Echocardiography in Infective Endocarditis

Sheila K. Heinle, M.D., FASE
Texas Heart Institute at
CHI Baylor St. Luke’s Medical Center
Associate Professor, Baylor College of Medicine
Houston, Texas
Infective Endocarditis

**Incidence:** 20,000-30,000 new cases/yr

**At Risk:** Cardiac Devices, Age, DM

**Microorganism:** Staph aureus, Strep viridans

**Mortality:** 20-25%

AHA Guideline Circulation 2007
Thuny et al. Lancet 2012
DeSimone et al. Circulation July 2012
Duval et al. JACC, May 2012
2015 AHA Scientific Statement

Initial TTE in all patients with suspected IE

- Quantifying Hemodynamic Dysfunction
- Valvular Regurgitation, esp. right sided
- Ventricular Dysfunction
- Left and Right Filling Pressures and PAP
- Meal within 6 hours
- Emergent TEE unavailable

Circulation 2015;132:1435
Questions to be answered by Echo

- Presence, location, and morphologic characteristics of vegetation
Questions to be answered by Echo

- Severity of valvular destruction
- Complications
- Hemodynamic effects
Questions to be answered by Echo

- Severity of valvular destruction
- Complications
- Hemodynamic effects
Echo ≠ screening test for fever

“Echo is NOT indicated for evaluation of transient fever without evidence of bacteremia or new murmur (class III).”

2011 ACC/AHA/ASE Appropriate Use Criteria for Echocardiography
Defining a low probability for IE by the collective absence of these criteria

<table>
<thead>
<tr>
<th>Clinical Criteria</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embolism</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Central venous access</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Injected drug use</td>
<td>0.002</td>
</tr>
<tr>
<td>Prosthetic valve</td>
<td>0.03</td>
</tr>
<tr>
<td>Positive blood culture</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Greaves et al. Heart 2003
Duke Criteria for Infective Endocarditis

Major Echo Criteria

- Vegetation
- New valvular regurgitation
- Abscess
- Prosthetic valve dehiscence

Technological Advances

- Harmonic Imaging
- Three-dimensional echocardiography
- PET – CT Scan
- MRI

Kort JASE 2006; 19:130
Nemes JASE 2006;19:355.e13
Thuny et al. Lancet March 2012
Fagman Eur Radiol 2012
Feuchtn JACC 2009
Duval Ann Intern Med 2010
PET/CT Scan for Prosthetic Valve IE

Saby et al. J Am Coll Cardiol 2013;61:2374
Thuny et al. Can J Cardiol 2014;20:1046
Incremental Value of TEE

Increases Diagnostic Accuracy of the Duke Criteria by:

Native valves 11%

Prosthetic valves 34%

Roe et al. Am Heart J 2000
Sensitivity of Echo for Vegetations

Native Valves

TTE  75%
TEE  90%

Habib et al. JACC 1999
Transthoracic Echocardiography

<table>
<thead>
<tr>
<th>Vegetation Size</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5mm</td>
<td>25%</td>
</tr>
<tr>
<td>6-10mm</td>
<td>70%</td>
</tr>
<tr>
<td>&gt;10mm</td>
<td>100%</td>
</tr>
</tbody>
</table>
## Sensitivity of Echo for Vegetations

<table>
<thead>
<tr>
<th></th>
<th>Native</th>
<th>Prosthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTE</td>
<td>75%</td>
<td>36%</td>
</tr>
<tr>
<td>TEE</td>
<td>90%</td>
<td>86%</td>
</tr>
</tbody>
</table>
Transthoracic Echocardiography

False negative

- Small vegetation (<5mm)
- Prosthetic valve
- Poor acoustic window
- Timing of echo exam
Transthoracic Echocardiography

**False positive**
- Non-specific focal thickening
- Myxomatous valve
- Thrombus or pannus formation
- Ruptured chordae
- Flail leaflet
Transthoracic Echocardiography

Torn MV
Chordae
Indications for TEE

- Prosthetic valves\(^1,8\)
- High pretest probability of infective endocarditis\(^1-3,8\) or suspected complications\(^1,4\)
- Infected pacemaker lead\(^5,8\)
- Pulmonic valve endocarditis
- Staph. aureus or fungemia w/o clear source\(^1,6,8\)
- Culture negative endocarditis\(^7\)

1. AHA Scientific Statement, *Circulation* 2005
5. San Roman et al. *JACC* 1993
8. Douglas et al. AUC *JACC/JASE* 2011
# Superior Diagnostic Value of TEE

<table>
<thead>
<tr>
<th>Infected PL</th>
<th>Abscess</th>
<th>CN</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTE</td>
<td>23%</td>
<td>28%</td>
</tr>
<tr>
<td>TEE</td>
<td>94%</td>
<td>87%</td>
</tr>
</tbody>
</table>

San Roman et al. JACC 1993  
Daniel et al. NEJM 1991  
Kupferwasser et al. Am Heart J 2001
Infected Cardiac Device Outcome

Athan et al. JAMA April 2012

No. at risk
Device removal 141 112 98 94 92 87 84 80
No device removal 34 22 19 17 16 14 13 12

No. at risk
No valve infection
Device removal 79 66 61 59 57 54 53 50
No device removal 25 18 15 14 13 11 11 10
Valve infection
Device removal 62 46 37 35 35 33 31 30
No device removal 9 4 4 3 3 3 2 2

Log-rank P = .009

Log-rank P < .001
Predictors of Endocarditis in Staph. Aureus Bacteremia

- Community acquired bacteremia
- Intracardiac device or prosthetic valve
- Prolonged bacteremia ≥ 72 hours

Clin. Infect. Disease 2015;61;18
Potential Echo Indications for Surgery

Vegetation

Persistent after embolization
AMVL > 10 mm
Increased size on Abx

Valve dysfunction

Acute AR or MR with CHF
CHF on medical tx

Valve perforation/rupture

Perivalvular extension
dehiscence, rupture, fistula
new or extended abscess (HB)

AHA Scientific Statement, Circulation 2015
TEE for Suspected Complications of Infective Endocarditis
2015 AHA Scientific Statement

• TEE if TTE is negative or inadequate with ongoing suspicion for IE or complications with positive initial TTE

• Repeat TEE in 3-5 days if high suspicion and neg. TEE

• Repeat TEE if suspect IE complications after positive initial TEE

Circulation 2015;132:1435
TEE three days after negative TTE
Class I indications for Echo re-evaluation:

1. Virulent microorganism
2. Hemodynamic compromise
3. Aortic valve involvement
4. Persistent fever or bacteremia
5. Symptomatic deterioration
## Percent Reclassified After Repeat Exams

<table>
<thead>
<tr>
<th># of exams</th>
<th>TTE</th>
<th>TEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>21.2%</td>
<td>68.5%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>13.5%</td>
<td>46.9%</td>
</tr>
<tr>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>7.5%</td>
<td>20.0%</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Baddor Circulation 2005;111:3167-64
AHA Scientific Statement 2005
Prosthetic Valve Endocarditis

Positive Predictive Value of 94% by the presence of:

- Valve Dehiscence
- Pseudoaneurysm
- Fistula
- Mod/Sev. Paravalvular Regurgitation

Vegetations detected in only 50%

Ronderos et al. JASE 2004
Prosthetic Valve Endocarditis?
Prosthetic Valve Endocarditis?
Post TAVR Endocarditis

Clinical Findings:
1. Incidence < 1%, Median time: 5 months
2. Staph, Enterococcal infection
3. Hosp. Mortality 47%, at 1 year 66%

Echo Findings:
1. Leaflet vegetations
2. Severe mitral regurgitation
3. Rupture or perforation of AMVL
4. LVOT – LA Fistula

Circulation 2015;131:1566
J Am Coll Cardiol Intv 2015;8:334
Post TAVR Endocarditis
Outcome after Treatment

Thuny et al. Am Heart J. 2012
# Prognostic Value of Infected Site

<table>
<thead>
<tr>
<th>Site of Infection</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Aortic &amp; Prosthetic Valves</td>
<td>Mortality, Abscess, Surgery</td>
</tr>
<tr>
<td>• Mitral Valve</td>
<td>Emboli</td>
</tr>
</tbody>
</table>

Rohmann et al. Eur Heart J 1992  
Buda et al. Am Heart J. 1986  
Hoen et al. JAMA 2002
Vegetation Mobility

Di Salvo et al. JACC 2001

% embolic events

12/53
9/52
11/31
34/42

Absent  Low  Moderate  Severe

Vegetation mobility
Vegetation Mobility
Embolic Complications of Infective Endocarditis
### Does Echocardiographic Vegetation Size Predict Embolic Events?

<table>
<thead>
<tr>
<th>Study</th>
<th>Relationship</th>
<th>n</th>
<th>EE(%)</th>
<th>Echo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutas et al.</td>
<td>Negative</td>
<td>77</td>
<td>22</td>
<td>TTE</td>
</tr>
<tr>
<td>Mugge et al.</td>
<td>Positive</td>
<td>105</td>
<td>31</td>
<td>TTE/TEE</td>
</tr>
<tr>
<td>Jaffe et al.</td>
<td>Negative</td>
<td>70</td>
<td>43</td>
<td>TTE</td>
</tr>
<tr>
<td>Sanfilippo</td>
<td>Positive</td>
<td>204</td>
<td>33</td>
<td>TTE</td>
</tr>
<tr>
<td>Steckelberg</td>
<td>Negative</td>
<td>207</td>
<td>13</td>
<td>TTE</td>
</tr>
<tr>
<td>Rohmann</td>
<td>Positive</td>
<td>118</td>
<td>26</td>
<td>TEE</td>
</tr>
<tr>
<td>Heinle et al.</td>
<td>Negative</td>
<td>41</td>
<td>49</td>
<td>TTE</td>
</tr>
<tr>
<td>Werner et al.</td>
<td>Positive(&gt;20)</td>
<td>106</td>
<td>35</td>
<td>TTE/TEE</td>
</tr>
<tr>
<td>DeCastro</td>
<td>Negative</td>
<td>57</td>
<td>44</td>
<td>TTE/TEE</td>
</tr>
<tr>
<td>Di Salvo</td>
<td>Positive</td>
<td>176</td>
<td>37</td>
<td>TEE</td>
</tr>
</tbody>
</table>
Incidence of Embolic Events in Patients With Infective Endocarditis

Conclusions

1. **Pre-test probability of disease** determines the diagnostic utility of the echocardiogram

2. TEE is indicated for high clinical suspicion of IE or its complications

3. Large (>10mm) mobile MV vegetations by TEE are associated with greater incidence of clinical emboli.
Conclusions

4. Multicenter randomized clinical trials are necessary to study the role of new diagnostic modalities, treatment strategies and clinical factors affecting outcome.

5. The absence of vegetations does not eliminate the diagnosis of IE or the risk of embolic complications.

6. Appropriate use of echocardiography for suspected endocarditis should be guided by sound clinical judgement.