

The Importance of Echocardiography in Specific
Settings:

**In the study of Endocarditis in
Implanted Cardiac Devices**

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Disclosures

- No conflicts of interest

Overview

- Role of echocardiography in evaluation and management of patients with device related infection / endocarditis

Major Criteria for IE Diagnosis

Major criteria

1. Blood cultures positive for IE

- a. Typical microorganisms consistent with IE from 2 separate blood cultures:
 - *Viridans streptococci*, *Streptococcus gallolyticus* (*Streptococcus bovis*), *HACEK* group, *Staphylococcus aureus*; or
 - Community-acquired enterococci, in the absence of a primary focus; or
- b. Microorganisms consistent with IE from persistently positive blood cultures:
 - ≥ 2 positive blood cultures of blood samples drawn >12 h apart; or
 - All of 3 or a majority of ≥ 4 separate cultures of blood (with first and last samples drawn ≥ 1 h apart); or
- c. Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titre $>1:800$

2. Imaging positive for IE

- a. Echocardiogram positive for IE:
 - Vegetation;
 - Abscess, pseudoaneurysm, intracardiac fistula;
 - Valvular perforation or aneurysm;
 - New partial dehiscence of prosthetic valve.
- b. Abnormal activity around the site of prosthetic valve implantation detected by ^{18}F -FDG PET/CT (only if the prosthesis was implanted for >3 months) or radiolabelled leukocytes SPECT/CT.
- c. Definite paravalvular lesions by cardiac CT.

Minor Criteria for IE Diagnosis

Minor criteria

1. Predisposition such as predisposing heart condition, or injection drug use.
2. Fever defined as temperature $>38^{\circ}\text{C}$.
3. Vascular phenomena (including those detected by imaging only): major arterial emboli, septic pulmonary infarcts, infectious (mycotic) aneurysm, intracranial haemorrhage, conjunctival haemorrhages, and Janeway's lesions.
4. Immunological phenomena: glomerulonephritis, Osler's nodes, Roth's spots, and rheumatoid factor.
5. 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.

Definition of infective endocarditis 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

Echocardiography in Infective Endocarditis

- Diagnosis / Prognosis / Risk of embolization
- Follow up during treatment
- Identify surgical indications
- Intraoperative reevaluation
- Follow up after treatment

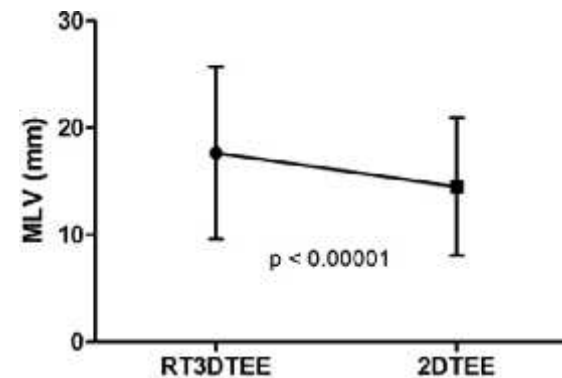
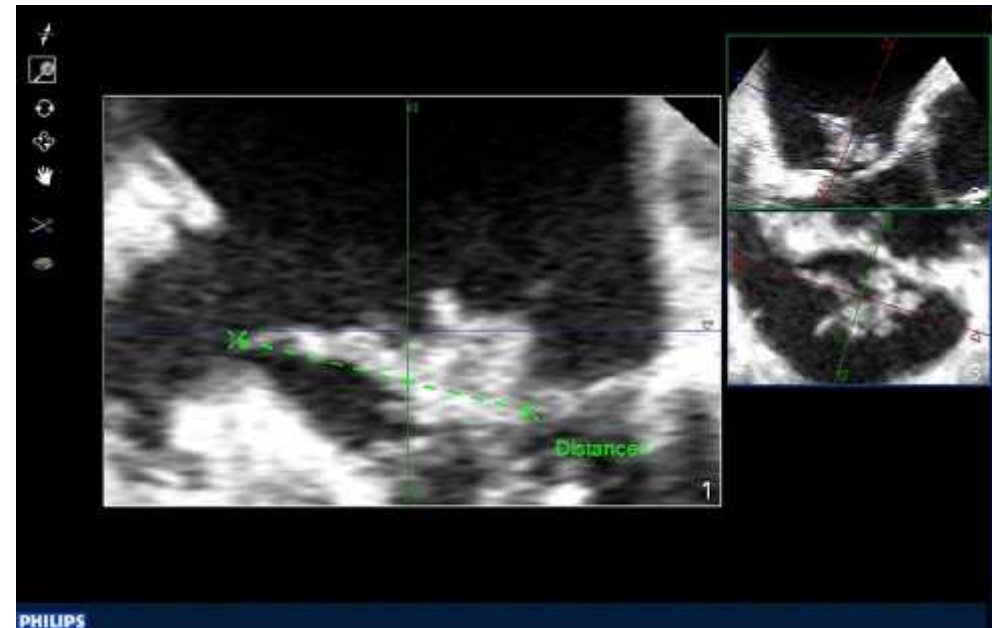
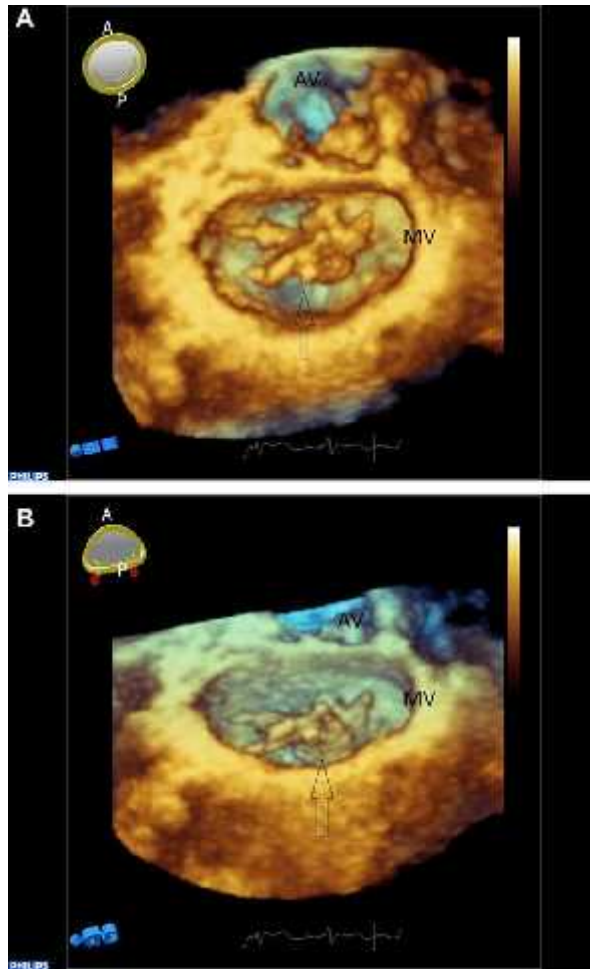
Echo Features of Endocarditis

Vegetation

- Infected mass attached to an endocardial structure or on implanted intracardiac material
- **Oscilating intracardiac mass** on valve or other endocardial structure or implanted material

short & case
mitral aortic and native
mitral valve endocarditis
www.ecocardio.cl

3-D Enhances Visualization and Sizing of Vegetations



Circ Cardiovasc Imaging. 2014;7:149-154

Echo Features of Endocarditis

Abscess

- Perivalvular cavity with necrosis and purulent material not communicating with the cardiovascular lumen.
- Thickened, not homogeneous perivalvular area with echodense or echolucent appearance.



Echo Features of Endocarditis

Pseudoaneurysm

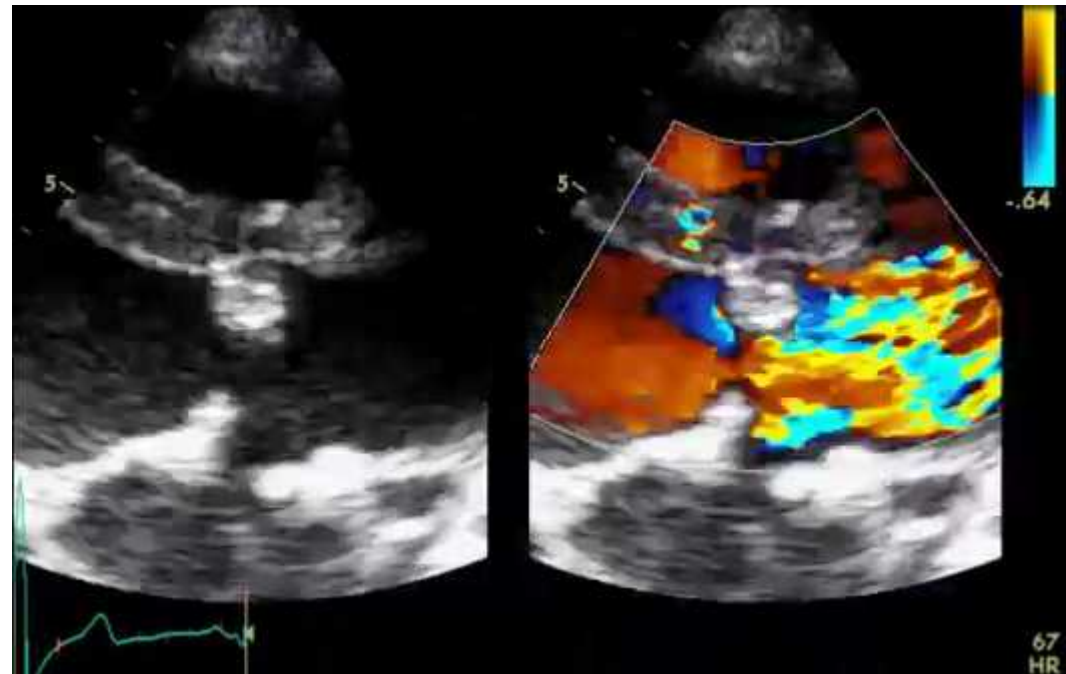
- Perivalvular cavity communicating with the cardiovascular lumen
- Pulsatile perivalvular echo-free space, with colour-Doppler detected.



Echo Features of Endocarditis

Perforation / fistula

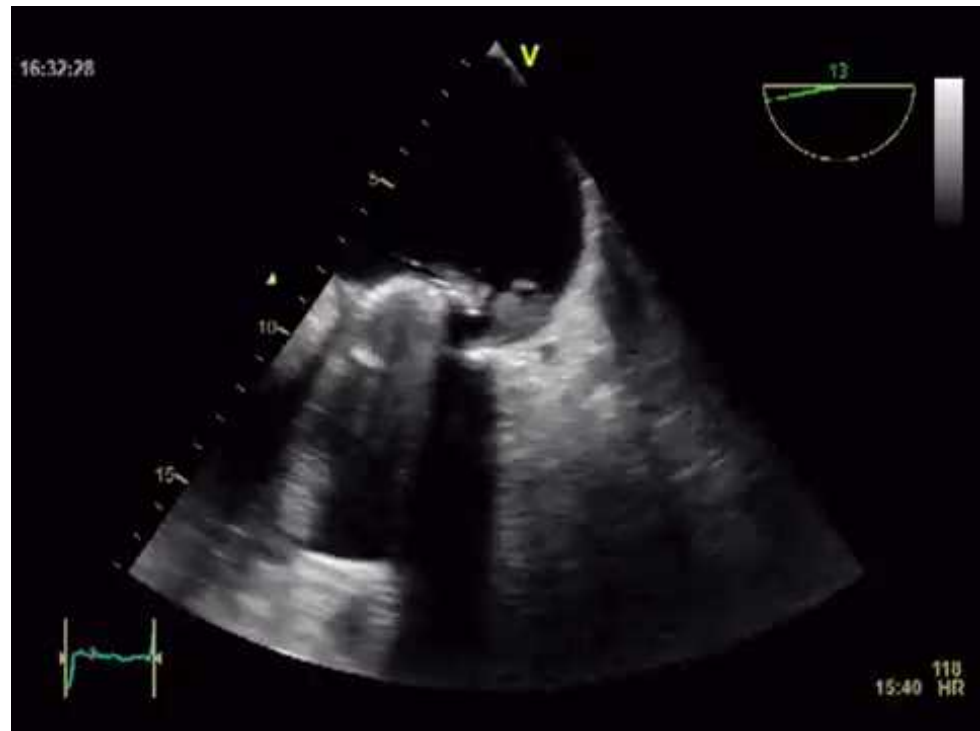
- Communication between two neighbouring cavities through a perforation.
- Colour-Doppler communication between two neighbouring cavities through a perforation.



Echo Features of Endocarditis

Dehiscence of a prosthetic valve

- Paravalvular regurgitation by TTE/TOE, with or without rocking motion of the prosthesis.



Implantable cardiac devices

- Pacemakers
- Implantable cardioverter defibrillators
- Surgical prosthetic valves
- Transcatheter heart valves
- Mitraclips
- Devices used in congenital heart diseases
- Newer devices e.g. atrial appendage closure

Infection of Cardiac Implantable Electronic Devices (pacemaker systems)

- Over 4.2 million implantations in US 1993-2008
- Incidence of infection 1.9/1000 device-years
- Higher incidence with defibrillators vs. pacemakers
- Infection → Severe disease with significant associated morbidity / mortality
 - Comorbidities, age, need for pacemaker system
- Prompt diagnosis and management critical for improved survival

Infection of Cardiac Implantable Electronic Devices (pacemaker systems)

- Local (pocket only)
 - Deeper infection
 - Leads
 - Tricuspid valve leaflets
 - Endocardial surface of right atrium / ventricle (mural endocarditis)
 - Other valve involvement
- ➔ Device related endocarditis

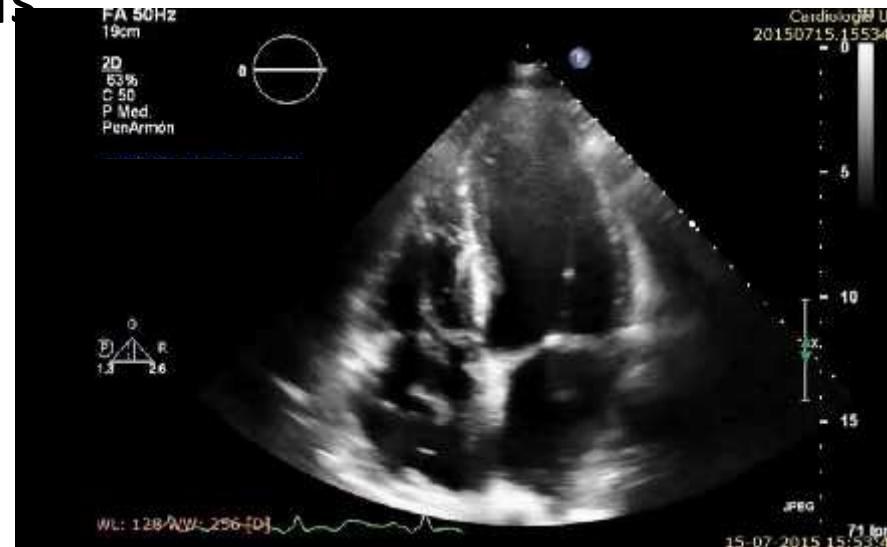
Clinical Characteristics and Outcome of Infective Endocarditis Involving Implantable Cardiac Devices

- N=177 patients with cardiac device endocarditis
- Coexisting valve involvement in (n=66) 37.3%
 - Most common the tricuspid valve
- Significant in hospital and 1-year mortality

Role of Echocardiography in Device Related Endocarditis

Diagnosis

- Identify vegetations on leads
 - Always transthoracic, but transesophageal more sensitive
 - Sizing of vegetations
- Tricuspid valve involvement
 - Degree of regurgitation



Pacemaker lead infection: echocardiographic features, management, and outcome

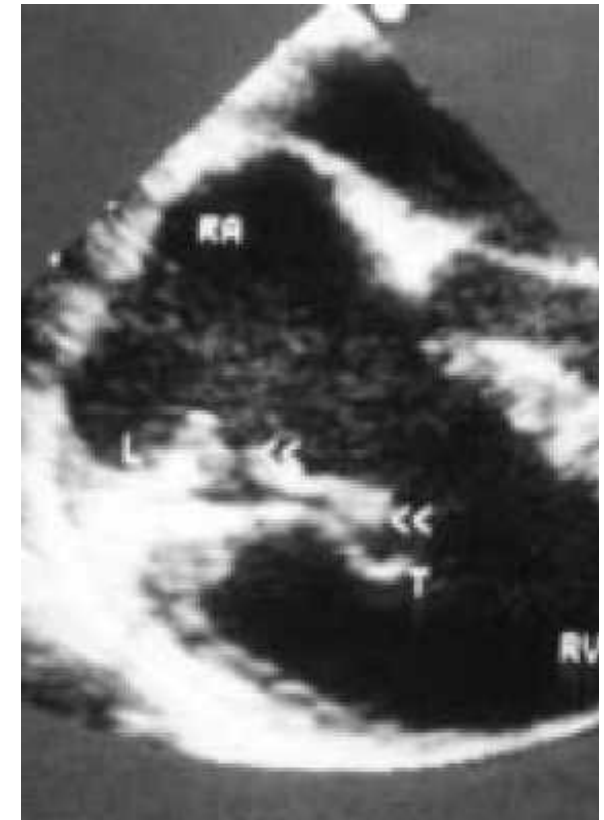
F Victor, C De Place, C Camus, H Le Breton, C Leclercq, D Pavin, P Mabo, C Daubert



Multiple lobulated with pedicles



Single round shaped



Thick flat stripes

Heart 1999;**81**:82–87

Role of Echocardiography in Device Related Endocarditis

Diagnosis

- Identify vegetations on leads
- Always transthoracic, but transesophageal more sensitive
- Intracardiac echo even more sensitive than TEE
 - But invasive, costly, limited expertise



Usefulness of Intracardiac Echocardiography for the Diagnosis of Cardiovascular Implantable Electronic Device–Related Endocarditis

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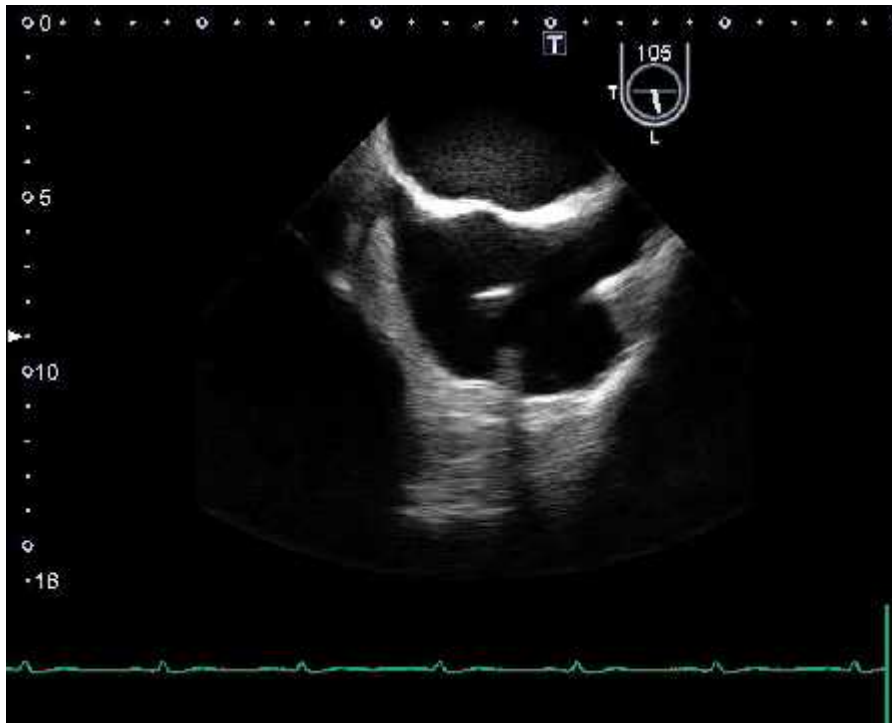
- N=152 patients with infection, possibly device related, referred for lead extraction

Intracardiac Echo (ICE) increases diagnosis of lead related masses

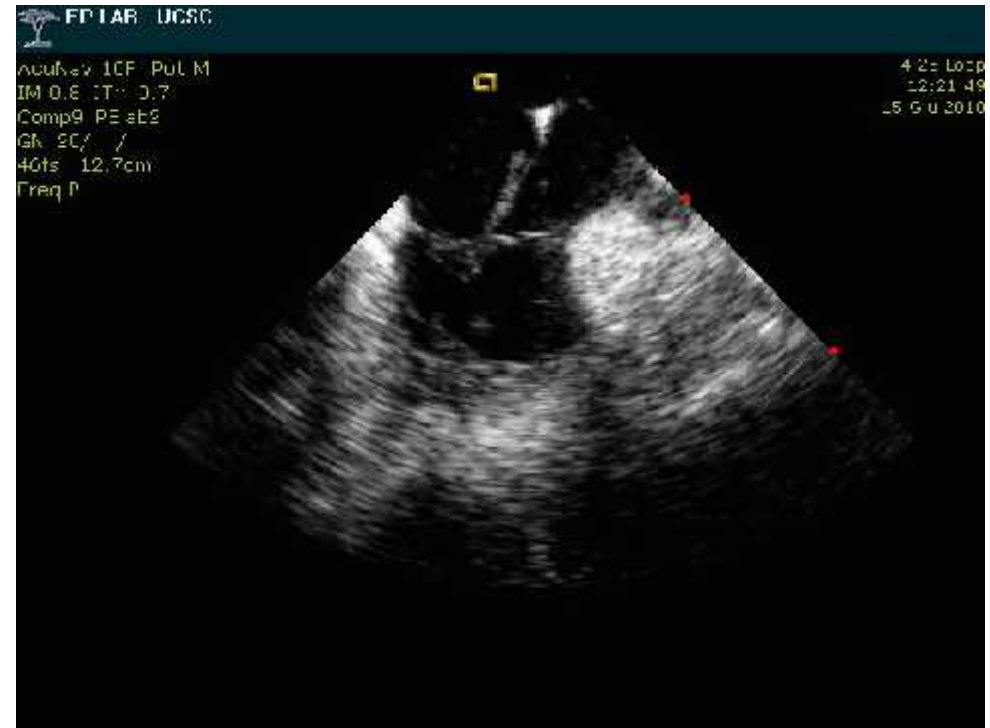
- In those with **high clinical suspicion** (n=44) ICE identified masses on the leads in all patients vs. only in 73% for TEE
- In those with moderate suspicion (n=52) ICE identified 8 patients (15%) with masses on the leads when TEE was negative
- In those with low suspicion (n=56) no significant difference between TEE and ICE in detection of abnormal findings

Intracardiac Echo

Transesophageal Imaging



Intracardiac Imaging



Important Considerations

- Not all masses on leads diagnostic of endocarditis...
- Biofilm on leads may harbor bacteria without evident masses...
- Clinical judgment (e.g. persistent fevers, blood culture results) to determine if cardiac implantable device needs to be extracted

Incidence and prognosis of pacemaker lead associated masses: a study of 1,569 transesophageal echocardiograms.

- N=125 patients with pacemaker or ICD leads in right atrium
 - 15 with echogenic masses on the leads
 - 9 with clinically suspected lead endocarditis
 - 6 with incidental finding of mass (5%)
- Benign clinical course in those with incidentally found masses on the lead

Cardiac Device Related Endocarditis

- Microbiologic data critical
- Imaging with TTE
→ TEE → ICE
- SPECT / PET scanning for evidence of inflammation

A. Diagnosis			
1. Three or more sets of blood cultures are recommended before prompt initiation of antimicrobial therapy for CIED infection	I	C	
2. Lead-tip culture is indicated when the CIED is explanted	I	C	
3. TOE is recommended in patients with suspected CDRIE with positive or negative blood cultures, independent of the results of TTE, to evaluate lead-related endocarditis and heart valve infection	I	C	
4. Intracardiac echocardiography may be considered in patients with suspected CDRIE, positive blood cultures and negative TTE and TOE results	IIb	C	
5. Radiolabelled leucocyte scintigraphy and ¹⁸ F-FDG PET/CT scanning may be considered additive tools in patients with suspected CDRIE, positive blood cultures and negative echocardiography	IIb	C	

Cardiac Implantable Electronic Device Infection

→ System Removal

- Percutaneous extraction in most patients
- If vegetations on leads >20mm and / or severe tricuspid IE → surgical consideration

Recommendations	Class ^a	Level ^b	Ref. ^c
1. Percutaneous extraction is recommended in most patients with CDRIE, even those with vegetations >10 mm	I	B	382, 391, 405
2. Surgical extraction should be considered if percutaneous extraction is incomplete or impossible or when there is associated severe destructive tricuspid IE	IIa	C	
3. Surgical extraction may be considered in patients with large vegetations (>20 mm)	IIb	C	

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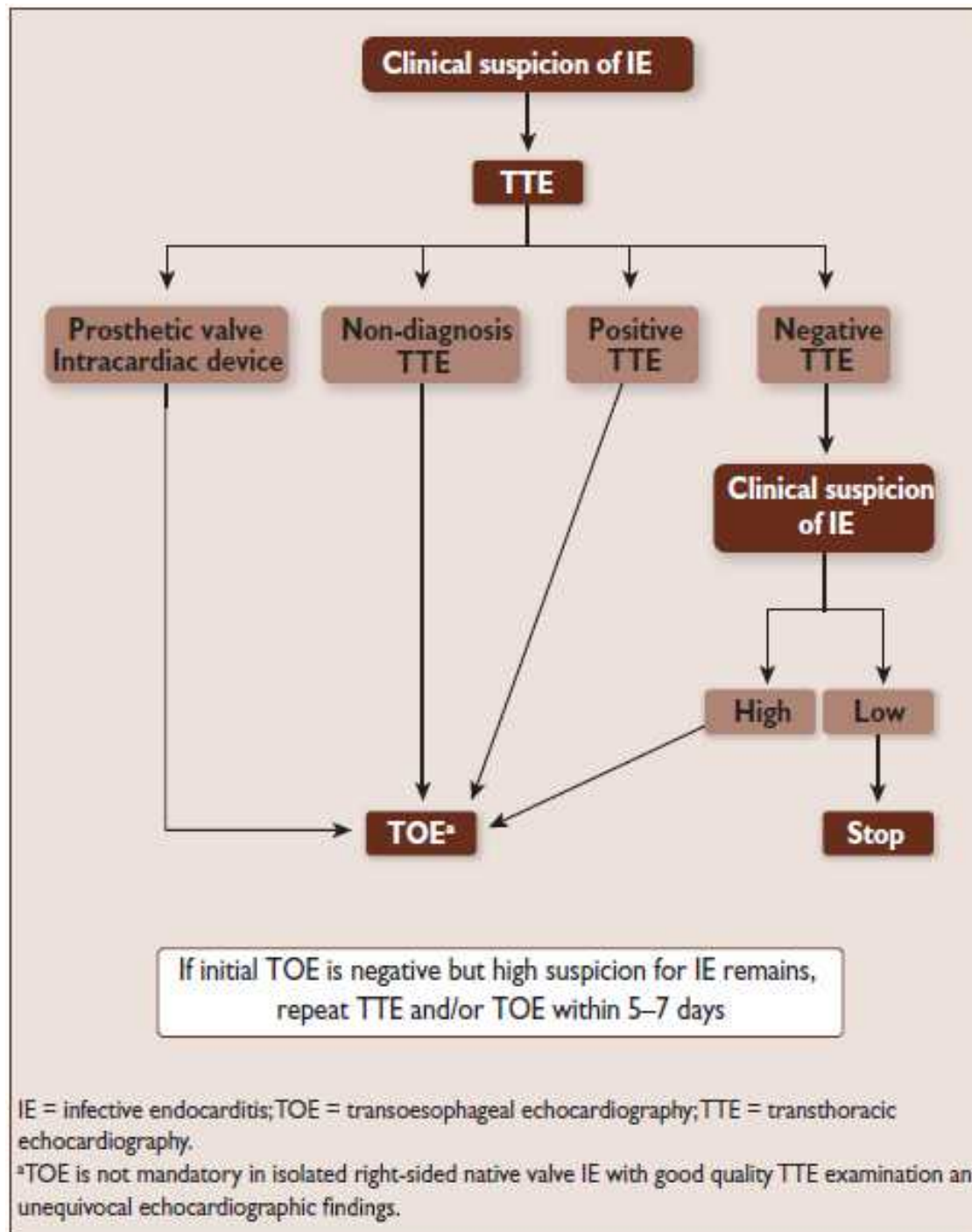
Prosthetic Valve Endocarditis (PVE)

- Most severe form of infectious endocarditis
- Incidence 0.3-1.2% per patient-year
- PVE accounts for 10-30% of all endocarditis
 - Mechanical / Bioprosthetic affected equally
- Classified as
 - Early <60 days
 - Intermediate 60-365 days
 - Late >365 day

PVE Pathogenesis and Echo Findings

- ***Perioperative*** contamination, infection involves the junction between sewing ring and annulus → Perivalvular abscess, dehiscence, pseudoaneurysms, fistulae
- ***Late PVE***, infection at the leaflets of prosthesis → vegetations, cusp rupture, perforation

New regurgitation most commonly, less likely stenosis due to large vegetation



Role of Echocardiography in Prosthetic Valve Endocarditis (PVE): Diagnosis

- Identify perivalvular complications
 - Anatomic (perforation, abscess, dehiscence)
 - Hemodynamic (regurgitation, fistulae)
- More challenging due to acoustic shadowing
 - TEE overcomes this to some degree
- Negative TEE does not exclude PVE
 - Need to repeat in 7-10 days

Role of Echocardiography in Prosthetic Valve Endocarditis (PVE): Follow up

- Echo re-evaluation if change in clinical status (new murmur, embolism, fever, AV block, worsening heart failure)
- Severe valve dysfunction
- Perivalvular complications
- Risk of embolization (if large size, or if prior embolic event)

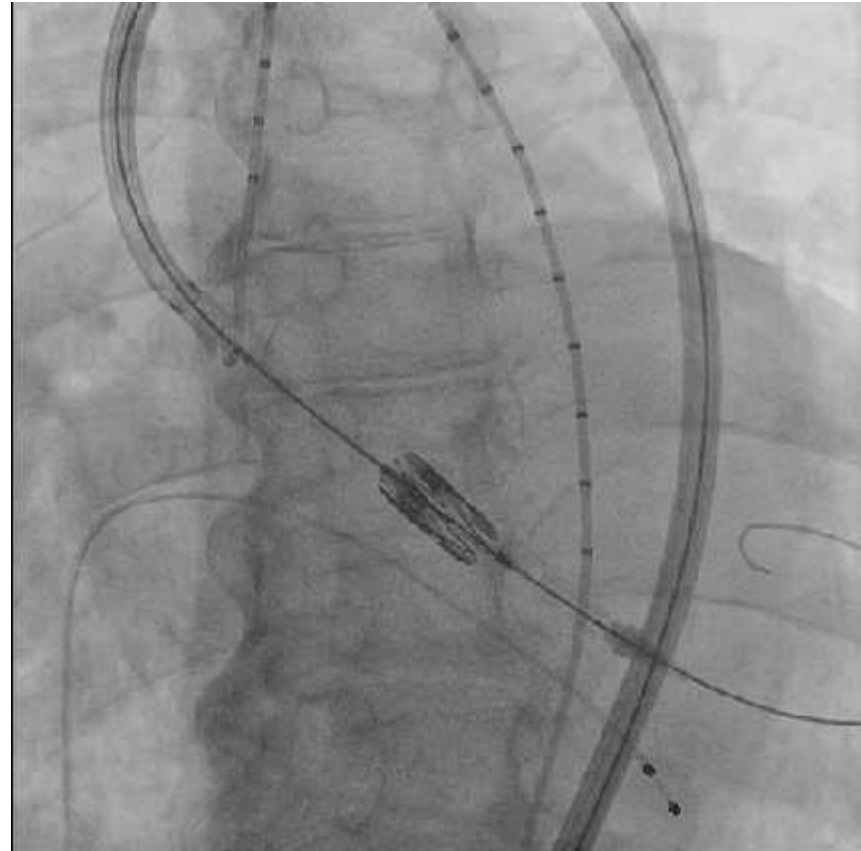
Role of Echocardiography in Prosthetic Valve Endocarditis (PVE): Intraoperative

- Final reassessment of condition for any changes
- Evaluate result of surgical intervention

Examples of TAVR prosthetic valve endocarditis

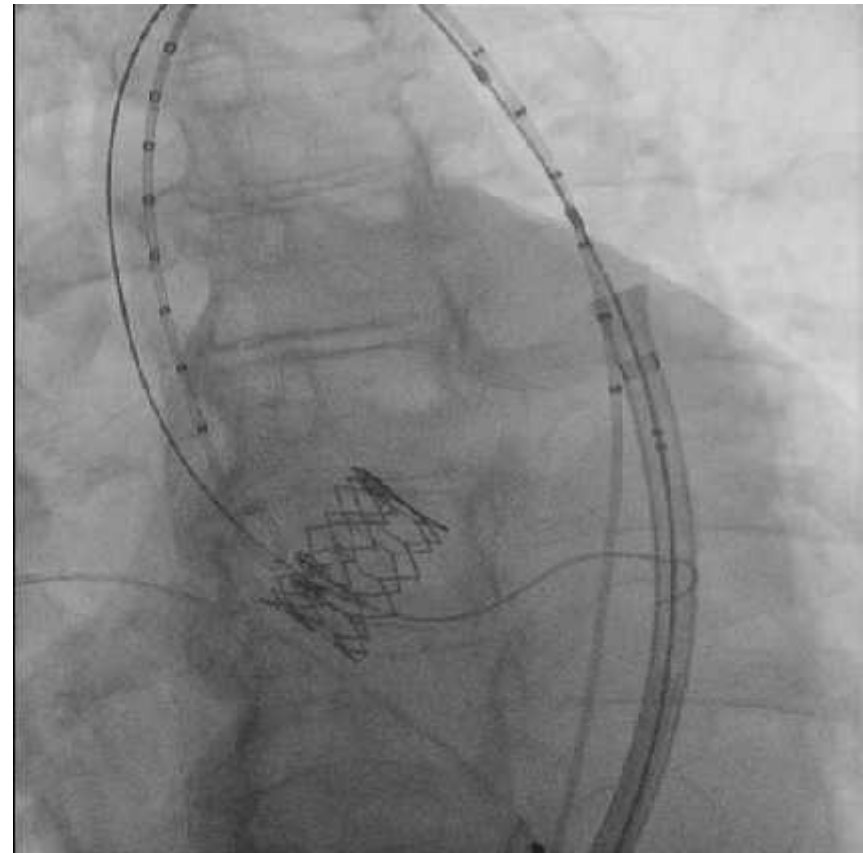
Endocarditis in TAVR (I)

- 84 year old male
- Sapien XT 26mm for severe aortic stenosis
- Uneventful procedure



Endocarditis in TAVR (I)

- 84 year old male
- Sapien XT 26mm for severe aortic stenosis
- Uneventful procedure
- 4 months later...
- Fever and bacteremia with Staph. Epidermidis
- TEE



Endocarditis in TAVR (I)

- 84 year old male
- Sapien XT 26mm for severe aortic stenosis
- Uneventful procedure
- 4 months later...
- Fever and bacteremia with Staph. Epidermidis
- TTE



Early Prosthetic Valve Endocarditis in TAVR



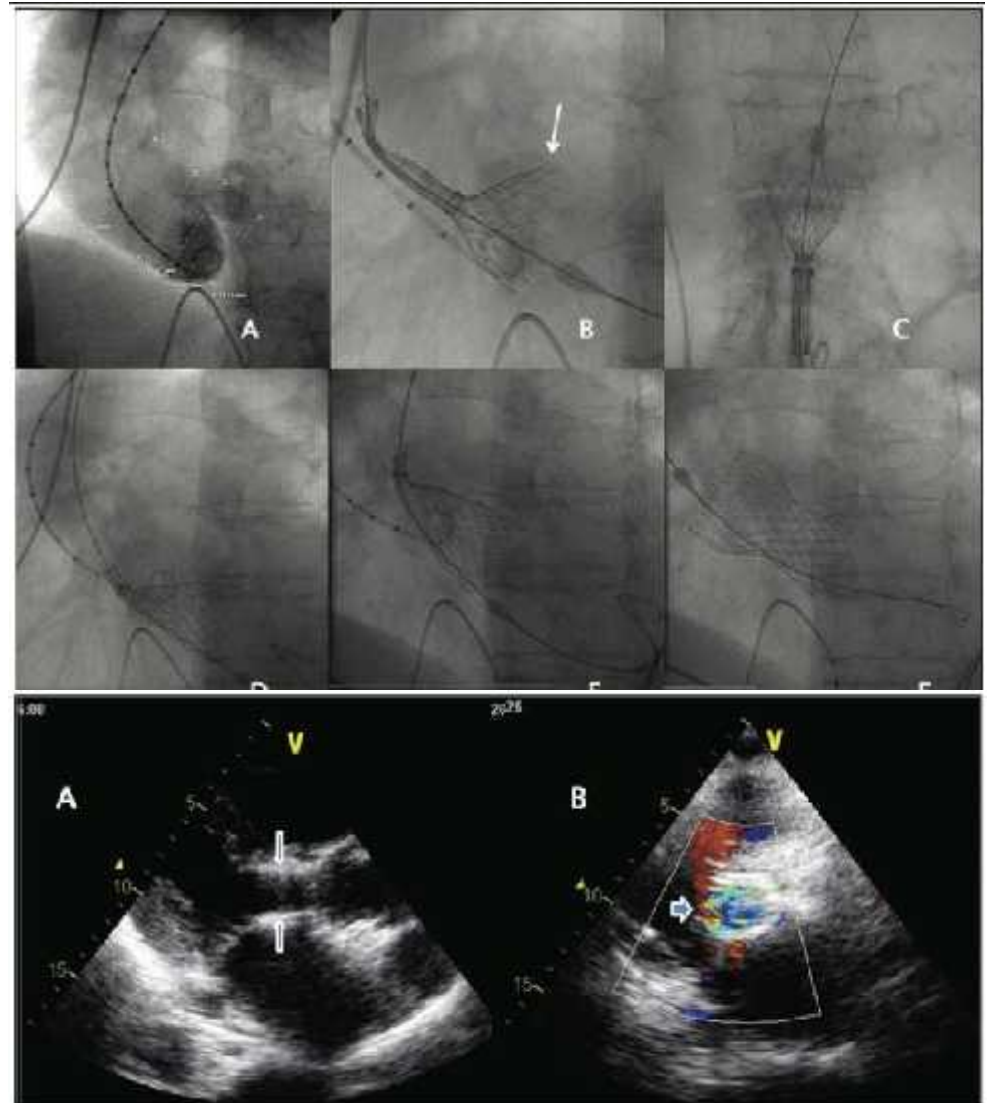
Early Prosthetic Valve Endocarditis in TAVR



Rx with prolonged course of iv antibiotics and po suppressive therapy, clinically well at the 18-month follow up

Endocarditis and TAVR (II)

- 84 year-old male
- Difficult CoreValve 29mm implantation requiring extensive handling of the device
- Final successful, with PAR 2+
- At 80 days... Staph. Epidermidis bacteremia /sepsis
- TEE no vegetations
- Rx with iv antibiotics for early PVE
- Stable at the 12 month f/up

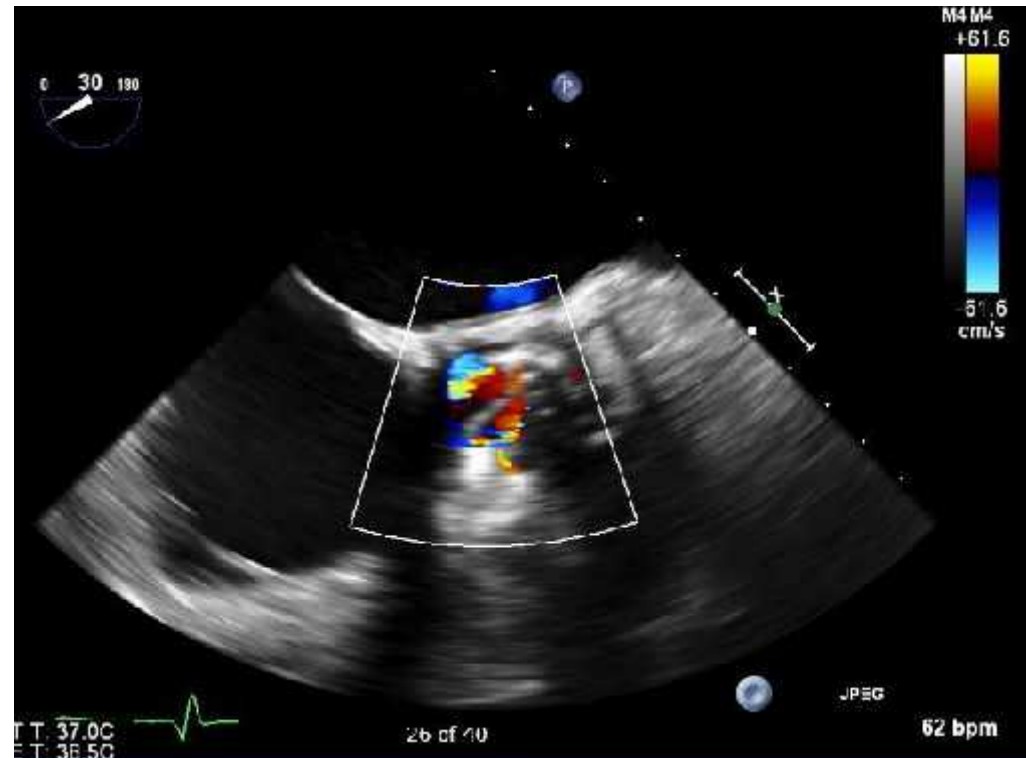


Role of Echocardiography in Prosthetic Valve Endocarditis (PVE): Long term follow up

- Reassess presence / significance of any paraprosthetic leaks after surgical therapy
 - (often friable tissues and with difficulty in suturing the new valve in place)
 - If this occurs, and patient is symptomatic, then consider catheter based closure of leaks

Echocardiography Following Surgical Treatment of Prosthetic Valve Endocarditis: Significant Leak

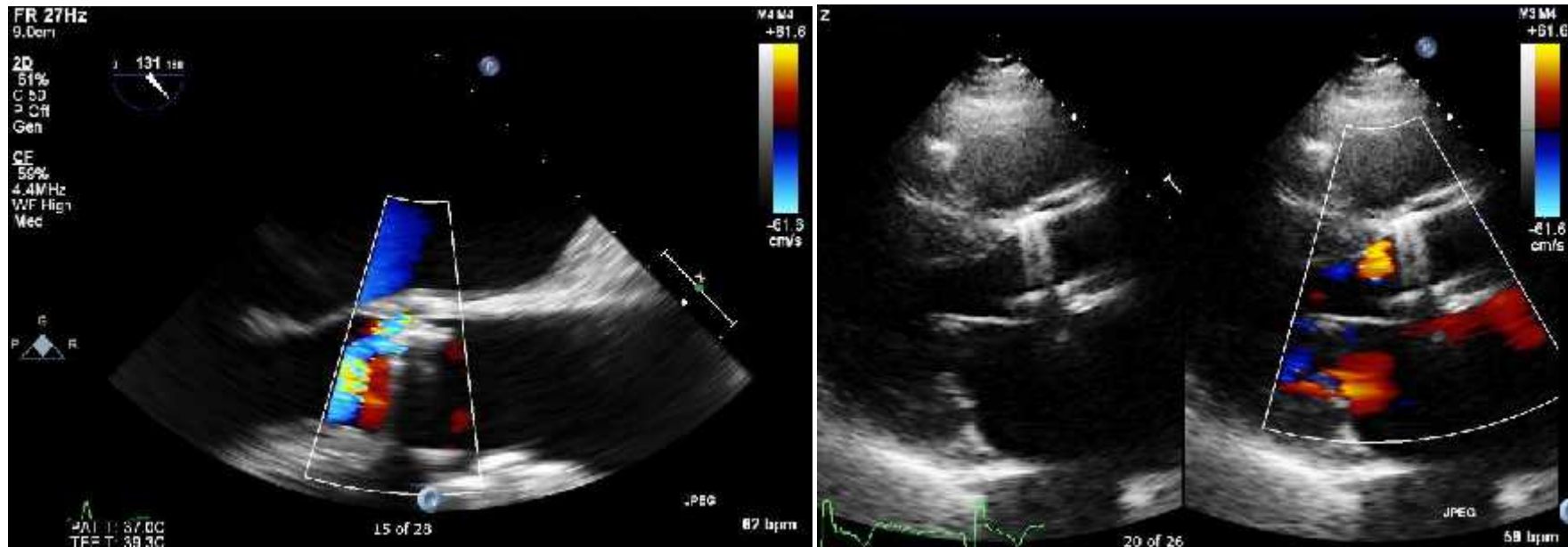
- 75 male
- sAVR in 2012
- Endocarditis 15 months later with root abscess
- Redo sAVR → ATS 24
- **Follow up echo:** Significant paravalvular AR
- Rx with closure device



Closure of Paraprosthetic Leak

Baseline significant PVL

After closure with AVP II 10x7



2015 ESC Guidelines for the management of infective endocarditis

The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC)

European Heart Journal doi:10.1093/eurheartj/ehv319

2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Developed in Collaboration With the American Association for Thoracic Surgery, American Society of Echocardiography, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons

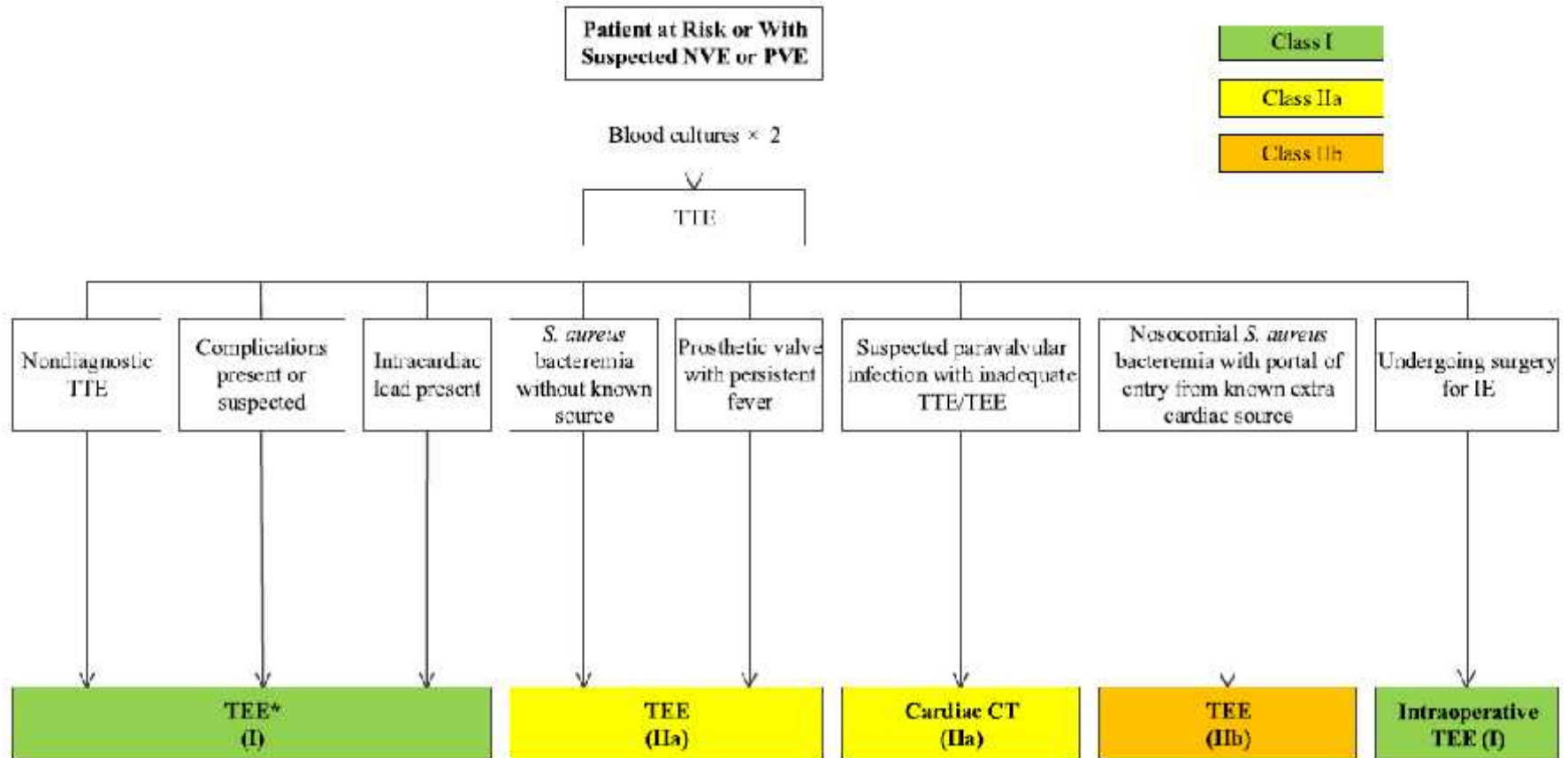


In Summary

- Endocarditis due to infection of implantable cardiac devices is a serious complication
- Echocardiography is essential in early diagnosis, disease monitoring, complication assessment, guidance during surgery and long term follow up
- Important to have an “Endocarditis Team” to manage these often high risk patients

Ευχαριστώ!

Echocardiography in Suspected IE



Role of Echocardiography in Infective Endocarditis

Table 6.3 Role of echocardiography in infective endocarditis

Recommendations: echocardiography	Class ^a	Level ^b
A. Diagnosis		
• TTE is recommended as the first-line imaging modality in suspected IE	I	B
• TEE is recommended in patients with high clinical suspicion of IE and a normal TTE	I	B
• Repeat TTE/TEE within 7–10 days are recommended in the case of an initially negative examination when clinical suspicion of IE remains high	I	B
• TEE should be considered in the majority of adult patients with suspected IE, even in cases with positive TTE, owing to its better sensitivity and specificity, particularly for the diagnosis of abscesses and measurement of vegetation size	IIa	C
• TEE is not indicated in patients with a good-quality negative TTE and a low clinical suspicion of IE	III	C
B. Follow-up under medical therapy		
• Repeat TTE and TEE are recommended as soon as a new complication of IE is suspected (new murmur, embolism, persistent fever, heart failure, abscess, atrioventricular block)	I	B
• Repeat TTE and TEE should be considered during follow-up of uncomplicated IE, in order to detect new silent complication and monitor vegetation size. The timing and mode (TTE or TEE) of repeat examination depend on the initial findings, type of microorganism, and initial response to therapy	IIa	B
C. Intraoperative echocardiography		
• Intraoperative echocardiography is recommended in all cases of IE requiring surgery	I	C
D. Following completion of therapy		
• TTE is recommended at completion of antibiotic therapy for evaluation of cardiac and valve morphology and function	I	C

Adapted from Habib et al. [5]

TEE: transesophageal echocardiography, TTE: transthoracic echocardiography

^aClass of recommendation

^bLevel of evidence