Catheter Based Cardiac Surgery: Anesthesia in the Hybrid Suite and Cath Lab

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Learning Objectives:
At the Conclusion of this lecture, participants should be able to:
1) List the key risk factors for patients undergoing interventional cardiac procedures;
2) Differentiate among critical monitoring techniques based on interventional procedure type;
3) List the advantages or disadvantages for general anesthesia in electrophysiology procedures;
4) Describe the challenges of providing anesthetic care for cardiac patients in off-site locations;

Disclosures
- Editor in Chief Seminars in Cardiothoracic and Vascular Anesthesiology – SAGE Publications
- Editor - Manual Clinical Anesthesiology – LWW publications
- Haemonetics: Research Reagent Support

Interventional Cardiology
- Interventional Cardiology has evolved significantly over past 70 years beginning with central catheterization and PCI.
- Topics Covered Today:
  - TAVR
  - AFib interventions – Lariat
  - Lead Extractions
  - ASD closures
  - Mitra-clip

TAVR
- Total Aortic Valve Replacement
- TAVI: Total Aortic Valve Implantation

Aortic Valve Replacement
Currently Available Transcatheter Valves

(A) The Edwards SAPIEN THV balloon-expandable valve incorporates a stainless steel frame, bovine pericardial leaflets, and a fabric sealing cuff.

(B) The SAPIEN XT THV utilizes a cobalt chromium alloy frame and is compatible with lower profile delivery catheters.

(C) The Medtronic CoreValve incorporates a self-expandable frame, porcine pericardial leaflets, and a pericardial seal.

Am Coll Cardiol. 2012;60(6):483-492

Partner I Trial


Two-year with 1-year landmark analysis of all-cause mortality Kaplan–Meier curve in PARTNER trial cohort


Two-year time trends in hemodynamics after TAVI vs. SAVR

Randomization and Analysis Populations.

Anesthetic Management

- GETA typically employed**
- Slow, gentle induction tailored for AS
- Anticipate extubation at conclusion
- Pre-induction Arterial Line
- Central Access following induction
  - PAC in higher risk patients (PHTN, RV failure)
- TEE
- Temporary pacing

Transcatheter Aortic-Valve Replacement with a Self-Expanding Prosthesis

David H. Adams, M.D., Jeffrey J. Popma, M.D., Michael J. Reardon, M.D., Steven J. Yadav, M.D., Joseph S. Coselli, M.D., S. Michael Dean, M.D., Thomas G. Griep, M.D., Maurice Glagov, M.D., James S. Lamb, Jr., M.D., Neil S. Kleiman, M.D., Ulric Chetut, M.D., John Heuser, M.D., William Helm, D.O., George Ziem, M.D., Peter Taplin, M.D., Neil Robinson, M.D., George Peterson, M.D., D. Chad Hughes, M.D., J. Rand Hanley, M.D., J. Scott Goss, M.D., Beidar Kalar, M.D., H. Emad Kasim, M.D., Marie Greenspan, M.D., M.B., B.S., and A. El-Khatib, M.D., for the U.S. Eapen Clinical Investigators.

Kaplan–Meier Cumulative Frequency of Death from Any Cause.

Subgroup Analysis for the Rate of Death from Any Cause at 1 Year.

** GETA typically employed**
**Complications**

- **Peripheral Vascular Injury**
- **Stroke (3-4%)**

<table>
<thead>
<tr>
<th>Paravalvular Insufficiency Based on Circumferential Extent</th>
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<tbody>
<tr>
<td>Mild</td>
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<tr>
<td>&lt;10%</td>
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- **Post-TAVR aortic insufficiency (> 60%)**

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**Lead Extractions:**

- **Class I indications:**
  - INFx
  - Definite CIED system infection
  - Pocket infection, abscess, erosion through skin
  - Endocarditis
  - Occult Gram + bacteremia

- **Lead issues:**
  - Arrhythmias secondary to retained leads
  - Interference of retained leads with CIED
  - Interference with treatment for malignancy

- **Thrombosis:**
  - Thrombotic events associated with lead
  - SVC occlusion and need for additional lead placement
  - Lead presence with planned stent deployment

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**Recommendations:**

- Highly complex procedures or procedures on patients with certain conditions and comorbidities that are associated with higher procedural risk should not be performed in a freestanding laboratory
- Emergency cardiovascular surgical support should be immediately available extraction of chronic device leads and complex mapping/ablation procedures, particularly those requiring pericardial access

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**2014 Consensus Statement**


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John F. Beshal, MD, FHRS, FACC, Nelli Breslevitz, MD, Christina Chiu-Mai, MD, CEPS, CIDS, FHRS,
Kathryn K. Collins, MD, FHRS, Matthew Darr, CEPS, Kenneth Fetterly, PA-C, John D. Fisher, MD, FHRS,
Richard Hongyo, MD, FHRS, Samuel Ineff, MD, John Lopez, RN,
John M. Miller, MD, FHRS, James C. Perry, MD, FHRS, David J. Sturhiner, MD,
Gary F. Tomassoni, MD, FHRS, FACC, Esther Weiss, APN, CNS, MSN, CDS, CEPS

Heart Rhythm, Vol 11, No 8, August 2014

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**Recommendations:**

- High-risk procedures in critically ill patients, such as ablation of ventricular tachycardia in patients requiring extracorporeal hemodynamic support, can only be safely performed in institutions offering comprehensive programs with active engagement from electrophysiologists, surgeons, intensivists, and anesthesiologists.
**Recommended Personnel**

- 1 EP or device-credentialed MD performing the procedure
- 1 Secondary operator (Fellow, NP, PA, and technician performing under the supervision of an MD responsible for the procedure [as approved by the institution])
- 1 AA / CRNA administering anesthesia under the supervision of an MD anesthesiologist, or 1 nurse trained and credentialed in procedural sedation
- 1 CV surgeon to be immediately available (may be required to be in the room for the critical part of the procedure)
- 1 nurse – circulating
- 1 technologist or nurse scrubbing

**Lead Extraction Evidence**

Clinical predictors of adverse patient outcomes in an experience of more than 5000 chronic endovascular pacemaker and defibrillator lead extractions

Michael P. Brunner, MD, Edmond M. Conin, MB, MICPE, Valeria E. Duarte, MD, Chingfung Yu, MS,1 Khaldoun S. Tanaji, MD, MPH, FIHRS, David O. Martin, MD, MPH,2
Prume Callahan, MD, FIHRS,3 Saima J. Cameron, MD, FIHRS,4 Mark J. Neubauer, MD, PhD, FIHRS,5
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Brian Bzowski, MD,9 Bocc L. Wilcoff, MD, FIHRS


<table>
<thead>
<tr>
<th>Table 2 Lead characteristics (n = 5521)</th>
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<tbody>
<tr>
<td>Type of lead [n (% of total leads)]</td>
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<tr>
<td>Pacemaker</td>
</tr>
<tr>
<td>Dual-coil ICD</td>
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<tr>
<td>Single-coil ICD</td>
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<tr>
<td>Location [n (% of total leads)]</td>
</tr>
<tr>
<td>Right atrium</td>
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<tr>
<td>Right ventricle</td>
</tr>
<tr>
<td>Coronary venous system</td>
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<tr>
<td>Superior vena cava</td>
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<tr>
<td>Leads extracted per procedure</td>
</tr>
<tr>
<td>Median</td>
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<tr>
<td>&gt; 2</td>
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<tr>
<td>&gt; 3</td>
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<tr>
<td>Implant duration of leads extracted per procedure (years)</td>
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<tr>
<td>Median</td>
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<tr>
<td>Age of oldest lead</td>
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<tr>
<td>Combined age of leads</td>
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<td>ICD = implantable cardioverter-defibrillator.</td>
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**Multivariate Analysis Results**

- Major Complications: (1.8%)
  - Cerebrovascular Dz, reduced EF, low platelets, INR > 1.2, use of mechanical sheath.
- MCVI – (1.1%)
  - Low platelets, combined age of leads > 7 yrs, use of mechanical or powered sheath

**Cleveland Clinic TVLE Catastrophes**

- 25 patients experience complications required emergent surgical or endovascular intervention. This is 0.8% of their population
- Twenty patients required cardiac surgical intervention
  - Eighteen patients required sternotomy
  - 2 patients required thoractomy
- There were 15 SVC lacerations, 2 right atrial perforations, 3 ventricular perforations
Cleveland Clinic TVLE Catastrophes

- Two patients required vascular repair at the procedural access site for SCL vein or artery laceration
- Three patients were managed with an endovascular approach for SVC laceration, left axillary laceration and brachiocephalic vein and artery fistula

Cleveland Clinic TVLE Catastrophes

- Six of the 25 died intraoperatively
- Three of the 25 made it out of the operating room but did not survive to hospital discharge

Case:

- 34 yo female – developed post partum cardiomyopathy 8 years ago
- CIED placed at that time
- Heart function has since recovered, with near normal LV systolic function
- Plan is to remove leads / device

Anesthesia Recommendations:

- General Anesthesia
- Standard ASA + Arterial line
- Possible Central line
- TEE
- LB IV access – preferably femoral
- Type and Cross
- CPB / CT surgeon standby*
- Stratus low / intermediate vs high risk patients

Left Atrial Appendage (LAA) → Percutaneous Closure


Fuller et al. Curr Card Rep 2011

Saady et al. Heart 1999

Fuller et al. Curr Card Rep 2011

Fuller et al. Curr Card Rep 2011
Percutaneous LAA Closure

- WATCHMAN
- Amplatzer Cardiac Plug
- PLAATO
- LARIAT

LARIAT
HYBRID: ENDOCARDIAL/EPICARDIAL APPROACH

Access  Delivery  Capture  Close  Remove

EndoCATH w/.025" FindrWIRE

CONFIRM
Before  After

A  B  C
D  E  F
Global Difficulty Rating

Clinical Exclusion Criteria
- History of Pericarditis
- Hx of Cardiac Surgery
- Pectus Excavatum
- Recent MI (< 3mos)
- Recent embolic event in last 30 days
- Heart Failure NYHA IV
- Systolic HF (EF < 30%)
- Thoracic Radiation

Anatomic Exclusion:
- LAA > 40mm
- Superiorly oriented LAA
- Bilobed LAA

**TABLE 2** Major Bleeding Events During Hospitalization in the Study Population (n = 154)*

| Major bleed | 14 (9.1) |
| Any transfusion with overt bleeding | 7 (4.5) |
| Overt bleed, hemoglobin drop 3 to <5 g/dL | 5 (3.2) |

**CONCLUSIONS** In this initial multicenter experience of LAA ligation with the Lariat device, the rate of acute closure was high, but procedural success was limited by bleeding.

"Given the considerable incidence of complications, the relatively high incidence of incomplete LAA occlusion, and the lack of long-term efficacy data, we agree with the suggestion of the authors that this method should be reserved only for very well-selected patients with substantial thromboembolic and bleeding risk."

Alternative oral anticoagulants

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Values are n (%). Bleeding Academic Research Consortium type 3A or greater.

*More than 1 bleeding event may have occurred in a single patient.

**Warfarin**
- Contact activation (intrinsic) pathway
- Activation of Factor X
- Formation of Xa and factor Va complex
- Formation of thrombin (IIa)
- Inhibition of factor Xa and thrombin

**Dabigatran**
- Direct inhibition of factor IIa (thrombin)
Anesthesia Recommendations

- Arterial Line
- General Anesthesia
- TEE
- Large Bore IV
- CPB / CT surgeon standby**
- Type and Cross

Structural Interventions

- Multiple lesions now being intervened upon
  - ASD closure
  - Mitral valve (regurgitation) → Mitra Clip

ASD

Complications

- Typical Anesthesia Management:
  - General Anesthesia following any right heart catheter measurements for Qp:Qs (cardiologist may want to do this on room air)
  - TEE monitoring
  - IV access and standard ASA monitors
  - Arterial line only for patients with severe heart disease
  - Aggressive removal of air from IV lines etc

Mitra – Clip for Mitral Regurgitation

- Percutaneous approach to Alfieri repair (1991) – or the edge to edge repair
- FDA approval for Mitra-clip in 2013
- Indicated for patients with severe MR and high surgical risk
  - Ideally used for Type II and Type IIIb patients with functional MR

ASD closure – how common?

- ASD device


Reported complications include:
- device embolization,
- erosion into adjacent cardiac structures,
- arrhythmias,
- fracture of device,
- stroke,
- and device thrombus

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Evidence:

• First arm → 279 patients with 3 or 4+ MR randomized to Mitral clip vs surgical repair
  – 12-month results demonstrated equivalent mortality, improved efficacy with surgery vs Mitral Clip (73% vs 55%), yet reduced adverse events compared to the surgical group.

EVEREST SUMMARY

- Second arm (Everest II trial) → High Risk Study (HRS) which looked at high surgical risk patients (>12% estimated mortality) with grade III/IV MR.
  - Compared retrospectively to “comparator” group
  - Device repair was achieved in in 96% of the 76 patients.
  - 12-month survival rate was 76% for intervention group and 55% for control group. The intervention group also demonstrated reduction in MR severity, LV volume, improvement in NYHA classification, and improved quality of life indicators
RadiaDon risk to Anesthesia

- Radiation
  - Highest for anesthesia providers!
  - 15x higher than the dose received by the scrub nurse
  - Attributed to the lack of effective shielding, which was available but not utilized due to inconvenience
  - Effective shielding can reduce radiation dose by up to 80%
  - Real time dosimeter increases awareness

Making sense of radiation units

- NY to LA flight 40 μSv
- Chest X: 20 μSv
- One EVAR average exposure 38 – 112 μSv
- Anesthesia exposure 268 μSv
- CT spin: up to 5 mSv
- Yearly limit: 50mSv

How to protect ourselves from Radiation?

- Lead apron with thyroid shield
- Two ceiling mounted transparent shields
- Table or free standing
- Moveable lead curtain
- Move far away during injections and scans
- Real time dosimetry
- Discuss the plan with Interventional Team — Impact when to induce general anesthesia — Impact degree of monitoring
- Keep in mind the risk of failure — and the need to mobilize the OR urgently when needed
- Advanced TEE training is needed to help guide many of these procedures.

Structural interventions