (Consensus Statement 4).
- [18F]FDG-PET/CT or combinations of imaging modalities (e.g. thoracic/ abdominal CT, duplex venous ultrasound, etc.) that evaluate the most likely sites of infectious foci are acceptable approaches to evaluate those at increased risk for deep-seated or metastatic foci of infection and with an unknown focus after initial evaluation.

- [18F]FDG-PET/CT findings should be carefully interpreted in the context of the patient's clinical course; treatment duration should not be extended solely based on non-specific uptake or incidental findings.

Barriers

- Lack of availability or limited access to [18F]FDG-PET/CT and providers trained in interpretation precludes implementation in many centers.
- Delays in access to [18F]FDG-PET/CT may affect detection rates; however, evidence on the effect of antimicrobial treatment duration on detection of infection foci is mixed, with some studies showing no impact and others indicating reduced sensitivity [17, 18] .
- Cost of [18F]FDG-PET/CT and lack of insurance coverage and reimbursement is a barrier to access in many countries, including the U.S.
- If using combinations of imaging modalities, there may be some ambiguity about the imaging intensity required to safely exclude a deep-seated or metastatic focus.

Research needs for the adult population

Prospective, randomized controlled studies are needed to evaluate the effect of [18F]FDG-PET/CT scan compared to other imaging strategies on clinical outcomes, to define the populations most likely to benefit (all SAB or increased-risk SAB; unknown focus; known focus with persistent bacteremia), as well as its cost-effectiveness. Randomized studies, including TEPSTAR [19] and *Staphylococcus aureus* Network Adaptive Protocol (SNAP) trial [20] that are currently underway, should help elucidate the role of [18F]FDG-PET/CT in the diagnostic evaluation of SAB.

Pediatrics perspective

Summary of the literature review on the pediatric population

We did not identify any studies evaluating the impact of whole-body imaging versus no whole-body imaging on patient-important outcomes such as mortality and relapse in children with SAB.
The most common foci of infection in children with community-acquired SAB are skin and soft tissue, musculoskeletal, lung, and heart [21-23], while hospital-acquired SAB in children is frequently associated with intravenous catheters [22]. Most of these foci are suspected based on history and physical examination and confirmed with targeted investigations [24].
A retrospective study of 298 children with SAB (84% with at least one comorbidity) at a U.S. tertiary centre [24] found that 58 (19%) had evidence of deep-seated infection detected by bone imaging, abdominal imaging, or echocardiogram. Only 11 (3.7%) were unsuspected based on clinical assessment. These clinically unsuspected cases were significantly more likely to have positive blood cultures for more than one day (OR 4.99, 95% CI 1.16-19.8) than those without deep-seated infections, and all had underlying medical conditions (e.g., prematurity, immunosuppression, severe neuro-disability, congenital malformations, cardiac catheters) that may have limited detection.

An 11-year surveillance study found that 5.7% (36/631) of SAB episodes in children without congenital heart disease or central venous catheters had no identifiable focus; 86% of these episodes occurred in children with immunosuppression, prematurity, chronic respiratory insufficiency, or impaired skin integrity [25].

A large prospective study in Australia and New Zealand found that SAB was associated with multiple non-contiguous foci of infection in 16% (87/552) of pediatric SAB cases, with a significantly higher 90-day mortality rate compared to those without multiple foci (adjusted OR 22.6, 95% CI 1.4-498.5) [23]. However, it remains unclear what proportion of these foci were clinically unsuspected and whether their identification leads to improved outcomes among children with SAB.

As stated, osteoarticular infections are the most common focus of SAB in children. While osteomyelitis in neonates may be caused by a variety of pathogens, the most common etiology is *S. aureus* [26]. Importantly osteoarticular infections in neonates often involve multiple bones and joints [27]. There may be a role for whole body imaging in young infants with SAB without clear focus or ongoing SAB despite source control, however, data are limited. It is uncertain from the available literature, how often such multifocal disease is unsuspected based on clinical presentation or the direct clinical impact of whole-body imaging in neonates/young infants with SAB.

Rationale for the consensus statement for the pediatric population

Whole-body imaging using PET/CT or MRI has been shown in case studies and small case series to detect occult foci of infection in children with SAB, including septic pulmonary emboli and endocarditis [28-32]. However, it is uncertain whether these foci would have been detected by other combinations of focused cross-sectional and sonographic imaging modalities.
Whilst imaging modalities like PET/CT and whole-body MRI may lead to the detection of unsuspected foci of infection, it is unclear whether this directly improves outcomes or could possibly lead to unnecessary interventions and longer duration of treatment.
Whole-body imaging may be most beneficial in:

- Children with persistent SAB and no identifiable focus despite targeted evaluation,
- Non-verbal or medically complex children, where clinical assessment may be challenging,
- Patients not responding as expected to initial therapy.

There is insufficient evidence to suggest whole-body imaging over a combination of other imaging modalities that evaluate the most likely sites of infectious foci. Imaging decisions should be tailored based on patient age, size, comorbidities, current clinical condition, and availability of each imaging modality.

Implementation considerations for the pediatric population

Practical advice

- Diagnostic evaluation for identification of a focus of infection is warranted in all children with SAB and should be guided by history, clinical exam and knowledge of the most likely anatomic foci of infection. Common foci of infection in children with SAB in descending order of frequency include musculoskeletal infection, central venous catheters, skin-and-soft tissue infection, pneumonia and endocarditis.
- [18F]FDG-PET/CT may be considered in select children with an otherwise unrevealing diagnostic evaluation (e.g., echocardiogram or musculoskeletal MRI). Decisions regarding the performance of [18F]FDG-PET/CT should weigh the availability and risks/benefits of this modality.

Barriers

- Limited access to [18] FDG-PET/CT at many pediatric centers, compounded with radiation exposure, need for sedation or anesthesia, and transport of acutely ill patients—often to off-site facilities, both limits and complicates the use of this modality in children [30].

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Research needs for the pediatric population

Randomized controlled studies are needed to evaluate the effect of whole-body imaging on clinical outcomes, and future studies are needed to define the population most likely to benefit from whole-body imaging modalities, especially PET/CT, relative to other imaging strategies.

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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Catherine Liu (panel chair at IDSA and manuscript lead), Alex Soriano, Loren Miller, Vance Fowler, and Vincent LeMoing contributed to screening, data abstraction, conception and design of the analysis, interpretation of data, revision, and final approval of the consensus statement and manuscript. J. Chase McNeil and Aubrey Cunnington served as co-leads for the pediatrics section and contributed to data abstraction, interpretation of data, revision, and final approval of the consensus statement and manuscript. Catherine Liu (panel chair at IDSA), Henry F. Chambers (co-chair at IDSA), François Vandenesch (co-chair at ESCMID), and Winfried V. Kern (co-chair at ESCMID) oversaw and guided the whole process of consensus statement development and contributed to the interpretation of the data, revision and final approval of the consensus statement and manuscript. Remaining panelists contributed to the interpretation of data, drafting, revision, and final approval of the consensus statement and manuscript. Lara A. Kahale, the current methodologist, contributed to project management, screening, data interpretation, guiding the panel through the drafting of the consensus statement, and drafting the manuscript and supplementary files. Nigar Sekercioglu, the former methodologist, was responsible for project management, screening, designing, and supporting the panel through the process.

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