The Infected Tricuspid Valve

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Executive Director of the Bluhm Cardiovascular Institute
Chief of Cardiac Surgery Division
Heller-Sacks Professor of Surgery in the Feinberg School of Medicine

Michigan Society of Thoracic and Cardiovascular Surgery 53rd Annual Meeting
August 10, 2018
Crystal Mountain
Thompsonville, MI
Disclosure

• Edwards Lifesciences: Consultant; Mc3 Royalties
Case
TV endocarditis

- 27 year old female
- IVDU
- Severe TR with EF 30%
- *Staph Aureus*
Severe TR
TV endocarditis
Objectives

• Describe the controversy surrounding surgical treatment of tricuspid valve endocarditis
• Review Guidelines
• Latest Information on Outcomes
• Special Situations and Tips
• New Approaches
Key Facts

Tricuspid valve endocarditis

• Up to 86% of TV endocarditis is due to intravenous drug use (IVDU)

• More than 60% of TV endocarditis is associated with *Staphylococcus Aureus*

• 30-day mortality of 7.3%

• High recurrence rate, especially in IVDU
Controversy
TV endocarditis

• When to operate?

• What operation?
Current Outcomes for Tricuspid Valve Infective Endocarditis Surgery in North America

Jeffrey G. Gaca, MD, Shubin Sheng, PhD, Mani Darmoehrad, MD, | Scott Raskin, MD, Matthew L. Williams, MD, Sean M. O’Brien, PhD, and James S. Gammie, MD

Background. Tricuspid valve (TV) infective endocarditis (IE) accounts for 1-2% of IE cases and was mostly in the context of medical therapy. Surgical intervention is rare, and understanding of treatment options is based on small series of patients. The purpose of this study was to describe the population and outcomes for isolated TV IE using the Society of Thoracic Surgeons Adult Cardiac Databases. Methods. Between 2002 and 2008, 910 operations for TV IE were performed. Procedures included replacement, and valve repair. Sixty-three (7.0%) patients had Staphylococcus aureus as the causative agent. Results. Of 747 patients, 491 (66.2%) were male, with a mean age of 63 years (range 18-88). Mean EuroSCORE II was 22.6% (range 0-79%). Overall mortality rates among the 910 patients were 30-day mortality 3.3% (n=30), 30-day mortality 6.3% (n=30), 30-day mortality 7.6% (n=30), and 30-day mortality 12% (n=30). Survival analysis revealed no significant difference in mortality among surgical subgroups (p = 0.34).

Conclusions. Isolated TV IE is a rare clinical entity with a variety of surgical options to individualize the treatment. The outcomes of surgical treatment for TV IE were favorable, with low mortality rates. The low incidence of TV IE may be attributed to the use of antibiotics and the early detection and treatment of IE.

STS database
TV endocarditis
910 operations
30-day mortality
- Valvectomy – 12%
- Valve repair – 7.6%
- Valve replacement – 6.3%

p = 0.34

The incidence of tricuspid valve IE has been steadily increasing over the last 2 decades [2, 3]. The primary causes are intravenous drug use, right sided cardiac device implantation, central venous catheterization, and repaired congenital defects, all of which are increasing in prevalence [2]. Most patients with tricuspid valve IE can be treated successfully with antibiotic therapy but in approximately 20% of cases, persistent infection, symptomatic valvular regurgitation, concomitant left-sided infection, or recurrent septic pulmonary embolic complications necessitate surgical intervention [4].
When to operate - TV endocarditis

- RH failure secondary to severe TR  
  class IIa

- Vegetation >20mm + PE  
  class IIa

- Difficult-to-treat organism  
- Sustained infection  
  class IIa


Avoid surgery when possible in IV drug user

Surgical Management of Tricuspid Valve Infective Endocarditis: A Systematic Review and Meta-Analysis

Bobby Yanagawa, MD, PhD, Malak Elbatarny, MD, Subodh Verma, MD, F
Samantha Hill, MD, Amine Mazine, MD, John D. Puskas, MD, and
Jan O. Friedrich, MD, DPhil

Ann Thorac Surg 2018, in press

Fig 1. MEDLINE and EMBASE were searched for all records until 2016. Abstracts were reviewed for 1,072 citations. Thirteen studies were retrieved for full text review, and after excluding one study published only as an abstract, 12 studies met inclusion criteria after full article review. (MeSH = medical subject headings.)
What operation?
TV endocarditis

Surgical Management of Tricuspid Valve Infective Endocarditis: A Systematic Review and Meta-Analysis

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“The main outcomes were mortality, recurrent IE, and need for reoperation...The most common indications for surgery were septic pulmonary embolism, left-sided IE, right-side heart failure, and persistent bacteremia. Median repair proportion was 59% and replacement was 41% among studies. The primary repair strategies are vegetectomy, De Vega procedure, annuloplasty ring, bicuspidization, and leaflet patch augmentation. Of valve replacements, 83% were bioprosthetic and 17% mechanical prostheses. There were no differences in perioperative mortality between tricuspid valve repair versus replacement (relative risk [RR] 0.62, 95% confidence interval [CI]: 0.26 to 1.46, p [ 0.3).”

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Valve repair was associated with lower recurrent IE (RR 0.17, 95% CI: 0.05 to 0.57, p < 0.004) and need for reoperation (RR 0.26, 95% CI: 0.07 to 0.92, p < 0.04) but a trend toward greater risk of moderate to severe tricuspid regurgitation (RR 4.14, 95% CI: 0.80 to 21.34, p < 0.09). Furthermore, tricuspid valve repair is associated with lower need for permanent pacemaker (RR 0.20, 95% CI: 0.11 to 0.35, p < 0.001).
Valve repair rather than replacement is the operation of choice for TV endocarditis, according to Baddour, L.M., et al. (2015). This recommendation is classified as class I.

Principles of surgery

“The principles of surgery for TVIE include radical debridement of vegetations/infected tissue and valve repair whenever possible. If the valve is largely destroyed and non-repairable, and if the pulmonary pressures and vascular resistance are elevated, replacement is necessary (1,5,7). If pulmonary vascular resistance is low-normal, excising the valve without replacement may work as a temporary solution (1,3). In IVDUs patients, who are most likely young and non-compliant, valve replacement is associated with a higher risk of recurrent infection and reoperation (7).”
Tricuspid valve endocarditis

Syed T. Hussain¹, James Witten², Nabin K. Shrestha³, Eugene H. Blackstone¹, Gösta B. Pettersson¹

Tricuspid valve excision

“Complete excision of the TV without prosthetic replacement was first described by Arbulu *et al*. (25). They reported 64% survival among 53 IVDUs patients, 22 years after valvulectomy (25). However, in up to a third of patients it will cause ascites, peripheral edema and low cardiac output due to right ventricular dysfunction within 6–9 months. Surprisingly, valvectomy accounted for 7.2% of operations performed for TVIE in North America (3). TV excision for IE should be limited to extreme cases only, and only if pulmonary artery pressure and vascular resistance are not elevated (1). Subsequent valve replacement should be considered once the infection is resolved.”
“A rarely considered third surgical option is tricuspid valvectomy, which has been proposed to completely avoid any foreign material in cases of high recidivism in the intravenous drug use population, intractable infection, or poor compliance with antibiotic therapy [11]. It may be offered as a staged or a palliative procedure; it is poorly tolerated in patients with moderate-severe pulmonary hypertension, and approximately 20% of patients have acute right-sided hemodynamic compromise [11, 12].”
Surgical Management of Tricuspid Valve Infective Endocarditis: A Systematic Review and Meta-Analysis

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Fig 2. Forest plot for postoperative tricuspid regurgitation (TR): individual study and pooled risk ratios (RRs) in unadjusted observational studies comparing patients with tricuspid valve repair versus replacement. The pooled RRs with 95% confidence interval (CI) were calculated using random-effects models. (IV = independent variable.)

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Repair Events</th>
<th>Total</th>
<th>Replace Events</th>
<th>Total</th>
<th>Weight</th>
<th>Risk Ratio IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4.1 Post-Operative TR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renzulli (moderate) 1999</td>
<td>2</td>
<td>11</td>
<td>0</td>
<td>10</td>
<td>24.2%</td>
<td>4.58 [0.25, 85.33]</td>
</tr>
<tr>
<td>Capoun (&gt;trivial) 2010</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>11</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Morokuma (mod or sev) 2010</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>Not estimable</td>
<td></td>
</tr>
<tr>
<td>Baraki (Grade ≥2) 2013</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>18</td>
<td>23.6%</td>
<td>5.94 [0.31, 114.88]</td>
</tr>
<tr>
<td>Jiang (severe) 2011</td>
<td>1</td>
<td>24</td>
<td>0</td>
<td>4</td>
<td>0.0%</td>
<td>0.60 [0.03, 12.71]</td>
</tr>
<tr>
<td>Jiang (mod or sev) 2011</td>
<td>4</td>
<td>24</td>
<td>0</td>
<td>4</td>
<td>27.2%</td>
<td>1.80 [0.11, 28.42]</td>
</tr>
<tr>
<td>Dawood (severe) 2015</td>
<td>1</td>
<td>32</td>
<td>0</td>
<td>24</td>
<td>0.0%</td>
<td>2.27 [0.10, 53.47]</td>
</tr>
<tr>
<td>Dawood (mod or sev) 2015</td>
<td>4</td>
<td>32</td>
<td>0</td>
<td>24</td>
<td>25.0%</td>
<td>6.82 [0.38, 120.87]</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>85</td>
<td>12</td>
<td>0</td>
<td>69</td>
<td>100.0%</td>
<td>4.17 [0.99, 17.59]</td>
</tr>
</tbody>
</table>

Total events: 12

Heterogeneity: \( \tau^2 = 0.00 \); \( \chi^2 = 0.53 \), df = 3 (\( P = 0.91 \)); \( I^2 = 0.0 \%

Test for overall effect: \( Z = 1.95 \) (\( P = 0.05 \))
Surgical Management of Tricuspid Valve Infective Endocarditis: A Systematic Review and Meta-Analysis

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Fig 3. Forest plot for all-cause long-term mortality: individual study and pooled incidence rate ratios (IRRs) in unadjusted observational studies comparing patients with tricuspid valve repair versus replacement. The pooled IRRs with 95% confidence interval (CI) were calculated using random-effects models. (IV = independent variable.)

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>log[Incident Rate Ratio]</th>
<th>SE</th>
<th>Repair</th>
<th>Replace</th>
<th>Repair Total</th>
<th>Replace Total</th>
<th>Weight</th>
<th>Incident Rate Ratio</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renzulli 1999</td>
<td>-0.4607</td>
<td>0.866</td>
<td>11</td>
<td>0.2%</td>
<td>0.67 [0.12, 3.63]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musci 2007</td>
<td>-0.1697</td>
<td>0.2157</td>
<td>47</td>
<td>2.5%</td>
<td>0.84 [0.55, 1.29]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dawood 2015</td>
<td>-0.0116</td>
<td>0.0349</td>
<td>32</td>
<td>97.3%</td>
<td>0.99 [0.92, 1.06]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td></td>
<td></td>
<td>90</td>
<td>100.0%</td>
<td>0.98 [0.92, 1.05]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2 = 0.00; \chi^2 = 0.73, df = 2 (P = 0.69), I^2 = 0\%$

Test for overall effect: $Z = 0.47 (P = 0.64)$
Surgical Management of Tricuspid Valve Infective Endocarditis: A Systematic Review and Meta-Analysis

Bobby Yanagawa, MD, PhD, Malak Elbattar, MD, Subodh Verma, MD, PhD, Samantha Hill, MD, Amine Mazin, MD, John D. Puskas, MD, and Jan O. Friedrich, MD, DPhil
Ann Thorac Surg 2018, in press

Fig 4. Forest plot for all-cause follow-up mortality, reinfection, reoperation, and tricuspid regurgitation (TR): individual study and pooled risk ratios (RRs) in unadjusted observational studies comparing patients with tricuspid valve repair versus replacement. The pooled RRs with 95% confidence interval (CI) were calculated using random-effects models. (IV = independent variable; Mod = moderate; sever = severe.)
Tricuspid valve endocarditis

Syed T. Hussain¹, James Witten², Nabin K. Shrestha³, Eugene H. Blackstone⁴, Gösta B. Pettersson¹

Post-operative Outcomes

“Medical therapy remains the primary treatment and is effective, with surgery reserved for a minority of cases (1,4,19). TVIE has an in-hospital mortality of <10% and long-term mortality of <15% (1,2,19). Continuing IVDU is a significant risk factor for IE recurrence and death. S. aureus infection is another independent predictor of poor outcomes (1,5,22), as is hemodialysis (15), valve replacement (vs. repair) (7), vegetation >20 mm, fungal etiology and HIV infection with a CD4 count below 200 cells/μL (1).

Higher priority of surgery (emergency vs. urgent vs. elective) could be pointed to as an independent risk factor for early mortality as well (5).”
Special Situations and “Tips”

• TVIE with left side IE
• Indwelling leads
• Heart Block
Case Study NM

• 66 year old male with cardiac sarcoid s/p ICD implant in 2015, now with complete heart block
• Presented to ER in 2018 with back pain and fever, intermittent sweats several days
• Diagnostic findings:
  – Gram + cocci bacteremia
  – TEE with vegetations on RV wire and possibly on tricuspid valve
  – Abx started
  – Evidence of emboli to lungs
• Multidisciplinary decision to proceed with surgery
Case Study NM

OR findings

• RV lead across septal leaflet with 30 x 15 x 5 mm vegetation and abscess
MC¹ Ring Size 28 mm

Inner area = 3.46 cm²
9-9-13: MVR 29 Pericardial; LA Maze 28 MC3, close AP Commissure

The Challenge Of TV Imaging
TV Tethering
Early experience treating tricuspid valve endocarditis with a novel extracellular matrix cylinder reconstruction


18 patients
12 surgeons

Gerdisch, Marc
Boyd, Doug
Harlan, J. L.
Richardson, J. B., Jr.
Flack, J. E., 3rd
Palafox, B. A.
Johnson, W. E., 3rd
Sun, B.
Lee, Rick
Guy, Sloane
Gang, Gyu
Cox, Jim
Rao, Viv
Early experience treating tricuspid valve endocarditis with a novel extracellular matrix cylinder reconstruction.

Key findings

- 18 patients
- 0% 30-day mortality
- 0% pacemaker rate
- 3 (17%) valve dehiscence
- 1 (5.6%) recurrence rate
Conclusions: Cylinder reconstruction with ECM could be a suitable technique for replacing the tricuspid valve while preserving annuloventricular continuity in patients with infective endocarditis not repairable by conventional techniques.
Case

TV endocarditis

- 27 year old female
- IVDU
- Severe TR with EF 30%
- *Staph Aureus*
Pledged non-absorbable stitch to papillary head

TV endocarditis
Valve seating
TV endocarditis
Papillary muscles on the inside of the tube

TV endocarditis
Annular running stitch
TV endocarditis
Saline test

TV endocarditis
Intraop TEE – post repair
TV endocarditis
Dismissal TTE
TV endocarditis
The authors of this report present 19 patients who underwent a novel tricuspid valve replacement using a cylinder technique using CorMatrix. Importantly, only 8 patients had follow-up data available at 6 months, and only 3 patients had follow-up for 1 year. There were 3 patients who experienced failure of this de novo valve owing to sutures pulling through the papillary muscles.

Dr. Damien J. LaPar (Charlottesville, Va)

An acellular, non-crosslinked, extracellular matrix bioscaffold was used to construct a tubular bioprosthetic tricuspid valve. Following surgical implantation in sheep, the tubular valves demonstrated normal mechanical function and showed signs of progressive tissue remodeling over 12 months of study.

Atrial view of in vivo tricuspid valve after 5 months
PI - Joseph Dearani, MD
Kevin Accola, Marc Gerdisch, Andrew Lodge, David Morales, Eric Roselli, Patrick McConnell
Feasibility trial – 15 patients
Case Study

• 70 year old male with prior history of NICM, CHF, AF, HTN
• CRT implantation 2011, AV Nodal ablation 2013
• Septicemia and TV endocarditis (enterococcus faecalis endocarditis) with vegetations 2016, treated with IV and oral Abx
• Follow-up blood cultures again positive; 36 additional days of IV Abx
• Scheduled for lead extraction
Case Study

• 70 year old male with prior history of NICM, CHF, AF, HTN
• CRT implantation 2011, AV Nodal ablation 2013
• Septicemia and TV endocarditis (enterococcus faecalis endocarditis) with vegetations 2016, treated with IV and oral Abx
• Follow-up blood cultures again positive; 36 additional days of IV Abx
• Surgery? If so, Which Operation?
Case Study

Echo Results NM
Aspiration of TV Endocarditis with an 8F System

Yasir Akhtar MD
Tennova Health
Knoxville, TN
Presentation

• 30 year old Female presents with the ER unresponsive, hypotensive.

• Shock on vasopressors, Intubated with Acute Respiratory Failure

• History of IV Drug abuse with cocaine
Endocarditis with Septic Shock

- Continued Antibiotics
- Deemed high risk for sternotomy and valve debridement
- Poor respiratory status with left pneumothorax and effusion s/p chest tube placement
- ? Septic Pulmonary Emboli
- Eventual tracheostomy and PEG tube placement after 15 days
Percutaneous Aspiration

- Intracardiac ECHO guided – St Jude 10 F venous sheath
- Steerable Guide Sheath – Medtronic Tourguide 8.5 F
- Penumbra Cat8 8F Mechanical Aspiration System
IntraCardiac ECHO
Aspiration
ICE – After Aspiration
Specimen sent to Pathology
• Fevers resolved
• Leukocytosis improved
• Hgb down to 6.5 from 7.8 – Transfused 2 Units PRBCs
• Weaned off vent
• Discharged home after 45 days in the hospital
Conclusion

• Percutaneous “debridement” with an 8F mechanical aspiration system is effective, feasible and safe in patients deemed high risk for surgical debridement.

• Aspiration is limited by volume loss and post procedure transfusion needs

• More studies are needed in this area
Case Study

Surgical procedure

• AngioVac aspiration procedure attempted intraoperatively to allow for laser lead extraction
  – Several attempts to remove vegetation by interventional radiologist
  – Only small pieces removed
• ICD generator and lead removal via open sternotomy
  – 3cm vegetation adhered to atrial lead
  – CS and RV leads removed without difficulty
• Epicardial leads placed to left ventricle, right ventricle and atrial; new CRT device
Case Study

Echo Results Post removal
Conclusions

TV endocarditis

• Indications for surgery in TV endocarditis are not based on strong data

• Valve repair somewhat better than replacement (and valvectomy)

• ECM TVR is a novel solution for TV endocarditis and feasibility trials underway

• Aspiration for some High Risk Patients??
How to put in your own Photo:

Go to 'View'

Go to 'Insert'

Browse to the image you would like to place. Image should be 1024x768, 1200x900, or other 4:3 aspect ratio

Select image and click OK

Scale to full screen size if necessary.

Click image, go to 'Format'

Send to Back

Go to 'View'

return to slides

Thank you
Follow-up one year later

- Admitted to OSH for symptoms similar to prior endocarditis
  - Recent travel to Port-au-Prince
  - TEE showed stranded echodensity in RA and RV; cards review felt no vegetation on lead
  - BCx neg x 2

- Transferred to NM
  - TEE without vegetation
  - BCx neg x 3
  - Started Abx for 2 weeks empiric treatment
  - Dental extractions recommended and performed as outpatient

- To date continues without infection
Case study
Post-Discharge

- 6 weeks of Abx
- Repeat echo surveillance
CorMatrix 30mm x 5cm tube

TV endocarditis

30mm x 5 cm tube

Length = annulus x 1.2
TV inspection

TV endocarditis
TV excision

TV endocarditis
TV specimen
TV endocarditis
TV papillary muscles
TV endocarditis
Secure papillary head to tube

TV endocarditis
Unclamped, heart-beating

TV endocarditis
Intraop TEE – post repair
TV endocarditis
Surgical Indications
Left-Sided IE
IE Guidelines
AHA and ESC 2015

AHA Scientific Statement

Infective Endocarditis in Adults: Diagnosis, Antimicrobial Therapy, and Management of Complications
A Scientific Statement for Healthcare Professionals From the American Heart Association

Endorsed by the Infectious Diseases Society of America

Larry M. Baddour, MD, FAHA; Chair; Walter R. Wilson, MD; Arnold S. Buyer, MD; Vance G. Fowler, Jr, MD, MHS; Iman M. Tleyjeh, MD, MSc; Michael J. Rybak, PharmD, MPH; Bruno Barsic, MD, PhD; Peter B. Lockhart, DDS; Michael H. Gewitz, MD; FAHA; Matthew E. Levison, MD; Ann F. Bolger, MD, FAHA; James M. Steckelberg, MD; Robert S. Baltimore, MD; Anne M. Finak, PhD, RN; Patrick O’Gara, MD, FAHA; Kathryn A. Talbert, PhD, FAHA; on behalf of the American Heart Association Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease of the Council on Cardiovascular Disease in the Young, Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and Stroke Council

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)

Endorsed by: European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Nuclear Medicine (EANM)

Authors/Task Force Members: Gilbert Habib* (Chairperson) (France), Patrizio Lancellotti* (co-Chairperson) (Belgium), Manuel J. Antunes (Portugal), Maria Grazia Bongiorni (Italy), Jean-Paul Casalta (France), Francesco Del Zotti (Italy), Raluca Dulgheru (Belgium), Gebrine El Khoury (Belgium), Paola Anna Erba* (Italy), Bernard Jung (France), Jose M. Miro (Spain), Barbara J. Mulder (The Netherlands), Edyta Pionkska-Goscińska (Poland), Susanna Price (UK), Jollien Roos-Hesselink (The Netherlands), Ulrika Snygg-Martin (Sweden), Frantck Thuny (France), Pilar Tornos Mas (Spain), Isidre Vilacosta (Spain), and Jose Luis Zamorano (Spain)

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## Guidelines

**Surgical Indications for Left-Sided IE**

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>ESC 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Failure</td>
<td>Heart Failure</td>
</tr>
<tr>
<td>Uncontrolled Infection</td>
<td>Uncontrolled Infection</td>
</tr>
<tr>
<td>Prevention of Embolism</td>
<td>Prevention of Embolism</td>
</tr>
</tbody>
</table>
# Heart Failure

## Surgical Indications for Left-Sided IE

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>Class, LOE</th>
<th>ESC 2015</th>
<th>Class, LOE</th>
<th>Timing†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early surgery* is indicated in patients with IE who present with valve dysfunction resulting in symptoms or signs of HF</td>
<td>I, B</td>
<td>Aortic or mitral NVE, or PVE with severe acute regurgitation, obstruction, or fistula causing refractory pulmonary edema or cardiogenic shock</td>
<td>I, B</td>
<td>Emergency</td>
</tr>
<tr>
<td>Early surgery* is indicated in patients with PVE with symptoms or signs of HF resulting from valve dehiscence, intracardiac fistula, or severe prosthetic valve dysfunction</td>
<td>I, B</td>
<td>Aortic or mitral NVE, or PVE with severe regurgitation or obstruction causing symptoms of HF, or echocardiographic signs of poor hemodynamic tolerance</td>
<td>I, B</td>
<td>Urgent</td>
</tr>
</tbody>
</table>

*Indications for early surgery are based on symptoms or signs of heart failure (HF) and the severity of valve dysfunction. Early surgery is recommended for patients with severe valve dysfunction and symptoms of HF. Emergency surgery is indicated for conditions that require immediate intervention to prevent worsening of HF or other serious complications. Urgent surgery is recommended for situations that require prompt intervention but are not immediately life-threatening.
<table>
<thead>
<tr>
<th>Heart Failure</th>
<th>Surgical Indications for Left-Sided IE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AHA 2015</strong></td>
<td><strong>ESC 2015</strong></td>
</tr>
<tr>
<td>NVE causing HF</td>
<td>I, B</td>
</tr>
<tr>
<td>PVE causing HF</td>
<td>I, B</td>
</tr>
</tbody>
</table>
# Uncontrolled Infection

## Surgical Indications for Left-Sided IE

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>Class, LOE</th>
<th>ESC 2015</th>
<th>Class, LOE</th>
<th>Timing†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early surgery* is indicated in patients when IE is complicated by heart block, annular or aortic abscess, or destructive penetrating lesions</td>
<td>I, B</td>
<td>Locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation)</td>
<td>I, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Early surgery* is reasonable for patients with relapsing PVE</td>
<td>Ila, C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early surgery* should be considered, particularly in patients with IE caused by fungi or highly resistant organisms (e.g., VRE, multidrug-resistant gram-negative bacilli)</td>
<td>I, B</td>
<td>Infection caused by fungi or multiresistant organisms</td>
<td>I, C</td>
<td>Urgent/elective</td>
</tr>
<tr>
<td>Early surgery* is indicated for evidence of persistent infection (manifested by persistent bacteremia or fever lasting &gt;5–7 d, and provided that other sites of infection and fever have been excluded) after the start of appropriate antimicrobial therapy</td>
<td>I, B</td>
<td>Persisting positive blood cultures despite appropriate antibiotic therapy and adequate control of septic metastatic foci</td>
<td>Ila, B</td>
<td>Urgent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PVE caused by staphylococci or non-HACEK gram-negative bacteria</td>
<td>Ila, C</td>
<td>Urgent/elective</td>
</tr>
</tbody>
</table>
## Uncontrolled Infection

### Surgical Indications for Left-Sided IE

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>ESC 2015</th>
<th>Class, LOE</th>
<th>Class, LOE</th>
<th>Timing†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart block, abscess, or destructive penetrating lesions</td>
<td>Locally uncontrolled infection (abscess, false aneurysm, fistula, enlarging vegetation)</td>
<td>I, B</td>
<td>I, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Fungi or highly resistant organisms</td>
<td>Fungi or multiresistant organisms</td>
<td>I, B</td>
<td>I, C</td>
<td>Urgent/elective</td>
</tr>
<tr>
<td>Persistent infection</td>
<td>Persisting positive blood cultures</td>
<td>I, B</td>
<td>IIa, B</td>
<td>Urgent</td>
</tr>
</tbody>
</table>
**Prevention of Embolism**

**Surgical Indications for Left-Sided IE**

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>Class, LOE</th>
<th>ESC 2015</th>
<th>Class, LOE</th>
<th>Timing†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early surgery* is reasonable in patients who present with recurrent emboli and persistent or enlarging vegetations despite appropriate antibiotic therapy</td>
<td>Ila, B</td>
<td>Aortic or mitral NVE, or PVE with persistent vegetations &gt;10 mm after ≥1 embolic episode despite appropriate antibiotic therapy</td>
<td>I, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Early surgery* is reasonable in patients with severe valve regurgitation and mobile vegetations &gt;10 mm</td>
<td>Ila, B</td>
<td>Aortic or mitral NVE with vegetations &gt;10 mm, associated with severe valve stenosis or regurgitation, and low operative risk</td>
<td>Ila, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Early surgery* may be considered in patients with mobile vegetations &gt;10 mm, particularly when involving the anterior leaflet of the mitral valve and associated with other relative indications for surgery</td>
<td>IIb, C</td>
<td>Aortic or mitral NVE, or PVE with isolated very large vegetations (&gt;30 mm)</td>
<td>IIa, B</td>
<td>Urgent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aortic or mitral NVE, or PVE with isolated large vegetations (&gt;15 mm) and no other indication for surgery</td>
<td>IIb, C</td>
<td>Urgent</td>
</tr>
</tbody>
</table>
## Prevention of Embolism

**Surgical Indications for Left-Sided IE**

<table>
<thead>
<tr>
<th>AHA 2015</th>
<th>ESC 2015</th>
<th>Class, LOE</th>
<th>Class, LOE</th>
<th>Timing†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation with recurrent emboli</td>
<td>Vegetation with ≥1 embolic episode</td>
<td>IIa, B</td>
<td>I, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Mobile vegetations &gt;10 mm and severe valve regurgitation</td>
<td>Vegetations &gt;10 mm with severe valve stenosis or regurgitation</td>
<td>IIa, B</td>
<td>IIa, B</td>
<td>Urgent</td>
</tr>
<tr>
<td>Mobile vegetations &gt;10 mm, particularly when involving the AML</td>
<td>Very large vegetations (&gt;30 mm)</td>
<td>IIb, C</td>
<td>IIa, B</td>
<td>Urgent</td>
</tr>
<tr>
<td></td>
<td>Large vegetations (&gt;15 mm)</td>
<td>IIb, C</td>
<td>IIb, C</td>
<td>Urgent</td>
</tr>
</tbody>
</table>
Surgical Approach

Left-Sided IE
Clinical Practice Guidelines
Infective Endocarditis – Surgical Management

Surgical Management of Endocarditis: The Society of Thoracic Surgeons Clinical Practice Guideline

John G. Byrne, MD, Katayoun Rezai, MD, Juan A. Sanchez, MD, MPA, Richard A. Bernstein, MD, PhD, Eric Okum, MD, Marzia Leacche, MD, Jorge M. Balaguer, MD, Shyam Prabhakaran, MD, MS, Charles R. Bridges, MD, ScD, and Robert S. D. Higgins, MD, MSHA

Department of Cardiac Surgery, Vanderbilt University Medical Center, Nashville, Tennessee; Division of Infectious Diseases, Rush University, Chicago, Illinois; Department of Surgery, Saint Mary’s Hospital, Waterbury, Connecticut; Feinberg School of Medicine of Northwestern University, Northwestern Memorial Hospital, Chicago, Illinois; Cardiovascular and Thoracic Surgeons, Cincinnati, Ohio; Department of Surgery, University of Pennsylvania Medical Center, Philadelphia, Pennsylvania; Department of Cardiovascular-Thoracic Surgery, Rush University Medical Center, Chicago, Illinois; and Division of Cardiac Surgery, The Ohio State University Medical Center, Columbus, Ohio

2016 The American Association for Thoracic Surgery (AATS)

consensus guidelines: Surgical treatment of infective endocarditis: Executive summary

AATS Surgical
Gösta B. Pettersson, MD, PhD,a and Joseph S. Coselli, MD,b,c

Treatment of Infective Endocarditis

Consensus Guidelines Writing Committee Chairs:

Writing Committee: Gösta B. Pettersson, MD, PhD,a Joseph S. Coselli, MD,b,c Syed T. Hassain, MD,a Brian Griffin, MD,d Eugene H. Blackstone, MD,a Steven M. Gordon, MD,a Scott A. LeMaire, MD,b,c,d and Laila E. Woc-Colburn, MD,e

Invited Experts: See Appendix E1.

STs 2011

AATS 2017
Native MV Endocarditis

All infected and necrotic tissue and foreign material should be radically debrided and removed.
Radical Debridement
NVE of mitral valve

“All grossly infected tissue is removed without concern for the possibility of repair” –Gosta Pettersson
Native MV Endocarditis

All infected and necrotic tissue and foreign material should be radically debrided and removed.  

MV repair is preferred choice, including use of an annuloplasty ring.  

MV repair is recommended to treat native mitral valve endocarditis.
AML Drop Lesion

Patch repair
PML Prolapse with IE

P2 resection
Trends and Outcomes of Tricuspid Valve Surgery in North America: An Analysis of More Than 50,000 Patients From The Society of Thoracic Surgeons Database

Arman Kiliç, MD, Paramita Saha-Chaudhuri, PhD, J. Scott Rankin, MD, and John V. Conte, MD

Division of Cardiac Surgery, Johns Hopkins Hospital, Baltimore, Maryland; Department of Biostatistics and Bioinformatics, Duke University School of Medicine, Durham, North Carolina; and Centennial Medical Center and Vanderbilt University, Nashville, Tennessee