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2016 Annual Spring Scientific Conference of the KSC in conjunction with KSIC, KSE, and KSLA
& The 8th Asian Pacific Congress of Heart Failure

• HICO, Gyeongju, Korea • April 15 – 16, 2016

One Heart, One Life

April 16, 09:00-09:15

Role of Echocardiography in Infective Endocarditis(IE)

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When to perform Echocardiography in IE?

- **Vegetations?** (pathologic hallmark)
- **Whatever the level of suspicion**
- **Intracardiac abscess?**
- **Confirm or R/O at the Earliest Opportunity.**
- **New or progressive valvular regurgitation?**
- **Prosthetic valve dehiscence?**



Risk factors

- preexisting heart disease(CHD...)
- indwelling central lines
- prosthetic material
- persistent bacteremia, or infection with organisms
- prolonged fever
- **Modified Duke's criterias**

Class I (procedure or Tx **should** be performed):

- At least **2 sets of blood cultures** should be obtained at risk for IE
 - Unexplained fever > 48 hours
 - Newly Dx Lt-sided valve regurgitation.
 - Underlying [CHD or acquired valvular HD, previous IE, prosthetic valves, immunodeficiency states, or injection drug users..]
- **Modified Duke criteria**
- **TTE** : suspected IE
- **TEE** : when Cx developed/ intracardiac device.
- **TTE / TEE**
 - **Re-evaluation**
 - **High risk of Cx**
- **Intraoperative TEE**

Class II (it is **reasonable** to perform procedure):

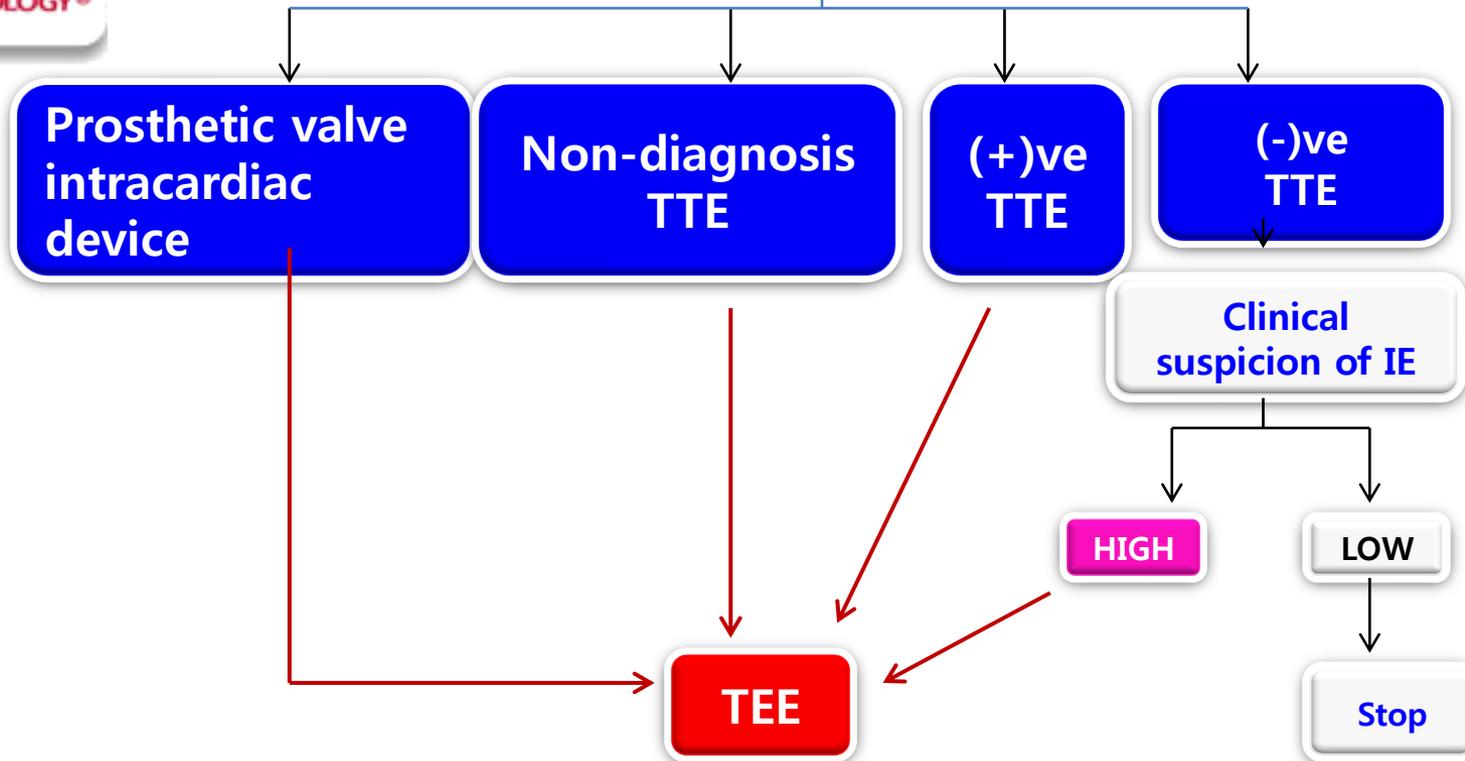
- TEE: *Staphylococcal aureus* bacteremia without a known source.
- TEE: prosthetic valve in the presence of persistent fever without bacteremia or a new murmur.

Clinical suspicion of IE

- (+)ve blood cultures
- New valve regurgitation
- Fever

☞ **Modified Duke criteria**

TTE



If initial TEE is negative, but high suspicion for IE remains, **Repeat TTE / TEE within 5~7 days**

TEE is **not mandatory** in isolated Rt-sided native valve IE with good quality TTE and unequivocal echo graph findings



American
Heart
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Modified Duke criteria for Dx of IE



Definitive IE: any of the Following:

Pathologic criteria

Pathologic lesions: vegetation or intracardiac abscess demonstrating active endocarditis on histology **OR**

Microorganism: demonstrated by culture or histology of a vegetation or intracardiac abscess

Clinical criteria

Using specific definitions listed in **Table B:**

2 major clinical criteria **OR**

1 major and 3 minor clinical criteria **OR**

5 minor clinical criteria

Possible IE

Presence of 1 major and 1 minor clinical criteria **OR** presence of 3 minor clinical criteria

Reject IE

A firm alternate diagnosis is made **OR**

Resolution of clinical manifestations occurs after ≤ 4 days of antibiotic therapy **OR**

No pathologic evidence of infective endocarditis is found at surgery or autopsy after antibiotic therapy for four days or less

Clinical criteria for possible or definite IE not met

"Major criteria" --Modified Duke Clinical Criteria

Positive blood cultures for IE (one of the following):

Typical microorganisms consistent with IE from two separate blood cultures

Staphylococcus aureus

Viridans streptococci

Streptococcus gallolyticus (formerly *S. bovis*), including nutritional variants spp and *Abiotrophia defectiva*)

HACEK group: *Haemophilus* spp, *Aggregatibacter* (formerly *Actinobacillus* ac), *Cardiobacterium hominis*, *Eikenella* spp, and *Kingella kingae*

Community-acquired enterococci, in the absence of a primary focus; **OR**

Persistently positive blood culture:

For organisms that are typical causes of IE: At least two positive blood cultures in two samples drawn >12 hours apart

For organisms that are more commonly skin contaminants: Three or a majority of ≥ 4 separate blood cultures (with first and last drawn at least one hour apart)

Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titer >1:800*

Evidence of endocardial involvement (one of the following):

Echocardiogram positive for IE:

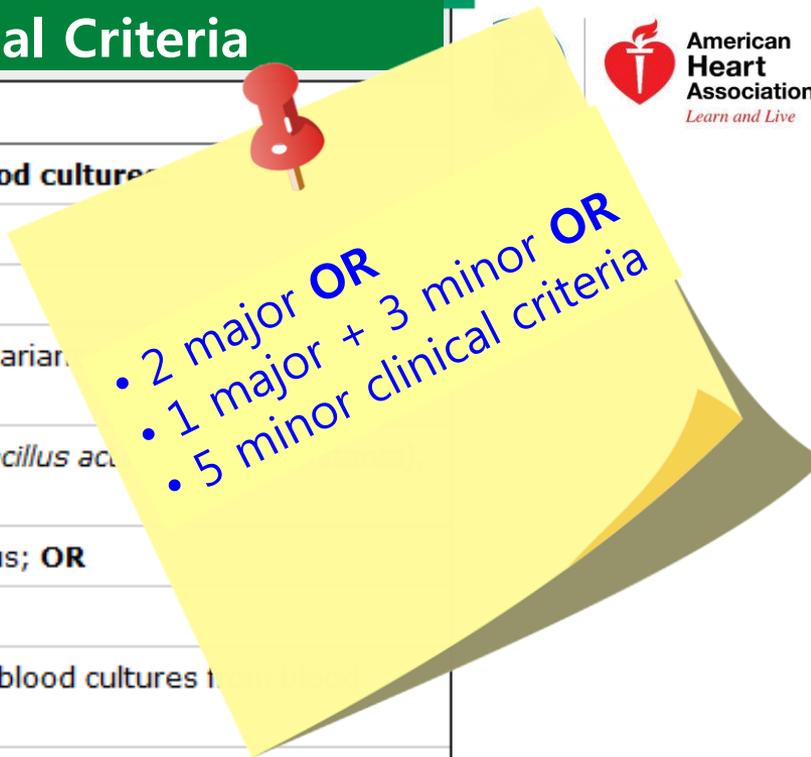
Vegetation (oscillating intracardiac mass on a valve or on supporting structures, in the path of regurgitant jets, or on implanted material, in the absence of an alternative anatomic explanation) **OR**

Abscess **OR**

New partial dehiscence of prosthetic valve

New valvular regurgitation

Increase in or change in preexisting murmur not sufficient

- 
- 2 major **OR**
 - 1 major + 3 minor **OR**
 - 5 minor clinical criteria



Evidence of Endocardial involvement (one of following)

Echo. Positive for IE

- **Vegetation OR**
- **Abscess OR**
- **New partial dehiscence of prosthetic valve**

New valvular regurgitation

Increase in or change in preexisting murmur **not sufficient**

“ Minor criteria” --Modified Duke criteria

Predisposition: Intravenous drug use or presence of a predisposing heart condition (prosthetic heart valve or a valve lesion associated with significant regurgitation or turbulence of blood flow)

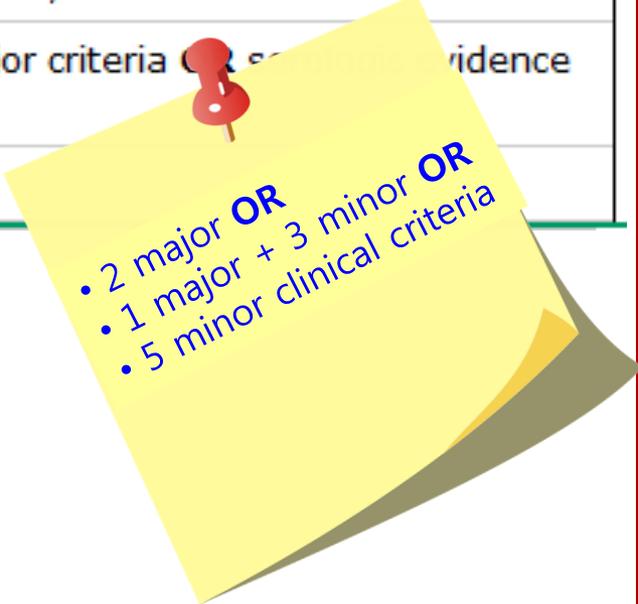
Fever: Temperature $\geq 38.0^{\circ}\text{C}$ (100.4°F)

Vascular phenomena: Major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, or Janeway lesions

Immunologic phenomena: Glomerulonephritis, Osler nodes, Roth spots, or rheumatoid factor

Microbiologic evidence: Positive blood cultures that do not meet major criteria OR serologic evidence of active infection with organism consistent with IE

(Echocardiographic minor criteria eliminated)*

- 
- 2 major **OR**
 - 1 major + 3 minor **OR**
 - 5 minor clinical criteria

Echocardiography

- **Should be** performed **as soon as the IE is suspected**
- **Repeat** examination is important, esp. in high risk group



TTE

(TransThoracic Echo)

- Non-invasive
- Easily available
- Less expensive
- Infants/ younger children
- Hemodynamic monitor
- Valvular function

TEE

(TransEsophageal Echo)

- Better sensitivity (92~94%)
- Small vegetations(<3mm)
- Intra-operative
- Specific condition of child



Careful F/U with Clinical Judgment

Pediatric TEE is helpful in case of:

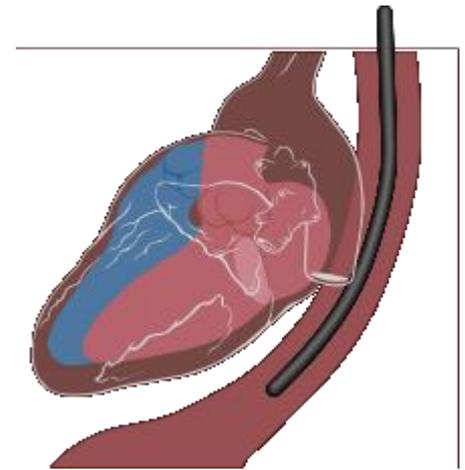
TTE provides inadequate d/t suboptimal echo windows

- Overweight children
- Muscular children
- Significant respiratory disease
- Prior surgically repaired complex CHD
 - artifacts from prosthetic material (grafts and conduits)
- Chest wall disruption from prior surgery or trauma
- Congenital anomalies involving the thoracic cage
 - eg, severe pectus excavatum
- Aortic valve IE: TEE > TTE

- Both TTE and TEE may give false -ve results

Role of echocardiography in IE

- **Diagnosis**
- **Detection of Complication**
- **Intraoperative echo**
- **Follow Up** under medical Tx
- **Prognostic** assessment

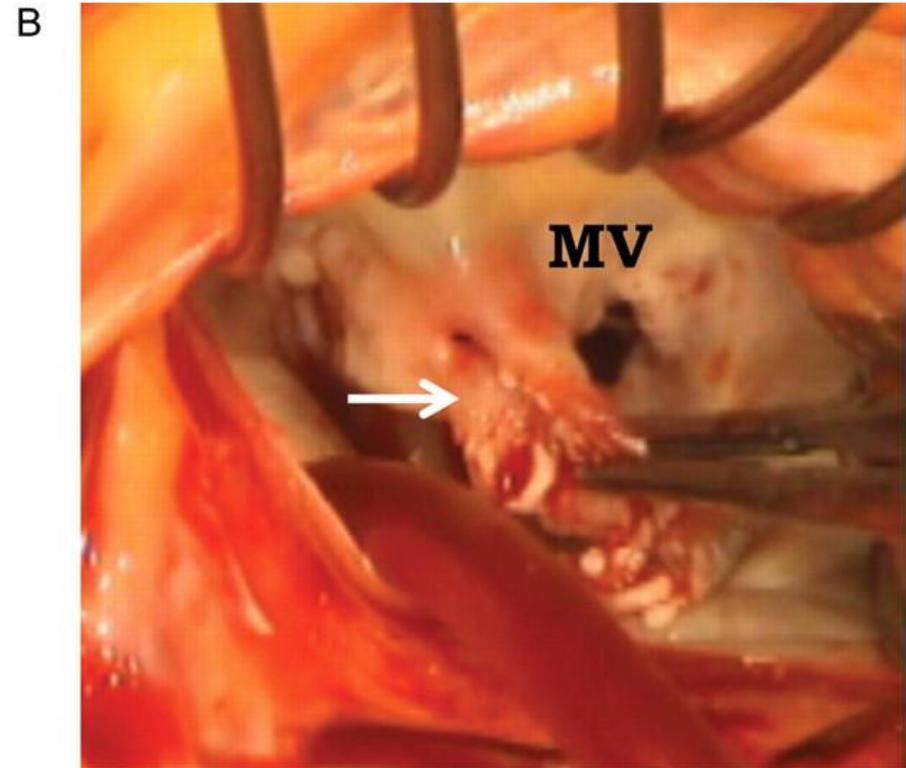
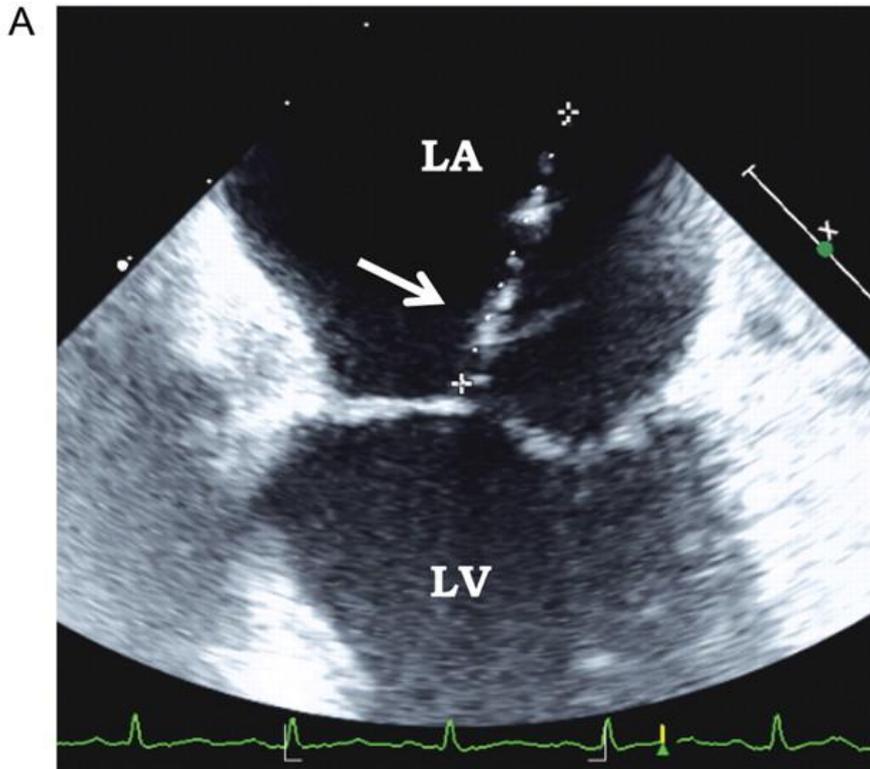


Echocardiographic criteria for IE

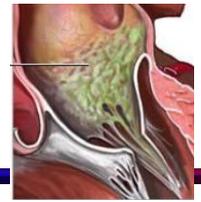
- Vegetation
- Abscess
- Pseudoaneurysm
- Perforation
- Fistula
- Valve aneurysm
- Dehiscence of a prosthetic valve

vegetation

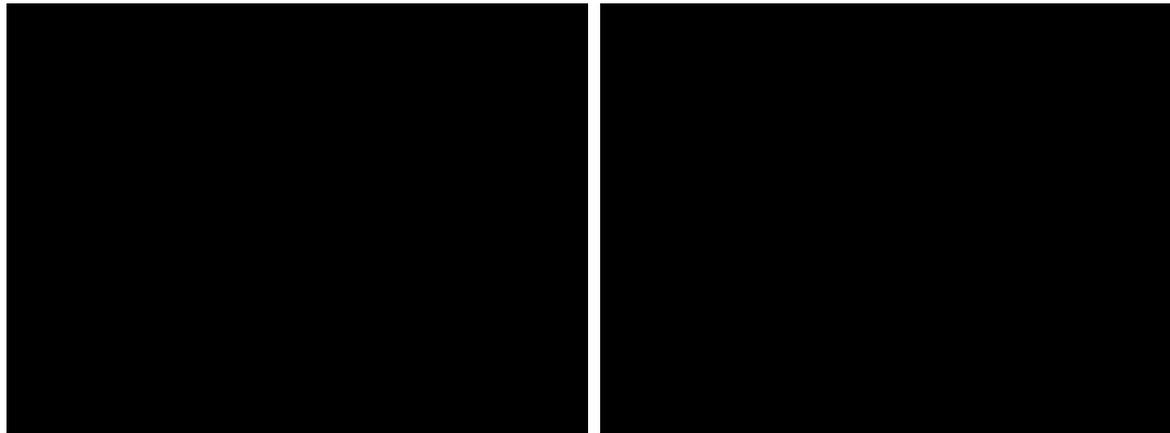
- **Hallmark lesion** of IE.
- Oscillating mass attached to a valvular structure, with a motion independent to that of the valve



Diagnostic criteria for Vegetation

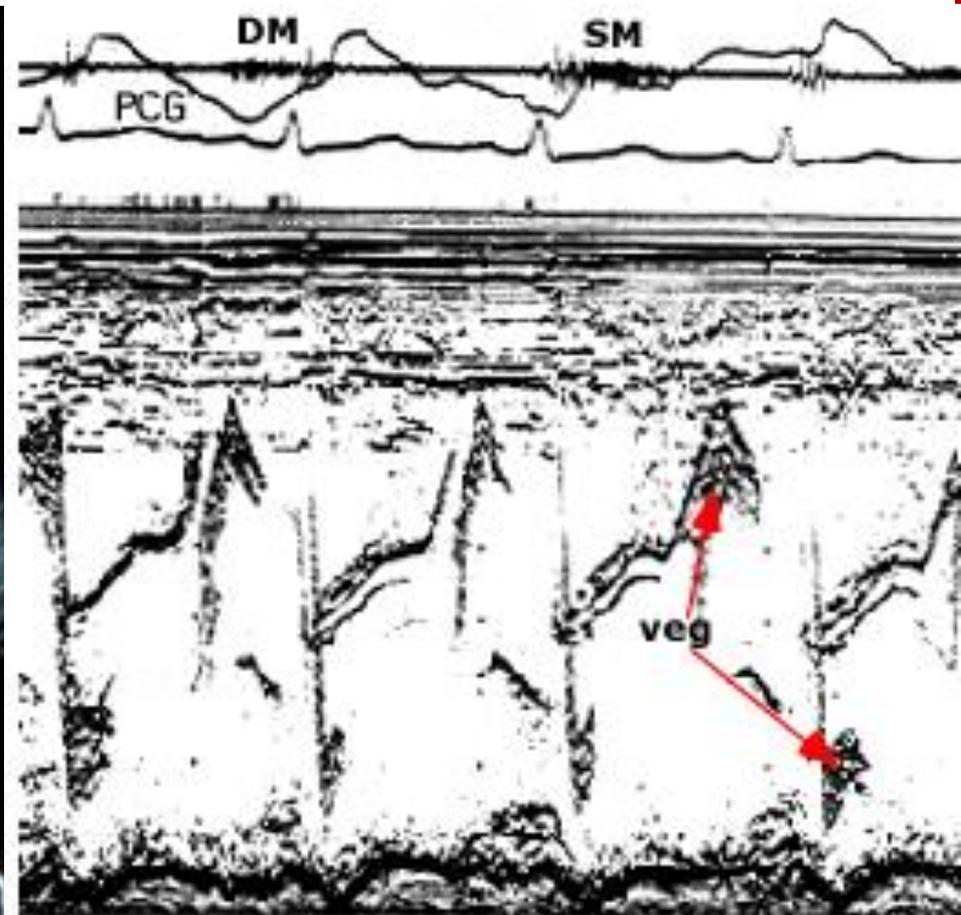
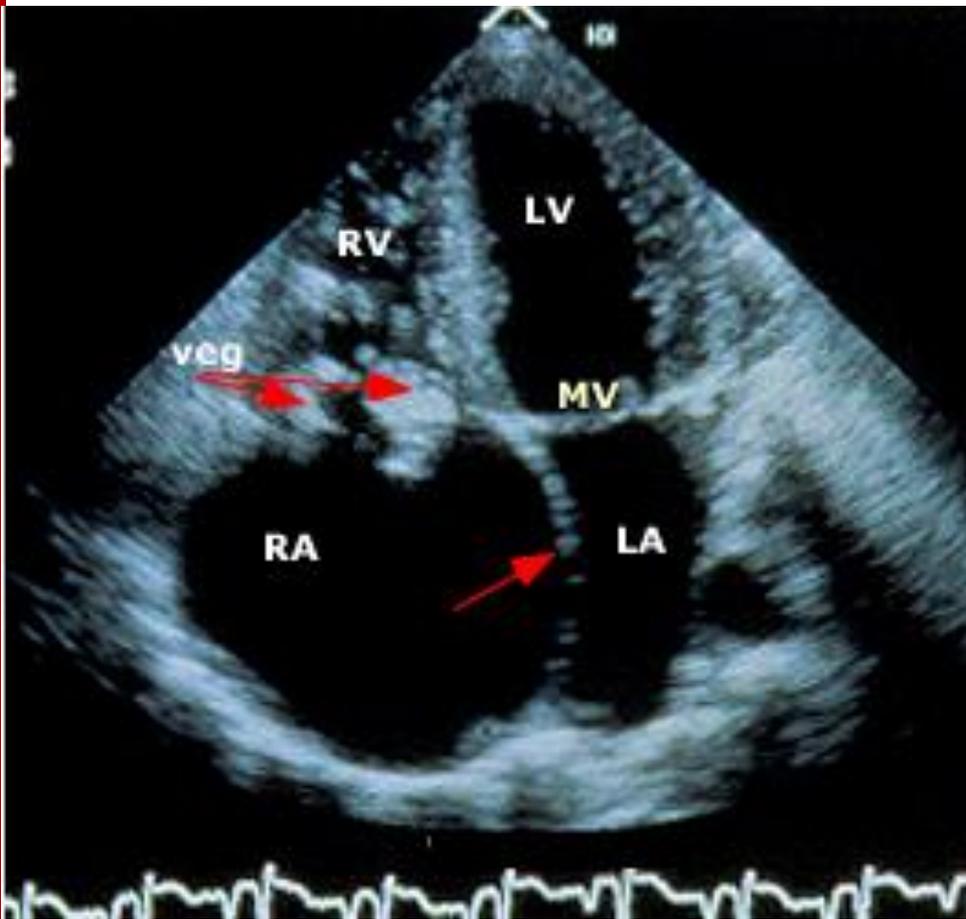


- **Texture** – gray scale and reflectance of myocardium
- **Location** – upstream side, in the path of the jet or on prosthetic material
- **Motion** – chaotic, orbiting; indep. of valve motion
- **Shape** – lobulated / amorphous
- **Accompanying abnormalities**
 - abscess, pseudoaneurysm, fistulae, prosthetic dehiscence,
 - paravalvular leak, significant preexisting or new regurgitation
- Prolapse into the upstream chamber

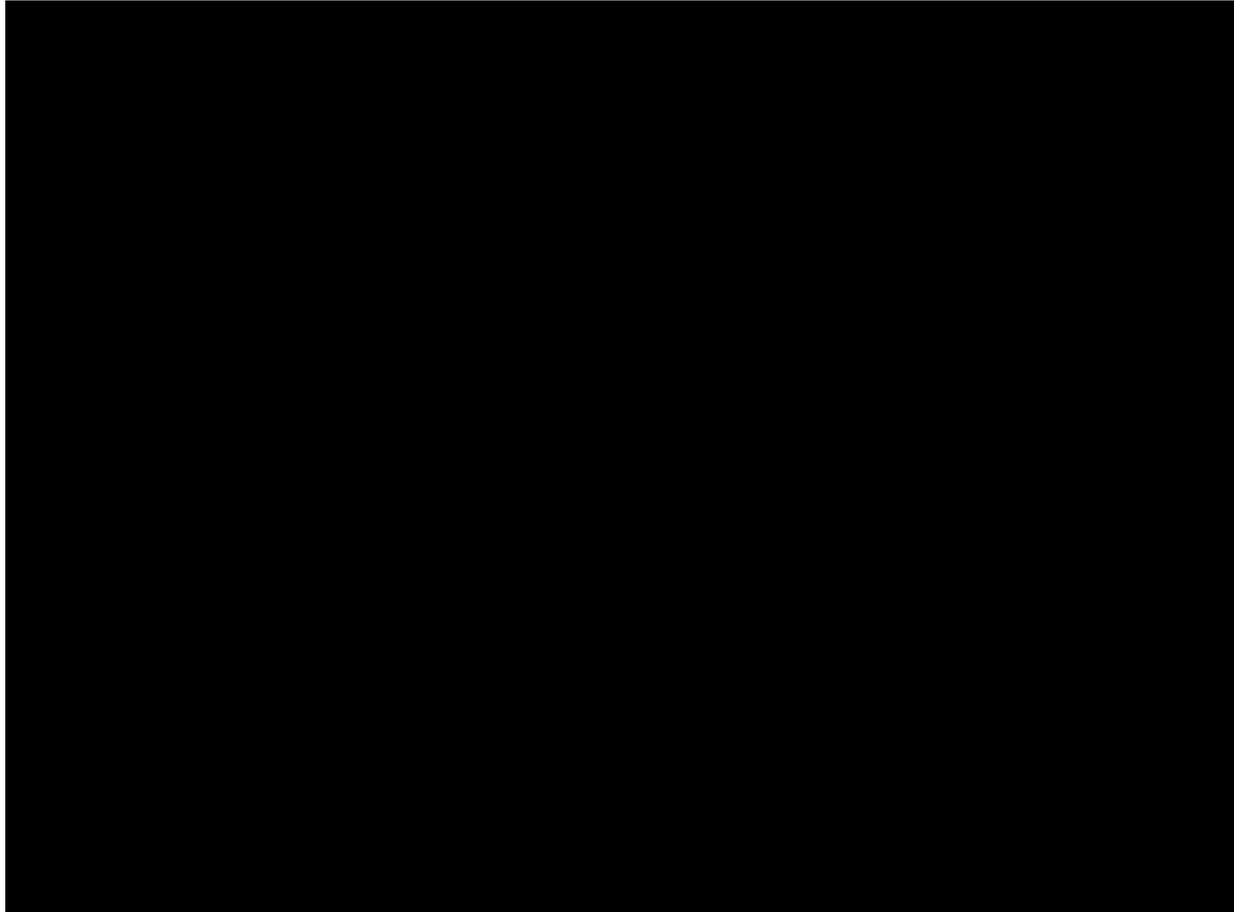


M-mode echocardiography

- >5 mm
- Discrete echogenic, shaggy masses

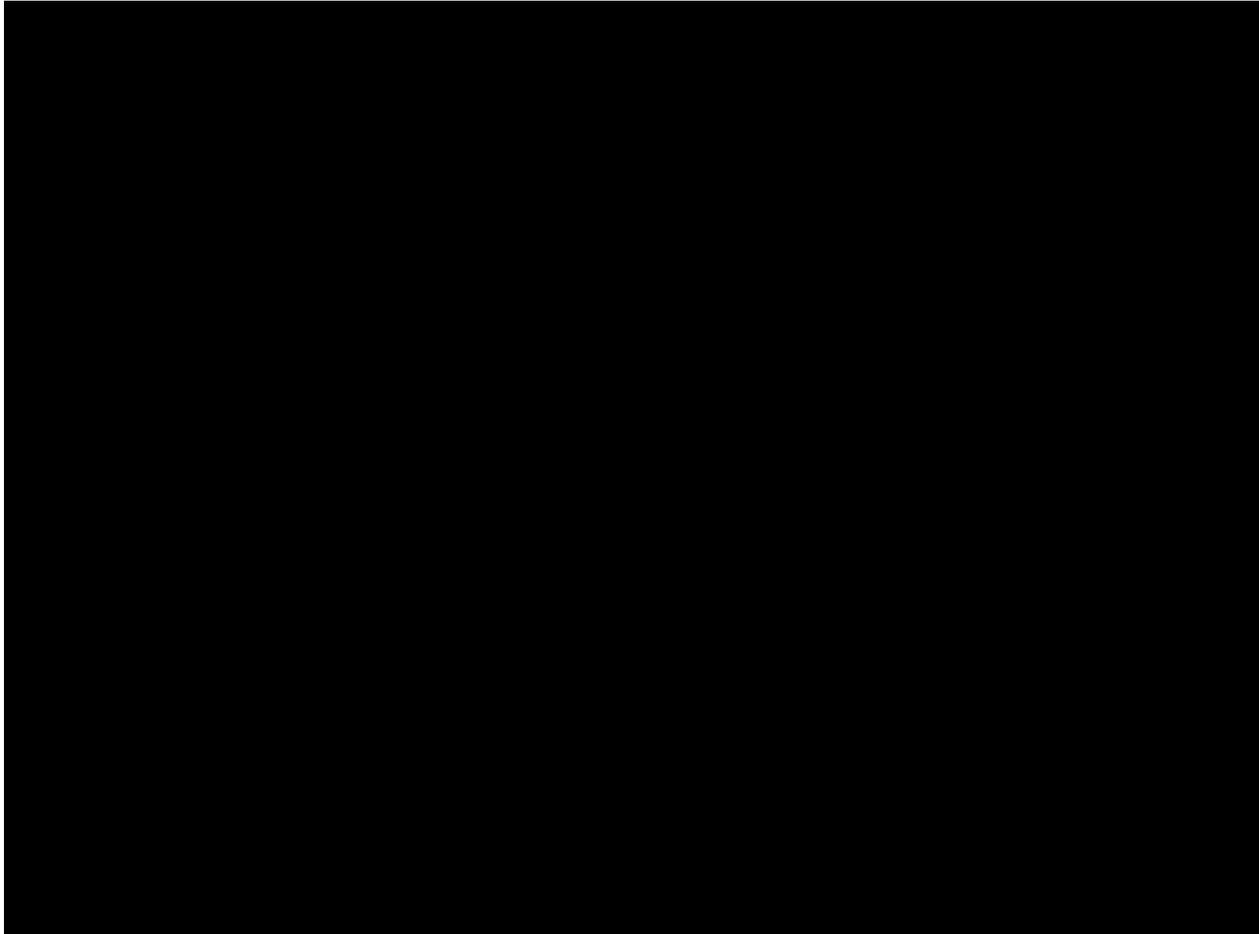


Aortic valve vegetation (Parasternal long axis view TTE)



Aortic valve shows large vegetations of both leaflets.

Large vegetation of ant MV leaflet. (TEE)



Large vegetation of the anterior MV leaflet. The posterior leaflet appears to have limited mobility, suggesting mitral stenosis.

Natural history of vegetations

- **Increase in size**
 - active disease, ominous sign (embolic risk)
- **Persistent after bacterial cure.**
- **Organism:** important determinant of vegetation size.
 - *S. aureus*: ↑ in size or were unchanged during 4~8 weeks of Tx
 - *S. viridans*: more commonly ↓ in size

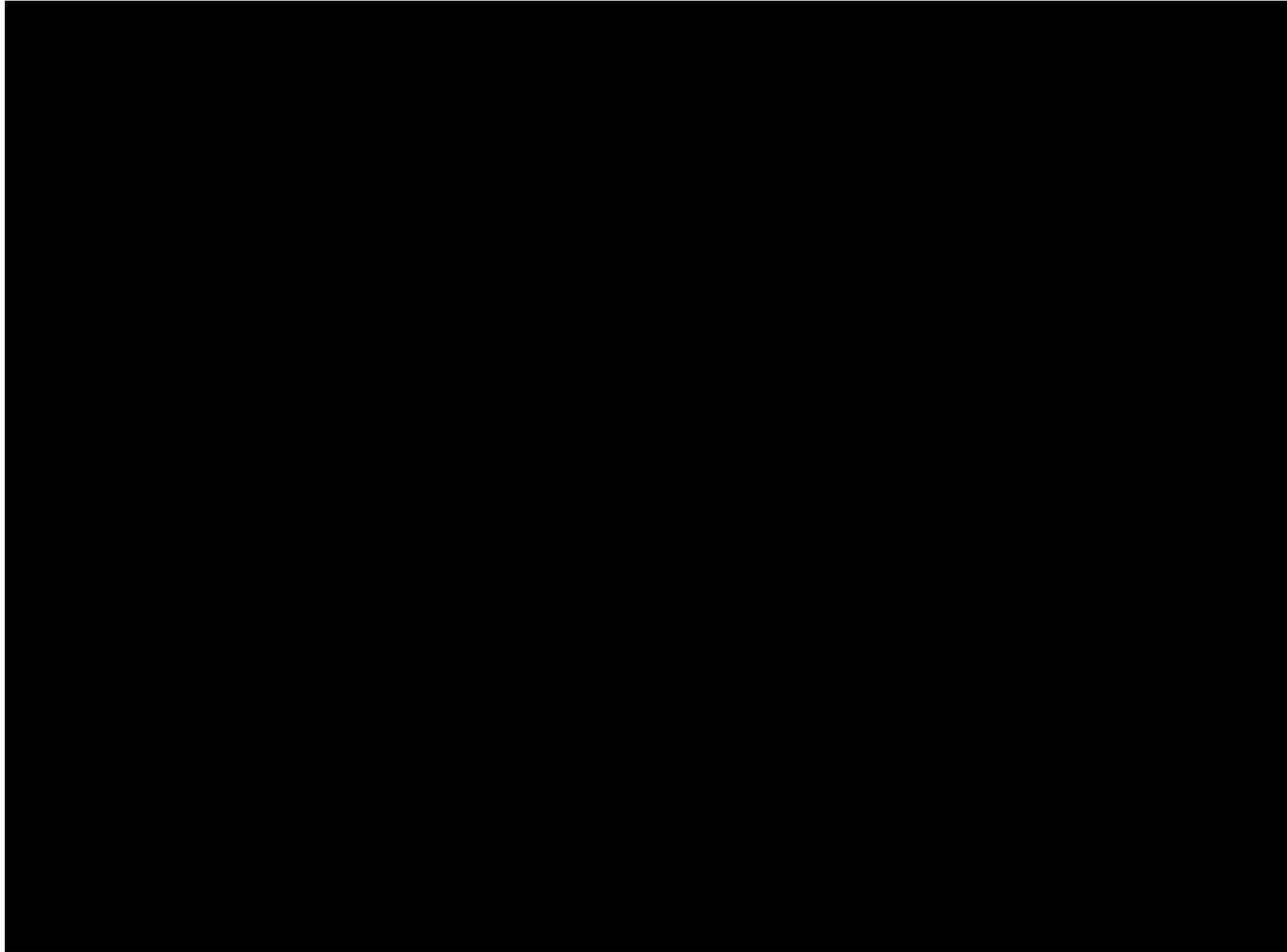
Detection of vegetation

	TTE only	TEE only	TTE with TEE
sensitivity	≅ 75 %	≅ 85~90 %	>>95%
Limitation	<ul style="list-style-type: none">• Small vegetations (<3 mm)• Underestimates the size and complexity	<ul style="list-style-type: none">• Invasive• expensive	

Recognition of intracardiac Cx of endocarditis

- Valve Regurgitation
- Valve perforation
- Abscess / fistula formation

AV endocarditis with regurgitation (Parasternal long axis view TTE)



Marked LV dilatation, severe AR

Perivalvular abscess or fistula

- The 2nd major criterion
- Aortic valve > Mitral-aortic intervalvular fibrosa.
- Prosthetic valve
- *S. aureus* : most likely.
- **Echo findings**
 - Perivalvular zone of ↓ echo density, without color flow inside.
 - Clear free-space in the aortic root

sensitivity		
TTE only	TEE only	TTE with TEE
≅ 50 %	≅ 90 %	>>90%

both TTE and TEE are mandatory

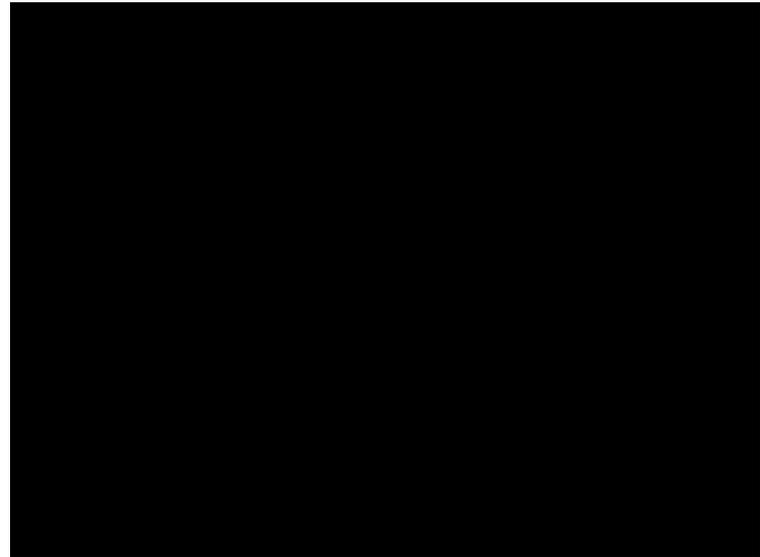
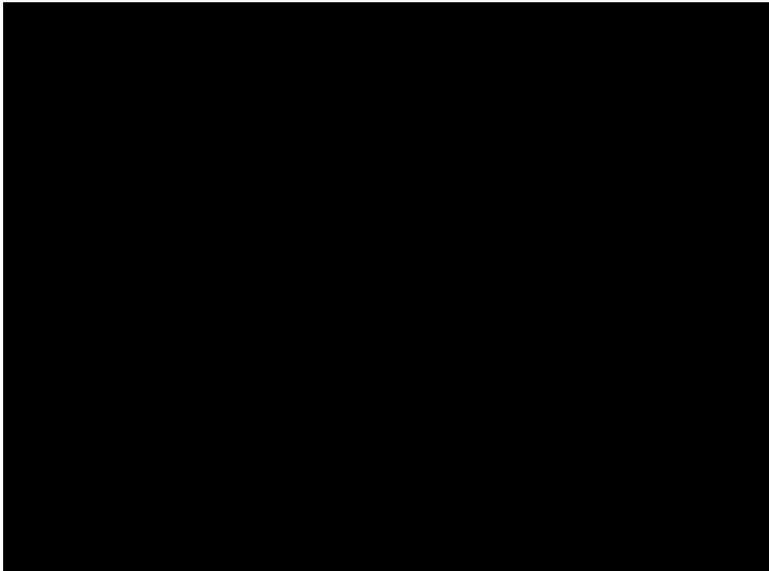
Vegetations of AV leaflets, abscess of the MV annulus. (TEE)



Vegetations of the AV leaflets due to endocarditis and an abscess of the mitral valve annulus

Right-sided Endocarditis

- MC: *S. aureus*
- Marked ↑ mortality (>2 cm vegetation)
- Pulmonic valve ,RV pacemaker or device leads or indwelling catheters
- Both TTE=TTE(sensitivity, specificity)
- RV function, Pulmonary pressures estimation



Prosthetic valve endocarditis

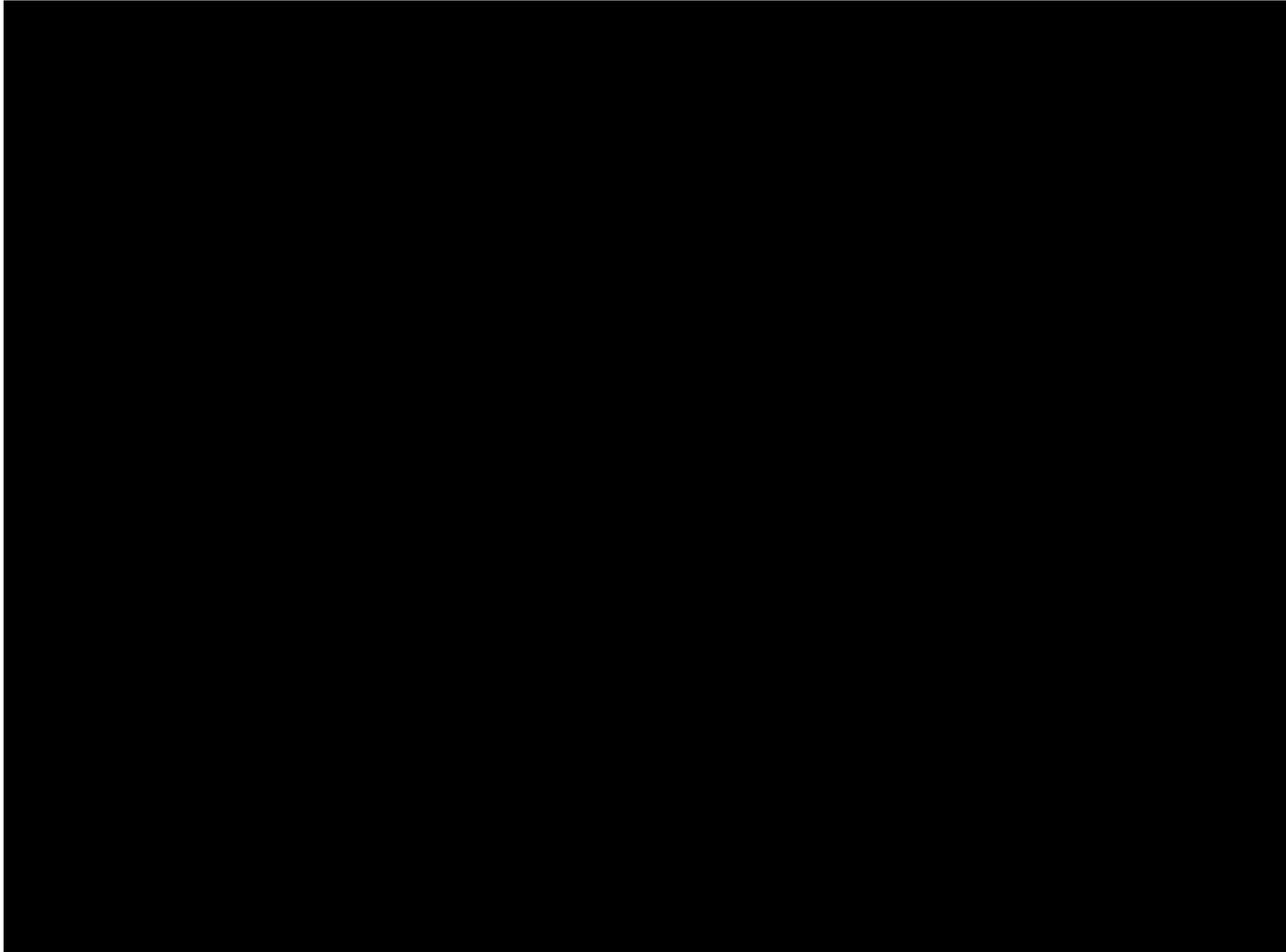


- New perivalvular regurgitation
- **TEE** >> TTE
- Negative predictive value of TEE: 100 %
- Echocardiographic findings
 - vegetations, impair leaflet motion, perivalvular abscess / fistula formation, valve dehiscence.
 - Paravalvular regurgitation(mod~ severe) 🖱️ suggestive

Multiple hazy echos on the prosthetic MV compatible with vegetations from endocarditis

Vegetation on pacemaker wire

TEE bicaval view



Large vegetation on a pacemaker electrode suggesting an infected wire

Estimation of Complications

- **Three Major Cx**
 - Heart Failure
 - Perivalvular abscess
 - Embolism
- **Overall incidence** of Cx: 55%
 - Native \approx Prosthetic valves
 - Mitral \approx aortic \approx tricuspid \approx prosthetic valve
-  **Urgent TTE/TEE:** as soon as suspected
- **Indications for early surgery**

Complications

- **Clinical Manifestations**

- Drug failure requiring a change in antibiotic Tx
- New onset CHF, embolization, surgery and death

- **Specific risk factors**

- **Size & mobility** : most powerful predictor
 - 10 % in 6 mm , 50 % in 11 mm, 100% \geq 16 mm
- **Higher mobility** and lesion extent.
- Discernible valvular abnormalities (27%)
- **Initial** \uparrow in during appropriate antibiotics
- **Staphylococcus**
- **Mitral valve** vegetations
- **Enlarged or remained** static during 4~8weeks of Tx.

Embolic events

- Common, severe Cx (20–50%)
- Risk
 - First 2 weeks of antibiotic Tx
 - Depends
 - Size, mobility, location, previous embolism, microorganism
 - duration of antibiotic Tx.
 - Large (>10–15mm), very mobile
 - TEE: key to Dx
- Requires systematic TTE & TEE

Intraoperative TEE.

Key points

- Useful for the planning of surgery
- Conservative valve surgery / complex procedures.

Recommendation:

- all patients with IE undergoing cardiac surgery.

Echo for F/U & Prognostic assessment

Echo F/U and Prognostic assessment

- 1) At admission
- 2) F/U under Tx
- 3) F/U after discharge & long-term prognosis

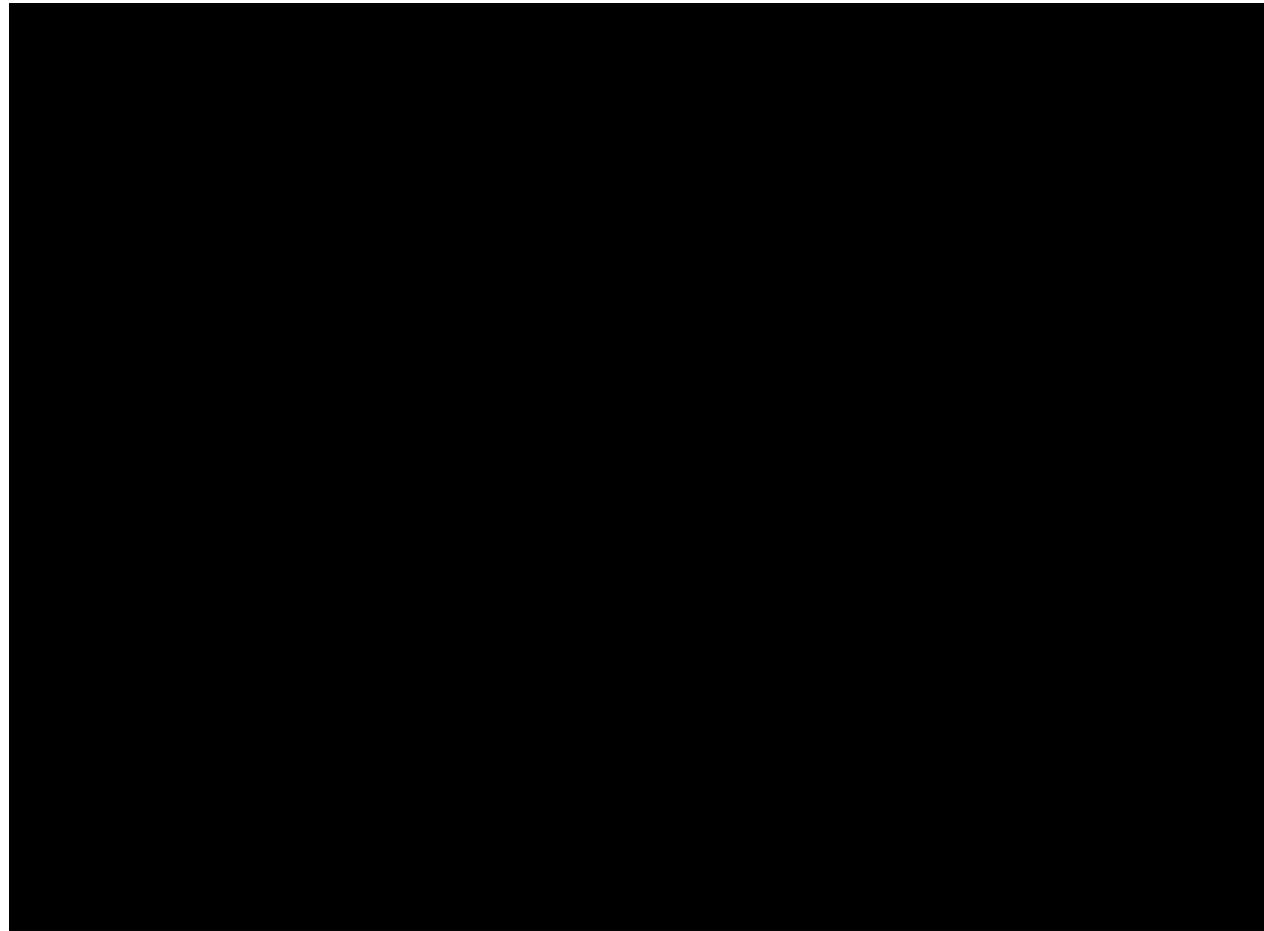
Repeat TTE / TEE is recommended

- 1) As soon as a new complication is suspected.
- 2) F/U , monitor
- 3) Before discharge for comparison.
- 4) Periodic F/U is mandatory during the first year after the end of antibiotic Tx.

Conclusion

- Index of suspicion is important
- Echo. plays a key role in IE
 - Dx, Cx, F/U , Px assessment.
 - Before surgery / during surgery(intraop TEE)
- Recent advances in 3D Echo
- Results of echo. may be interpreted taking into account the clinical features.

Mitral valve ring dehiscence in IE (3D, TEE)



Limitations and pitfalls of Echo.

Clinician must be aware that:

1. Sensitivity / specificity of TTE / TEE : **not 100%**
2. Negative echo. findings does **not R/O IE**
3. **Repeat** TTE/TEE may be necessary.
4. **Must be interpreted with** caution, taking into account the clinical presentation



- Thank you for your attention!