

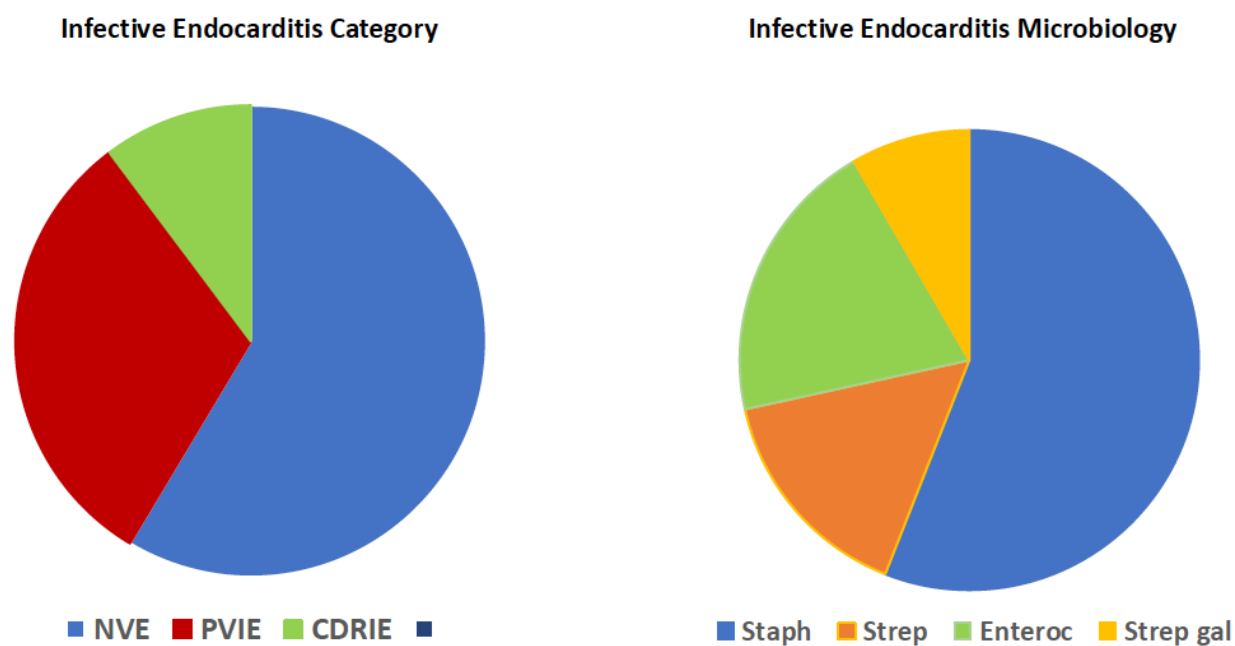
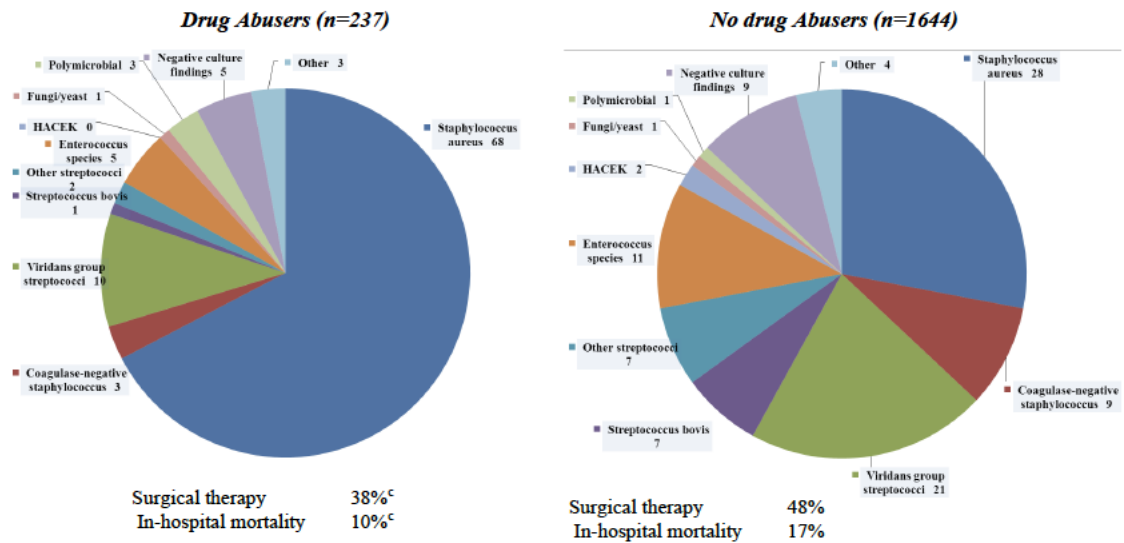


Figure 1. Epidemiology of endocarditis

NVE: native valve endocarditis; PVIE: prosthetic valve endocarditis; CDRIE: cardiac device related endocarditis;
 Staph: Staphylococci; Strep: oral Streptococci; Enteroc: enterococci; Strep gal: Streptococcus gallolyticus.

Data from Habib G, et al. Clinical presentation, aetiology and outcome of infective endocarditis. Results of the ESC-EORP EURO-ENDO (European infective endocarditis) registry: a prospective cohort study. *Eur Heart J.* 2019;40:3222-3232.

Native Valve IE



Intracardiac Device IE

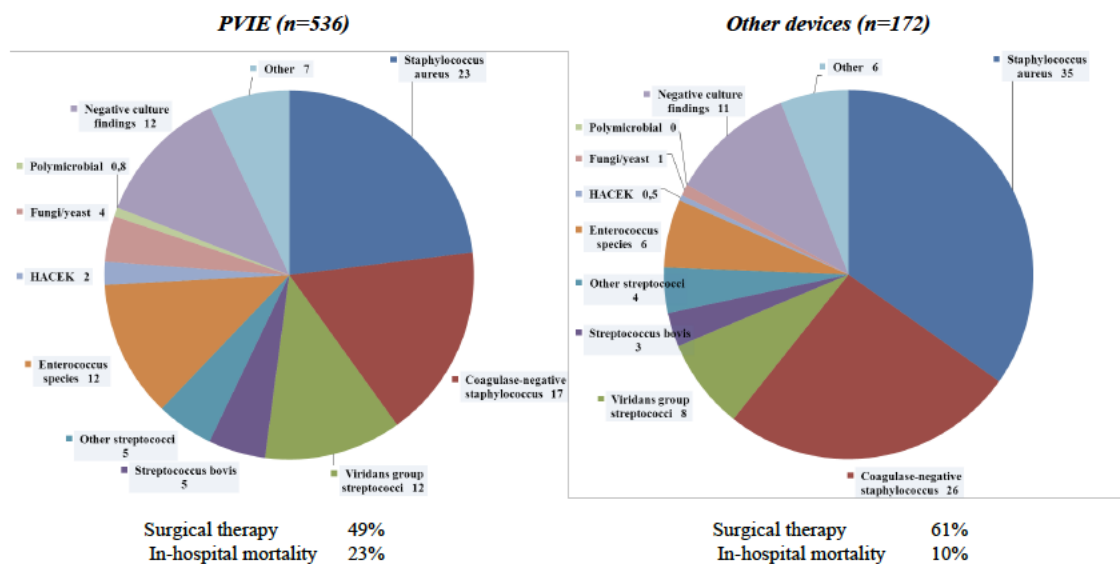


Figure 2. Microbiology of endocarditis

HACEK, bacteria consisting of *Haemophilus* species, *Aggregatibacter* (formerly *Actinobacillus*) *actinomycetemcomitans*, *Cardiobacterium hominis*, *Eikenella corrodens*, and *Kingella* species; IE, infective endocarditis; PVIE, prosthetic valve IE.

a Only percentages less than 1% are carried to the first decimal place.

b Including pacemakers and implantable cardioverter defibrillators.

c For pure right-sided IE only, 23 of 107 patients (21.5%) underwent surgical therapy and 6 of 108 (5.6%) died in the hospital.

Data by Murdoch DR, Corey GR, Hoen B, et al. Clinical presentation, etiology, and outcome of infective endocarditis in the 21st century: the International Collaboration on Endocarditis-Prospective Cohort Study. *Arch Intern Med.* 2009;169:463-732

Table 1. Diagnosis of Infective Endocarditis (IE)

Diagnosis of IE according to the modified Duke criteria

Definite IE

Pathological criteria

- Microorganisms demonstrated by culture or on histological examination of a vegetation, a vegetation that has embolized, or an intracardiac abscess specimen; or
- Pathological lesions; vegetation or intracardiac abscess confirmed by histological examination showing active endocarditis

Clinical criteria

- 2 major criteria; or
- 1 major criterion and 3 minor criteria; or
- 5 minor criteria

Possible IE

- 1 major criterion and 1 minor criterion; or
- 3 minor criteria

Rejected IE

- Firm alternate diagnosis; or
- Resolution of symptoms suggesting IE with antibiotic therapy for ≤ 4 days; or
- No pathological evidence of IE at surgery or autopsy, with antibiotic therapy for ≤ 4 days; or
- Does not meet criteria for possible IE, as above

ACC/AHA 2020 GL on Valvular Heart Disease. Major and Minor Criteria in the Modified Duke Criteria for the Diagnosis of IE

Major criteria

Blood culture positive for IE

Typical microorganisms consistent with IE from 2 separate blood cultures:

- *Viridans streptococci*, *Streptococcus bovis*, HACEK group (*Haemophilus* spp, *Actinobacillus actinomycetemcomitans*, *Cardiobacterium hominis*, *Eikenella* spp, and *Kingella kingae*), *S. aureus*; or community-acquired enterococci, in the absence of a primary focus;

or

Microorganisms consistent with IE from persistently positive blood culture results, defined as follows:

- At least 2 positive culture results of blood samples drawn 12 h apart; or
- All of 3 or most of ≥ 4 separate culture samples of blood (with first and last samples drawn at least 1 h apart)
- Single positive blood culture result for *Coxiella burnetii* or antiphase I IgG antibody titer $>1:800$

Evidence of endocardial involvement

- Echocardiogram positive for IE defined as follows:
 - Oscillating intracardiac mass on valve or supporting structures, in the path of regurgitant jets, or on implanted material in the absence of an alternative anatomic explanation
 - Abscess; or
 - New partial dehiscence of prosthetic valve
- New valvular regurgitation (worsening or changing of preexisting murmur not sufficient)

Minor criteria

Predisposition, predisposing heart condition, or injection drug use

Fever, temperature $>38^{\circ}\text{C}$ (100.4°F)

Vascular phenomena, major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, and Janeway lesions

Immunological phenomena: glomerulonephritis, Osler's nodes, Roth's spots, and rheumatoid factor

Microbiological evidence: positive blood culture but does not meet a major criterion as noted above* or serological evidence of active infection with organism consistent with IE

*Excludes single positive cultures for coagulase-negative staphylococci and organisms that do not cause IE. Adapted from Durack DT, et al. (2) and Kupferwasser LL, et al. (3)
IE indicates infective endocarditis; IgG, immunoglobulin G; and spp, species.

Definitions of the 2023 European Society of Cardiology modified diagnostic criteria of infective endocarditis

Major criteria
(i) Blood cultures positive for IE (a) Typical microorganisms consistent with IE from two separate blood cultures: Oral streptococci, <i>Streptococcus gallolyticus</i> (formerly <i>S. bovis</i>), HACEK group, <i>S. aureus</i>, <i>E. faecalis</i> (b) Microorganisms consistent with IE from continuously positive blood cultures: • ≥ 2 positive blood cultures of blood samples drawn >12 h apart. • All of 3 or a majority of ≥ 4 separate cultures of blood (with first and last samples drawn ≥ 1 h apart). (c) Single positive blood culture for <i>C. burnetii</i> or phase I IgG antibody titre $>1:800$. (ii) Imaging positive for IE: Valvular, perivalvular/periprosthetic and foreign material anatomic and metabolic lesions characteristic of IE detected by any of the following imaging techniques: • Echocardiography (TTE and TOE). • Cardiac CT. • [18F]-FDG-PET/CT(A). • WBC SPECT/CT.
Minor criteria
(i) Predisposing conditions (i.e. predisposing heart condition at high or intermediate risk of IE or PWIDs)^a (ii) Fever defined as temperature $>38^{\circ}\text{C}$ (iii) Embolic vascular dissemination (including those asymptomatic detected by imaging only): • Major systemic and pulmonary emboli/infarcts and abscesses. • Haematogenous osteoarticular septic complications (i.e. spondylodiscitis). • Mycotic aneurysms. • Intracranial ischaemic/haemorrhagic lesions. • Conjunctival haemorrhages. • Janeway's lesions. (IV) Immunological phenomena: • Glomerulonephritis. • Osler nodes and Roth spots. • Rheumatoid factor. (V) Microbiological evidence: • Positive blood culture but does not meet a major criterion as noted above. • Serological evidence of active infection with organism consistent with IE.
IE Classification (at admission and during follow-up)
Definite: • 2 major criteria. • 1 major criterion and at least 3 minor criteria. • 5 minor criteria. Possible: • 1 major criterion and 1 or 2 minor criteria. • 3–4 minor criteria. Rejected: • Does not meet criteria for definite or possible at admission with or without a firm alternative diagnosis.

[18F]-FDG-PET/CT, ¹⁸F-fluorodeoxyglucose positron emission tomography; CT(A), computed tomography (angiography); HACEK, *Haemophilus*, *Aggregatibacter*, *Cardiobacterium*, *Eikenella*, and *Kingella*; IE, infective endocarditis; Ig, immunoglobulin; PWID, people who inject drugs; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography; WBC SPECT/CT, white blood cell single photon emission tomography/computed tomography.

Table 2. ESC 2023 GL on endocarditis. Recommendations for the Endocarditis Team

Diagnosis and management of patients with complicated IE to be performed at an early stage in a Heart Valve Centre, with immediate surgical facilities and an ‘Endocarditis Team’ to improve the outcomes I B

For patients with uncomplicated IE managed in a Referring Centre, early and regular communication between the local and the Heart Valve Centre endocarditis teams to improve the outcomes of the patients I B

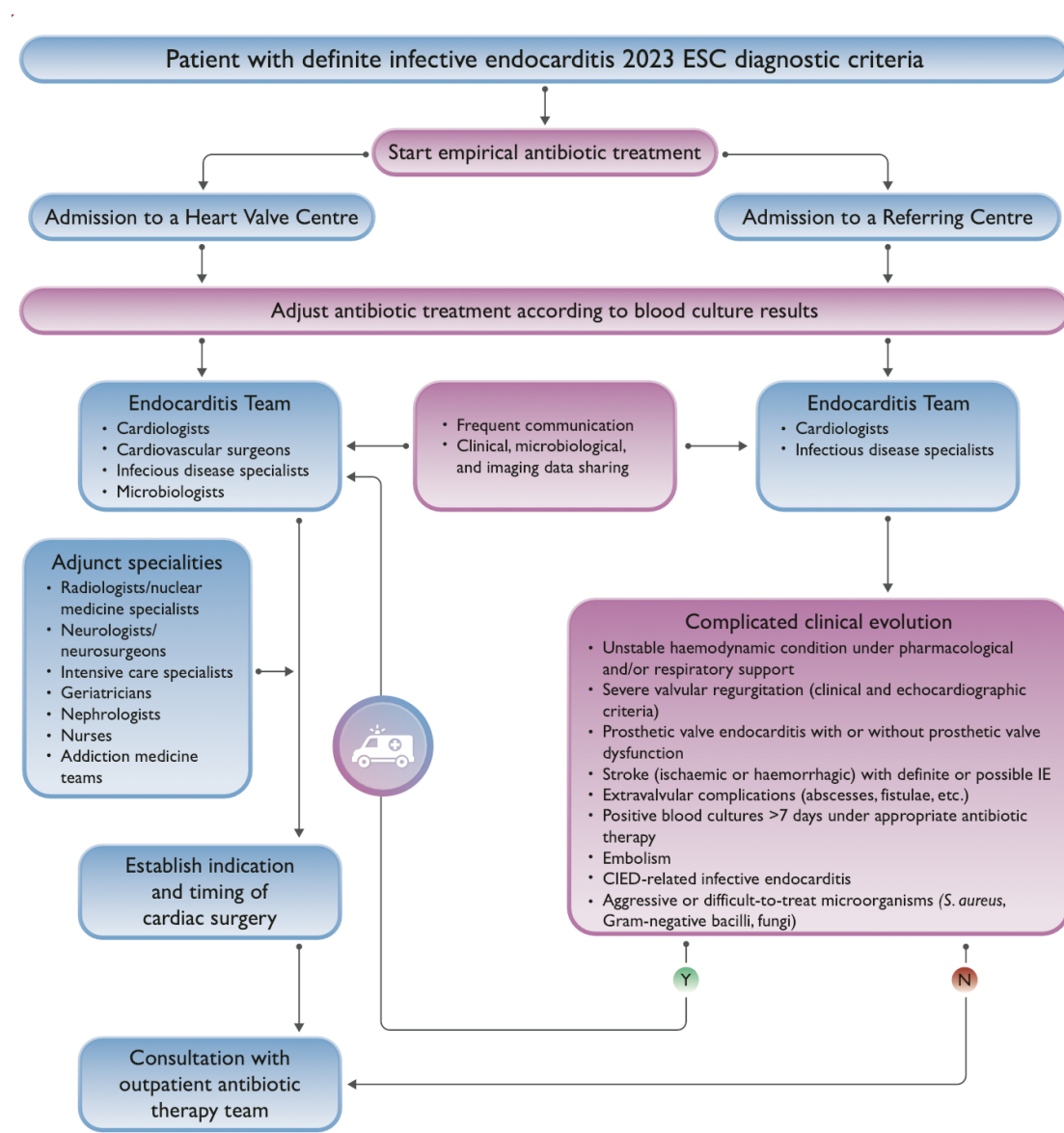


Figure 3. ESC 2023 GL on endocarditis. Management of patients with infective endocarditis: positioning of the Endocarditis Team.

CIED, cardiovascular implanted electronic device.

Table 3. ACC/AHA 2020 GL on Valvular Heart Disease. Recommendations for Diagnosis of IE

Culture samples in patients at risk of IE (eg, those with congenital or acquired VHD, previous IE, prosthetic heart valves, certain congenital or heritable heart malformations, immunodeficiency states, or injection drug use) who have unexplained fever blood, culture samples should be obtained.	I-B-NR
At least 2 sets of blood culture samples in patients with the recent onset of left-sided valve regurgitation	I-B-NR
Use Modified Duke Criteria for diagnosis	I-B-NR
Management by a multispecialty Heart Valve Team, which includes an infectious disease specialist, cardiologist, and cardiac surgeon; a cardiac anesthesiologist for surgically managed patients; and a neurologist for patients with neurological events.	I-B-NR
TTE to identify vegetations, characterize the hemodynamic severity of valvular lesions, assess ventricular function and pulmonary pressures, and detect complications.	I-B-NR
TTE when complications have developed or are clinically suspected or when intracardiac device leads are present, in all patients with known or suspected IE and nondiagnostic TTE results	I-B-NR
In change in clinical signs or symptoms (eg, new murmur, embolism, persistent fever, HF, abscess, or atrioventricular heart block) and in patients at high risk of complications (eg, extensive infected tissue, large vegetation on initial echocardiogram, or staphylococcal, enterococcal, or fungal infections), TTE and/or TEE for reevaluation.	I-B-NR
Intraoperative TEE in patients undergoing valve surgery for IE	I- B-NR
In patients being considered for an early change to oral antibiotic therapy for the treatment of stable IE, a baseline TEE before switching to oral therapy and a repeat TEE 1 to 3 days before completion of the oral antibiotic regimen	I-B-NR
TEE to diagnose possible IE in Staphylococcus aureus bacteremia without a known source	IIa-B-NR
TEE in patients with a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur	IIa-B-NR
CT imaging in patients in whom the anatomy cannot be clearly delineated by echocardiography in the setting of suspected paravalvular infections	IIa-B-NR
18F-fluorodeoxyglucose PET/CT as adjunct diagnostic imaging in patients classified by Modified Duke criteria as having “possible IE,”	IIa-B-NR
TEE to detect concomitant staphylococcal IE in patients with nosocomial S. aureus bacteremia with a known portal of entry from an extracardiac source	IIb-B-NR

Table 4. ESC 2023 GL on endocarditis. Diagnosis
Cardiac and non-cardiac risk factors

Cardiac risk factors
Previous infective endocarditis
Valvular heart disease
Prosthetic heart valve
Central venous or arterial catheter
Transvenous cardiac implantable electronic device
Congenital heart disease
Non-cardiac risk factors
Central venous catheter
People who inject drugs
Immunosuppression
Recent dental or surgical procedures
Recent hospitalization
Haemodialysis

Recommendations for the role of echocardiography in infective endocarditis

A. Diagnosis

TTE as the first-line imaging modality in suspected IE	I B
TOE in all patients with clinical suspicion of IE and a negative or non-diagnostic TTE	I B
TOE in patients with clinical suspicion of IE, when a prosthetic heart valve or an intracardiac device is present	I B
Repeating TTE and/or TOE within 5–7 days in cases of initially negative or inconclusive examination when clinical suspicion of IE remains high.	I C
TOE in patients with suspected IE, even in cases with positive TTE, except in isolated right-sided native valve IE with good quality TTE examination and unequivocal echocardiographic findings.	I C
Performing an echocardiography in <i>S. aureus</i> , <i>E. faecalis</i> , and some <i>Streptococcus</i> spp. bacteraemia	IIa B

B. Follow-under medical therapy

Repeating TTE and/or TOE as soon as a new complication of IE is suspected (new murmur, embolism, persisting fever and bacteraemia, HF, abscess, AVB)	I B
TOE when patient is stable before switching from intravenous to oral antibiotic therapy	I B
During follow-up of uncomplicated IE, repeat TTE and/ or TOE to detect new silent complications. The timing of repeat TTE and/or TOE depends on the initial findings, type of microorganism, and initial response to therapy	IIa B

C. Intra-operative echocardiography

Intra-operative echocardiography in all cases of IE requiring surgery I C

D. Following completion of therapy

TTE and/or TOE at completion of antibiotic therapy for evaluation of cardiac and valve morphology and function in patients with IE who did not undergo heart valve surgery I C

AVB, atrioventricular block; HF, heart failure; IE, infective endocarditis; PVE, prosthetic valve endocarditis; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography.

Recommendations for the role of computed tomography, nuclear imaging, and magnetic resonance in infective endocarditis

Cardiac CTA in patients with possible NVE to detect valvular lesions and confirm the diagnosis of IE I B

[18F]FDG-PET/CT(A) and cardiac CTA in possible PVE to detect valvular lesions and confirm the diagnosis of IE I B

Cardiac CTA in NVE and PVE to diagnose paravalvular or periprosthetic complications if echocardiography is inconclusive I B

Brain and whole-body imaging (CT, [18F]FDG-PET/ CT, and/or MRI) in symptomatic patients (suggesting septic embolic complications) with NVE and PVE to detect peripheral lesions or add minor diagnostic criteria I B

WBC SPECT/CT in patients with high clinical suspicion of PVE when echocardiography is negative or inconclusive and when PET/CT is unavailable IIa C

[18F]FDG-PET/CT(A) in possible CIED-related IE to confirm the diagnosis of IE IIb B

Brain and whole-body imaging (CT, [18F]FDG-PET/ CT, and MRI) in NVE and PVE for screening of peripheral lesions in asymptomatic patients IIb B

[18F]FDG-PET/CT, ¹⁸F-fluorodeoxyglucose positron emission tomography/computed tomography; CAD, coronary artery disease; CT, computed tomography; CTA, computed tomography angiography; IE, infective endocarditis; MRI, magnetic resonance imaging; NVE, native valve endocarditis; PVE, prosthetic valve endocarditis; WBC SPECT/CT, white blood cell single photon emission tomography/computed tomography.

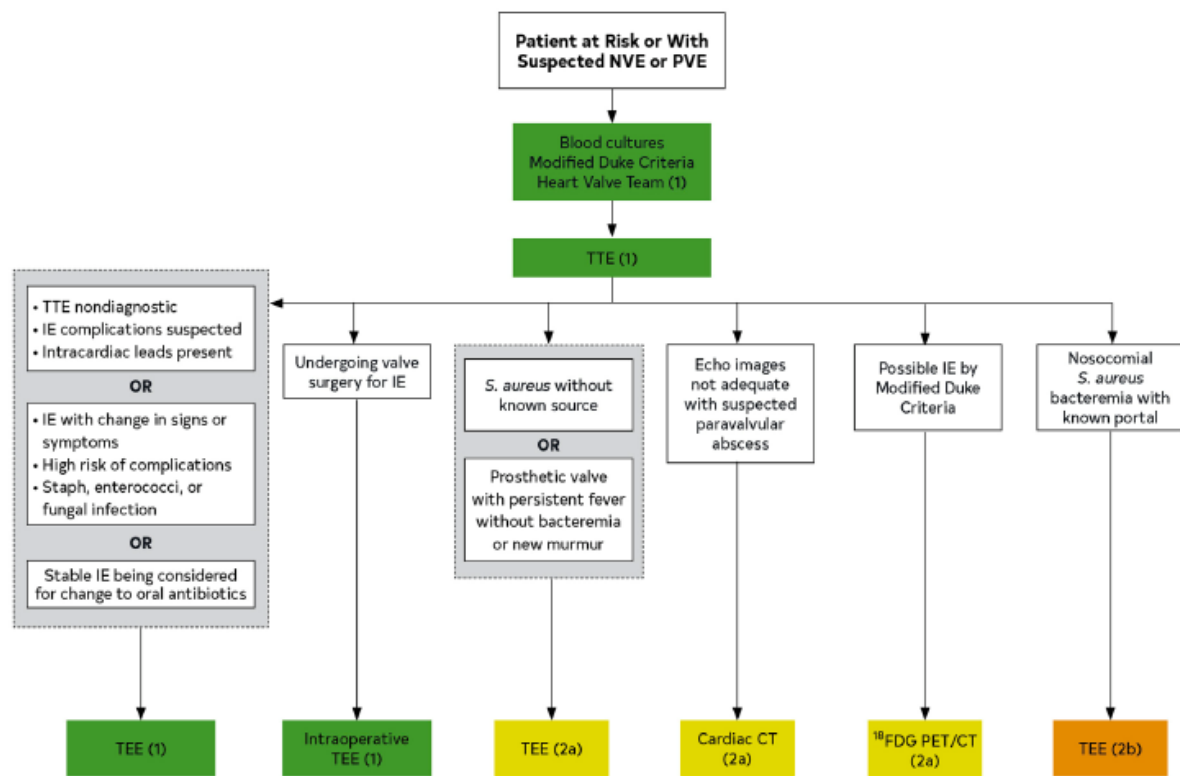


Figure 4. ACC/AHA 2020 GL on VHD. Diagnosis of IE

CT indicates computed tomography; IE, infective endocarditis; 18FDG, 18F-fluorodeoxyglucose; NVE, native valve endocarditis; PET, positron emission tomography; PVE, prosthetic valve endocarditis; TEE, transesophageal echocardiography; and TTE, transthoracic echocardiography.

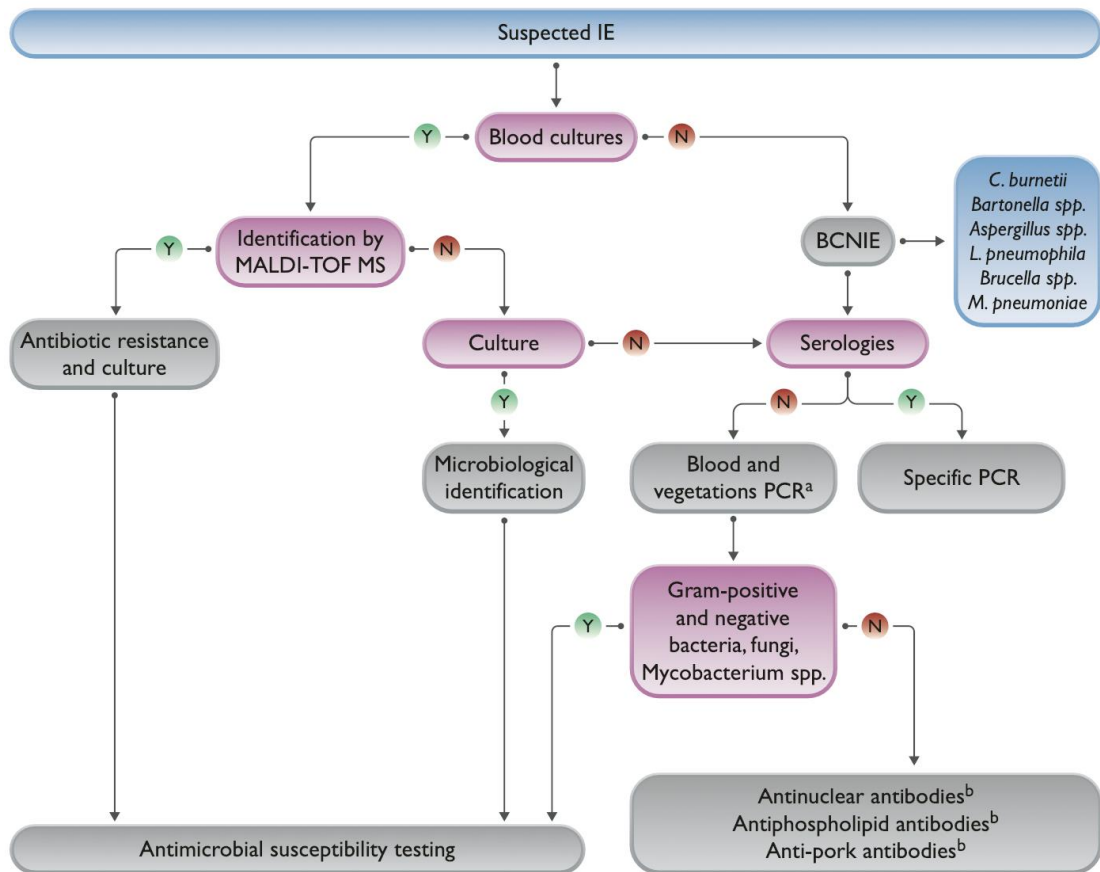


Figure 5. ES 2023 GL on endocarditis. Microbiological diagnostic algorithm in culture-positive and culture-negative infective endocarditis.

BCNIE, blood cultures negative endocarditis; IE, infective endocarditis; MALDI-TOF MS, matrix-assisted laser desorption ionization time-of-flight mass spectrometry; PCR, polymerase chain reaction.

^aQualified microbiological laboratory. ^bImmunological laboratory.

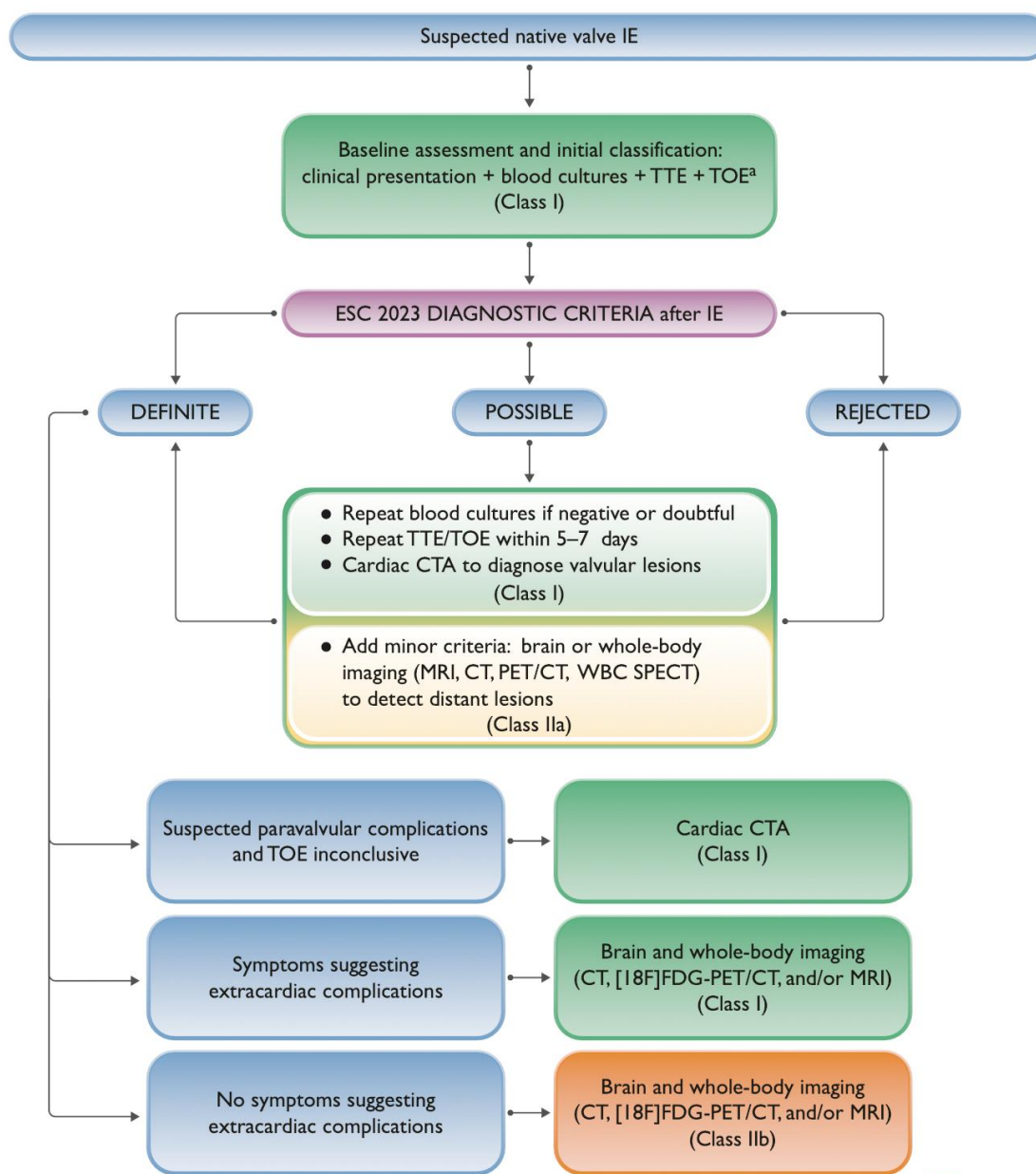


Figure 6. European Society of Cardiology 2023 algorithm for diagnosis of native valve infective endocarditis.

[18F]FDG, ¹⁸F-fluorodeoxyglucose; CT, computed tomography; CTA, computed tomography angiography; ESC, European Society of Cardiology; IE, infective endocarditis; MRI, magnetic resonance imaging; NVE, native valve endocarditis; PET, positron emission tomography; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography; WBC SPECT, white blood cell single photon emission tomography.

^aTOE for diagnosis and to detect perivalvular complications in all cases (unless right-sided NVE when TTE is good quality and conclusive).

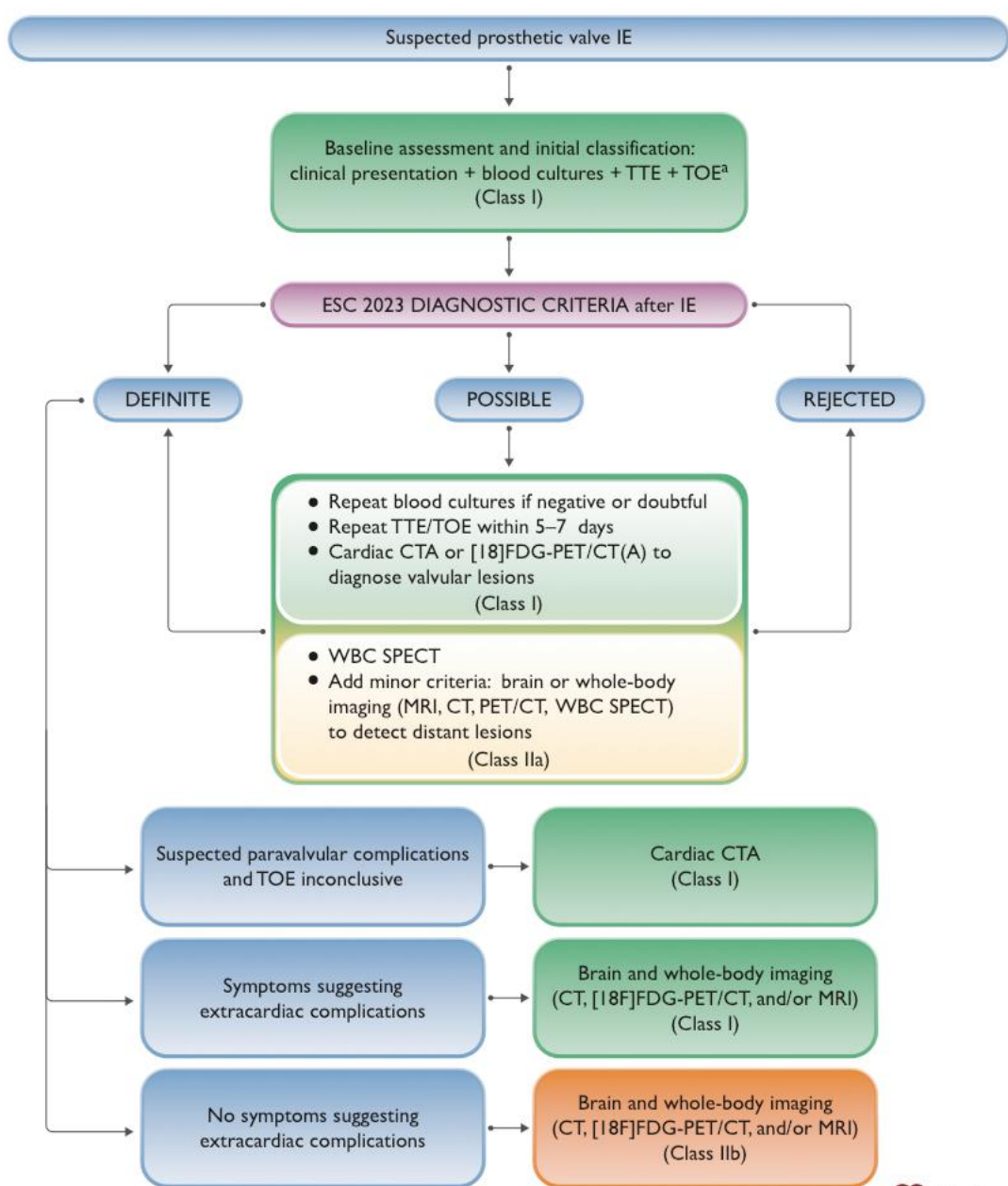


Figure 7. European Society of Cardiology 2023 algorithm for diagnosis of prosthetic valve infective endocarditis.

[18F]FDG, ¹⁸F-fluorodeoxyglucose; CT, computed tomography; CTA, computed tomography angiography; ESC, European Society of Cardiology; IE, infective endocarditis; MRI, magnetic resonance imaging; PET, positron emission tomography; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography; WBC SPECT, white blood cell single photon emission tomography.

^aTOE for diagnosis and to detect perivalvular complications in all cases (unless right-sided NVE when TTE is good quality and conclusive).

Table 5. AHA 2025 Statement on IE. Epidemiological clues that may be helpful in defining the etiological diagnosis of culture-negative endocarditis.

Epidemiological Feature	Common Microorganism
IDU	<i>S aureus</i> , including community-acquired oxacillin-resistant strains Coagulase-negative staphylococci β -Hemolytic streptococci Fungi Aerobic Gram-negative bacilli, including <i>Pseudomonas aeruginosa</i> Polymicrobial
Indwelling cardiovascular medical devices	<i>S aureus</i> Coagulase-negative staphylococci Fungi Aerobic Gram-negative bacilli <i>Corynebacterium</i> sp
Genitourinary disorders, infection, and manipulation, including pregnancy, delivery, and abortion	<i>Enterococcus</i> sp Group B streptococci (<i>S agalactiae</i>) <i>Listeria monocytogenes</i> Aerobic Gram-negative bacilli <i>Neisseria gonorrhoeae</i>
Chronic skin disorders, including recurrent infections	<i>S aureus</i> β -Hemolytic streptococci
Poor dental health, dental procedures	VGS Nutritionally variant streptococci <i>Abiotrophia defectiva</i> <i>Granulicatella</i> sp <i>Gemella</i> sp HACEK organisms
Alcoholism, cirrhosis	<i>Bartonella</i> sp <i>Aeromonas</i> sp <i>Listeria</i> sp <i>S pneumoniae</i> β -Hemolytic streptococci
Burn	<i>S aureus</i> Aerobic Gram-negative bacilli, including <i>P aeruginosa</i> Fungi
Diabetes mellitus	<i>S aureus</i> β -Hemolytic streptococci <i>S pneumoniae</i>
Early (≤ 1 y) prosthetic valve placement	Coagulase-negative staphylococci <i>S aureus</i> Aerobic Gram-negative bacilli Fungi <i>Corynebacterium</i> sp <i>Legionella</i> sp
Late (> 1 y) prosthetic valve placement	Coagulase-negative staphylococci <i>S aureus</i> Viridans group streptococci <i>Enterococcus</i> species Fungi <i>Corynebacterium</i> sp
Dog or cat exposure	<i>Bartonella</i> sp <i>Pasteurella</i> sp <i>Capnocytophaga</i> sp
Contact with contaminated milk or infected farm animals	<i>Brucella</i> sp <i>Coxiella burnetii</i> <i>Erysipelothrix</i> sp
Homeless, body lice	<i>Bartonella</i> sp
AIDS	<i>Salmonella</i> sp <i>S pneumoniae</i> <i>S aureus</i>
Pneumonia, meningitis solid organ transplantation	<i>S pneumoniae</i> <i>S aureus</i> <i>Aspergillus fumigatus</i> <i>Enterococcus</i> sp <i>Candida</i> sp
Gastrointestinal lesions	<i>S gallolyticus</i> (bovis) <i>Enterococcus</i> sp <i>Clostridium septicum</i>

HACEK indicates Haemophilus species, Aggregatibacter species, Cardiobacterium hominis, Eikenella corrodens, and Kingella species; IDU, injection drug use; and VGS, viridans group streptococci.

Table 6. ESC 2023 GL on endocarditis. Investigation of rare causes of blood culture- negative infective endocarditis

Pathogen	Diagnostic procedures
<i>Brucella</i> spp.	Serology, blood cultures, tissue culture, immunohistology, and 16S rRNA sequencing of tissue
<i>C. burnetii</i>	Serology (IgG phase I >1:800), tissue culture, immunohistology, and 16S rRNA sequencing of tissue
<i>Bartonella</i> spp.	Serology (IgG phase I >1:800), blood cultures, tissue culture, immunohistology, and 16S rRNA sequencing of tissue
<i>T. whipplei</i>	Histology and 16S rRNA sequencing of tissue
<i>Mycoplasma</i> spp.	Serology, tissue culture, immunohistology, and 16S rRNA sequencing of tissue
<i>Legionella</i> spp.	Serology, blood cultures, tissue culture, immunohistology, and 16S rRNA sequencing of tissue
Fungi	Serology, blood cultures, 18S rRNA sequencing of tissue
Mycobacteria (including <i>Mycobacterium chimaera</i>)	Specific blood cultures, 16S rRNA sequencing of tissue

Ig, immunoglobulin; rRNA, ribosomal ribonucleic acid.

Table 7. ACC/AHA 2020 GL on Valvular Heart Disease. Recommendations for Medical Therapy for IE

Antibiotic therapy initiated and continued after blood cultures are obtained, with guidance from antibiotic sensitivity data and the infectious disease experts on the multidisciplinary team (MDT)	I-B-NR
Refer patients with suspected or confirmed IE associated with drug use to addiction treatment for opioid substitution therapy.	I-B-R
In patients with evidence of cerebral embolism or stroke, regardless of the other indications for anticoagulation, temporarily discontinue anticoagulation.	IIa-B-NR
In left-sided IE caused by streptococcus, Enterococcus faecalis, S. aureus, or coagulase-negative staphylococci deemed stable by the MDT after initial intravenous antibiotics, consider a change to oral antibiotic therapy if TEE before the switch to oral therapy shows no paravalvular infection, if frequent and appropriate follow-up can be assured by the care team, and if a follow-up TEE can be performed 1 to 3 days before the completion of the antibiotic course.	IIb-B-R
Temporary discontinuation of VKA in patients receiving VKA anticoagulation at the time of IE diagnosis	IIb-B-NR
Patients with known VHD should not receive antibiotics before blood cultures are obtained for unexplained fever	III-C-LD (Harm)

Table 8. ESC 2023 GL on endocarditis. Recommendations for antibiotic regimens for initial empirical treatment of infective endocarditis (before pathogen identification)^a

In patients with community-acquired NVE or late PVE (≥12 months post-surgery), ampicillin in combination with ceftriaxone or with (flu)cloxacillin and gentamicin should be considered using the following doses: ²⁵⁵		IIa	C
Adult antibiotic dosage and route			
Ampicillin	12 g/day i.v. in 4–6 doses		
Ceftriaxone	4 g/day i.v. or i.m. in 2 doses		
(Flu)cloxacillin	12 g/day i.v. in 4–6 doses		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 1 dose		
Paediatric antibiotic dosage and route			
Ampicillin	300 mg/kg/day i.v. in 4–6 equally divided doses		
Ceftriaxone	100 mg/kg i.v. or i.m. in 1 dose		
(Flu)cloxacillin	200–300 mg/kg/day i.v. in 4–6 equally divided doses		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 3 equally divided doses		
In patients with early PVE (<12 months post-surgery) or nosocomial and non-nosocomial healthcare-associated IE, vancomycin or daptomycin combined with gentamicin and rifampin may be considered using the following doses: ³⁹⁵		IIb	C
Adult antibiotic dosage and route			
Vancomycin ^e	30 mg/kg/day i.v. in 2 doses		
Daptomycin	10 mg/kg/day i.v. in 1 dose		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 1 dose		
Rifampin	900–1200 mg i.v. or orally in 2 or 3 doses		
Paediatric antibiotic dosage and route			
Vancomycin ^e	40 mg/kg/day i.v. in 2–3 equally divided doses		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 3 equally divided doses		
Rifampin	20 mg/kg/day i.v. or orally in 3 equally divided doses		
Allergy to beta-lactams			
In patients with community-acquired NVE or late PVE (≥12 months post-surgery) who are allergic to penicillin, cefazolin, or vancomycin in combination with gentamicin may be considered using the following doses:		IIb	C
Adult antibiotic dosage and route			
Cefazolin	6 g/day i.v. in 3 doses		
Vancomycin ^e	30 mg/kg/day i.v. in 2 doses		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 1 dose		
Cefazolin	6 g/day i.v. in 3 doses		
Vancomycin ^e	40 mg/kg/day i.v. in 2–3 equally divided doses		
Gentamicin ^d	3 mg/kg/day i.v. or i.m. in 3 equally divided doses		

BCNIE, blood culture-negative infective endocarditis; IE, infective endocarditis; i.m., intramuscular; i.v., intravenous; NVE, native valve endocarditis; PVE, prosthetic valve endocarditis.

^aIf initial blood cultures are negative and there is no clinical response, BCNIE aetiology and the extension of the antibiotic spectrum to blood culture-negative pathogens should be considered. If cardiac surgery is indicated, molecular diagnosis can be performed.

^dMaximum doses 240mg/day. High doses are associated with increased risk of nephrotoxicity. Renal function and serum gentamicin concentrations should be monitored once a week. When given in a single daily dose, pre-dose (trough) concentrations should be <1 mg/L and post-dose (peak; 1 h after injection) serum concentrations should be ~10–12 mg/L.

^eSerum vancomycin concentrations should achieve 10–15 mg/L at pre-dose (trough) level, although some experts recommend to increase the dose of vancomycin to 45–60 mg/kg/day i.v. in 2 or 3 divided doses to reach serum trough vancomycin levels (C_{min}) of 15–20 mg/L as in staphylococcal endocarditis. However, vancomycin dose should not exceed 2 g/d unless serum levels are monitored and can be adjusted to obtain a peak plasma concentration of 30–45 µg/mL 1 h after completion of the i.v. infusion of the antibiotic.

Table 9. ESC 2023 GL on endocarditis. Antibiotic treatment of blood culture- negative infective endocarditis

Pathogens	Proposed therapy ^a	Treatment outcome
<i>Brucella</i> spp.	Doxycycline (200 mg/24 h) plus cotrimoxazole (960 mg/12 h) plus rifampin (300–600 mg/24 h) for ≥3–6 months ^b orally	Treatment success defined as an antibody titre <1:60. Some authors recommend adding gentamicin for the first 3 weeks
<i>C. burnetii</i> (Q fever agent)	Doxycycline (200 mg/24 h) plus hydroxychloroquine (200–600 mg/24 h) ^c orally (>18 months of treatment)	Treatment success defined as anti-phase I IgG titre <1:400, and IgA and IgM titres <1:50
<i>Bartonella</i> spp. ^d	Doxycycline 100 mg/12 h orally for 4 weeks plus gentamicin (3 mg/24 h) i.v. for 2 weeks	Treatment success expected in ≥90%
<i>Legionella</i> spp.	Levofloxacin (500 mg/12 h) i.v. or orally for ≥6 weeks or clarithromycin (500 mg/12 h) i.v. for 2 weeks, then orally for 4 weeks plus rifampin (300–1200 mg/24 h)	Optimal treatment unknown
<i>Mycoplasma</i> spp.	Levofloxacin (500 mg/12 h) i.v. or orally for ≥6 months ^e	Optimal treatment unknown
<i>T. whipplei</i> (Whipple's disease agent) ^f	Doxycycline (200 mg/24 h) plus hydroxychloroquine (200–600 mg/24 h) ^c orally for ≥18 months	Long-term treatment, optimal duration unknown

IE, infective endocarditis; Ig, immunoglobulin; i.v., intravenous.

^aOwing to the lack of large series, the optimal duration of treatment of IE due to these pathogens is unknown. The presented durations are based on selected case reports. Consultation with an infectious disease specialist is recommended.

^bAddition of streptomycin (15 mg/kg/24 h in 2 doses) for the first few weeks is optional.

^cDoxycycline plus hydroxychloroquine (with monitoring of serum hydroxychloroquine levels) is significantly superior to doxycycline.

^dSeveral therapeutic regimens have been reported, including ampicillin or amoxicillin, (12 g/ 24 h i.v.) or cephalosporins (ceftriaxone 2 g/24 h i.v.) combined with aminoglycosides (gentamicin or netilmicin). Dosages are as for streptococcal and enterococcal IE.

^eNewer fluoroquinolones (levofloxacin, moxifloxacin) are more potent than ciprofloxacin against intracellular pathogens such as *Mycoplasma* spp., *Legionella* spp., and *Chlamydia* spp.

^fTreatment of Whipple's IE remains highly empirical. In the case of central nervous system involvement, sulfadiazine 1.5 g/6 h orally must be added to doxycycline. An alternative therapy is ceftriaxone (2 g/24 h i.v.) for 2–4 weeks or penicillin G (2 million U/4 h) and streptomycin (1 g/24 h) i.v. for 2–4 weeks followed by cotrimoxazole (800 mg/12 h) orally. Trimethoprim is not active against *T. whipplei*. Successes have been reported with long-term therapy (1 year).

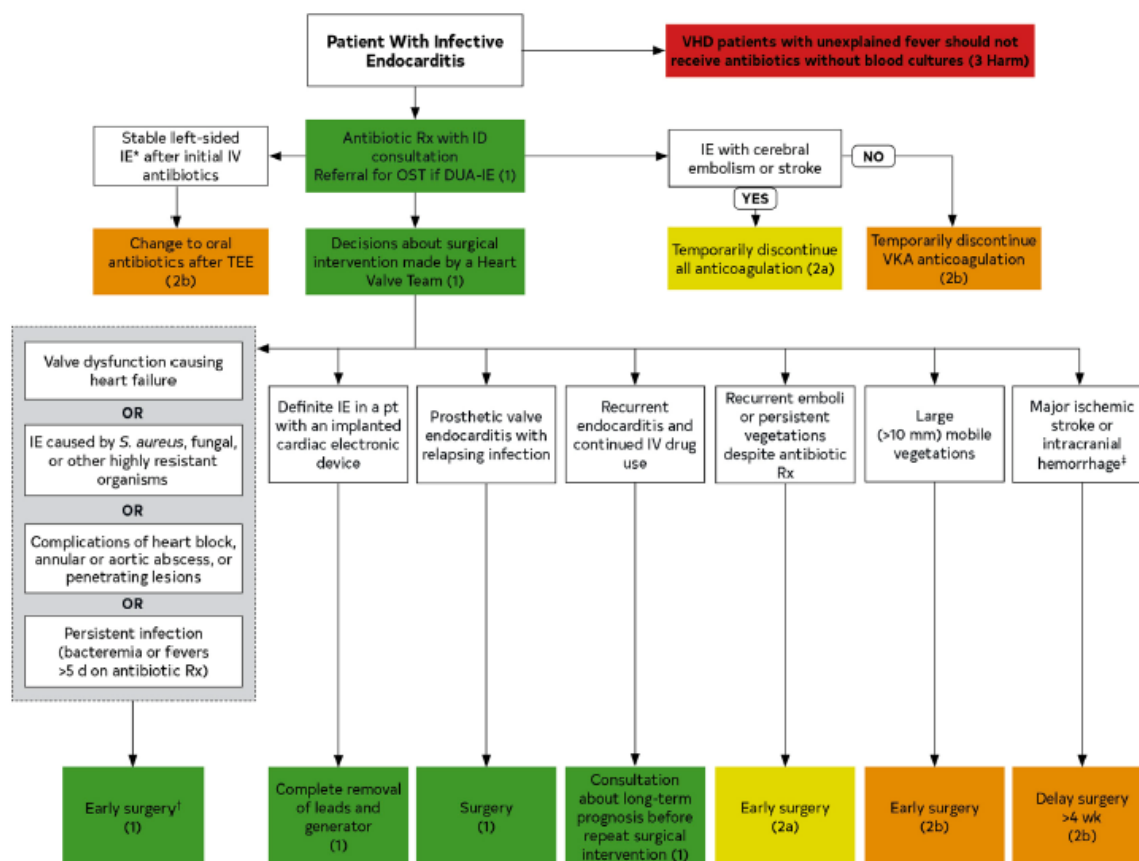


Figure 8. ACC/AHA 2020 GL on VHD. Endocarditis treatment

*IE caused by streptococcus, *E. faecalis*, *S. aureus*, or coagulase-negative staphylococci deemed stable by the Heart Valve Team.

†Early surgery defined as during initial hospital course and before completion of a full course of appropriate antibiotics.

‡In patients with an indication for surgery and a stroke but no evidence of intracranial haemorrhage or extensive neurological damage, surgery without delay may be considered.

DUA indicates drug use associated endocarditis; HF, heart failure; ICD, implantable cardioverter-defibrillator; ID, infectious disease; IE, infective endocarditis; IV, intravenous; NVE, native valve endocarditis; OST, opioid substitution treatment; pt, patient; PVE, prosthetic valve endocarditis; Rx, therapy; *S. aureus*, *Staphylococcus aureus*; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography; VHD, valvular heart disease; and VKA, vitamin K antagonist.

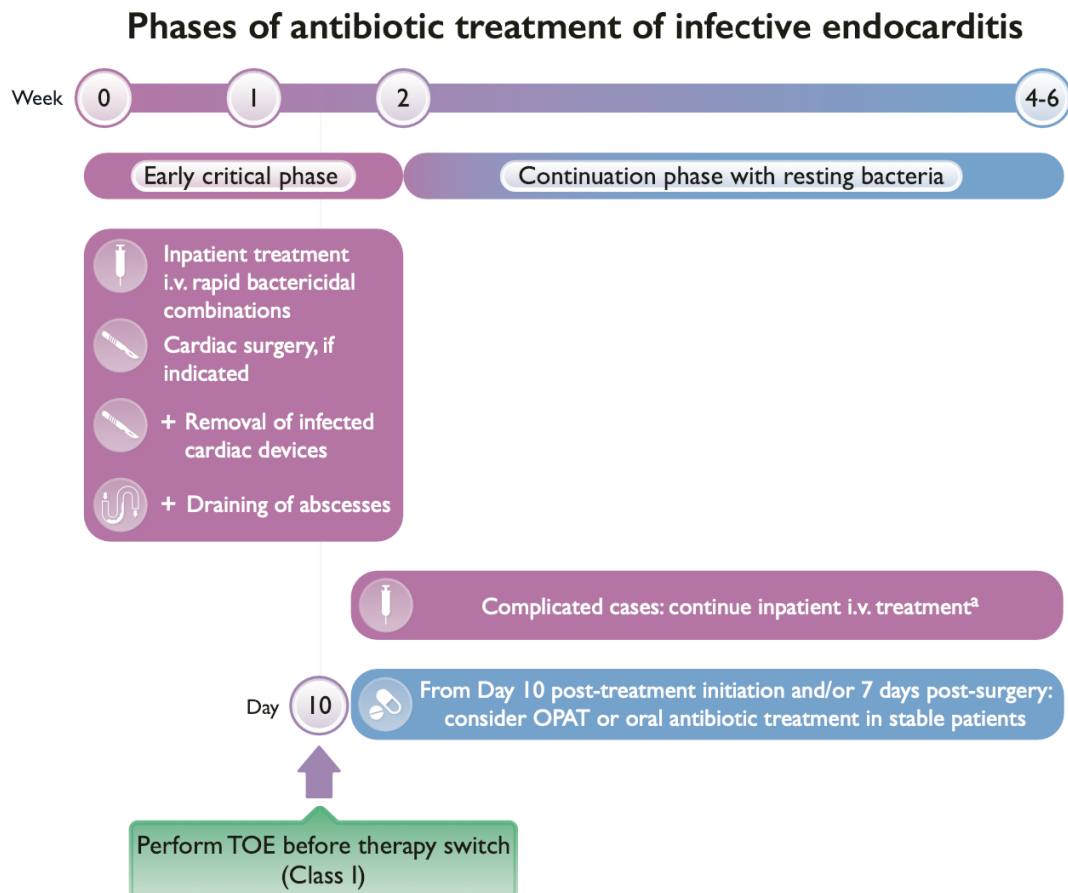


Figure 9. ES 2023 GL on endocarditis Phases of antibiotic treatment for infective endocarditis in relation to outpatient parenteral antibiotic therapy and partial oral endocarditis treatment.

i.v., intravenous; OPAT, outpatient parenteral antibiotic treatment; TOE, transoesophageal echocardiography.

^aCriteria for switching to OPAT or partial oral treatment of endocarditis are given in the [Supplementary data online](#)

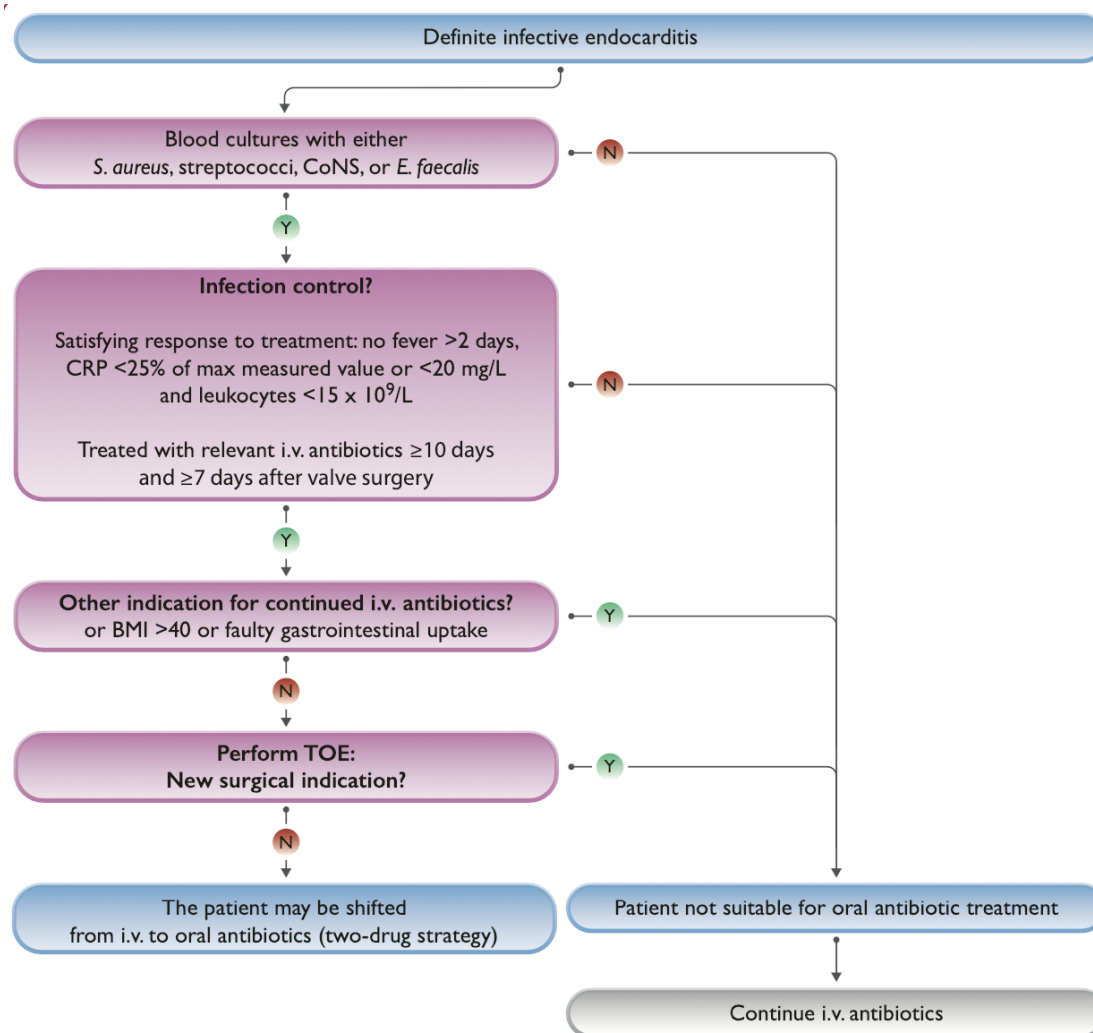


Figure 10. ES 2023 GL on endocarditis Flowchart to assess clinical stability based on the Partial Oral Treatment of Endocarditis trial.
BMI, body mass index; CoNS, coagulase-negative staphylococci; CRP, C-reactive protein; i.v., intravenous; TOE, transoesophageal echocardiography.

Table 10. ESC 2023 GL on endocarditis. Recommendations for outpatient antibiotic treatment of infective endocarditis

Outpatient parenteral or oral antibiotic treatment in patients with left-sided IE caused by <i>Streptococcus</i> spp., <i>E. faecalis</i> , <i>S. aureus</i> , or CoNS who were receiving appropriate i.v. antibiotic treatment for at least 10 days (or at least 7 days after cardiac surgery), are clinically stable, and who do not show signs of abscess formation or valve abnormalities requiring surgery on TOE	IIa A
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Outpatient parenteral antibiotic treatment is not recommended in patients with IE caused by highly difficult-to-treat microorganisms, ^a liver cirrhosis (Child-Pugh B or C), severe cerebral nervous system emboli, untreated large extracardiac abscesses, heart valve complications, or other severe conditions requiring surgery, severe post-surgical complications, and PWID-related IE.	III C
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CoNS, coagulase-negative staphylococci; IE, infective endocarditis; i.v., intravenous; TOE, transoesophageal echocardiography; PWID, people who inject drugs.

^aHighly difficult-to-treat microorganism: microorganisms requiring i.v. antibiotic combinations that cannot be administered by means of outpatient parenteral antibiotic treatment or that require strict monitoring of drug levels either in blood or in other fluids owing to their potential toxicity or narrow therapeutic index (e.g. MRSA or vancomycin-resistant enterococci also resistant to alternative drugs such as daptomycin and linezolid, multidrug- or extensively drug-resistant Gram-negative rods, highly penicillin-resistant oral streptococci, fungi other than *Candida*).

Table 11. ACC/AHA 2020 GL on Valvular Heart Disease. Recommendations for Intervention for IE

Decisions about the timing of surgical intervention should be made by a Heart Valve Team	I-B-NR
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Early surgery (during initial hospitalization and before completion of a full therapeutic course of antibiotics), in:

Valve dysfunction resulting in symptoms of HF	I-B-NR
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Left-sided IE caused by <i>S. aureus</i> , a fungal organism, or other highly resistant organisms	I-B-NR
---	--------

IE complicated by heart block, annular or aortic abscess, or destructive penetrating lesions	I-B-NR
--	--------

IE and evidence of persistent infection as manifested by persistent bacteremia or Fevers lasting >5 days after onset of appropriate antimicrobial therapy	I-B-NR
---	--------

IE presenting with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy	IIa-B-NR
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Native left-sided valve endocarditis who exhibit mobile vegetations >10 mm in length (with or without clinical evidence of embolic phenomenon)	IIb-B-NR
--	----------

In all patients with definite endocarditis and an implanted cardiac electronic device, complete removal of the pacemaker or defibrillator systems, including all leads and the generator	I-B-NR
Surgery for prosthetic valve endocarditis and relapsing infection (defined as recurrence of bacteremia after a complete course of appropriate antibiotics and subsequent negative blood culture results) without other identifiable source of infection	I-C-LD
In recurrent endocarditis and continued intravenous drug use, consultation with addiction medicine to discuss the long-term prognosis for the patient's refraining from actions that risk reinfection before repeat surgical intervention	I-C-LD
Operation without delay in patients with IE and an indication for surgery who have suffered a stroke but have no evidence of intracranial hemorrhage or extensive neurological damage	IIb-B-NR
For IE and major ischemic stroke with extensive neurological damage or intracranial hemorrhage, if the patient is hemodynamically stable, delay valve surgery for at least 4 weeks	IIb-B-NR

Table 12. ESC 2023 GL on endocarditis. Surgery for endocarditis

Recommendations for the main indications of surgery in infective endocarditis (native valve endocarditis and prosthetic valve endocarditis)

Heart Failure

Emergency ^a surgery in aortic or mitral NVE or PVE with severe acute regurgitation, obstruction, or fistula causing refractory pulmonary oedema or cardiogenic shock.	I B
Urgent ^a surgery in aortic or mitral NVE or PVE with severe acute regurgitation or obstruction causing symptoms of HF or echocardiographic signs of poor haemodynamic tolerance	I B

Uncontrolled infection

Urgent ^a surgery in locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation, prosthetic dehiscence, new AVB	I B
Urgent ^a or non-urgent surgery in IE caused by fungi or multiresistant organisms according to the haemodynamic condition of the patient.	I C
Urgent ^a surgery in IE with persistently positive blood cultures >1 week or persistent sepsis despite appropriate antibiotic therapy and adequate control of metastatic foci.	IIa B
Urgent ^a surgery in PVE caused by <i>S. aureus</i> or non-HACEK Gram-negative bacteria.	IIa C

Prevention of embolism

Urgent ^a surgery in aortic or mitral NVE or PVE with persistent vegetations ≥ 10 mm after one or more embolic episodes despite appropriate antibiotic therap	I B
Urgent ^a surgery in IE with vegetation ≥ 10 mm and other indications for surgery	I C

Urgent ^a surgery in aortic or mitral IE with vegetation ≥ 10 mm and without severe valve dysfunction or without clinical evidence of embolism and low surgical risk	I Ib B
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AVB, atrioventricular block; HACEK, *Haemophilus*, *Aggregatibacter*, *Cardiobacterium*, *Eikenella*, *Kingella*; HF, heart failure; IE, infective endocarditis; NVE, native valve endocarditis; PVE, prosthetic valve endocarditis.

^aEmergency, within 24 h. Urgent, within 3–5 days. Non-urgent, within same hospital admission.

Recommendations for pre-operative coronary anatomy assessment in patients requiring surgery for infective endocarditis

A high-resolution multislice coronary CTA in haemodynamically stable patients with aortic valve vegetations who require cardiac surgery and are high risk for CAD	I B
Invasive coronary angiography in patients requiring heart surgery who are high risk for CAD, in the absence of aortic valve vegetations.	I C
In emergency situations, valvular surgery without pre-operative coronary anatomy assessment regardless of CAD risk	IIa C
Invasive coronary angiography despite the presence of aortic valve vegetations in selected patients with known CAD or at high risk of significant obstructive CAD	IIb C

CAD, coronary artery disease, CTA, computed tomography angiography.

Features favouring a non-mechanical valve substitute in the setting of surgery for acute infective endocarditis

Early surgery after a recent ischaemic stroke
Evidence of intracranial bleeding
Woman of childbearing age
High likelihood of prolonged mechanical circulatory support
Advanced age or frailty
Poor or unknown medical compliance
Expected complicated and prolonged post-operative course
Patient preference

Indications and timing of cardiac surgery after neurological complications in active infective endocarditis

After a transient ischaemic attack, cardiac surgery, if indicated, without delay.	I B
After a stroke, surgery without any delay in the presence of HF, uncontrolled infection, abscess, or persistent high embolic risk, as long as coma is absent and the presence of cerebral haemorrhage has been excluded by cranial CT or MRI	I B
Following intracranial haemorrhage, delaying cardiac surgery >1 month, if possible,	IIa C

with frequent re-assessment of the patient's clinical condition and imaging

In patients with intracranial haemorrhage and unstable clinical status due to HF, uncontrolled infection or persistent high embolic risk, urgent or emergency surgery weighing the likelihood of a meaningful neurological outcome IIa C

CT, computed tomography; HF, heart failure; MRI, magnetic resonance imaging.

Recommendations for prosthetic valve endocarditis

Surgery is recommended for early prosthetic valve endocarditis (within 6 months of valve surgery) with new valve replacement and complete debridement. I C

Recommendations for the surgical treatment of right-sided infective endocarditis

Surgery in patients with right-sided IE who are receiving appropriate antibiotic therapy for the following scenarios:

Right ventricular dysfunction secondary to acute severe tricuspid regurgitation non-responsive to diuretics I B

Persistent vegetation with respiratory insufficiency requiring ventilatory support after recurrent pulmonary emboli. I B

Large residual tricuspid vegetations (>20 mm) after recurrent septic pulmonary emboli. I C

Patients with simultaneous involvement of left-heart structures. I C

Tricuspid valve repair instead of valve replacement, when possible. IIa B

Surgery in patients with right-sided IE who are receiving appropriate antibiotic therapy and present persistent bacteraemia/sepsis after at least 1 week of appropriate antibiotic therapy. IIa C

Prophylactic placement of an epicardial pacing lead at the time of tricuspid valve surgical procedures. IIa C

Debulking of right intra-atrial septic masses by aspiration in selected patients who are high risk for surgery. IIb C

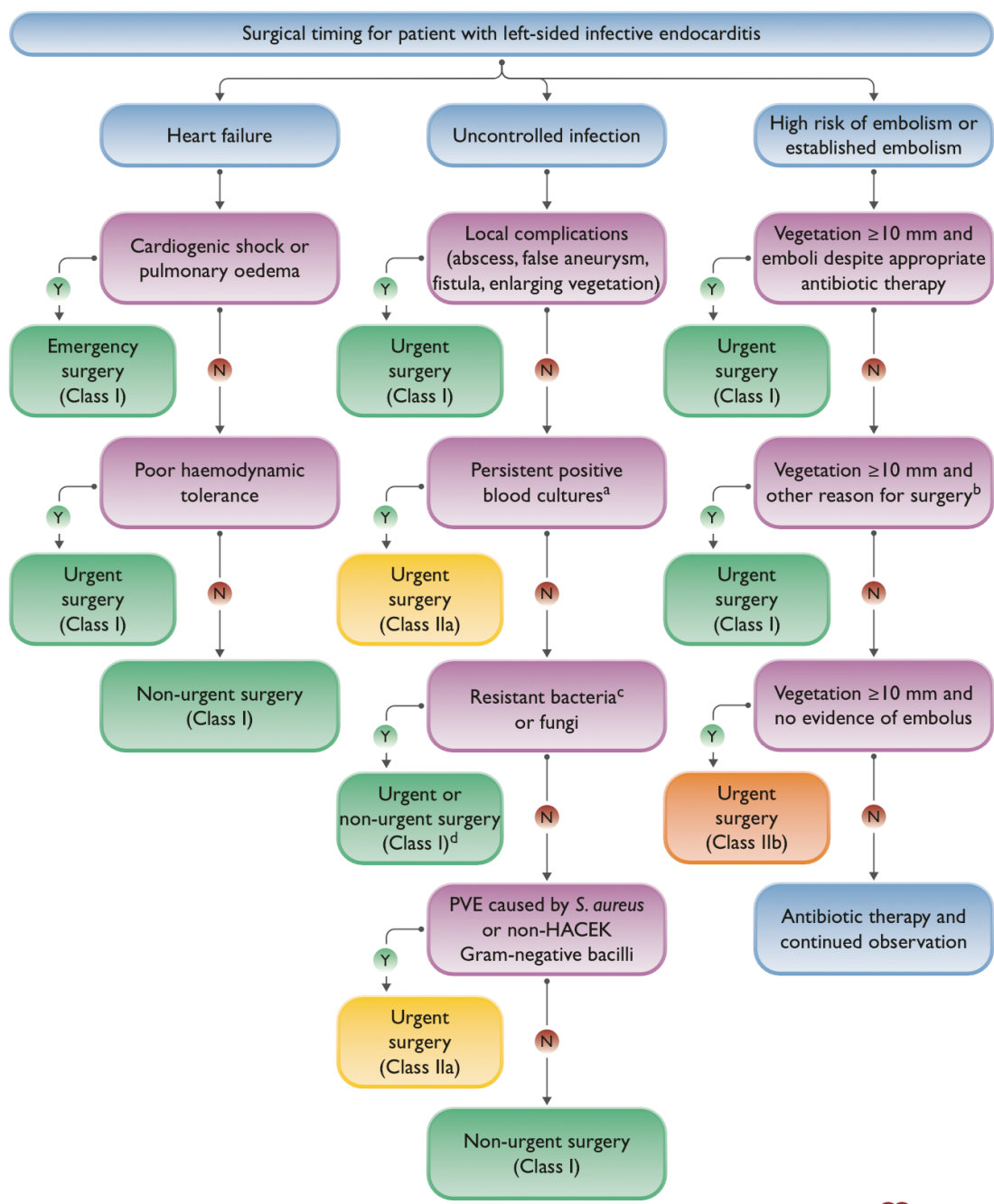


Figure 11. ESC 2023 GL on endocarditis. Proposed surgical timing for infective endocarditis. HACEK, *Haemophilus*, *Aggregatibacter*, *Cardiobacterium*, *Eikenella*, and *Kingella*; PVE, prosthetic valve endocarditis. Surgery timing: emergency, within 24 h. Urgent, within 3–5 days. Non-urgent, within same hospital admission.

^aDespite appropriate antibiotic therapy for >1 week and control of septic embolic foci.

^bE.g. patients with significant valvular dysfunction that is, or is not, a direct result of endocarditis process.

^c*S. aureus* (methicillin resistant and non-methicillin resistant), vancomycin-resistant enterococci, non-HACEK Gram-negative bacteria and fungi.

^dUrgent for *S. aureus*, non-urgent for others.

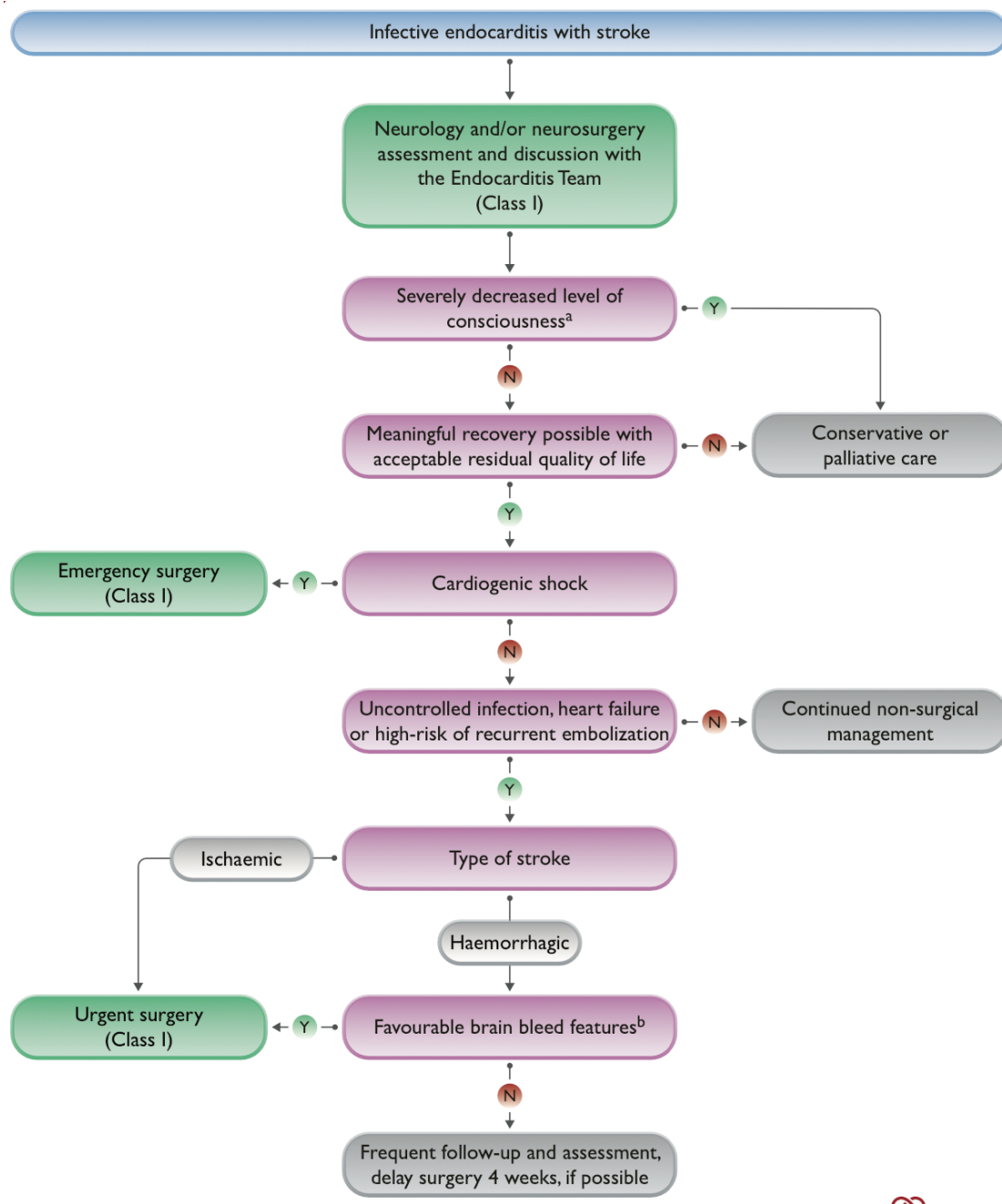


Figure 12. ESC 2023 GL on endocarditis. Surgery for infective endocarditis following stroke.

NIHSS, National Institutes of Health Stroke Scale Score. Surgery timing: emergency, within 24 h. Urgent, within 48–72 h. Non-urgent, within same hospital admission.

^aGlasgow Coma Scale ≤ 4 or NIHSS > 18 .

^bIntracranial haemorrhage volume < 30 mL or NIHSS < 12 .

Table 13. ESC 2023 GL on endocarditis. Recommendations for the use of antithrombotic therapy in infective endocarditis

Interruption of antiplatelet or anticoagulant therapy in the presence of major bleeding (including intracranial haemorrhage)	I C
In patients with intracranial haemorrhage and a mechanical valve, reinstitute unfractionated heparin as soon as possible following multidisciplinary discussion.	IIa C
In the absence of stroke, replacement of oral anticoagulant therapy by unfractionated heparin under close monitoring in cases where indication for surgery is likely (e.g. <i>S. aureus</i> IE).	IIa C
Thrombolytic therapy is not recommended in patients with IE	III C

**Table 14. ESC 2023 GL on endocarditis. Complications of endocarditis
Recommendations for the treatment of neurological complications of infective endocarditis**

Brain CT or MRA in patients with IE and suspected infective cerebral aneurysms.	I B
Neurosurgery or endovascular therapy for large aneurysms, those with continuous growth despite optimal antibiotic therapy, and ruptured intracranial infective cerebral aneurysms.	I C
Invasive angiography if non-invasive techniques are negative and the suspicion of infective aneurysm remains.	IIa B
In embolic stroke, mechanical thrombectomy if the expertise is available in a timely manner	IIb C
Thrombolytic therapy is not recommended in embolic stroke due to IE	III C

CT, computed tomography; IE, infective endocarditis; MRA, magnetic resonance angiography.

Recommendations for pacemaker implantation in patients with complete atrioventricular block and infective endocarditis

Immediate epicardial pacemaker implantation in patients undergoing surgery for valvular IE and complete AVB if one of the following predictors of persistent AVB is present: pre-operative conduction abnormality, <i>S. aureus</i> infection, aortic root abscess, tricuspid valve involvement, or previous valvular surgery	IIa C
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AVB, atrioventricular block; IE, infective endocarditis.

Recommendations for patients with musculoskeletal manifestations of infective endocarditis

MRI or PET/CT in patients with suspected spondylodiscitis and vertebral osteomyelitis complicating IE	I C
TTE/TOE to rule out IE in patients with spondylodiscitis and/or septic arthritis with positive blood cultures for typical IE microorganisms	I C

More than 6-week antibiotic therapy should be considered in patients with osteoarticular IE-related lesions caused by difficult-to-treat microorganisms, such as *S. aureus* or *Candida* spp., and/or complicated with severe vertebral destruction or abscesses. IIa C

IE, infective endocarditis; MRI, magnetic resonance imaging; PET/CT, positron emission tomography/computed tomography, TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography.

Table 15. ESC 2023 GL on endocarditis. Recommendations for post-discharge follow-up

Patient education on the risk of recurrence and preventive measures, with emphasis on dental health, and based on the individual risk profile, is recommended during follow-up.	I C
Addiction treatment for patients following PWID-related IE	I C
Cardiac rehabilitation including physical exercise training in clinically stable patients based on an individual assessment	IIa C
Psychosocial support to be integrated in follow-up care, including screening for anxiety and depression, and referral to relevant psychological treatment	IIb C

IE, infective endocarditis; PWID, persons who inject drugs.

Table 16. ESC 2023 GL on endocarditis. Factors associated with an increased rate of relapse of infective endocarditis

Inadequate antibiotic treatment (i.e. agent, dose, duration)
Resistant microorganisms (i.e. <i>Brucella</i> spp., <i>Legionella</i> spp., <i>Chlamydia</i> spp., <i>Mycoplasma</i> spp., <i>Mycobacterium</i> spp., <i>Bartonella</i> spp., <i>C. Burnetii</i> , fungi)
Infective endocarditis caused by <i>S. aureus</i> and <i>Enterococcus</i> spp.
Polymicrobial infection in people who inject drugs
Periannular extension
Prosthetic valve endocarditis
Persistent metastatic foci of infection (abscesses)
Resistance to conventional antibiotic regimens
Positive valve culture
Persistence of fever at the 7th post-operative day
Chronic kidney disease, especially on dialysis
High-risk behaviour, inability to adhere to medical treatment
Poor oral hygiene

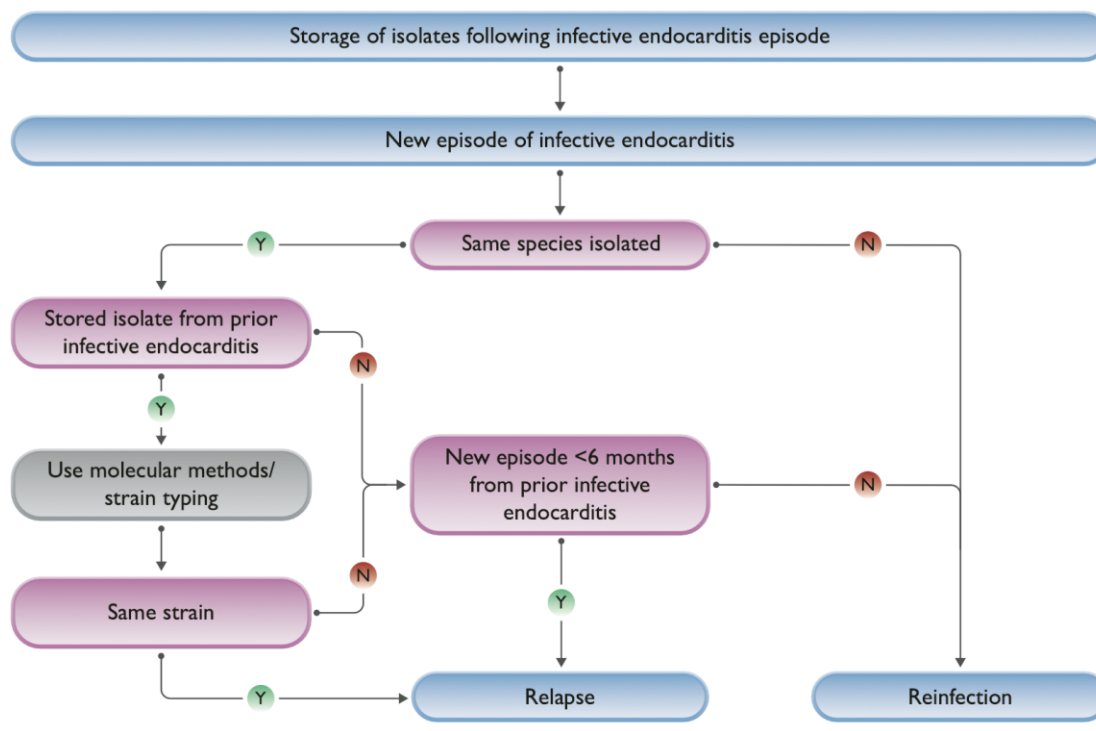


Figure 13. ESC 2023 GL on endocarditis. Algorithm differentiating relapse from reinfection.

Table 17. 2023 ESC GL on endocarditis. Endocarditis Prophylaxis
General prevention measures to be followed in patients at high and intermediate risk of infective endocarditis

Patients should be encouraged to maintain twice daily tooth cleaning and to seek professional dental cleaning and follow-up at least twice yearly for high-risk patients and yearly for others.
Strict cutaneous hygiene, including optimized treatment of chronic skin conditions.
Disinfection of wounds.
Curative antibiotics for any focus of bacterial infection.
No self-medication with antibiotics.
Strict infection control measures for any at-risk procedure.
Discouragement of piercing and tattooing.
Limitation of infusion catheters and invasive procedures, when possible.
Strict adherence to care bundles for central and peripheral cannulae should be performed.

Recommendations for antibiotic prophylaxis in patients with cardiovascular diseases undergoing oro-dental procedures at increased risk for infective endocarditis

General prevention measures in individuals at high and intermediate risk for IE	I C
Antibiotic prophylaxis in patients with:	
Previous IE	I B
Surgically implanted prosthetic valves and with any material used for surgical cardiac valve repair	I C
Transcatheter implanted aortic and pulmonary valvular prostheses	I C
Untreated cyanotic CHD, and patients treated with surgery or transcatheter procedures with post-operative palliative shunts, conduits, or other prostheses. After surgical repair, in the absence of residual defects or valve prostheses, antibiotic prophylaxis is recommended only for the first 6 months after the proced	I C
Ventricular assist devices	I C
Transcatheter mitral and tricuspid valve repair	IIa C
Recipients of heart transplant	IIb C
Antibiotic prophylaxis is not recommended in other patients at low risk for IE	III C

CHD, congenital heart disease; IE, infective endocarditis.

Recommendations for infective endocarditis prevention in high-risk patients

Antibiotic prophylaxis in dental extractions, oral surgery procedures, and procedures requiring manipulation of the gingival or periapical region of the teeth I B

Systemic antibiotic prophylaxis may be considered for high-risk^a patients undergoing an invasive diagnostic or therapeutic procedure of the respiratory, gastrointestinal, genitourinary tract, skin, or musculoskeletal system IIb C

^a This recommendation does not apply to patients with intermediate risk for IE or to the general population.

Recommendations for infective endocarditis prevention in cardiac procedures

Pre-operative screening for nasal carriage of *S. aureus* before elective cardiac surgery or transcatheter valve implantation to treat carriers I A

Peri-operative antibiotic prophylaxis before placement of a CIED I A

Optimal pre-procedural aseptic measures of the site of implantation to prevent CIED infections I B

Periprocedural antibiotic prophylaxis in patients undergoing surgical or transcatheter implantation of a prosthetic valve, intravascular prosthetic, or other foreign material I B

Surgical standard aseptic measures are recommended during the insertion and manipulation of catheters in the catheterization laboratory environment. I C

Elimination of potential sources of sepsis (including of dental origin) ≥ 2 weeks before implantation of a prosthetic valve or other intracardiac or intravascular foreign material, except in urgent procedures IIa C

Antibiotic prophylaxis covering for common skin flora including *Enterococcus* spp. and *S. aureus* before TAVI and other transcatheter valvular procedures IIa C

Systematic skin or nasal decolonization without screening for *S. aureus* is not recommended III C

CIED, cardiac implantable electronic device; TAVI, transcatheter aortic valve implantation.

Education of high-risk patients to prevent infective endocarditis



Figure 14. ESC 2023 GL on endocarditis. Education of high-risk patients to prevent infective endocarditis.

Table 17. ACC/AHA 2020 GL on Valvular Heart Disease. Recommendations for IE Prophylaxis

Before dental procedures that involve manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa in patients with VHD and: IIa-C-LD

- a. Prosthetic cardiac valves, including transcatheter-implanted prostheses and homografts.
- b. Prosthetic material used for cardiac valve repair, such as annuloplasty rings, chords, or clips.
- c. Previous IE.
- d. Unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valvular regurgitation at the site of or adjacent to the site of a prosthetic patch or prosthetic device.
- e. Cardiac transplant with valve regurgitation attributable to a structurally abnormal valve.

In patients with VHD who are at high risk of IE, antibiotic prophylaxis is not recommended for nondental procedures (eg, TEE, esophagogastroduodenoscopy, colonoscopy, or cystoscopy) in the absence of active infection III-B-NR

Table 18. AHA 2020 Statement on Viridans Group Streptococcal Infective Endocarditis. Antibiotic prophylaxis for a Dental Procedure: Underlying Conditions for Which Prophylaxis Is Suggested

Prosthetic cardiac valve or material
Presence of cardiac prosthetic valve
Transcatheter implantation of prosthetic valves
Cardiac valve repair with devices, including annuloplasty, rings, or clips
Left ventricular assist devices or implantable heart
Previous, relapse, or recurrent IE
CHD
Unrepaired cyanotic congenital CHD, including palliative shunts and conduits.
Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by transcatheter during the first 6 mo after the procedure
Repaired CHD with residual defects at the site of or adjacent to the site of a prosthetic patch or prosthetic device
Surgical or transcatheter pulmonary artery valve or conduit placement such as Melody valve and Contegra conduit
Cardiac transplant recipients who develop cardiac valvulopathy
AP for a dental procedure not suggested
Implantable electronic devices such as a pacemaker or similar devices
Septal defect closure devices when complete closure is achieved
Peripheral vascular grafts and patches, including those used for hemodialysis
Coronary artery stents or other vascular stents
CNS ventriculoatrial shunts
Vena cava filters
Pledgets

AP indicates antibiotic prophylaxis; CHD, congenital heart disease; CNS, central nervous system; and IE, infective endocarditis.

Table 19. AHA 2020 Statement on Viridans Group Streptococcal Infective Endocarditis. Dental Procedures and Antibiotic Prophylaxis

AP suggested
All dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa
AP not suggested
Anesthetic injections through noninfected tissue, taking dental radiographs, placement of removable prosthodontic or orthodontic appliances, adjustment of orthodontic appliances, placement of orthodontic brackets, shedding of primary teeth, and bleeding from trauma to the lips or oral mucosa

AP indicates antibiotic prophylaxis

Prevention of Viridans Group Streptococcal Infective Endocarditis: A Scientific Statement From the American Heart Association. *Circulation*. 2021:CIR0000000000000969.

Table 20. Regimens before dental procedures when endocarditis prophylaxis is indicated.

2023 ESC GL on endocarditis. Prophylactic antibiotic regime for high-risk dental procedures

Situation	Antibiotic	Single-dose 30–60 min before procedure	
		Adults	Children
No allergy to penicillin or ampicillin	Amoxicillin	2 g orally	50 mg/kg orally
	Ampicillin	2 g i.m. or i.v.	50 mg/kg i.v. or i.m.
	Cefazolin or ceftriaxone	1 g i.m. or i.v.	50 mg/kg i.v. or i.m.
Allergy to penicillin or ampicillin	Cephalexin ^{a,b}	2 g orally	50 mg/kg orally
	Azithromycin or clarithromycin	500 mg orally	15 mg/kg orally
	Doxycycline	100 mg orally	<45 kg, 2.2 mg/kg orally >45 kg, 100 mg orally
	Cefazolin or ceftriaxone ^b	1 g i.m. or i.v.	50 mg/kg i.v. or i.m.

i.m., intramuscular; i.v., intravenous.

^a Or other first- or second-generation oral cephalosporin in equivalent adult or paediatric dosing.

^b Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticarial with penicillin or ampicillin.

AHA 2020 Statement on Viridans Group Streptococcal Infective Endocarditis. Antibiotic Regimens for a Dental Procedure Regimen: Single Dose 30 to 60 Minutes Before Procedure.

Situation	Agent	Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin OR cefazolin or ceftriaxone	2 g IM or IV	50 mg/kg IM or IV
		1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillin or ampicillin—oral	Cephalexin* OR azithromycin or clarithromycin OR doxycycline	2 g	50 mg/kg
		500 mg 100 mg	15 mg/kg <45 kg, 4.4 mg/kg >45 kg, 100 mg
Allergic to penicillin or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone†	1 g IM or IV	50 mg/kg IM or IV

Clindamycin is no longer recommended for antibiotic prophylaxis for a dental procedure.

IM indicates intramuscular; and IV, intravenous.

*Or other first- or second-generation oral cephalosporin in equivalent adult or pediatric dosing.

†Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticarial with penicillin or ampicillin.