Role of Echocardiography in Infective Endocarditis (IE)

중앙대학교

윤 신 원
When to perform Echocardiography in IE?

- **Vegetations?** (pathologic hallmark)
- Intracardiac abscess?
- 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 criteria
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
Recommendations for Echo
The AHA/ACC guideline

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

Prosthetic valve intracardiac device

Non-diagnosis TTE

(+)ve TTE

(-)ve TTE

Clinical suspicion of IE

HIGH

LOW

Stop

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

Authors/Task Force Members et al. Eur Heart J 2015;eurheartj.ehv319
Modified Duke criteria for Dx of IE

**Clin Infect Dis. 2000;30(4):633**

**Circulation. 2015;**

<table>
<thead>
<tr>
<th>Definitive IE: any of the Following:</th>
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</thead>
<tbody>
<tr>
<td>Pathologic criteria</td>
</tr>
<tr>
<td>Pathologic lesions: vegetation or intracardiac abscess demonstrating active endocarditis on histology <strong>OR</strong></td>
</tr>
<tr>
<td>Microorganism: demonstrated by culture or histology of a vegetation or intracardiac abscess</td>
</tr>
<tr>
<td>Clinical criteria</td>
</tr>
<tr>
<td>Using specific definitions listed in Table B:</td>
</tr>
<tr>
<td>2 major clinical criteria <strong>OR</strong></td>
</tr>
<tr>
<td>1 major and 3 minor clinical criteria <strong>OR</strong></td>
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<tr>
<td>5 minor clinical criteria</td>
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<tr>
<td>Possible IE</td>
</tr>
<tr>
<td>Presence of 1 major and 1 minor clinical criteria <strong>OR</strong> presence of 3 minor clinical criteria</td>
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<tr>
<td>Reject IE</td>
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<tr>
<td>A firm alternate diagnosis is made <strong>OR</strong></td>
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<tr>
<td>Resolution of clinical manifestations occurs after ≤4 days of antibiotic therapy <strong>OR</strong></td>
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<tr>
<td>No pathologic evidence of infective endocarditis is found at surgery or autopsy after antibiotic therapy for four days or less</td>
</tr>
<tr>
<td>Clinical criteria for possible or definite IE not met</td>
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</table>
**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 galolyticus* (formerly *S. bovis*), including nutritional variants, *spp and Abiotrophia defectiva*
  - HACEK group: *Haemophilus* spp, *Aggregatibacter* (formerly *Actinobacillus actinomycetemcomitans*), *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 samples drawn \( >12 \) hours apart

For organisms that are more commonly skin contaminants: Three or a majority of \( \geq 4 \) 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

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*Clin Infect Dis. 2000;30(4):633*  
*Circulation. 2015*
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

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Predisposition</strong></td>
<td>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)</td>
</tr>
<tr>
<td><strong>Fever</strong></td>
<td>Temperature ≥38.0°C (100.4°F)</td>
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<tr>
<td><strong>Vascular phenomena</strong></td>
<td>Major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, or Janeway lesions</td>
</tr>
<tr>
<td><strong>Immunologic phenomena</strong></td>
<td>Glomerulonephritis, Osler nodes, Roth spots, or rheumatoid factor</td>
</tr>
<tr>
<td><strong>Microbiologic evidence</strong></td>
<td>Positive blood cultures that do not meet major criteria OR supportive evidence of active infection with organism consistent with IE</td>
</tr>
<tr>
<td><em>(Echocardiographic minor criteria eliminated)</em></td>
<td></td>
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</table>

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 shows large vegetations of both leaflets.
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

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<tr>
<th>TTE only</th>
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<th>TTE with TEE</th>
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<tr>
<td>sensitivity</td>
<td>≅ 75 %</td>
<td>≅ 85~90 %</td>
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</table>
| Limitation | • Small vegetations (<3 mm)  
• Underestimates the size and complexity | • 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

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<tr>
<td>Sensitivity</td>
<td>≦ 50 %</td>
<td>≦ 90 %</td>
<td>&gt; &gt;90%</td>
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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
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 ≒ Prosthetic valves
  - Mitral ≒ aortic ≒ tricuspid ≒ 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% ≥16 mm
  - Higher mobility and lesion extent.
  - Discernible valvular abnormalities (27%)
  - Initial ↑ in during appropriate antibiotics
  - *Staphylococcus*
  - *Mitral valve* vegetations
  - Enlarged or remained static during 4~8 weeks 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
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!