



# STS 54th Annual Meeting

## Abstract Book

Fort Lauderdale, Florida

January 27-31, 2018



The Society  
of Thoracic  
Surgeons

The Society of Thoracic Surgeons gratefully acknowledges the following companies for providing educational grants for the STS 54th Annual Meeting.

*This list is accurate as of December 13, 2017.*

### **Platinum Benefactors**

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*Provided \$10,000-\$24,999*

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## GENERAL INFORMATION

### MISSION STATEMENT

The mission of The Society of Thoracic Surgeons is to enhance the ability of cardiothoracic surgeons to provide the highest quality patient care through education, research, and advocacy.

### OVERALL MEETING OBJECTIVE

The overall objective of this meeting is to provide a forum for all cardiothoracic surgeons and their teams to learn the most up-to-date information on research, surgical techniques, patient management, and social, ethical, and political issues in order to maintain the highest level of care for the cardiothoracic patient.

### STS CONTINUING MEDICAL EDUCATION (CME) MISSION STATEMENT

The continuing medical education mission of The Society of Thoracic Surgeons is to provide a forum for reporting results of scientific research and for updating information in the disciplines of cardiovascular, general thoracic and congenital heart surgery. The principal continuing education programs conducted by the Society include an annual scientific meeting, self-study programs, and other stand-alone meetings. The Annual Meeting is composed of peer-reviewed scientific abstracts, invited overview presentations, small group presentations, presentations on new technologies and video programs. The broad scope of topics related to cardiothoracic surgery is covered during each Annual Meeting. In addition to and separate from the national meeting, topical meetings are held that focus on relevant information needs of cardiothoracic surgeons. These educational sessions frequently highlight a multidisciplinary approach and include content relevant to cardiothoracic surgeons as well as other physicians and health care providers in related disciplines. STS programs are developed and provided with the intent of confirming existing knowledge base, imparting new knowledge, and promoting competence in the content areas covered for cardiothoracic surgeons, residents, and their allied health care providers.

*Amended by the STS Board of Directors: January 25, 2009*

### FUTURE MEETINGS OF THE SOCIETY OF THORACIC SURGEONS

#### **Symposium on Robotic Cardiac Surgery: Mitral Valve Repair, Coronary Bypass, and More**

March 23-24, 2018  
Chicago, Illinois

#### **Symposium on Robotic Thoracic Surgery**

May 18-19, 2018  
Chicago, Illinois

#### **STS/ELSO ECMO Management**

##### **Symposium**

July 13-15, 2018  
Tampa, Florida

#### **Advances in Quality & Outcomes:**

##### **A Data Managers Meeting**

September 26-28, 2018  
Los Angeles, California

#### **15th Annual Multidisciplinary Cardiovascular and Thoracic Critical Care Conference**

October 4-6, 2018  
Washington, DC

#### **STS 55th Annual Meeting**

January 26-30, 2019  
San Diego, California

*The information in this Abstract Book is accurate as of December 13, 2017.*

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## Friday, January 26

3:00 PM – 6:00 PM Registration

## Saturday, January 27

6:30 AM – 6:00 PM Registration

7:00 AM – 6:30 PM Tech-Con Exhibits

7:00 AM – 8:00 AM BREAKFAST—Visit Tech-Con Exhibits

8:00 AM – 9:30 AM  **Tech-Con Adult Cardiac Track I: Innovations in Aortic Valve and Aortic Aneurysm Management**

 **Tech-Con General Thoracic Track I: Emerging and/or Game-Changing Technologies in the Management of Lung Cancer**

9:30 AM – 10:15 AM BREAK—Visit Tech-Con Exhibits

10:15 AM – 12:00 PM  **Tech-Con Adult Cardiac Track II: Cutting-Edge Surgery for Heart Failure and Coronary Artery Disease**

 **Tech-Con General Thoracic Track II: Emerging and/or Game-Changing Technologies in the Management of Esophageal Diseases**

12:00 PM – 1:00 PM LUNCH—Visit Tech-Con Exhibits

1:00 PM – 2:30 PM  **Tech-Con Adult Cardiac Track III: Contemporary and Future Mitral Valve and Atrial Fibrillation Practice**

 **Tech-Con General Thoracic Track III: Emerging and/or Game-Changing Minimally Invasive Surgery and Other Technologies**

2:30 PM – 3:00 PM BREAK—Visit Tech-Con Exhibits

3:00 PM – 5:00 PM  **Tech-Con Joint Session: Robotic Cardiothoracic Innovations and “Shark Tank” –Rapid-Fire Pitches of Revolutionary Technology**

5:00 PM – 6:30 PM Tech-Con Reception

## Sunday, January 28

7:00 AM – 6:30 PM Registration

8:00 AM – 12:00 PM  **Adult Congenital Heart Disease Symposium: Surgical Management of Hypertrophic Cardiomyopathy and Anomalous Aortic Origin of a Coronary Artery in Children and Adults**

**Practice Management Summit**

 **STS/AATS Critical Care Symposium: When Things Go Wrong in the CTICU and What to Do About It**

 **CHEST @ STS: Advanced Bronchoscopy and Surgical Airway Symposium**

**SCA @ STS: Integrating Perioperative Echocardiography Into Cardiac Surgical Clinical Decision Making**

8:00 AM – 4:00 PM **Multidisciplinary Innovations in Cardiothoracic Patient Care**

10:00 AM – 4:30 PM **“My Tube” Adult Cardiac How-To Video Session**

12:00 PM – 1:00 PM BREAK

1:00 PM – 4:00 PM  **Residents Symposium: Transitioning From Residency to a Successful Practice**

1:00 PM – 4:30 PM **How-To Video Session: Technical Tips to Avoid Pitfalls and Simplify Congenital and Pediatric Cardiac Surgical Procedures**

**How-To Video Session: Tips and Tricks to Maximize Efficiency in Minimally Invasive General Thoracic Surgery**

2:00 PM – 6:30 PM **Scientific Posters**

4:30 PM – 6:30 PM **Opening Reception in STS Exhibit Hall**

7:00 PM – 10:00 PM  **President’s Reception**



## Monday, January 29

6:30 AM – 5:00 PM	Registration
9:00 AM – 4:30 PM	Exhibit Hall Scientific Posters
7:00 AM – 7:15 AM	Opening Remarks
7:15 AM – 8:15 AM	J. Maxwell Chamberlain Memorial Papers
8:15 AM – 9:00 AM	Abstract Presentations
9:00 AM – 9:40 AM	<b>BREAK</b> —Visit Exhibits and Scientific Posters <i>Complimentary coffee available in the Exhibit Hall</i>
9:40 AM – 9:50 AM	Introduction of the President: Keith S. Naunheim
9:50 AM – 10:50 AM	Presidential Address: Richard L. Prager
10:50 AM – 11:30 AM	<b>BREAK</b> —Visit Exhibits and Scientific Posters <i>Complimentary coffee available in the Exhibit Hall</i>
11:30 AM – 12:30 PM	Adult Cardiac: Arrhythmia/Atrial Fibrillation Basic Science Research: Adult Cardiac Basic Science Research: General Thoracic Congenital: Adult Congenital Critical Care
	❗ ✓ Diversity and Inclusion in Cardiothoracic Surgery: What's In It for Me? General Thoracic: New Technology
	✓ STS/CATS/CSCS: Difficult Decisions in Thoracic Surgery—Advice From Canadian and American Experts
12:30 PM – 1:30 PM	<b>BREAK</b> —Visit Exhibits and Scientific Posters
1:15 PM – 5:15 PM	✓ Clinical Scenarios: Cardiologists and Surgeons Working Together
1:30 PM – 3:30 PM	Adult Cardiac: Aorta I Adult Cardiac: Ischemic Congenital: Pediatric Congenital I General Thoracic: Lung Cancer I General Thoracic: Lung Transplantation International Symposium: Confronting Infectious Diseases in Young Adults Undergoing Cardiac Surgery SVS @ STS: Sharing Common Ground for Cardiovascular Problems
3:30 PM – 4:15 PM	<b>BREAK</b> —Visit Exhibits and Scientific Posters <i>Complimentary coffee available in the Exhibit Hall</i>
4:15 PM – 5:15 PM	Adult Cardiac: VAD Transplant/ECMO Ethics Debate: Neighborly Help or Itinerant Surgery? Research Using the STS National Database STS Key Contacts: Advocates for Cardiothoracic Surgery The Annals Academy: Preparation and Interpretation of National Database Research
	❗ The Importance of Physician Documentation in Reimbursement Women in Thoracic Surgery: How to Successfully Implement Surgical Innovations and New Technologies Into Practice
5:15 PM – 6:30 PM	Scientific Posters and Wine
5:30 PM – 6:30 PM	Business Meeting (STS Members Only)

**Tuesday, January 30**

6:30 AM – 4:30 PM	Registration
9:00 AM – 3:30 PM	Exhibit Hall
9:00 AM – 5:00 PM	Scientific Posters
7:30 AM – 8:30 AM	Meet the Experts Sessions
7:30 AM – 8:30 AM	Health Policy Forum: The Changing Medicare Quality Reporting and Payment Landscape
9:00 AM – 10:00 AM	Thomas B. Ferguson Lecture
10:00 AM – 10:45 AM	BREAK—Visit Exhibits and Scientific Posters <i>Complimentary coffee available in the Exhibit Hall</i>
10:45 AM – 11:00 AM	Award Presentations
11:00 AM – 12:00 PM	C. Walton Lillehei Lecture
12:00 PM – 1:00 PM	BREAK—Visit Exhibits and Scientific Posters
	 Residents Luncheon
1:00 PM – 3:00 PM	Adult Cardiac: General
	Adult Cardiac: Mitral and Tricuspid Valves
	Congenital: Pediatric Congenital II
	EACTS @ STS: Bicuspid Aortic Valve Repair With Aortic Valve Insufficiency and Proximal Aortic Aneurysm Repair
	 STS/ISHLT Joint Symposium: LVAD Therapy in 2018—Worldwide Perspectives
	General Thoracic: Lung Cancer II
	General Thoracic: Mediastinal/Pulmonary
1:00 PM – 5:30 PM	 Patient Safety Symposium: Biases and Errors—Why We Do What We Do
3:00 PM – 3:30 PM	BREAK—Visit Exhibits and Scientific Posters <i>Complimentary coffee available in the Exhibit Hall</i>
3:30 PM – 4:30 PM	Cardiothoracic Surgical Education
3:30 PM – 5:30 PM	Adult Cardiac: Aorta II
	Adult Cardiac: Aortic Valve/Novel Technologies
	Advanced Therapies for End-Stage Cardiopulmonary Disease
	Congenital: Pediatric Congenital III
	ESTS @ STS: Controversial Issues in General Thoracic Surgery—Perspectives From Europe and North America
	General Thoracic: Esophageal
4:30 PM – 5:30 PM	Quality Improvement

**Wednesday, January 31**

6:30 AM – 9:30 AM	Registration & Breakfast
7:00 AM – 9:00 AM	 STS University
9:30 AM – 11:30 AM	 STS University (courses repeated)

**CONTINUING MEDICAL EDUCATION CREDIT****STS 54th Annual Meeting**

The Society of Thoracic Surgeons is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

The Society of Thoracic Surgeons designates this live activity for a maximum of 26.75 *AMA PRA Category 1 Credits*<sup>™</sup>. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

The Society of Thoracic Surgeons has been approved by the American Board of Cardiovascular Perfusion to award 31.7 Category I CEUs for this activity.

**Learning Objectives for the STS 54th Annual Meeting**

Upon completion of this activity, participants should be able to:

- Review the results of clinical and laboratory investigations designed to reveal new knowledge of cardiothoracic disease or to develop new technology applicable to the management of cardiothoracic disease
- Evaluate the impact of new knowledge and the application of new technology on the treatment of cardiothoracic disease
- Discuss the importance of patient safety issues and how current strategies can be introduced into one's practice or institution
- Discuss surgical techniques in order to improve the standard of care within the specialty
- Examine how public policy can impact the treatment of one's patients
- Share and summarize information provided through small group discussions facilitated by leaders in cardiothoracic surgery

**STS EDUCATION DISCLOSURE POLICY**

As a sponsor of continuing medical education accredited by the Accreditation Council for Continuing Medical Education (ACCME), The Society of Thoracic Surgeons requires that any individual who is in a position to control the content of an educational activity must disclose all relationships with commercial interests (including known relationships of his or her immediate family, department, and partners). The ACCME defines a commercial interest as "any entity producing, marketing, reselling, or distributing health care goods or services consumed by, or used on, patients. The ACCME does not consider providers of clinical service directly to patients to be commercial interests." The question of whether a disclosed conflict situation could represent undue influence on the educational activity by a commercial interest or whether the disclosed information is sufficient to consider an abstract, presentation, or other educational enduring material to represent potentially biased information must be resolved prior to an individual's involvement in STS educational programming.

Required disclosures include (1) a financial interest of any amount (e.g., through ownership of stock, stock options, or bonds) (2) the receipt of any amount of cash, goods or services within the current 12-month period (e.g., through research grants, employment, consulting fees, royalties, travel, or gifts) or (3) a nonremunerative position of influence (e.g., as officer, director, trustee or public spokesperson). EXCLUDED from this disclosure requirement are blind trusts or other passive investments such as mutual funds. In the case of a financial or other relationship disclosure, the company, product/service, and specific nature of the

relationship must be noted. Disclosure is mandatory for any person involved in the planning, management, presentation, and/or evaluation of STS educational activities.

Failure to disclose all relationships with commercial interests disqualifies the individual from being a planning committee member, a teacher, or an author of educational materials, and this individual cannot have any responsibility for the development, management, presentation, or evaluation of STS educational activities. This requirement is intended neither to imply any impropriety of such relationships nor to prejudice any individual planner, presenter or author. It is merely to identify such relationships through full disclosure, and to allow STS to assess and resolve potential influences on the educational activity prior to the planning and implementation of an educational activity. If no relationships with commercial interests exist, the individual must indicate this on the disclosure form.

Additionally, the fact that the presentation, paper, or other educational product describes (a) the use of a device, product, or drug that is not FDA approved or (b) an off-label use of an approved device, product, or drug must also be disclosed. This requirement has been adopted in response to FDA policy and case law involving medical societies, and is not intended to prohibit or inhibit independent presentation or discussion regarding the uses of devices, products, and drugs as described in (a) or (b) above.

For live presentations, all disclosures must be stated orally and on a slide at the beginning of the presentation and will be noted in published material related to the activity. Slides, handouts, and other materials utilized as part of an educational activity cannot contain any advertising, trade names or a product group message. Speakers are required to disclose that they have nothing to disclose if this is the case.

*Amended by the STS Executive Committee: April 11, 2012*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

## ELECTRONIC CME/CEU EVALUATION

The STS 54th Annual Meeting utilizes an entirely electronic evaluation and CME/Perfusion CEU credit claim process. Both physicians and perfusionists can use this system to claim credit, complete evaluations, and print CME/Perfusion CEU certificates. Certificates of Attendance also are available for other attendees and international physicians not wishing to claim CME/Perfusion CEU credit. Attendees will not be able to evaluate and claim CME/Perfusion CEU credit for ticketed sessions unless they have registered for those sessions. *Please note that CME credit is not available for the Residents Symposium, Residents Luncheon, or STS/AATS Tech-Con 2018.*

Attendees can complete the overall meeting evaluations and all individual session evaluations onsite at CME Stations located in the Grand Ballroom Foyer and the Floridian Ballroom Foyer. Certificate printing is available.

Attendees also can complete evaluations and claim credit by visiting **[www.sts.org/2018evaluation](http://www.sts.org/2018evaluation)** or using the STS Meetings app. In order to make this process more convenient for attendees, the meeting evaluations will be available online through Monday, February 12, 2018.

Attendees can log in to the website with the following information:

- **Username:** 6-digit STS member ID number printed on the upper right corner of their meeting badge
- **Password:** First initial and last name

## PHYSICIAN COMPETENCIES

As an accredited provider of continuing medical education, STS strives to provide the best, most relevant educational experience for those who take part in the Society's educational activities. The Accreditation Council for Continuing Medical Education (ACCME) has stressed the importance of CME program planning and implementation that is focused on quality with the aim of improving health care. In an effort to help clarify how STS programming focuses on the Accreditation Council for Graduate Medical Education (ACGME) / American Board of Medical Specialties (ABMS) competencies, physician competencies are listed prior to STS 54th Annual Meeting information. Sessions may touch upon other competencies in addition to those identified below.

**Practice-Based Learning and Improvement:** Show an ability to investigate and evaluate patient care practices, appraise and assimilate scientific evidence, and improve the practice of medicine.

**Patient Care and Procedural Skills:** Provide care that is compassionate, appropriate, and effective treatment for health problems and to promote health.

**Systems-Based Practice:** Demonstrate awareness of and responsibility to the larger context and systems of health care. Be able to call on system resources to provide optimal care (eg, coordinating care across sites or serving as the primary case manager when care involves multiple specialties, professions, or sites).

**Medical Knowledge:** Demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences and their application in patient care.

**Interpersonal and Communication Skills:** Demonstrate skills that result in effective information exchange and teaming with patients, their families, and professional associates (eg, fostering a therapeutic relationship that is ethically sound, uses effective listening skills with non-verbal and verbal communication; working as both a team member and at times as a leader).

**Professionalism:** Demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to diverse patient populations.

## RULES REGARDING ORAL PRESENTATIONS

1. For each abstract that is presented orally or as a poster during the STS 54th Annual Meeting, **a corresponding full manuscript must be submitted to *The Annals of Thoracic Surgery*** for publication consideration on or before Wednesday, January 31, 2018, unless the STS Board of Directors or Executive Committee has granted an explicit waiver, as discussed below. Manuscripts must be submitted online at [www.editorialmanager.com/annals](http://www.editorialmanager.com/annals). Editorial staff will be available in the Exhibit Hall at booth #807 to assist you in submitting your paper if you need help. Manuscripts will not be considered for publication if submitted after Wednesday, January 31, 2018, at 11:59 PM Eastern Standard Time. All papers shall become the property of the Society. Publication of manuscripts in *The Annals of Thoracic Surgery* is not assured. If manuscripts are not submitted to *The Annals* before or at the time of the STS 54th Annual Meeting, a 2-year period of ineligibility for participation in the STS Annual Meeting will be imposed upon all authors of the paper. The same 2-year sanction applies to all manuscripts returned to authors for revisions that are not resubmitted within 1 calendar year of the request for revision. Notwithstanding the foregoing, the STS Board of Directors or Executive Committee may waive the requirement that authors of an abstract accepted for presentation at the STS Annual Meeting submit a corresponding manuscript to *The Annals of Thoracic Surgery* for publication consideration in unusual circumstances. Requests for such waivers must be submitted in writing to the STS Secretary and may be granted subject to certain terms and conditions. In all such circumstances, manuscripts derived from STS Annual Meeting presentations may not be published before presentation of the material at the Annual Meeting.
2. Presenters for scientific sessions are provided with time limits for their presentations and must comply with these limits. Please refer to your confirmation notification for your specific time limit.
3. All visuals accompanying scientific oral presentations must be produced in Microsoft Office PowerPoint. Presenters must report to the Speaker Ready Room (Rooms 317-318) at least 24 hours prior to their scheduled presentation time to upload their PowerPoint into the presentation system.
4. Reserved seating is available for presenters and invited discussants at the front of the room for the General Sessions. In the interest of time, presenters and discussants should sit in this reserved seating.
5. Presenters will remain with discussants on the dais during the oral presentations to respond directly to the discussants' queries.
6. Commercial and regulatory disclosures as defined in the STS Education Disclosure Policy (see page 9) must be disclosed orally to the audience at the beginning of each presentation. This requirement is for moderators, presenters, and invited discussants. The first slide of a presentation must be used to reveal the nature of the disclosure. Disclosure information also will be provided in the text of this *Abstract Book*.

**NOTE:** The Society of Thoracic Surgeons does not necessarily endorse the opinions expressed by any moderator, presenter, or discussant.

## RULES REGARDING SCIENTIFIC POSTERS

1. For each abstract that is presented orally or as a poster during the STS 54th Annual Meeting, a **corresponding full manuscript must be submitted to *The Annals of Thoracic Surgery*** for publication consideration on or before Wednesday, January 31, 2018, unless the STS Board of Directors or Executive Committee has granted an explicit waiver, as discussed below. Manuscripts must be submitted online at [www.editorialmanager.com/annals](http://www.editorialmanager.com/annals). Editorial staff will be available in the Exhibit Hall at booth #807 to assist you in submitting your paper if you need help. Manuscripts will not be considered for publication if submitted after Wednesday, January 31, 2018, at 11:59 PM Eastern Standard Time. All papers shall become the property of the Society. Publication of manuscripts in *The Annals of Thoracic Surgery* is not assured. If manuscripts are not submitted to *The Annals* before or at the time of the STS 54th Annual Meeting, a 2-year period of ineligibility for participation in the STS Annual Meeting will be imposed upon all authors of the paper. The same 2-year sanction applies to all manuscripts returned to authors for revisions that are not resubmitted within 1 calendar year of the request for revision. Notwithstanding the foregoing, the STS Board of Directors or Executive Committee may waive the requirement that authors of an abstract accepted for presentation at the STS Annual Meeting submit a corresponding manuscript to *The Annals of Thoracic Surgery* for publication consideration in unusual circumstances. Requests for such waivers must be submitted in writing to the STS Secretary and may be granted subject to certain terms and conditions. In all such circumstances, manuscripts derived from STS Annual Meeting presentations may not be published before presentation of the material at the Annual Meeting.
2. Scientific posters have been assigned designated poster boards. Each scientific poster must correspond with the assigned poster board number. Scientific poster numbers begin with "P" followed by the corresponding poster board, eg, P12.
3. Scientific posters must be designed to fit the poster board, which is 4 feet high by 8 feet wide. The poster title and author block must be displayed across the top of the poster. This will allow meeting participants to find posters easily. Poster material should be readable from a distance of at least 6 feet.
4. Commercial and regulatory disclosures as defined in the STS Education Disclosure Policy (see page 9) must be included on the poster in the lower right-hand corner. Posters not containing commercial and regulatory disclosures may be removed from the scientific poster area. If you do not have anything to disclose, please print "Nothing to Disclose" in the lower right-hand corner. This requirement is not intended to imply any impropriety of such relationships or to prejudice any individual presenter, author, or discussant. It is merely to identify such relationships through full disclosure and to allow audience members to form their own judgments regarding the poster presentation.
5. Scientific posters may be set up on Saturday, January 27, from 8:00 AM to 5:00 PM and Sunday, January 28, from 8:00 AM to 2:00 PM in the Third Floor Concourse. STS will move posters chosen for the Scientific Posters and Wine event (see next page) between 2:00 PM and 4:00 PM on Monday, January 29. You will be notified via email by 7:00 PM on Sunday, January 28, if your poster was selected for the Scientific Posters and Wine event.

6. Scientific posters accepted for the STS 54th Annual Meeting must be displayed at the meeting for the entire time assigned and in the assigned location. Authors who do not display their posters will be subjected to a 2-year period of ineligibility for participation in the STS Annual Meeting. This sanction applies to all poster authors.
7. The STS 54th Annual Meeting will feature a unique Scientific Posters and Wine event on Monday, January 29, from 5:15 PM to 6:30 PM in the Floridian Ballroom Foyer. Moderators for each of the three subspecialties will guide participants through a discussion of the selected poster abstracts. If your poster is selected for this event, please arrive at the Floridian Ballroom Foyer no later than 5:00 PM on Monday, January 29, to prepare.
8. All posters will be graded on the evening of Sunday, January 28. Authors of the top graded posters will present their poster during the Scientific Posters and Wine event and will have their presentations graded by selected reviewers. A winner for each category will be announced shortly thereafter.
9. Scientific posters must remain on display until 5:00 PM on Tuesday, January 30, after which they may be taken down. STS is not responsible for any scientific posters remaining after 10:00 AM on Wednesday, January 31. STS will not ship posters back to authors.

## Commercial Relationships of Program Planners

**The Society would like to thank the following individuals for planning the educational content of STS/AATS Tech-Con 2018. Unless otherwise noted, these individuals have no commercial relationships to disclose:**

**T. Sloane Guy**, Co-Chair, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Consultant/Advisory Board, Edwards Lifesciences, Ethicon, Johnson & Johnson, Medtronic, Verb Surgical

**James D. Luketich**, Co-Chair, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Ownership Interest, Elsevier, Express Scripts, Intuitive Surgical; Nonremunerative Position of Influence, Deputy Editor for the *The Annals of Thoracic Surgery*

**Vinay Badhwar**

**Lisa M. Brown**, Workforce on Annual Meeting (Tech-Con Task Force)

**Nimesh Desai**, Workforce on Annual Meeting (Tech-Con Task Force), Workforce on National Databases

COMMERCIAL RELATIONSHIPS Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic, Abbott, W. L. Gore & Assoc

**Melanie A. Edwards**, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Nonremunerative Position of Influence, Southern Thoracic Surgical Association - Member, Postgraduate Committee, Women in Thoracic Surgery - Historian

**Ali Khoynzad**, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Research Grant, AtriCure, Bard; Speakers Bureau/Honoraria, AtriCure, Bard; National PI, AtriCure, Bard

**Tom C. Nguyen**, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Speakers Bureau/Honoraria, Edwards Lifesciences, Abbott

**Michael F. Reed**, Workforce on Annual Meeting (Tech-Con Task Force)

COMMERCIAL RELATIONSHIPS Consultant/Advisory Board, Spiration

**Arash Salemi**

**Inderpal S. Sarkaria**

**Brendon M. Stiles**

**John M. Stulak**, Workforce on Annual Meeting (Tech-Con Task Force)

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## Friday, January 26

3:00 PM – 6:00 PM

Atrium Lobby, First Floor

### Registration

## Saturday, January 27

6:30 AM – 6:00 PM

Atrium Lobby, First Floor

### Registration

7:00 AM – 6:30 PM

Grand Ballroom Foyer

### Tech-Con Exhibits

7:00 AM – 8:00 AM

Grand Ballroom Foyer

### BREAKFAST—Visit Tech-Con Exhibits

8:00 AM – 9:30 AM

Grand Ballroom C-H



## Adult Cardiac Track I: Innovations in Aortic Valve and Aortic Aneurysm Management

*Moderators: Edward P. Chen, Atlanta, GA, and Nimesh Desai, Philadelphia, PA*

8:00 AM

### Overview: Current Challenges in Aortic and Endovascular Surgery

*Nimesh Desai, Philadelphia, PA*

8:04 AM

### A Practical Approach to Aortic Valve Repair

*Emmanuel Lansac, Paris, France*

**COMMERCIAL RELATIONSHIPS** E. Lansac: Ownership Interest, Coroneo; Consultant/Advisory Board, Coroneo

**REGULATORY DISCLOSURE** This presentation describes the use of the Coroneo Extra Aortic Ring, which has an FDA status of Investigational.

8:12 AM

### Sutureless Aortic Valve Replacement: Prosthesis Selection and Challenging Scenarios

*Malakh Shrestha, Hanover, Germany*

8:20 AM

### Submitted Presentation: Bioprosthetic Valve Fracture to Facilitate Valve-in-Valve Transcatheter Aortic Valve Replacement (TAVR)

*Keith B. Allen, Kansas City, MO*

**COMMERCIAL RELATIONSHIPS** K. B. Allen: Research Grant, Abbott, Edwards Lifesciences, Medtronic, Zimmer Biomet; Consultant/Advisory Board, Zimmer Biomet; Speakers Bureau/Honoraria, Edwards Lifesciences

**REGULATORY DISCLOSURE** This presentation describes the off-label use of the Tru balloon to fracture bioprosthetic surgical valves.

8:28 AM

**Navigating Complex TAVR Scenarios: Managing Left Ventricular Outflow Tract Calcium, Isolated Aortic Insufficiency, Bicuspid Valve, and Others***Arash Salemi, New York, NY***COMMERCIAL RELATIONSHIPS** A. Salemi: Consultant/Advisory Board, Edwards Lifesciences, Medtronic

8:36 AM

**Panel Discussion**

8:47 AM

**Submitted Presentation: Advanced Aortic Root Surgery Techniques via Right Minithoracotomy***Joseph Lamelas, Houston, TX***COMMERCIAL RELATIONSHIPS** J. Lamelas: Ownership Interest, Miami Instruments; Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic, Abbott

8:55 AM

**Endovascular Repair in the Ascending Aorta: Is Endo Bentall a Reality?***Ali Khojnejhad, Los Angeles, CA***COMMERCIAL RELATIONSHIPS** A. Khojnejhad: Research Grant, AtriCure; Consultant/Advisory Board, AtriCure

9:03 AM

**Frozen Elephant Trunk and Evolving Arch Surgery Techniques***Eric E. Roselli, Cleveland, OH***COMMERCIAL RELATIONSHIPS** E. E. Roselli: Research Grant, W. L. Gore & Assoc; Consultant/Advisory Board, LivaNova, Medtronic; Speakers Bureau/Honoraria, LivaNova, Medtronic, Vascutek, W. L. Gore & Assoc**REGULATORY DISCLOSURE** This presentation describes the use of investigational branched and hybrid stentgraft devices for proximal aortic repair. This presentation describes the off-label use of commercially available aortic stentgraft devices for proximal aortic repair.

9:11 AM

**Branched Endografting Techniques in the Arch and Thoracoabdominal Aorta***Himanshu J. Patel, Ann Arbor, MI***COMMERCIAL RELATIONSHIPS** H. J. Patel, Consultant/Advisory Board, Terumo, W. L. Gore & Assoc

9:19 AM

**Panel Discussion**

8:00 AM – 9:30 AM

**Grand Ballroom A-B****General Thoracic Track I: Emerging and/or Game-Changing Technologies in the Management of Lung Cancer***Moderator: Lisa M. Brown, Sacramento, CA*

**8:00 AM****Submitted Presentation: Electromagnetic Navigational Video-Assisted Thoracoscopic Surgery (N-VATS) for Precision-Guided Resection of Intrathoracic Lesions***Wissam Raad, New York, NY***8:12 AM****Submitted Presentation: 3D Computed Tomography Reconstruction and Mix Reality for Sublobar Resection***Xinghua Cheng, Shanghai, China***8:24 AM****Submitted Presentation: Robotic Bronchoscopy***Kazubiro Yasufuku, Toronto, Canada***REGULATORY DISCLOSURE** This presentation describes the use of the Auris Surgical Robotics endoscopy platform, which is not FDA approved.**8:36 AM****Use of Ultrasound Imaging for Localizing Nodules Robotically***John F. Lazar, Mechanicsburg, PA***8:48 AM****Radiofrequency Ablation of Lung Tumors***Katie S. Nason, Pittsburgh, PA***9:00 AM****Cryoablation: Update on SOLSTICE Study—Is It Applicable to Primary Lung Cancer?***Matthew R. Callstrom, Rochester, MN***COMMERCIAL RELATIONSHIPS** M. R. Callstrom: Research Grant, Galil Medical, EDDA; Consultant/Advisory Board, Johnson & Johnson, Thermedical**9:12 AM****Energy Sources for Pulmonary Resection***Moishe A. Liberman, Montreal, Canada***COMMERCIAL RELATIONSHIPS** M. A. Liberman: Research Grant, Boston Scientific, Cook Medical, Ethicon**9:30 AM – 10:15 AM****Grand Ballroom Foyer****BREAK—Visit Tech-Con Exhibits****10:15 AM – 12:00 PM****Grand Ballroom C-H**** Adult Cardiac Track II: Cutting-Edge Surgery for Heart Failure and Coronary Artery Disease***Moderators: Arash Salemi, New York, NY, and John M. Stulak, Rochester, MN***COMMERCIAL RELATIONSHIPS** A. Salemi: Consultant/Advisory Board, Edwards Lifesciences, Medtronic**10:15 AM****Overview: Current Challenges in Heart Failure and Coronary Artery Disease (CAD)***Arash Salemi, New York, NY***COMMERCIAL RELATIONSHIPS** A. Salemi: Consultant/Advisory Board, Edwards Lifesciences, Medtronic

10:19 AM

**HeartMate 3 Clinical Trial Update***Chris T. Salerno, Carmel, IN*

10:27 AM

**PREVENT II: Rationale and Trial Study Design***TBD*

10:35 AM

**Thoracotomy Implant of HeartWare HVAD: HVAD LATERAL Study***Simon Maltais, Rochester, MN*

10:43 AM

**Total Artificial Heart Clinical Trial Update***Francisco A. Arabia, Los Angeles, CA***COMMERCIAL RELATIONSHIPS** F. A. Arabia: Consultant/Advisory Board, Medtronic; Other, Trainer for Medtronic and SynCardia**REGULATORY DISCLOSURE** This presentation will describe the use of the SynCardia Total Artificial Heart as destination therapy, a use that has an FDA status of Investigational.

10:51 AM

**Hemocompatibility of Fully Magnetically Levitated Pumps***Nir Uriel, Chicago, IL***COMMERCIAL RELATIONSHIPS** N. Uriel: Research Grant, Abbott, HeartWare, Novartis; Consultant/Advisory Board, Medtronic, Novartis

10:59 AM

**Panel Discussion**

11:07 AM

**Submitted Presentation: EpicHeart™ Soft Robotic Device to Support Heart Function***William C. Altman, Houston, TX***COMMERCIAL RELATIONSHIPS** W. C. Altman: Employment, CorInnova; Ownership Interest, CorInnova**REGULATORY DISCLOSURE** This presentation describes the use of the EpicHeart Soft Robotic Cardiac Assist Device, which is not FDA approved.

11:15 AM

**Submitted Presentation: First-in-Human Clinical Trial of a Minimally Invasive Left Ventricular Assist Device***Valluvan Jeevanandam, Chicago, IL*

11:23 AM

**Coronary Artery Bypass Grafting (CABG) or Percutaneous Coronary Intervention for Ischemic Cardiomyopathy***David P. Taggart, Oxford, United Kingdom***COMMERCIAL RELATIONSHIPS** D. P. Taggart: Ownership Interest, VGS; Research Grant, Medistim, VGS; Consultant/Advisory Board, Stryker; Speakers Bureau/Honoraria, Medistim, Medtronic, Stryker, VGS; Other Research Support, VGS

11:31 AM

**External Stent for Saphenous Vein Grafts in CABG***David P. Taggart, Oxford, United Kingdom***COMMERCIAL RELATIONSHIPS** D. P. Taggart: Ownership Interest, VGS; Research Grant, Medistim, VGS; Consultant/Advisory Board, Stryker; Speakers Bureau/Honoraria, Medistim, Medtronic, Stryker, VGS; Other Research Support, VGS

11:39 AM

**Robotic-Assisted Totally Endoscopic Coronary Artery Bypass for Multivessel CAD: Beyond Most Surgeons' Reach?***Husam H. Balkhy, Chicago, IL***COMMERCIAL RELATIONSHIPS** H. H. Balkhy: Speakers Bureau/Honoraria, AtriCure, Intuitive Surgical

11:47 AM

**Panel Discussion**

10:15 AM – 12:00 PM

**Grand Ballroom A-B****General Thoracic Track II: Emerging and/or Game-Changing Technologies in the Management of Esophageal Diseases***Moderators: Melanie A. Edwards, St Louis, MO, and James D. Luketich, Pittsburgh, PA***COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, P&G; Research Grant, Accuray; Other, Elsevier Patent from University of Pittsburgh, The Annals of Thoracic Surgery Deputy Editor

10:15 AM

**Endoscopic Approach to Zenker's Diverticulum***Ryan M. Levy, Pittsburgh, PA*

10:30 AM

**Update on Advances in Antireflux Surgery***Brian E. Louie, Seattle, WA***COMMERCIAL RELATIONSHIPS** B. E. Louie: Research Grant, Intuitive Surgical, Torax Medical; Consultant/Advisory Board, Torax Medical

10:45 AM

**Endoluminal Management of Esophageal Leaks***David C. Rice, Houston, TX***COMMERCIAL RELATIONSHIPS** D. C. Rice: Speakers Bureau/Honoraria, Pacira Pharmaceuticals, Intuitive Surgical

11:00 AM

**Advances in Peroral Endoscopic Myotomy Technology and Endoscopic Mucosal Closure***Shanda H. Blackmon, Rochester, MN***COMMERCIAL RELATIONSHIPS** S. H. Blackmon: Ownership Interest, Boston Scientific; Consultant/Advisory Board, Dextera; Other Research Support, Medtronic

11:15 AM

**Robotic Esophagectomy***Inderpal S. Sarkaria, Pittsburgh, PA***COMMERCIAL RELATIONSHIPS** I. S. Sarkaria: Speakers Bureau/Honoraria, Intuitive Surgical

11:30 AM

**Endoscopic Techniques in Esophageal Cancer***Wayne L. Hofstetter, Houston, TX*

11:45 AM

**Submitted Presentation: A Bioengineered Implant for Esophageal Replacement***Saverio La Francesca, Holliston, MA***COMMERCIAL RELATIONSHIPS** S. La Francesca: Employment, Biostage; Ownership Interest, Biostage**REGULATORY DISCLOSURE** This presentation describes the use of the Cellspan Esophageal Implant, which is not FDA approved.

12:00 PM – 1:00 PM

*Floridian Ballroom***LUNCH**

1:00 PM – 2:30 PM

*Grand Ballroom C-H***Adult Cardiac Track III: Contemporary and Future Mitral Valve and Atrial Fibrillation Practice***Moderators: Vinay Badhwar, Morgantown, WV, and Tom C. Nguyen, Houston, TX***COMMERCIAL RELATIONSHIPS** T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott

1:00 PM

**Overview: Advances in Surgical Therapy for Mitral Valve Disease and Atrial Fibrillation***Vinay Badhwar, Morgantown, WV*

1:04 PM

**Defining the Mitral Valve Surgeon of the Future: Time for an Honest Appraisal***T. Sloane Guy, New York, NY***COMMERCIAL RELATIONSHIPS** T. S. Guy: Consultant/Advisory Board, Edwards Lifesciences, Verb Surgical

1:12 PM

**MitraClip, Transcatheter Mitral Valve Repair (TMVR), Robotics, Port Access, and Open Surgery: Can We Do It All?***Robert L. Smith, Plano, TX*

1:20 PM

**Robotic Reconstruction for Complex Primary Mitral Regurgitation: No Limits***Vinay Badhwar, Morgantown, WV*

1:28 PM

**Robotic/Minimally Invasive Cardiac Surgery Treatment Options for Atrial Fibrillation: Better Than Catheter Ablation?***Evelio Rodriguez, Nashville, TN***COMMERCIAL RELATIONSHIPS** E. Rodriguez: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Abbott, Boston Scientific; Speakers Bureau/Honoraria, Abbott

1:36 PM

**Panel Discussion**

1:46 PM

**Are Apically Delivered Chords Really the Answer?***Tirone E. David, Toronto, Canada*

1:54 PM

**Transcatheter Mitral Valve Replacement: Global and Early US Experience***Gilbert H. L. Tang, New York, NY***COMMERCIAL RELATIONSHIPS** G. H. L. Tang: Consultant/Advisory Board, Abbott Vascular, NeoChord; Speakers Bureau/Honoraria, Abbott Vascular, Edwards Lifesciences, Medtronic**REGULATORY DISCLOSURE** This presentation describes the off-label use of several devices (Intrepid, Tendyne, CardiAQ, Sapien 3, Caisson, Highlife, Tiara, Cephea) for TMVR.

2:02 PM

**Pipeline of TMVR: The Train Has Left the Station!***Michael J. Mack, Plano, TX***COMMERCIAL RELATIONSHIPS** M. J. Mack: Research Grant, Abbott Vascular, Edwards Lifesciences, Medtronic**REGULATORY DISCLOSURE** This presentation will describe approximately 12 devices that are not FDA approved.

2:10 PM

**Pipeline of Tricuspid Devices: Fumbling In the Dark or Zeroing In on an Indication?***Steven F. Bolling, Ann Arbor, MI*

2:18 PM

**Panel Discussion**

1:00 PM – 2:30 PM

**Grand Ballroom A-B****General Thoracic Track III: Emerging and/or Game-Changing Minimally Invasive Surgery and Other Technologies***Moderators: Michael F. Reed, Hershey, PA, and Inderpal S. Sarkaria, New York, NY***COMMERCIAL RELATIONSHIPS** M. F. Reed: Consultant/Advisory Board, Spiration; I. S. Sarkaria: Speakers Bureau/Honoraria, Intuitive Surgical

1:00 PM

**Novel Suture Technologies***Michael F. Reed, Hershey, PA***COMMERCIAL RELATIONSHIPS** M. F. Reed: Consultant/Advisory Board, Spiration

1:12 PM

**Chest Wall Reconstruction Technologies***Shanda H. Blackmon, Rochester, MN***COMMERCIAL RELATIONSHIPS** S. H. Blackmon: Ownership Interest, Boston Scientific; Consultant/Advisory Board, Dextera; Other Research Support, Medtronic

1:24 PM

**Advanced Imaging Technologies***Yolonda L. Colson, Boston, MA*

1:36 PM

**Submitted Presentation: Articulated Minimally Invasive Surgery Instrumentation***Joel Dunning, Middlesbrough, United Kingdom***COMMERCIAL RELATIONSHIPS** J. Dunning: Research Grant: Dextera Surgical

1:48 PM

**Submitted Presentation: Immersive Video Operating Room Training***Douglas R. Johnston, Cleveland, OH***COMMERCIAL RELATIONSHIPS** D. R. Johnston: Ownership Interest, JACE Medical; Research Grant, Edwards Lifesciences; Consultant/Advisory Board, LivaNova, Abbott

2:00 PM

**Submitted Presentation: Autonomous Camera System***Traves D. Crabtree, Springfield, IL***COMMERCIAL RELATIONSHIPS** T. D. Crabtree: Ownership Interest, CK Surgical Simulation; Consultant/Advisory Board, CK Surgical Simulation

2:12 PM

**Submitted Presentation: Alternate New Device for Chest Access***Daniel L. Miller, Marietta, GA***COMMERCIAL RELATIONSHIPS** D. L. Miller: Research Grant, Medela; Consultant/Advisory Board, Ethicon; Speakers Bureau/Honoraria, Medtronic**REGULATORY DISCLOSURE** This presentation describes the use of the AOK K-CAD: Chest Access Device, which is not FDA approved.

2:30 PM – 3:00 PM

**Grand Ballroom Foyer****BREAK—Visit Tech-Con Exhibits**

3:00 PM – 5:00 PM

**Grand Ballroom C-H**** Joint Session: Robotic Cardiothoracic Innovations and “Shark Tank”—Rapid-Fire Pitches of Revolutionary Technology***Moderators: Richard Lee, St Louis, MO, and James D. Luketich, Pittsburgh, PA**“Shark Tank” Judges: Rick Anderson, Austin, TX, Steven F. Bolling, Ann Arbor, MI, and William E. Cohn, Houston, TX***COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, Proctor and Gamble; Research Grant, Accuray; Other, Elsevier Patent from University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor

3:00 PM

**DEBATE: Robotic Mitral Valve Repair Is a Critical Part of the Future of Our Specialty**  
**CON: TBD***PRO: T. Sloane Guy, New York, NY***COMMERCIAL RELATIONSHIPS** T. S. Guy: Consultant/Advisory Board, Edwards Lifesciences, Verb Surgical

3:30 PM

**DEBATE: Robotic Thoracic Surgery Is a Critical Part of the Future of Our Specialty****CON:** *Mark S. Allen, Rochester, MN***PRO:** *Robert J. Cerfolio, New York, NY*

**COMMERCIAL RELATIONSHIPS** M. S. Allen: Ownership Interest, Medtronic; Speakers Bureau/Honoraria, Medtronic; Nonremunerative Position of Influence, Chair of STS Finance Committee, General Thoracic Surgical Club Executive Committee; R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher

3:50 PM

**What's New in Robotic Cardiothoracic Surgical Technology: Updates From Robotic Companies That Are Leading the Way—Intuitive Surgical***Catherine Mohr, Sunnyvale, CA***COMMERCIAL RELATIONSHIPS** C. Mohr: Employment, Intuitive Surgical

4:00 PM

**What's New in Robotic Cardiothoracic Surgical Technology: Updates From Robotic Companies That Are Leading the Way—Medtronic***Paul Hermes, North Haven, CT*

4:10 PM

**What's New in Robotic Cardiothoracic Surgical Technology: Updates From Robotic Companies That Are Leading the Way—Verb Surgical***TBD*

4:20 PM

**Submitted Presentation: Novel Nanoparticle for Enhanced Pulmonary Nodule Identification***Jeffrey Port, New York, NY***COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest, Angiocrine Bioscience, Nanocyte

4:30 PM

**Submitted Presentation: Left Ventricular Inflow Stent Reduces Suction Events and Improves Mechanical Circulatory Support***James H. Mebaffey, Charlottesville, VA***REGULATORY DISCLOSURE** The presentation includes a description of a product or device that is not FDA approved.

4:40 PM

**Submitted Presentation: Videoscope Cleaning Trocar for Minimally Invasive Surgery***Bryan M. Burt, Houston, TX***COMMERCIAL RELATIONSHIPS** B. M. Burt: Consultant/Advisory Board, Medtronic**REGULATORY DISCLOSURE** This presentation describes the off-label use of a minimally invasive surgery camera port; however, this device is in a preclinical stage of development and has not been used in humans to date.

5:00 PM – 6:30 PM

**Grand Ballroom Foyer****RECEPTION—Visit Tech-Con Exhibits**

6AM						
7AM	<b>7:00 AM – 6:30 PM</b> <b>Registration</b>					
8AM	<b>8:00 AM – 12:00 PM</b> Adult Congenital Heart Disease Symposium: Surgical Management of Hypertrophic Cardiomyopathy and Anomalous Aortic Origin of a Coronary Artery in Children and Adults ✓	<b>8:00 AM – 12:00 PM</b> Practice Management Summit	<b>8:00 AM – 12:00 PM</b> STS/AATS Critical Care Symposium: When Things Go Wrong in the CTICU and What to Do About It ✓	<b>8:00 AM – 12:00 PM</b> CHEST @ STS: Advanced Bronchoscopy and Surgical Airway Symposium ✓	<b>8:00 AM – 12:00 PM</b> SCA @ STS: Integrating Perioperative Echocardiography Into Cardiac Surgical Clinical Decision Making	<b>8:00 AM – 4:00 PM</b> Multidisciplinary Innovations in Cardiothoracic Patient Care
9AM						
10AM	<b>10:00 AM – 4:30 PM</b> "My Tube" Adult Cardiac How-To Video Session					
11AM						
12PM						
1PM		<b>1:00 PM – 4:00 PM</b> Residents Symposium: Transitioning From Residency to a Successful Practice	<b>1:00 PM – 4:30 PM</b> How-To Video Session: Technical Tips to Avoid Pitfalls and Simplify Congenital and Pediatric Cardiac Surgical Procedures	<b>1:00 PM – 4:30 PM</b> How-To Video Session: Tips and Tricks to Maximize Efficiency in Minimally Invasive General Thoracic Surgery		
2PM	<b>2:00 PM – 6:30 PM</b> <b>Scientific Posters</b>					
3PM						
4PM						
5PM		<b>4:30 PM – 6:30 PM</b> <b>Opening Reception in the STS Exhibit Hall</b>				
6PM						
7PM	<b>7:00 PM – 10:00 PM</b> <b>President's Reception</b>					
8PM						
9PM						

7:00 AM – 6:30 PM

**Registration**

8:00 AM – 12:00 PM

- ✓ **Adult Congenital Heart Disease Symposium: Surgical Management of Hypertrophic Cardiomyopathy and Anomalous Aortic Origin of a Coronary Artery in Children and Adults**

**Practice Management Summit**

- ✓ **STS/AATS Critical Care Symposium: When Things Go Wrong in the CTICU and What to Do About It**
- ✓ **CHEST @ STS: Advanced Bronchoscopy and Surgical Airway Symposium**

**SCA @ STS: Integrating Perioperative Echocardiography Into Cardiac Surgical Clinical Decision Making**

8:00 AM – 4:00 PM

**Multidisciplinary Innovations in Cardiothoracic Patient Care**

10:00 AM – 4:30 PM

**"My Tube" Adult Cardiac How-To Video Session**

1:00 PM – 4:00 PM

- CME **Residents Symposium: Transitioning From Residency to a Successful Practice**

1:00 PM – 4:30 PM

**How-To Video Session: Technical Tips to Avoid Pitfalls and Simplify Congenital and Pediatric Cardiac Surgical Procedures****How-To Video Session: Tips and Tricks to Maximize Efficiency in Minimally Invasive General Thoracic Surgery**

2:00 PM – 6:30 PM

**Scientific Posters**

4:30 PM – 6:30 PM

**Opening Reception in STS Exhibit Hall**

7:00 PM – 10:00 PM

- 🎫 **President's Reception**

7:00 AM – 6:30 PM

Atrium Lobby, First Floor

**Registration**

8:00 AM – 12:00 PM

Floridian Ballroom B-C

## ✓ **Adult Congenital Heart Disease Symposium: Surgical Management of Hypertrophic Cardiomyopathy and Anomalous Aortic Origin of a Coronary Artery in Children and Adults**

Hypertrophic cardiomyopathy (HCM) and anomalous aortic origin of a coronary artery (AAOCA) can lead to sudden death in children and adults. Only a few centers perform a high volume of septal myectomy operations each year, and even fewer have experience treating mid-cavitary obstruction and non-obstructive HCM through the transventricular approach. Adult and pediatric cardiac surgeons may find it difficult to begin doing these types of cases and even more difficult to master a reproducible technique that maximizes benefits and minimizes risks. Also, cardiologists may not know when to refer patients. In this session, pediatric and adult cardiac surgeons, as well as cardiologists, will discuss age-related differences in surgical technique, indications for surgery, and how to encourage bidirectional communication between surgeons and cardiologists about the referral timing of these patients.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- List the indications for surgery for HCM and AAOCA
- Describe a transventricular approach to septal myectomy for mid-cavitary obstruction in hypertrophic obstructive cardiomyopathy (HOCM)
- Summarize a combined aortic/transventricular approach to septal myectomy for difficult-to-reach obstruction in HOCM
- Explain the risks associated with a variety of coronary anomalies
- List two methods for surgical management of coronary anomalies

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, professionalism, interpersonal and communication skills, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through a series of lectures, videos, and question-and-answer sessions that will focus on the strategies for management of hypertrophic cardiomyopathy and anomalous aortic origin of a coronary artery in children and adults.*

**Moderators:** Stephanie M. Fuller, Philadelphia, PA, Charles B. Huddleston, St Louis, MO, Frank G. Scholl, Hollywood, FL, and James S. Tweddell, Cincinnati, OH

8:00 AM

**Basal Septal Myectomy for HOCM: Technical Tips**

Francis D. Pagani, Ann Arbor, MI

8:20 AM

**HOCM With Midventricular Obstruction: The Transventricular Approach**

Joseph A. Dearani, Rochester, MN

- 8:40 AM Nonobstructive HCM: LV Cavity Enlargement Using an Apical Approach**  
*Hartzell V. Schaff, Rochester, MN*
- 9:00 AM What to Do With the Mitral Valve in HOCM**  
*Nicholas G. Smedira, Cleveland, OH*
- 9:20 AM Risk Stratification in HOCM: When to Refer and ETOH Ablation vs Surgery**  
*Steve Ommen, Rochester, MN*
- 9:40 AM Panel Discussion/Q&A**
- 9:55 AM Break**
- 10:10 AM Imaging and Nomenclature for AAOCA**  
*Carlos M. Mery, Houston, TX*
- 10:30 AM How I Approach AAOCA: Children vs Adults**  
*Vaughn A. Starnes, Los Angeles, CA*
- 10:50 AM How I Approach AAOCA: Options Other Than Unroofing**  
*Frank L. Hanley, Stanford, CA*
- 11:10 AM What Is the Role for Coronary Artery Bypass Grafting in AAOCA, and When Do You Operate on the Anomalous Right Coronary Artery?**  
*James Jagers, Aurora, CO*
- 11:30 AM Risk Stratification in AAOCA: When to Offer Surgery**  
*Julie Brothers, Philadelphia, PA*
- 11:45 AM Panel Discussion/Q&A**

8:00 AM – 12:00 PM

Rooms 304-305

**Practice Management Summit**

The business of health care is evolving and being reshaped by payers, who are demanding value for their dollars. This paradigm shift away from volume of services delivered has many physicians questioning their current practice patterns. Gaining a better understanding of these fundamental changes, as well as hearing first-hand accounts of surgeons who have successfully navigated this new arena, will provide attendees with viable countermeasure options.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe how to negotiate a contract from a position of strength
- Explain the value proposition of individual practice types
- Discuss the direction of health care and cardiothoracic surgery
- List the practice transition options available to cardiothoracic surgeons
- Describe how to leverage the cardiovascular service line structure to promote value
- Explain the dangers associated with variability in health care delivery

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*The physician competencies addressed in this session are professionalism, interpersonal and communication skills, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through a series of individual lectures and panel discussions that are meant to cover concerns over the changes in health care that have impacted providers and hospitals. The program will have an open discussion forum at the end to encourage questions and participant discussion.*

**Moderators:** Frank L. Fazzalari, Ann Arbor, MI, and Paul S. Levy, Jonesboro, AR

**8:00 AM Introduction**

Frank L. Fazzalari, Ann Arbor, MI

**8:10 AM Compensation and Participation: Contracting Challenges and Choices**

Mark Kopson, Bloomfield Hills, MI

**8:35 AM Annual Update in Economic Survey Data, Trends, and Use**

Michael N. Heaton, Indianapolis, IN

**9:00 AM Partnering for Excellence in Today's Health Care Environment: HCA Healthcare's Cardiovascular Service Line 2018 Update**

Steven V. Manoukian, Nashville, TN

**9:25 AM Panel Discussion****9:50 AM Break****10:10 AM Roles and Responsibilities of a Medical Device Company Chief Medical Officer**

Thomas A. Vassiliades, Mounds View, MN

**COMMERCIAL RELATIONSHIPS** T. A. Vassiliades: Employment, Medtronic

- 10:30 AM**      **Built for Growth: Designing an Arrhythmia Center to Harvest Untapped Potential**  
*Aaron Robinson, Cocoa Beach, FL*
- 10:50 AM**      **Update From the STS Council on Health Policy and Relationships**  
*Alan M. Speir, Falls Church, VA*  
**COMMERCIAL RELATIONSHIPS** A. M. Speir: Consultant/Advisory Board, Medtronic
- 11:10 AM**      **The Next Wave of Innovation to Make Patients Safer**  
*Kathleen Sutcliffe, Baltimore, MD*
- 11:30 AM**      **Panel Discussion**



8:00 AM – 12:00 PM

Floridian Ballroom D

## ✓ STS/AATS Critical Care Symposium: When Things Go Wrong in the CTICU and What to Do About It

It is increasingly apparent that there is a rapidly evolving demographic of the “typical” cardiothoracic surgery patient. Increasing use of technology in an older and more frail population requires the health care team to be well versed in patient optimization, maintenance of safety and quality, and ethical decision making for high-cost interventions. This joint session by STS and the American Association for Thoracic Surgery will provide attendees with a comprehensive review of the roles and responsibilities of interdisciplinary team members and potential pitfalls in the context of increasingly complex patients.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Discuss the pearls and pitfalls of implementing an ERATS/ERACS program
- Describe the rationale behind handoff checklists
- Identify that failure to rescue from postoperative morbidity is a proposed metric of program quality
- Discern and discuss beneficence vs social justice and how to approach this tenuous balance as it impacts clinical and patient-centered decision making

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, interpersonal and communication skills, professionalism, and systems-based practice. These physician competencies will be addressed through a series of collaborative lectures by members of The Society of Thoracic Surgeons and the American Association for Thoracic Surgery. These lectures are meant to advance knowledge, expertise, and interdisciplinary teamwork in the complex field of cardiothoracic critical care. Panel discussions, case study presentations, and questions from the audience will augment these competencies.*

**Moderators:** Rakesh C. Arora, Winnipeg, Canada, Michael S. Firstenberg, Akron, OH, Jay G. Shake, Jackson, MS, and Glenn J. R. Whitman, Baltimore, MD

**COMMERCIAL RELATIONSHIPS** R. C. Arora: Research Grant, Pfizer Canada; Consultant/Advisory Board, CSU-ALS; Speakers Bureau/Honoraria, Mallinckrodt Pharmaceuticals; M. S. Firstenberg: Consultant/Advisory Board, Ethicon, Maquet, Medtronic; Speakers Bureau/Honoraria, Ethicon

### 8:00 AM Introduction and Welcome

Jay G. Shake, Jackson, MS

### Session 1: How to Make Things Go Right

### 8:05 AM Enhanced Recovery After Cardiothoracic Surgery

Jacob Moremen, Jackson, MS

### 8:25 AM Checklists in the CTICU

Subhasis Chatterjee, Houston, TX

### 8:45 AM Difficult Cases

Rita C. Milewski, Philadelphia, PA

- 9:00 AM Break and Networking**
- Session 2: When Things Go Wrong Again**
- 9:15 AM Evolution of Critical Care and Quality Improvement in the CTICU**  
*Richard L. Prager, Ann Arbor, MI*
- 9:35 AM Failure to Rescue in Cardiothoracic Surgery**  
*Gorav Ailawadi, Charlottesville, VA*  
**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic
- 9:55 AM Long-Term Fate After Discharge Following Cardiac Surgery**  
*Michael J. Mack, Plano, TX*  
**COMMERCIAL RELATIONSHIPS** M. J. Mack: Research Grant, Abbott Vascular, Edwards Lifesciences, Medtronic
- 10:15 AM Break and Networking**
- Session 3: When Is Enough, Enough? End-of-Life Discussions vs Continued Aggressive Therapy**
- 10:30 AM Ethics 101**  
*Rakesh C. Arora, Winnipeg, Canada*
- 10:55 AM **DEBATE:** Should E-CPR Be Included as Part of Every Cardiopulmonary Arrest Protocol?**
- Yes: Susan D. Moffatt-Bruce, Columbus, OH*  
*No: Ashish Shah, Nashville, TN*
- 11:35 AM Audience Q&A and Panel Discussion**

8:00 AM – 12:00 PM

Room 315

**✓ CHEST @ STS: Advanced Bronchoscopy and Surgical Airway Symposium**

Cardiothoracic surgeons are essential in the diagnosis and treatment of lung nodules and lung cancer. New technology, such as endobronchial ultrasound (EBUS), navigational bronchoscopy, and cutting-edge endobronchial therapeutics, have changed the approach of lung cancer staging and should be learned by cardiothoracic surgeons. Additional training in therapeutic bronchoscopy is needed to help patients with newly diagnosed lung nodules, as well as palliation of malignant airway obstruction. This joint session by STS and the American College of Chest Physicians will provide attendees with the knowledge they need to navigate this evolving field.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Identify indications, yield, and complications of EBUS and navigational bronchoscopy
- Recognize the benefits and limitations of airway ablative modalities
- State the benefits and limitations of various airway stents

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through a series of collaborative lectures and case-based presentations by members of The Society of Thoracic Surgeons and the American College of Chest Physicians on new technologies for the diagnosis and treatment of lung cancer.*

**Moderators:** Momen M. Wahidi, Durham, NC, and Richard I. Whyte, Boston, MA

**COMMERCIAL RELATIONSHIPS** M. M. Wahidi: Consultant/Advisory Board, Olympus

**8:00 AM Introduction and Welcome**

**8:10 AM EBUS and Transbronchial Needle Aspiration**

*Momen M. Wahidi, Durham, NC*

**COMMERCIAL RELATIONSHIPS** M. M. Wahidi: Consultant/Advisory Board, Olympus

**8:30 AM Navigational Bronchoscopy**

*Alex Chen, St Louis, MO*

**COMMERCIAL RELATIONSHIPS** A. Chen: Research Grant, Olympus, Veran; Speakers Bureau/Honoraria, Olympus

**8:50 AM EBUS Case Scenarios**

*Momen M. Wahidi, Durham, NC, and Richard I. Whyte, Boston, MA*

**COMMERCIAL RELATIONSHIPS** M. M. Wahidi: Consultant/Advisory Board, Olympus

**9:20 AM Panel Discussion**

**9:45 AM Break**

**10:00 AM Therapeutic Bronchoscopy**

*Moishe A. Liberman, Montreal, Canada*

**COMMERCIAL RELATIONSHIPS** M. A. Liberman: Research Grant, Boston Scientific, Cook Medical, Ethicon

- 10:20 AM**      **Tracheal Resection for Benign and Malignant Disease**  
*Matthew G. Hartwig, Durham, NC*
- 10:40 AM**      **Tracheobronchoplasty**  
*Sidbarta P. Gangadharan, Boston, MA*
- 11:00 AM**      **Airway Carcinoids – Endoscopic Management**  
*Adnan Majid, Boston, MA*
- 11:20 AM**      **Airway Carcinoids – Surgical Management**  
*Richard I. Whyte, Boston, MA*
- 11:40 AM**      **Panel Discussion**



8:00 AM – 12:00 PM

Floridian Ballroom A

**SCA @ STS: Integrating Perioperative Echocardiography Into Cardiac Surgical Clinical Decision Making**

This joint session by STS and the Society of Cardiovascular Anesthesiologists will address recent advances in the field of echocardiography, continuously changing technology for the treatment of valvular disease, and new evidence regarding the appropriateness of established procedures. New guidelines for assessment of native valvular regurgitation, updated guidelines on the treatment of ischemic mitral regurgitation, catheter-based procedures for mitral valve regurgitation, and procedural complications diagnosed by intraprocedural echocardiography will be reviewed.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Recognize the utility of echo anatomy and intraoperative echocardiographic analysis in surgical decision making for open and percutaneous procedures
- Discuss the integration of echocardiographic measurements with new clinical evidence in certain patient populations
- Identify and apply echocardiographic findings to case studies

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*The physician competencies addressed in this session are patient care and procedural skills. These physician competencies will be addressed through a series of collaborative lectures and case-based presentations by members of The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists on new guidelines and standards for use of echocardiography in cardiothoracic clinical decision making.*

**Moderators:** Alina Nicoara, Durham, NC, and Stanton K. Shernan, Boston, MA

**Panelists:** Vinay Badhwar, Morgantown, WV, John V. Conte, Hershey, PA, Tsuyoshi K. Kaneko, Boston, MA, and Vinod H. Thourani, Washington, DC

**COMMERCIAL RELATIONSHIPS** S. K. Shernan: Other, e-echocardiography.com Editor, Philips Healthcare Educator; J. V. Conte: Research Grant, Medtronic; Consultant/Advisory Board, Medtronic; T. K. Kaneko: Speakers Bureau/Honoraria, Abbott, Edwards Lifesciences; V. H. Thourani: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

**8:00 AM Introduction**

**8:10 AM Case 1: Ischemic Mitral Regurgitation—Impact of New Guideline Recommendations**

*Stanton K. Shernan, Boston, MA*

**COMMERCIAL RELATIONSHIPS** S. K. Shernan: Other, e-echocardiography.com Editor; Philips Healthcare Educator

**8:30 AM Panel Discussion**

**8:50 AM Case 2: MitraClip—A Complex Case**

*Charles B. Nyman, Boston, MA*

**COMMERCIAL RELATIONSHIPS** C. B. Nyman: Ownership Interest, Edwards Lifesciences; Speakers Bureau/Honoraria, Edwards Lifesciences

9:10 AM	<b>Panel Discussion</b>
9:30 AM	<b>Case 3: Left Ventricular Outflow Tract Obstruction After Mitral Valve Replacement</b> <i>Stanton K. Shernan, Boston, MA</i> <b>COMMERCIAL RELATIONSHIPS</b> S. K. Shernan: Other, e-echocardiography.com Editor; Philips Healthcare Educator
9:50 AM	<b>Panel Discussion</b>
10:10 AM	<b>Break</b>
10:30 AM	<b>Case 4: Right Ventricular Dysfunction After Tricuspid Valve Surgery</b> <i>Alina Nicoara, Durham, NC</i>
10:50 AM	<b>Panel Discussion</b>
11:10 AM	<b>Case 5: High Pressure Gradient After Aortic Valve Replacement</b> <i>Alina Nicoara, Durham, NC</i>
11:30 AM	<b>Panel Discussion</b>
11:50 AM	<b>Concluding Remarks</b>



8:00 AM – 4:00 PM

Room 316

**Multidisciplinary Innovations in Cardiothoracic Patient Care**

Allied health professionals are critical members of the cardiothoracic surgical team who enhance patient safety through multidisciplinary performance improvement and research activities, yet forums for the discussion and dissemination of these findings are limited. This session will update attendees on recent practice innovations while providing an opportunity to discuss and debate important practice issues with a broad audience. This focus on the surgical team will lead to enhanced communication and improve patient care across the continuum of care delivery.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Discuss recent innovations in cardiothoracic management that improve patient care
- Identify important areas of clinical research that impact the cardiothoracic patient
- Develop strategies for implementing care improvements locally

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, professionalism, interpersonal and communication skills, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through a series of lectures, case studies, and panel discussions that are meant to enhance understanding of the evolving roles within the interprofessional team. Questions from the audience, bibliographies, and handout materials will augment these competencies.*

**Moderators:** Tara Bartley, Birmingham, United Kingdom, and Sondra J. Ley, Greenbrae, CA

8:00 AM

**Welcome**

Richard L. Prager, Ann Arbor, MI

8:15 AM

**Percutaneous Valve Innovations: Impact for Non-Surgeons**

Patricia A. Keegan, Atlanta, GA

**COMMERCIAL RELATIONSHIPS** P. A. Keegan: Consultant/Advisory Board, Abbott, Edwards Lifesciences

8:45 AM

**Extracorporeal Membrane Oxygenation (ECMO) Innovations: Strategies That Make a Difference**

Michael Colligan, Houston, TX

9:15 AM

**Designing a Comprehensive Ventricular Assist Device Program**

Sarah D. Schettle, Rochester, MN

9:45 AM

**Break**

10:15 AM

**Caregiver Burnout**

Mary Zellinger, Atlanta, GA

10:30 AM

**Bundled Payments in Cardiac Surgery**

Jill R. Engel, Durham, NC

- 10:45 AM**      **Heart Service Line Approach to Safe Culture**  
*Brittany A. Zwischenberger, Lexington, KY*
- 11:00 AM**      **Negative Pressure Wound Therapy on Closed Wounds**  
*Richard Van Valen, Rotterdam, The Netherlands*
- 11:15 AM**      **Implementation of the STS Cardiac Surgical Resuscitation Protocol**  
*Richard S. Bell, Baltimore, MD, and Lauren M. Espeso, Baltimore, MD*
- 11:30 AM**      **Break**
- 12:45 PM**      **Innovations in Nursing: International Perspective**  
*Tara Bartley, Birmingham, United Kingdom*
- 1:30 PM**      **Current Thoughts on Medical Innovations**  
*Joel Dunning, Middlesbrough, United Kingdom*
- 2:15 PM**      **Break**

**2:30 PM** **Room 316**

**A Nurse-Driven Protocol Is Safe and Cost-Effective for Extracorporeal Membrane Oxygenator Support: A Cohort Study**

*Z. J. Kwapnoski, A. S. Siddique, T. R. Ryan, E. R. Lyden, M. J. Moulton, J. Y. Um, H. Merritt*  
*University of Nebraska Medical Center, Omaha*

**COMMERCIAL RELATIONSHIPS** J. Y. Um: Consultant/Advisory Board, Abbott

**Purpose:** Innovative methods to replace standard, continuous bedside perfusion care have arisen due to increasing utilization, coupled with limited resources, for extracorporeal membrane oxygenation (ECMO) support. Our center instituted a nurse-driven protocol to obviate the need for continuous in-house perfusion care. This study determined differences in costs and patient outcomes following the new protocol.

**Methods:** The charts of patients placed on ECMO between 2006 and 2017 at a single institution were retrospectively reviewed. Two cohorts were defined: Group 1 included patients with uninterrupted bedside perfusion care, and Group 2 consisted of patients under the new nurse-driven protocol, without perfusionists in-house continuously. Demographics, outcomes, and economic values were collected. Fiscal data included direct cost, contribution margin, and net income. Median and interquartile range (IQR), counts, and percentages were used to summarize data. Comparisons between cohorts were made using Fisher's exact test and the Mann-Whitney test.

**Results:** Over 10 years, a total of 248 patients required ECMO support at our institution, including 93 patients in Group 1 and 155 patients in Group 2. There was no statistically significant difference in ability to wean off ECMO, survival to hospital discharge, or survival 30 days after discharge (see Table). Both total hospital days and inpatient days following separation from ECMO were similar between groups. A decrease in mean direct cost of 21% was observed (\$205,989 vs \$162,991) between groups. The new protocol also generated an increase in mean contribution margin (net revenue - direct cost) by 82% (\$67,733 vs \$122,989). The mean net income increased by 727% (\$6922 vs \$57,244), with significant standard deviation (\$225,848 vs \$151,102).

**Conclusions:** Bedside ECMO care may be safely transitioned to critical care nurses without the need for continuous in-house perfusion support and without adverse effects on outcomes or hospital length of stay. Financial benefits were noted in our analysis, indicating a nurse-driven protocol may be a cost-effective alternative.

	Group 1 (n 93)	Group 2 (n 155)	p Value
Weaned from ECMO	60% (n 56)	54% (n 83)	0.35
Discharged from Hospital	52% (n 48)	50% (n 77)	0.79
Alive 30 Days after Discharge	52% (n 48)	46% (n 71)	0.80
Days of ECMO Support	4	6	0.63
Total Hospital Days	21	23	0.74
Inpatient Days after ECMO Wean	20	20	0.80
VA ECMO	51% (n 47)	48% (n 74)	0.05

2:45 PM

Room 316

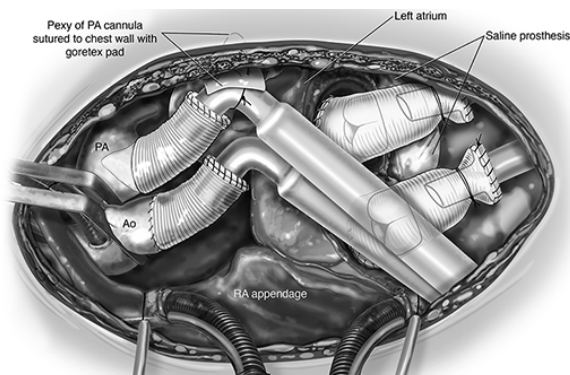
**Total Artificial Heart Using Bilateral Paracorporeal Pulsatile Ventricular Assist Devices in an 8.2 kg Child***R. K. Woods, R. A. Niebler, S. Kindel**Children's Hospital of Wisconsin, Milwaukee***REGULATORY DISCLOSURE** This presentation describes the off-label use of the Berlin EXCOR.

**Purpose:** Currently, there is no total artificial heart (TAH) designed for use in small children. We sought to adapt standard ventricular assist device (VAD) technology in order to allow effective total artificial heart support in an 8.2 kg patient.

**Methods:** This case report provides technical detail on the novel implantation of standard VAD technology as a TAH in a 15-month-old, 8.2 kg patient with swiss cheese apical ventricular septal defects and pulmonary artery (PA) band with biventricular dysfunction. Cardiac arrest occurred during attempted device closure. Although resuscitated, the patient remained critical despite maximal medical therapy. After surgical left ventricular apical exclusion and PA deband/PA reconstruction, and 10 days of extracorporeal membrane oxygenation (ECMO) support, poor biventricular function precluded wean from ECMO. A TAH approach was chosen due to concerns with standard left-sided inflow cannulation options.

**Results:** Bilateral support was provided by two paracorporeal pulsatile VADs (15-ml pumps, 9-mm cannulas, Dacron extension grafts to aorta and PA). Under warm aorta bicaval CPB, the ventricular mass was excised as for TAH implantation. For the left and right inflow, 18-mm and 20-mm porcine valved conduits were sewn to the mitral and tricuspid annuli, respectively. Inflow cannula cuffs were sewn to these conduits with the tips of the inflow cannulas positioned 2 cm from the ST junctions of the valves (see Figure). Chest was closed on postoperative day 1 after placing a saline prosthesis. After bilateral pump upsize (25 ml), the patient was extubated. After 17 days, support remains excellent, and the patient doing well with physical therapy.

**Conclusions:** Using valved inflow conduits to increase venous volume and prevent peaks in left atrial pressure, and standard paracorporeal pulsatile pumps, we achieved excellent pulsatile TAH support. We believe this approach offers a robust bailout solution for biventricular support when more standard approaches are not applicable.



3:00 PM

Room 316

**Dedicated Thoracic Enhanced Recovery Program Reduces Postoperative Narcotic Consumption***E. Podgaetz<sup>2</sup>, J. J. Berger<sup>1</sup>, M. Cohen<sup>2</sup>, R. S. Andrade<sup>2</sup>, M. Larson<sup>2</sup>, J. A. Wahr<sup>2</sup>*<sup>1</sup>University of Minnesota, Maple Grove, <sup>2</sup>University of Minnesota, Minneapolis

**Purpose:** We initiated a multidisciplinary Enhanced Recovery After Surgery Program (ERAS) for lung resections, where preemptive, regional, and multimodal analgesia work synergistically to treat postoperative pain. We compared the use of in-hospital narcotics (oral morphine equivalents) of this ERAS cohort compared to an age/gender/procedure-matched historical control group (NON-ERAS).

**Methods:** Over a 9-month period, we prospectively followed patients who underwent either pulmonary wedge resection or lobectomy who were enrolled in our ERAS program. As part of our ERAS program, patients receive preemptive analgesia with 1000 mg of acetaminophen orally, 200 mg of celecoxib orally, and 300 mg of gabapentin orally in the preoperative holding area. The patients got an ultrasound-guided ipsilateral paravertebral catheter running 0.2% ropivacaine at 14 mL/h. Intraoperatively, 0.25% bupivacaine with epinephrine is used for local port site analgesia. Postoperative ketorolac is used for four doses while continuing all preemptive analgesics.

**Results:** A total of 61 patients were included in our study (33 wedge resections and 28 lobectomies). 95% of surgeries were minimally invasive. An analysis of narcotics used during the hospital stay was performed retrospectively, and doses were expressed as oral morphine equivalents (NE). Intraoperative narcotic use was similar between both groups (NE 90.9/91.1,  $P = .97$ ). Post-anesthesia care unit use of narcotics also was not significantly different (NE 36.7/47.3,  $P = .08$ ). Use of narcotics during the first three 8-hour shifts was almost significantly reduced in the ERAS group (NE 14.8/29.9,  $P = .056$ ), and the total amount of narcotics used during the hospital stay was significantly less in the ERAS group (NE 212/338.5,  $P = .0018$ ).

**Conclusions:** Implementation of a multidisciplinary enhanced recovery program in thoracic surgery yields many benefits for the patients, one of which includes reduced requirements for narcotics postoperatively. ERAS pathways that emphasize preemptive, regional, and multimodal analgesia should be considered for all thoracic surgery patients undergoing pulmonary resection.

3:15 PM

Room 316

### The Effect of Frailty on Outcomes in Adult Cardiac Surgery Varies by Age

C. S. Bergquist<sup>1</sup>, E. A. Jackson<sup>1</sup>, L. M. Cabrera<sup>1</sup>, G. Paone<sup>2</sup>, A. Delucia<sup>3</sup>, C. N. He<sup>1</sup>, R. L. Prager<sup>4</sup>, D. S. Likosky<sup>1</sup>

<sup>1</sup>University of Michigan, Ann Arbor; <sup>2</sup>Henry Ford Hospital, Detroit, MI; <sup>3</sup>Bronson Methodist Hospital, Kalamazoo, MI; <sup>4</sup>University of Michigan Health System, Ann Arbor

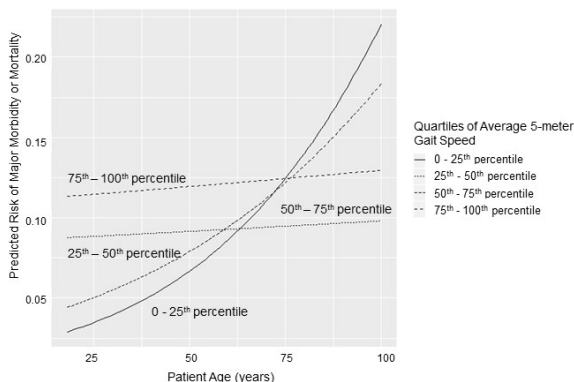
**COMMERCIAL RELATIONSHIPS** D. S. Likosky: Research Grant, AHRQ, NIH; Consultant/Advisory Board, AmSECT

**Purpose:** Prior work has identified a significant relationship between frailty and adverse outcomes among cardiac surgical patients. Due in part to differences between biological and chronological age, we used a statewide clinical database to identify whether frailty's association with adverse outcomes differed as a function of patient age.

**Methods:** We undertook an observational study of 51,013 patients undergoing coronary or valve surgery between July 2011 and June 2016 across 33 institutions participating in a statewide quality collaborative. Logistic regression was used to estimate the relationship between increasing quartiles of 5-m gait speed tests (a measure of frailty) and a patient's odds of major morbidity or mortality, after adjusting for patient demographics and disease characteristics. Heterogeneity of the relationship between 5-m gait speed and major morbidity or mortality was tested using an interaction term for patient age.

**Results:** Nearly one quarter (n=12,140, 23.8%) of patients, had at least one preoperative gait speed recorded. Patients in the slowest vs fastest quartile of gait speed were more likely to be older (72 years vs 60 years), have more complex comorbidities, and develop major morbidity and mortality (36.0% vs 7.4%),  $P < .0001$ . A significant moderator effect with frailty on major morbidity or mortality existed for age (Figure,  $P = .001$ ). For an age one standard deviation below the average (ie, 54.4 years), patients in the slowest vs fastest quartile had a 66% increased adjusted odds (ORadj 1.66, 95% CI: 1.16, 2.38) for major morbidity or mortality. A significant effect did not exist for patients at one standard deviation above the average age (ie, 79.4 years).

**Conclusions:** Increasing frailty was associated with increased odds for major morbidity or mortality, and the effect differed by patient age. These results suggest that factors beyond a patient's 5-meter walk test influence the role of frailty on poor outcomes following cardiac surgery.



3:30 PM

Room 316

### Evolution of a Mechanical Circulatory Support Program at a Freestanding Children's Hospital

C. D. Fraser Jr, I. Adachi, M. A. Chacon-Portillo, R. A. Zea-Vera, J. Heinle, C. M. Mery, L. C. Kane, A. G. Cabrera, A. M. Qureshi

*Texas Children's Hospital/Baylor College of Medicine, Houston*

**COMMERCIAL RELATIONSHIPS** I. Adachi: Consultant/Advisory Board, Berlin Heart, HeartWare

**Purpose:** Pediatric ventricular assist device (VAD) support is challenging due to the diversity of patients' sizes and the complexity of their cardiac pathophysiology. To account for such challenges, we have implemented a number of VAD technologies over the last 2 decades. We sought to report our institutional experience with pediatric VADs.

**Methods:** We conducted a retrospective review of all patients who underwent VAD support from March 1996 to May 2017 in our institution following institutional review board approval. VAD support was classified as either short- or long-term depending on the type of devices utilized. Extracorporeal membrane oxygenation (ECMO) support was not included. The etiology of heart failure was classified as dilated cardiomyopathy, congenital heart disease, graft dysfunction (including rejection), and other. Positive outcomes included bridge-to-transplantation (BTT), bridge-to-recovery (BTR), and bridge-to-bridge to another VAD (BTB). Death while on VAD support or during the same admission after VAD explantation was defined as VAD-mortality.

**Results:** Overall, 200 VADs were implanted in 136 patients, with 84 (42%) and 116 (58%) for short- and long-term support, respectively (Table). ECMO bridge-to-VAD occurred in 23/200 (12%). Annual implantation rates have increased progressively over time (Figure). Median (range) age, weight, and support duration for short-term VADs were 10 years (0-35 years), 29 kg (2.5-128 kg), and 5 days (0-45 days), respectively. 67/84 (80%) achieved positive outcomes, with BTR (41%) and BTB (31%) being the predominant outcomes. With the newer percutaneous VAD (Impella), graft dysfunction, challenging condition for surgically implanted VADs due to immunosuppression, has become a common etiology (14/23, 61%). Median (range) age, weight, and support duration for long-term VADs were 10 years (2 months-26 years), 25 kg (3-140 kg), and 3 months (2 days-5 years), respectively. 97/116 (84%) achieved positive outcomes, with BTT (62%) being the leading outcome. There is a clear tendency toward increasing support duration with newer devices, demonstrating "real" long-term support becoming the clinical reality in children.

**Conclusions:** Options for VAD support in children have improved during the last 2 decades. Given the ongoing advancement of pediatric VAD technology, we predict a major increase in pediatric VAD application in the future.

Figure – Number of ventricular assist device implantations per year.

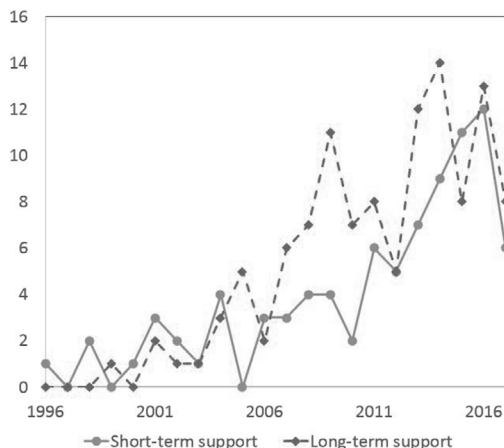


Table – Short- and long-term ventricular assist device demographic and outcome data.

Short-term	Biomedicus (n=24) 1996-2008	TandemHeart (n=3) 2009-2011	Rotaflo (n=34) 2009-2017	Impella (n=23) 2014-2017	Total (n=84)
Male, n (%)	12 (50)	2 (66)	15 (44)	17 (73)	46 (55)
Age years, median (range)	6 (11d-20y)	16 (15-23y)	4 (1d-23y)	18 (6-35y)	10 (1d-35y)
Weight kg, median (range)	20 (2.5-50)	93 (76-100)	14 (2.5-128)	68 (22-124)	29 (2.5-128)
Etiology, n (%)					
DCM	9 (37)	0	12 (35)	0	21 (25)
CHD	3 (13)	0	10 (29)	1 (4)	14 (16)
Graft Dysfunction	7 (29)	1 (33)	2 (6)	14 (61)	24 (28)
Other	5 (20)	2 (66)	10 (29)	8 (34)	25 (30)
Duration days, median (range)	5 (1-18)	5 (2-8)	5 (1-19)	7 (0-45)	5 (0-45)
Outcome, n (%)					
BTT	3 (12)	0	1 (2)	2 (8)	6 (7)
BTR	10 (42)	2 (66)	11 (32)	12 (52)	35 (41)
BTB	5 (20)	1 (33)	14 (41)	6 (26)	26 (31)
Death	6 (25)	0	8 (24)	3 (13)	17 (20)
Long-term	Other* (n=14) 1999-2007	Berlin (n=48) 2005-2017	HeartMate II (n=17) 2008-2014	HeartWare (n=35) 2011-2017	Total (n=116)
Male, n (%)	6 (43)	20 (42)	14 (82)	21 (60)	61 (53)
Age years, median (range)	13 (6-16y)	1.5 (2m-15y)	15 (10-18y)	11 (5-26y)	10 (2m-26y)
Weight kg, median (range)	42 (19-89)	10 (3-45)	61 (47-140)	30 (14-121)	25 (3-140)
Etiology, n (%)					
DCM	6 (43)	35 (73)	13 (76)	19 (54)	73 (63)
CHD	4 (28)	7 (15)	2 (12)	13 (37)	27 (23)
Other	4 (28)	6 (12)	2 (12)	3 (8)	16 (14)
Duration days, median (range)	38 (3-260)	60 (2-275)	89 (17-372)	188 (19-2059)	88 (2-2059)
Outcome, n (%)					
BTT	9 (64)	38 (79)	13 (76)	10 (29)	72 (62)
BTR	0	2 (4)	1 (6)	3 (8)	6 (5)
Ongoing	0	0	0	19 (54)	19 (16)
Death	5 (35)	8 (17)	3 (18)	3 (8)	19 (16)

BIVAD, biventricular ventricular assist device; BTB, bridge-to-bridge; BTR, bridge-to-recovery; BTT, bridge-to-transplant; CHD, congenital heart disease; DCM, dilated cardiomyopathy.

\*DeBaakey Child (n=3), Syncardia (n=2), Thoratec (n=11).

3:45 PM

## Closing Remarks

Sondra J. Ley, Greenbrae, CA

Room 316

10:00 AM – 4:30 PM

Grand Ballroom A-B

**“My Tube” Adult Cardiac How-To Video Session**

This session is designed for all practicing adult cardiac surgeons—experienced and novice, academic and private practice. This video-based session will emphasize technical tips to help surgeons improve their practice and outcomes immediately. Topics will include heart failure surgery, coronary disease, valvular disease, and aortic/great vessel disease.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the technical aspects of complex operations commonly performed in adult cardiac surgery
- Discuss the pitfalls of critical steps in complex cardiac surgery
- Identify novel tricks to make cardiac operations easier, safer, and more reproducible

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, professionalism, and interpersonal and communication skills. These physician competencies will be addressed through a series of surgical videos followed by discussion and questions from the audience.*

**Moderators:** Gorav Ailawadi, Charlottesville, VA, and Ahmet Kilic, Baltimore, MD

**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; A. Kilic: Speakers Bureau/Honoraria, Baxter International, HeartWare, Abbott

**Mitral/Atrial Fibrillation Surgery****10:00 AM Mitral Repair With Mitral Annular Calcification**

*Tirone E. David, Toronto, Canada*

**10:12 AM Simple Robotic Mitral Repair**

*Robert L. Smith, Plano, TX*

**10:24 AM Rheumatic Mitral Repair**

*Vinay Badhwar, Morgantown, WV*

**10:36 AM Mitral Repair With Hypertrophic Obstructive Cardiomyopathy**

*Michael Chu, London, Canada*

**COMMERCIAL RELATIONSHIPS** M. Chu: Speakers Bureau/Honoraria, Abbott Vascular, LivaNova, Medtronic, Symets

**10:48 AM Mitral Repair With Papillary Muscle Repositioning**

*Joseph Lamelas, Miami Beach, FL*

**COMMERCIAL RELATIONSHIPS** J. Lamelas: Ownership Interest, Miami Instruments; Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic, Abbott

- 11:00 AM**      **Surgical Left Atrial Appendage (LAA) Closure via Left Atrium and Epicardial**  
*A. Marc Gillinov, Cleveland, OH*  
**COMMERCIAL RELATIONSHIPS** A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure
- 11:12 AM**      **Surgical LAA Closure: Epicardial and Endocardial Techniques**  
*Richard Lee, St Louis, MO*
- 11:24 AM**      **Maze During Non-Mitral Surgery**  
*Jonathan M. Philpott, Norfolk, VA*  
**COMMERCIAL RELATIONSHIPS** J. M. Philpott: Research Grant, AtriCure; Speakers Bureau/Honoraria, AtriCure
- 11:36 AM**      **Question the Experts**
- 12:00 PM**      **Break**
- Coronary Artery Disease**
- 12:50 PM**      **Coronary Endarterectomy**  
*Silvana Marasco, Melbourne, Australia*  
**REGULATORY DISCLOSURE** This presentation describes the off-label use of a sternal wire as a dissector.
- 1:02 PM**      **Combined Carotid-Coronary Artery Bypass Grafting (CABG)**  
*TBD*
- 1:14 PM**      **Minimally Invasive CABG**  
*Joseph McGinn, Charlotte, NC*  
**COMMERCIAL RELATIONSHIPS** J. T. McGinn: Speakers Bureau/Honoraria, Medtronic  
**REGULATORY DISCLOSURE** This presentation describes the off-label use of the Medtronic Octopus System.
- 1:26 PM**      **Hybrid Coronary Revascularization (Robotic)**  
*Francis P. Sutter, Wynnewood, PA*  
**COMMERCIAL RELATIONSHIPS** F. P. Sutter: Speakers Bureau/Honoraria, Intuitive Surgical
- 1:38 PM**      **Question the Experts**
- Aortic Valve/Aortic Surgery**
- 1:50 PM**      **Sutureless Aortic Valve Replacement**  
*David A. Heimansohn, Indianapolis, IN*  
**COMMERCIAL RELATIONSHIPS** D. A. Heimansohn: Other, LivaNova, Proctor
- 2:02 PM**      **Rare Alternative Access Transcatheter Aortic Valve Replacement (TAVR) – Carotid, Transcaval**  
*Vinod H. Thourani, Washington, DC*  
**COMMERCIAL RELATIONSHIPS** V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc
- 2:14 PM**      **Surgical Removal of TAVR (Late Failure)**  
*Michael A. Borger, New York, NY*

- 2:26 PM Redo Arch Reconstruction**  
*John A. Kern, Charlottesville, VA*
- 2:38 PM Redo Root (Root Abscess)**  
*Wilson Y. Szeto, Philadelphia, PA*  
**COMMERCIAL RELATIONSHIPS** W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices
- 2:50 PM Dissection – Antegrade Stenting**  
*Derek R. Brinster, New York, NY*
- 3:02 PM Bicuspid Aortic Valve Repair**  
*Thomas G. Gleason, Pittsburgh, PA*  
**COMMERCIAL RELATIONSHIPS** T. G. Gleason: Research Grant, Medtronic; Nonremunerative Position of Influence, Medtronic, Steering and Screening Committee
- 3:14 PM Question the Experts**  
[Heart Failure Surgery](#)
- 3:26 PM Extracorporeal Membrane Oxygenation (ECMO) – Arterial Access (Femoral) With Distal Femoral Perfusion**  
*David A. Dean, Atlanta, GA*
- 3:38 PM ECMO – Left Ventricle Venting Strategies**  
*Jay K. Bhama, Iowa City, IA*
- 3:50 PM Temporary Left Ventricular Assist Device – Minimally Invasive**  
*Hiroo Takayama, New York, NY*  
**REGULATORY DISCLOSURE** This presentation describes the off-label use of the CentriMag pump.
- 4:02 PM Pump Exchange – Subcostal Approach**  
*Behzad Soleimani, Hershey, PA*
- 4:14 PM Minimally Invasive HVAD**  
*Jan Schmitto, Hanover, Germany*  
**REGULATORY DISCLOSURE** This presentation describes the minimally invasive implantation of HVAD, which is an off-label use.
- 4:26 PM Question the Experts**

12:00 PM – 1:00 PM

**BREAK**

1:00 PM – 4:00 PM

Palm Ballroom A, Second Floor

**CME Residents Symposium: Transitioning From Residency to a Successful Practice**

This symposium will help cardiothoracic surgery residents navigate the challenges of completing training and beginning practice. The first session will explain the process of finding a position: reasons for choosing private or academic practice, logistics and best practices for the job search, and considerations in contract negotiation. The second session will cover essential aspects of growing a new practice: building a clinical practice, benchmarks to set during the beginning of one's career, health care/individual surgeon finances, and achieving work-life balance. Each session will be followed by small group table discussions led by experienced surgeons and a larger group discussion with the speakers.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Outline the elements of a successful job search
- Explain the decision making behind choosing academic or private practice
- Describe the basic elements of contract negotiation
- Delineate benchmarks for early career development and clinical program development
- Discuss how cardiothoracic surgeons' individual finances relate to health care financing
- Identify aspects of work-life balance that are important to consider in career planning

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*The physician competencies addressed in this session are professionalism, practice-based learning and improvement, and interpersonal and communication skills. These physician competencies will be addressed through a series of individual lectures that will address practical early career information.*

**Moderator:** Craig J. Baker, Los Angeles, CA

1:00 PM

**Introduction****Session I: Finding a Job**

1:05 PM

**Why I Chose Private Practice**

*Asad A. Shah, Raleigh, NC*

1:18 PM

**Why I Chose Academics**

*Mara B. Antonoff, Houston, TX*

1:31 PM

**Mechanics of Finding a Job**

*Ravi Ghanta, Houston, TX*

1:44 PM

**Negotiating a Contract**

*Michael P. Robich, Portland, ME*

**COMMERCIAL RELATIONSHIPS** M. P. Robich: Speakers Bureau/Honoraria, LivaNova

1:57 PM

**Discussion**

**Session II: Transition to Practice**

- 2:30 PM**      **Building a Successful Clinical Practice: Challenges and Solutions**  
*Edward P. Chen, Atlanta, GA*
- 2:43 PM**      **Early Career Development**  
*Neel R. Sodha, Baltimore, MD*
- 2:56 PM**      **What You Need to Know About Finances: Coding, Billing, Reimbursement, and Margins**  
*Frederick Y. Chen, Boston, MA*
- 3:09 PM**      **Achieving a Successful Work-Life Balance**  
*Sidharta P. Gangadharan, Boston, MA*
- 3:22 PM**      **Discussion**

1:00 PM – 4:30 PM

Floridian Ballroom A

**How-To Video Session: Technical Tips to Avoid Pitfalls and Simplify Congenital and Pediatric Cardiac Surgical Procedures**

Textbooks and peer-reviewed publications are not ideal formats for showing the technical nuances of challenging operations. This video session will help congenital, pediatric, and adult congenital surgeons master difficult operative scenarios, such as complex atrioventricular valve disease and complex biventricular repairs. In addition, attendees will be exposed to emerging technology and unique strategies for improved surgical management of heart failure, mechanical support, and cardiac transplantation.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- List the technical aspects of complex operations performed in congenital and pediatric cardiac surgery
- Discuss pitfalls of critical steps in complex congenital and pediatric cardiac surgery
- Identify novel surgical approaches to make congenital and pediatric cardiac operations safer and more reproducible
- Describe the technical nuances for operative interventions that are not commonly seen in clinical practice

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through a series of individual lectures, video demonstrations, and case scenarios that will address issues in congenital heart surgery. Questions from the audience and panel discussions will augment these competencies.*

**Moderators:** S. Adil Husain, San Antonio, TX, and James S. Tweddell, Cincinnati, OH

**Session I: Ebstein Anomaly**

1:00 PM

**Starnes Procedure**

Vaughn A. Starnes, Los Angeles, CA

1:15 PM

**Neonatal Ebstein Repair**

Shu-Chien Huang, Taipei, Taiwan

1:30 PM

**Cone Procedure**

Joseph A. Dearani, Rochester, MN

**Session II: Systemic Atrioventricular (AV) Valve Disease**

1:45 PM

**Use of CorMatrix for Mitral Valve Surgery**

Richard G. Ohye, Ann Arbor, MI

**COMMERCIAL RELATIONSHIPS** R. G. Ohye: Consultant/Advisory Board, CryoLife, Novartis; Speakers Bureau/Honoraria, CryoLife

**REGULATORY DISCLOSURE** This presentation describes the off-label use of the CorMatrix valve.

- 2:00 PM**      **Melody Valve Use in the Mitral Position**  
*Sitaram M. Emani, Boston, MA*  
**COMMERCIAL RELATIONSHIPS** S. M. Emani: Consultant/Advisory Board, Paidon
- 2:15 PM**      **Complex AV Valve Repair Associated Stage II or III Palliation for Single Ventricle Disease**  
*Glen S. Van Arsdell, Ontario, Canada*
- 2:30 PM**      **Break**
- Session III: Complex Biventricular Repairs**
- 3:00 PM**      **Nikaidoh Procedure**  
*Victor Morell, Pittsburgh, PA*
- 3:15 PM**      **Biventricular Repairs in Complex Heterotaxy Patients**  
*Pedro J. del Nido, Boston, MA*  
**COMMERCIAL RELATIONSHIPS** P. J. del Nido: Ownership Interest, Nido Surgical
- 3:30 PM**      **Double Switch Operation**  
*James S. Tweddell, Cincinnati, OH*
- Session IV: Mechanical Surgical Support**
- 3:45 PM**      **Extracorporeal Membrane Oxygenation Simulation Program**  
*David M. McMullan, Seattle, WA*
- 4:00 PM**      **HeartWare Total Artificial Heart**  
*David L. Morales, Cincinnati, OH*  
**COMMERCIAL RELATIONSHIPS** D. L. Morales: Consultant/Advisory Board, Berlin Heart, HeartWare, SynCardia  
**REGULATORY DISCLOSURE** This presentation describes the off-label use of SynCardia TAH 70/70 in kids. It is approved for adults as a bridge to transplant device. This presentation describes the off-label use of HeartWare VAD in kids. HeartWare is approved for adults as a bridge to transplant.
- 4:15 PM**      **Transplant Techniques in Complex Fontan Patients**  
*Kirk R. Kanter, Atlanta, GA*

1:00 PM – 4:30 PM

Floridian Ballroom D

### How-To Video Session: Tips and Tricks to Maximize Efficiency in Minimally Invasive General Thoracic Surgery

This video session will focus on technical tips and tricks to make difficult, minimally invasive general thoracic surgeries more efficient. Topics include maximizing efficiency in robotic and thoracoscopic segmentectomy and lobectomy, as well as esophagectomy. Speakers also will discuss systems-based approaches to efficiency in the perioperative and postoperative periods, advice on nodule localization, and endoscopic approaches to esophageal cancer.

#### Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe techniques to improve efficiency in the conduct of minimally invasive lobectomy, segmentectomy, and esophagectomy
- Discuss methods for identifying lung nodules amenable to segmentectomy and for nodule localization
- Explain endoscopic approaches to esophageal cancer, including selection criteria and potential complications
- Describe systems-based methods to improve efficiency in the operative and postoperative setting

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, professionalism, practice-based learning and improvement, and systems-based practice. These physician competencies will be addressed through video demonstrations, individual lectures, and case-based presentations that will address issues in minimally invasive general thoracic surgery. Questions from the audience will augment these competencies.*

**Moderators:** Robert J. Cerfolio, New York, NY, and Janet P. Edwards, Calgary, Canada

**COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher

1:00 PM **Introduction**

1:05 PM **Robotic Lobectomy**

*Michael S. Kent, Boston, MA*

**COMMERCIAL RELATIONSHIPS** M. S. Kent: Other, Intuitive Surgical, Received travel funds for case observation

1:20 PM **Thoracoscopic Lobectomy**

*Michael J. Weyant, Aurora, CO*

1:35 PM **Lean and Efficient Surgery and Recovery: A Systems Approach**

*Mara B. Antonoff, Houston, TX, and David C. Rice, Houston, TX*

**COMMERCIAL RELATIONSHIPS** D. C. Rice: Speakers Bureau/Honoraria, Intuitive Surgical, Pacira Pharmaceuticals

1:50 PM **Panel Discussion**

2:05 PM **Break**



- 2:15 PM      Robotic Segmentectomy**  
*Robert J. Cerfolio, New York, NY*  
**COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher
- 2:30 PM      Thoracoscopic Segmentectomy**  
*Janet P. Edwards, Calgary, Canada*
- 2:45 PM      How Do I Find the Nodule? Tips, Tricks, and Novel Techniques**  
*Yolonda L. Colson, Boston, MA*
- 3:00 PM      Panel Discussion**
- 3:15 PM      Break**
- 3:30 PM      Robotic Ivor Lewis**  
*Inderpal S. Sarkaria, Pittsburgh, PA*  
**COMMERCIAL RELATIONSHIPS** I. S. Sarkaria: Speakers Bureau/Honoraria, Intuitive Surgical
- 3:45 PM      Transhiatal Esophagectomy**  
*Jules Lin, Ann Arbor, MI*
- 4:00 PM      Endoscopic Approaches to Esophageal Cancer**  
*Virginia R. Little, Boston, MA*
- 4:15 PM      Panel Discussion**

2:00 PM – 6:30 PM

Third Floor Concourse

**Scientific Posters**

4:30 PM – 6:30 PM

Halls ABC, First Floor

**Opening Reception in STS Exhibit Hall**

7:00 PM – 10:00 PM

**President's Reception**

Network with STS surgeon leaders and fellow meeting attendees at the President's Reception. This high-profile event will be held on an oceanfront terrace at the luxurious Fort Lauderdale Marriott Harbor Beach Resort & Spa. While a tropical-themed band plays in the background, enjoy gourmet food stations and an open bar. Colorful tropical birds will be on hand to help set the mood. This reception takes the place of the STS Social Event, which previously had been held on Monday evening, leaving the night open for industry-sponsored events or socializing with your colleagues. Tickets can be purchased for \$95. Don't miss this opportunity to connect with leaders in cardiothoracic surgery in a picturesque, informal setting.

6AM

7AM

8AM

9AM

10AM

11AM

12PM

1PM

2PM

3PM

4PM

5PM

6PM

7PM

8PM

9PM

6:30 AM – 5:00 PM

Registration

7:00 AM – 7:15 AM  
Opening Remarks

7:15 AM – 8:15 AM

J. Maxwell Chamberlain Memorial Papers

8:15 AM – 9:00 AM

Abstract Presentations

9:40 AM – 9:50 AM

Introduction of the President: Keith S. Naunheim

9:50 AM – 10:50 AM

Presidential Address: Richard L. Prager

9:00 AM –  
4:30 PM

Exhibit  
Hall

Scientific  
Posters

11:30 AM – 12:30 PM

Adult Cardiac:  
Arrhythmia/  
Atrial  
Fibrillation

Basic Science  
Research: Adult  
Cardiac

Basic Science  
Research:  
General  
Thoracic

Congenital:  
Adult  
Congenital

Critical Care

Diversity and Inclusion  
in Cardiothoracic  
Surgery: What's  
In It for Me?

General Thoracic:  
New Technology

STS/CATS/CSCS: Difficult  
Decisions in Thoracic  
Surgery Advice From  
Canadian and  
American Experts



1:30 PM – 3:30 PM

Adult  
Cardiac:  
Aorta I

Adult  
Cardiac:  
Ischemic

Congenital:  
Pediatric  
Congenital I

General  
Thoracic:  
Lung Cancer I

General  
Thoracic: Lung  
Transplantation

International  
Symposium

SVS @ STS

1:15 PM – 5:15 PM  
Clinical Scenarios:  
Cardiologists and  
Surgeons Working  
Together



4:15 PM – 5:15 PM

Adult Cardiac:  
VAD Transplant/ECMO

Ethics Debate:  
Neighborhood Help or  
Itinerant Surgery?

Research Using the  
STS National  
Database

STS Key Contacts:  
Advocates for  
Cardiothoracic  
Surgery

The Annals Academy:  
Preparation and  
Interpretation of  
National Database  
Research

The Importance  
of Physician  
Documentation in  
Reimbursement

Women in  
Thoracic Surgery



5:15 PM – 6:30 PM  
Scientific Posters  
and Wine

5:30 PM – 6:30 PM  
Business Meeting  
(STS Members Only)



New



Non-CME Session



Audience Poll



Ticketed Event

**6:30 AM – 5:00 PM**
**9:00 AM – 4:30 PM**
**7:00 AM – 7:15 AM**
**7:15 AM – 8:15 AM**
**8:15 AM – 9:00 AM**
**9:40 AM – 9:50 AM**
**9:50 AM – 10:50 AM**
**11:30 AM – 12:30 PM**
**Registration**
**Exhibit Hall**
**Scientific Posters**
**Opening Remarks**
**J. Maxwell Chamberlain Memorial Papers**
**Abstract Presentations**
**Introduction of the President: Keith S. Naunheim**
**Presidential Address: Richard L. Prager**
**Adult Cardiac: Arrhythmia/Atrial Fibrillation**
**Basic Science Research: Adult Cardiac**
**Basic Science Research: General Thoracic**
**Congenital: Adult Congenital**
**Critical Care**

**Diversity and Inclusion in Cardiothoracic Surgery: What's In It for Me?**
**General Thoracic: New Technology**

**STS/CATS/CSCS: Difficult Decisions in Thoracic Surgery Advice From Canadian and American Experts**
**1:15 PM – 5:15 PM**

**Clinical Scenarios: Cardiologists and Surgeons Working Together**
**1:30 PM – 3:30 PM**
**Adult Cardiac: Aorta I**
**Adult Cardiac: Ischemic**
**Congenital: Pediatric Congenital I**
**General Thoracic: Lung Cancer I**
**General Thoracic: Lung Transplantation**
**International Symposium: Confronting Infectious Diseases in Young Adults Undergoing Cardiac Surgery**
**SVS @ STS: Sharing Common Ground for Cardiovascular Problems**
**4:15 PM – 5:15 PM**
**Adult Cardiac: VAD Transplant/ECMO**
**Ethics Debate: Neighborly Help or Itinerant Surgery?**
**Research Using the STS National Database**
**STS Key Contacts: Advocates for Cardiothoracic Surgery**
**The Annals Academy: Preparation and Interpretation of National Database Research**

**The Importance of Physician Documentation in Reimbursement**
**Women in Thoracic Surgery: How to Successfully Implement Surgical Innovations and New Technologies Into Practice**
**5:15 PM – 6:30 PM**
**Scientific Posters and Wine**
**5:30 PM – 6:30 PM**
**Business Meeting (STS Members Only)**


6:30 AM – 5:00 PM

Atrium Lobby, First Floor

**Registration**

9:00 AM – 4:30 PM

Halls ABC, First Floor

**Exhibit Hall**

9:00 AM – 4:30 PM

Third Floor Concourse

**Scientific Posters**

7:00 AM – 10:50 AM

Grand Ballroom

**General Session I***Moderators: Richard L. Prager, Ann Arbor, MI, and Joseph F. Sabik III, Cleveland, OH***COMMERCIAL RELATIONSHIPS** J. F. Sabik: Research Grant, Abbott; Consultant/Advisory Board, Medtronic

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, and professionalism. These physician competencies will be addressed through a series of individual lectures and focused discussion on key points of presentations.*

7:00 AM

**Opening Remarks**

7:15 AM

**J. Maxwell Chamberlain Memorial Paper for Adult Cardiac Surgery****Does Surgical Atrial Fibrillation Ablation Improve Long-Term Survival? A Multicenter Analysis**

**A. Iribarne<sup>1</sup>, A. W. Discipio<sup>1</sup>, J. N. McCullough<sup>1</sup>, R. Quinn<sup>2</sup>, B. J. Leavitt<sup>3</sup>, B. M. Westbrook<sup>4</sup>, M. P. Robich<sup>5</sup>, R. S. Kramer<sup>5</sup>, E. M. Olmstead<sup>1</sup>, D. J. Malenka<sup>1</sup>**

<sup>1</sup>Dartmouth-Hitchcock Medical Center, Lebanon, NH, <sup>2</sup>Maine Medical Center Cardiovascular Institute, Portland, <sup>3</sup>University of Vermont Medical Center, Burlington, <sup>4</sup>Catholic Medical Center, Manchester, NH, <sup>5</sup>Maine Medical Center, Portland

**COMMERCIAL RELATIONSHIPS** R. Quinn: Consultant/Advisory Board, CryoLife, LivaNova; M. P. Robich: Speakers Bureau/Honoraria, LivaNova

**Discussant:** *A. Marc Gillinov, Cleveland, OH*

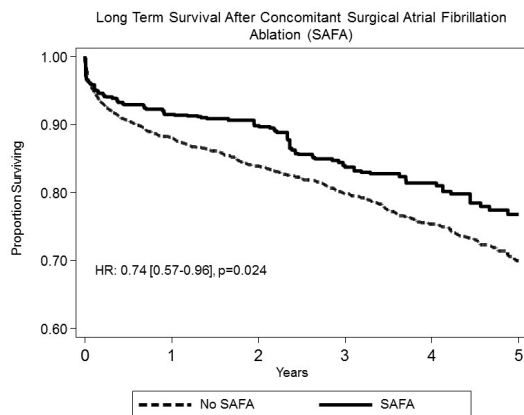
**COMMERCIAL RELATIONSHIPS** A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure

**Purpose:** STS recently issued new guidelines on surgical atrial fibrillation ablation (SAFA), given the effectiveness of this technique in achieving freedom from atrial fibrillation (AF). The goal of this analysis was to assess the influence of SAFA on long-term survival.

**Methods:** A multicenter, retrospective analysis of 20,407 consecutive coronary artery bypass grafting (CABG) or valve procedures from 2008 to 2015 in seven medical centers reporting to a prospectively maintained clinical registry was conducted. Patients undergoing first-time surgery with documented preoperative AF were included in the final analysis (n=2795). Patients with preoperative AF undergoing CABG or valve surgery with concomitant SAFA were then compared to those undergoing surgery without SAFA. The primary endpoint was all-cause mortality. Secondary endpoints included in-hospital morbidity and mortality. A propensity model and inverse probability weighting were used to estimate adjusted short- and long-term outcomes for the two groups.

**Results:** The overall frequency of SAFA in the study cohort was 28.3% (n=790), and there was a significant increase in annual SAFA volume over time ( $P < .001$ ), with a frequency of 35.8% in 2015. By procedure, concomitant SAFA was performed in: 21% (n=244) CABG, 35.5% (n=340) valve, and 30.5% (n=206) CABG/valve cases. There was a significant improvement in unadjusted survival among patients with preoperative AF undergoing concomitant SAFA (HR 0.59, 0.47-0.74;  $P < .001$ ). After inverse probability weighting, there were no significant differences in baseline characteristics between groups. At 5 years, patients undergoing concomitant SAFA had superior adjusted survival compared to those who did not (HR 0.74, 0.57-0.96;  $P = .024$ ), and the effect was observed among CABG, valve, and CABG/valve procedures (Table). In-hospital mortality did not differ between groups ( $P = 0.60$ ), and there were no differences in postoperative complications. While SAFA patients had longer bypass times ( $P < .001$ ), they had a shorter overall length of admission ( $P = .03$ ).

**Conclusions:** Among a multicenter cohort of patients with preoperative AF, concomitant SAFA resulted in significantly improved long-term survival across CABG, valve, and CABG/valve procedures at 5 years of follow-up. These findings support current STS guidelines recommending broader application of concomitant SAFA.



**Cox regression of concomitant SAFA vs no SAFA by procedure type**

	<b>Hazard ratio</b>	<b>95% CI</b>	<b>p-value</b>
CABG	0.64	0.41-0.97	0.036
Valve	0.48	0.33-0.70	0.001
CABG + valve	0.65	0.43-0.96	0.029

7:35 AM

Grand Ballroom

### J. Maxwell Chamberlain Memorial Paper for General Thoracic Surgery Enhanced Recovery Protocol Decreases Pulmonary and Cardiac Complications Following Thoracotomy for Primary Lung Cancer

R. M. Van Haren, R. Mehran, A. M. Correa, M. B. Antonoff, C. M. Baker, W. L. Hofstetter, G. E. Mena, J. A. Roth, B. Sepesi, S. G. Swisher, A. A. Vaporciyan, G. L. Walsh, D. C. Rice  
The University of Texas MD Anderson Cancer Center, Houston

**COMMERCIAL RELATIONSHIPS** G. E. Mena: Ownership Interest, Pacira Pharmaceutical; Consultant/Advisory Board, ConMed, Pacira Pharmaceutical; Speakers Bureau/Honoraria, Edwards Lifesciences; D. C. Rice: Speakers Bureau/Honoraria, Pacira Pharmaceuticals, Intuitive Surgical; J. A. Roth: Research Grant, Varian

**Discussant:** Farhood Farjah, Seattle, WA

**Purpose:** Enhanced recovery after surgery (ERAS) pathways aim to improve postoperative recovery through evidence-based practices, including early ambulation, multimodal opioid-sparing analgesia, reduction of surgical stress, and nutritional optimization. The purpose of this study was to evaluate outcomes following implementation of an ERAS pathway in patients undergoing resection for pulmonary malignancy.

**Methods:** We performed a retrospective review comparing outcomes for all patients undergoing pulmonary resection for primary lung cancer. Analysis was performed among three time periods: Pre-ERAS (January 1, 2006–December 31, 2011), transitional period with elements of ERAS (January 1, 2012–August 31, 2015), and after full implementation of the ERAS pathway (September 1, 2015–December 31, 2016). ERAS components included limited pre-anesthetic fasting, preemptive analgesia, intraoperative regional analgesia with liposomal bupivacaine intercostal blocks, drain minimization, postoperative opioid-sparing multimodal analgesia, and early ambulation and oral intake. Subgroup analysis was performed by surgical approach to evaluate impact of ERAS on thoracotomy and minimally invasive surgery (MIS). Statistical analysis was performed with univariate and multivariate logistic regression.

**Results:** 2886 lung resections were analyzed (Pre-ERAS n=1615, transitional n=929, ERAS n=342). Demographics were similar across time periods. Length of stay (LOS) decreased in both ERAS and transitional periods compared to Pre-ERAS (5.3 days  $\pm$  4.8 days vs 5.3 days  $\pm$  5.3 days vs 6.4 days  $\pm$  6.8 days,  $P < .001$ ). Pulmonary complications were decreased with ERAS compared to transitional and Pre-ERAS periods (19.9% vs 28.2% vs 28.7%,  $P = .004$ ). Likewise, cardiac complications decreased with ERAS (12.3% vs 13.1% vs 18.1%,  $P = .001$ ). There was less thoracic epidural use compared to transitional and Pre-ERAS periods (2.9% vs 44.5% vs 75.5%,  $P < .001$ ). There were no differences between periods in hospital readmission ( $P = .772$ ) or mortality rates ( $P = .417$ ). Following thoracotomy (but not MIS), ERAS was associated with decreased LOS ( $P < .001$ ), less ICU readmission ( $P = .026$ ), and decreased pneumonia ( $P = .007$ ), atrial arrhythmias ( $P < .001$ ), need for home oxygen ( $P = .004$ ), and discharge with chest tube ( $P = .003$ ) (Figure). ERAS was independently associated with decreased pulmonary ( $P = .007$ ) and cardiac ( $P = .020$ ) complications on logistic regression (Table).

**Conclusions:** Full implementation of ERAS was associated with improved postoperative outcomes, including decreased LOS, as well as decreased pulmonary and cardiac morbidity. Patients undergoing thoracotomy derived the greatest benefit from the ERAS pathway. The safety and feasibility of the pathway was manifest by low rates of adverse events without impact on hospital readmission or perioperative mortality.

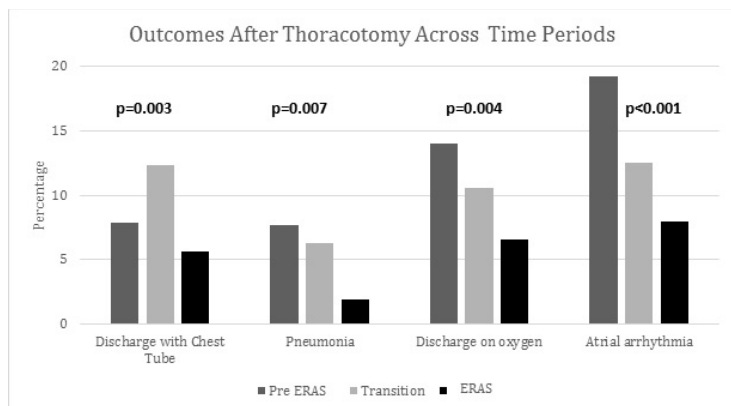


Table: Logistic Regression for Pulmonary and Cardiac Complications.

Pulmonary Complications	p=	OR	95% C.I. for OR	
			Lower	Upper
Time Period	0.017			
Pre ERAS (reference)				
Transition	0.818	1.022	0.851	1.226
ERAS	0.007	0.668	0.498	0.894
Age	<.001	1.021	1.013	1.030
Gender				
Female (reference)	1.0			
Male	0.008	1.253	1.060	1.480
Performance Status	0.015			
0 (reference)	1.0			
1	0.010	1.259	1.056	1.500
2-4	0.118	1.785	0.862	3.694
Type of Surgery				
Thoracotomy (reference)	1.0			
Minimally Invasive	0.003	0.761	0.636	0.910
Cardiac Complications	p=	OR	95% C.I. for OR	
			Lower	Upper
Time Period	0.002			
Pre ERAS (reference)	1.0			
Transition	0.002	0.687	0.542	0.871
ERAS	0.020	0.655	0.458	0.937
Age	<.001	1.644	1.330	2.033
Gender				
Female (reference)	1.0			
Male	0.000	1.656	1.335	2.054
Type of Surgery				
Thoracotomy (reference)	1.0			
Minimally Invasive	<.001	0.624	0.492	0.791
Extent of Surgery	<.001			
Sublobar	1.0			
Lobectomy/Sleeve	0.001	1.786	1.269	2.512
Pneumonectomy	<.001	4.165	2.528	6.861

7:55 AM

Grand Ballroom

# J. Maxwell Chamberlain Memorial Paper for Congenital Heart Surgery Where Are Patients From and Where Are They Going? Congenital Heart Surgery Referral Patterns in the US

T. Karamlou<sup>1</sup>, S. K. Pasquali<sup>2</sup>, C. L. Backer<sup>3</sup>, D. M. Overman<sup>4</sup>, J. C. Romano<sup>5</sup>, J. P. Jacobs<sup>6</sup>, K. F. Welke<sup>7</sup>

<sup>1</sup>Phoenix Children's Hospital, AZ, <sup>2</sup>University of Michigan, Ann Arbor, <sup>3</sup>Ann & Robert H. Lurie Children's Hospital of Chicago, IL, <sup>4</sup>Children's Heart Clinic at Children's Hospitals and Clinics of Minnesota, Minneapolis, <sup>5</sup>Michigan Congenital Heart Center, Ann Arbor, <sup>6</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL, <sup>7</sup>Children's Hospital of Illinois, Peoria

**COMMERCIAL RELATIONSHIPS** C. L. Backer: Consultant/Advisory Board, W. L. Gore & Assoc

**Discussant:** James S. Tweddell, Cincinnati, OH

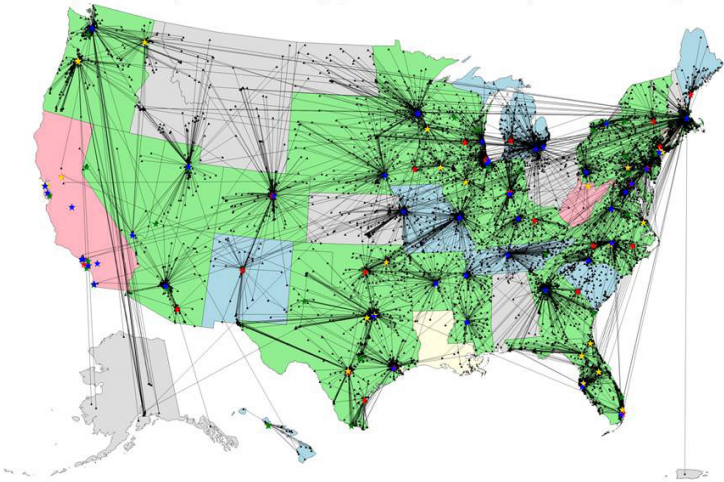
**Purpose:** Regionalization of care may provide a rational congenital heart surgery (CHS) model, but whether it is feasible, or even desirable, is unknown. We sought to describe the distribution of US CHS centers, demonstrate national referral patterns, and characterize the demographic currently traveling for CHS and the incurred travel burden.

**Methods:** State inpatient databases (n=38) from 2012 for patients ≤18 years were concatenated to characterize the current CHS network. Centers performing isolated ligation of ductus arteriosus among preterm infants were excluded (n=172). Complexity was determined using the RACHS-1 method, with RACHS-1 level ≥4 defined as high complexity. Hospital volume was stratified by quartiles of 50 case increments. Patient location was approximated using existing ZIP code data or by using the Federal Information Processing Standard. Hospitals were identified using National Provider Identifier or American Hospital Association ID. Stratified maps delineated national referral patterns based on patient location and CHS center destination.

**Results:** We identified 18,817 operations at 149 hospitals performing ≥RACHS-1 classifiable cases. Hospital distribution was non-uniform, with Missouri, Minnesota, and Maine having the highest number per capita, and three states having no centers (Figure). Median annual RACHS volume was 126 (range 1–797); 54 centers performed ≤50 and 46 performed >150 cases. Case mix varied, with 107 (72%) centers performing high-complexity cases. Of centers performing high-complexity cases, 36 (33%) performed ≤10 cases per year. Unadjusted overall mortality rate was 3.5% (n=664) and was lowest at the highest-volume programs. National referral patterns show that many patients already travel for CHS care, with most traveling to higher volume programs (Figure). Overall, 3729 patients (24%) traveled ≥100 miles for care, and 8027 (52%) bypassed the nearest CHS center. Travel distance was not appreciably (>10 miles) increased based on complexity or patient age. Importantly, self-pay insurance patients traveled less than all others (Table).

**Conclusions:** Many small-volume CHS programs are located in close proximity and perform a portion of high-complexity cases, with the majority concentrated in larger-volume hospitals. Patients travel long distances to high-volume, perceived high-quality centers, but these referral patterns appear unrelated to patient age, case complexity, or self-pay insurance status.

US Map demonstrating current referral patterns to CHS for available states. The black dots indicate patient origin and the colored stars depict where the patient underwent surgery. The colors refer to volume quartiles indicated in legend below.



Legend  
★ RACHS Cases LE 50 ★ RACHS Cases 51-100  
★ RACHS Cases 101-150 ★ RACHS Cases 151+

	RACHS Cases	Median Travel Distance	IQR	P-value
Overall	15375	37.1	14.6 – 97.8	
<b>RACHS-1 Classification</b>				< 0.01
Lower Severity	10782	39.4	15.3 – 99.9	
Higher Severity	1751	36.8	14.0 – 98.9	
Unclassified	2842	31.3	12.9 – 86.5	
<b>Age Day</b>				< 0.01
0-364	9556	34.8	13.9 – 92.3	
365+	5819	42.2	16.3 – 106	
<b>Insurance Type</b>				< 0.01
Commercial	6342	38.3	17.4 – 94.8	
Medicaid	7334	34.6	12.5 – 93.2	
Medicare	19	63.9	16.7 – 795.0	
Self-Pay	176	19.0	7.6 – 73.2	
Other/Unknown	920	57.2	17.5 – 136.0	

8:15 AM

Grand Ballroom

**Richard E. Clark Memorial Paper for Adult Cardiac Surgery****National Outcomes of Elective Hybrid Arch Debranching With Endograft Exclusion vs Total Arch Replacement Procedures: Analysis of the STS Adult Cardiac Surgery Database**

P. Vallabhajosyula<sup>1</sup>, T. Wallen<sup>1</sup>, T. X. Carter<sup>1</sup>, A. Habberthuer<sup>2</sup>, V. Badhwar<sup>3</sup>, J. P. Jacobs<sup>4</sup>, V. H. Thourani<sup>5</sup>, B. A. Yerokun<sup>6</sup>, D. Thibault<sup>6</sup>, A. Wallace<sup>7</sup>, R. C. Milewski<sup>1</sup>, W. Y. Szeto<sup>1</sup>, J. E. Bavaria<sup>1</sup>

<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>Hospital of the University of Pennsylvania, Philadelphia, <sup>3</sup>West Virginia University, Morgantown, <sup>4</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL, <sup>5</sup>Emory University, Atlanta, GA, <sup>6</sup>Duke University, Durham, NC, <sup>7</sup>Duke Clinical Research Institute, Durham, NC

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

**Discussant:** Himanshu J. Patel, Ann Arbor, MI

**COMMERCIAL RELATIONSHIPS** H. J. Patel, Consultant/Advisory Board, Terumo, W. L. Gore & Assoc

**Purpose:** Hybrid arch procedures involving arch vessel debranching with thoracic endovascular aortic repair (TEVAR) coverage of arch pathology have been presented as potential alternatives to total arch replacement (TAR). But multicenter-based analyses of these two procedures are needed to benchmark the field and establish areas of improvement.

**Methods:** The STS Adult Cardiac Surgery Database (v2.81) from July 2014 to December 2015 was queried for elective TAR and hybrid arch procedures (defined as arch debranching procedure under cardiopulmonary bypass with zone 0, 1, or 2 TEVAR). Demographics and operative characteristics were compared using Chi-square test and Wilcoxon rank-sum test. Stepwise variable selection was used to create a risk set used for adjustment of all multivariable models. Multivariable regression modeling was applied for the following outcomes: in-hospital/30-day mortality, stroke, reoperation, STS morbidity (composite renal failure, deep sternal infection, prolonged ventilation, reoperation for bleeding, stroke), mortality or stroke composite.

**Results:** Of 1011 patients meeting inclusion criteria, 884 underwent TAR and 127 had hybrid arch procedures. TAR patients were younger (mean age 62.7 years  $\pm$  13.3 years vs 66.7 years  $\pm$  11.9 years;  $P = .001$ ), had lower frequency of peripheral vascular disease (34.0% vs 49.6%;  $P < .001$ ) and preoperative dialysis status (1.7% vs 4.7%;  $P = .026$ ), but similar preoperative history of stroke ( $P = .91$ )/ cerebrovascular disease ( $P = .52$ ). Primary diagnosis was aneurysm (90.7% vs 90.6%;  $P = .95$ ). TAR patients had higher rates of concomitant cardiac procedures (60% vs 34.6%;  $P < .0001$ ). TAR patients had lower mortality (6.7% vs 12.6%;  $P = .02$ ), stroke (6.9% vs 15%;  $P = .002$ ), paralysis (1.8% vs 7.1%;  $P = .002$ ), new renal failure (4.6% vs 8.7%;  $P = .045$ ), and STS morbidity (34.2% vs 42.5%;  $P = .067$ ). Composite mortality, stroke, and paralysis was significantly lower in TAR group (11.5% vs 25.2%;  $P = .0001$ ). After risk adjustment, regression analysis showed hybrid arch procedures imparted an increased odds of mortality (OR 1.91,  $P = .046$ ), stroke (OR 2.3,  $P = .005$ ), and composite endpoint of stroke or mortality (OR 2.31,  $P = .0002$ ) (Table).

**Conclusions:** TAR remains the gold standard for elective aortic arch pathologies. Despite risk adjustment, hybrid arch procedures were associated with increased risk of mortality and stroke compared to TAR, advocating for careful adoption of these strategies. Randomized trials are required before embarking on extensive hybrid endovascular treatment strategies for aortic arch pathologies.

Variable	Total arch replacement (n=884)	Hybrid arch procedure (n=127)	P value
Demographics			
Age (years)	62.7±13.3	66.7±11.9	0.001
Gender (male)	58.6% (n=518)	57.5% (n=73)	0.811
Status: elective	100% (n=884)	100% (n=127)	-
Preoperative parameters			
Body surface area (BSA)	2.0±0.3	2.0±0.3	0.627
Congestive heart failure	17.1% (n=151)	9.4% (n=12)	0.027
NYHA III/IV (among CHF patients)	25.8% (n=39)	41.7% (n=5)	0.424
Dialysis	1.7% (n=15)	4.7% (n=6)	0.026
Diabetes	13.0% (n=115)	16.5% (n=21)	0.279
Hypertension	87.4% (n=773)	94.5% (n=120)	0.022
Peripheral vascular disease	34.0% (n=301)	49.6% (n=63)	<0.001
Cerebrovascular disease	20.5% (n=181)	22.8% (n=29)	0.523
Stroke	11.3% (n=100)	11.0% (n=14)	0.906
Intraoperative data			
Primary diagnosis (aneurysm)	90.7% (n=802)	90.6% (n=115)	0.950
Concomitant cardiac procedures	60.0% (n=530)	34.6% (n=44)	<0.001
Outcome variables			
Operative mortality	6.7% (n=59)	12.6% (n=16)	0.022
Stroke	6.9% (n=61)	15.0% (n=19)	0.002
Paralysis	1.8% (n=16)	7.1% (n=9)	0.002
Renal failure	4.6% (n=41)	8.7% (n=11)	0.045
STS morbidity	34.2% (n=302)	42.5% (n=54)	0.067
Composite outcome (operative mortality, operative stroke, permanent paralysis)	11.5% (n=102)	25.2% (n=32)	<0.001
Risk adjusted multivariate regression model for STS mortality			
Main	Level Effect	Odds Ratio (95% CI)	P value
Hybrid Arch vs TAR	Function 1: Hybrid Arch	1.91 (1.01, 3.61)	0.0461
Age (centered at 75 years)		1.12 (1.03, 1.22)	0.0071
Age by reoperation function 1		1.02 (0.99, 1.04)	0.1663
Creatinine function 1		2 (1.3, 3.09)	0.0018
Ejection Fraction		0.95 (0.91, 0.98)	0.0032
Female by BSA		0.04 (0.01, 0.2)	<.0001
Female by BSA squared		303.8 (13.18, 7005)	0.0004
Left main disease		0.24 (0.05, 1.1)	0.0667
Unstable angina		8.4 (2.69, 26.23)	0.0002
Risk adjusted multivariate regression model for stroke			
Main	Level Effect	Odds Ratio (95% CI)	P value
Hybrid Arch vs TAR	Function 1: Hybrid Arch	2.3 (1.3, 4.09)	0.0045
Age (centered at 75 years)		1.13 (1.04, 1.24)	0.0056
Age by reoperation function 1		1.01 (0.99, 1.03)	0.4495
Creatinine function 1		1.62 (1, 2.64)	0.0510
Ejection Fraction		0.96 (0.92, 0.99)	0.0106
Female by BSA		0.12 (0.01, 1.12)	0.0624
Female by BSA squared		0.37 (0, 699.8)	0.7939
Left main disease		5.15 (2.04, 13.01)	0.0005
Unstable angina		1.81 (0.49, 6.63)	0.3712

8:30 AM

Grand Ballroom

### Penetration, Completeness, and Representativeness of the STS General Thoracic Surgery Database for Lobectomy

B. C. Tong<sup>1</sup>, S. Kim<sup>2</sup>, A. S. Kosinski<sup>2</sup>, M. W. Onaitis<sup>3</sup>, D. J. Boffa<sup>4</sup>, R. H. Habib<sup>5</sup>, J. B. Putnam<sup>6</sup>, P. A. Cowper<sup>7</sup>, C. D. Wright<sup>8</sup>, J. P. Jacobs<sup>9</sup>, F. G. Fernandez<sup>10</sup>

<sup>1</sup>Duke University Medical Center, Durham, NC, <sup>2</sup>Duke Clinical Research Institute, Durham, NC, <sup>3</sup>University of California, San Diego, La Jolla, <sup>4</sup>Yale University School of Medicine, New Haven, CT, <sup>5</sup>The Society of Thoracic Surgeons, Chicago, IL, <sup>6</sup>Baptist MD Anderson Cancer Center, Jacksonville, FL, <sup>7</sup>Duke University, Durham, NC, <sup>8</sup>Massachusetts General Hospital, Boston, <sup>9</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL, <sup>10</sup>Emory University, Atlanta, GA

**COMMERCIAL RELATIONSHIPS** P. A. Cowper: Research Grant, AstraZeneca, Eli Lilly, General Electric, Gilead, Merck, Tenax Therapeutics; J. B. Putnam: Consultant/Advisory Board, Merck

**Purpose:** Not all surgeons performing lobectomy in the United States report their outcomes to the STS General Thoracic Surgery Database (GTSD). Our objective was to examine the penetration, completeness, and representativeness of the GTSD for pulmonary lobectomy in the Centers for Medicare & Medicaid Services (CMS) population.

**Methods:** Lobectomies from 2002 to 2013 were considered. Center-level penetration was the number of CMS lobectomy (CMS-L) sites matched to STS sites for patients >65 years, divided by the total number of CMS-L sites. Patient-level penetration was the number of CMS-L patients at STS sites, divided by the total number of CMS-L patients. Completeness was the ratio of STS patients linked to CMS patients, to the total number of CMS-L patients at STS sites. Patients were linked with a deterministic matching algorithm, using variables common to CMS and STS databases. Representativeness compared demographics and outcomes of CMS-L patients from GTSD non-participants and participants.

**Results:** Of the sites submitting claims to CMS for lobectomy between 2002 and 2013, approximately half recorded more than five cases per year in any particular year (range 46%–50%). Using more than five cases per year as a minimum for inclusion in the analysis, center-level penetration steadily increased from 1.2% (10/859 sites) at the inception of the GTSD in 2002 to 25% (169/675 sites) in 2013. Patient-level penetration was at its highest, 38% (4177/11,018) in 2013. Completeness at GTSD sites varied from 59% to 78% over the study period, which is lower than the 98% reported for the Adult Cardiac Surgery Database in 2012. Postoperative length of stay was longer for non-participants than for GTSD participants (median 6 days vs 5 days,  $P < .0001$ ; Table). Similarly, operative (30-day or in-hospital) mortality was higher for non-participants than for GTSD participants (3.3% vs 1.8%,  $P < .0001$ ).

**Conclusions:** GTSD participation has increased over time but still includes only a minority of thoracic surgery sites. GTSD participants have superior observed perioperative outcomes for lobectomy compared to non-participants. Database participation may reflect high-quality care. These data should encourage increased participation in the GTSD to stimulate quality improvement efforts.

Figure 1. Center-level penetration of The Society of Thoracic Surgeons General Thoracic Surgery Database, stratified by state (2013). White = 0%; grey = 1 to 5%; yellow = 6 to 10%; orange = 11 to 15%; red = 16 to 20%; purple = 21 to 47%.

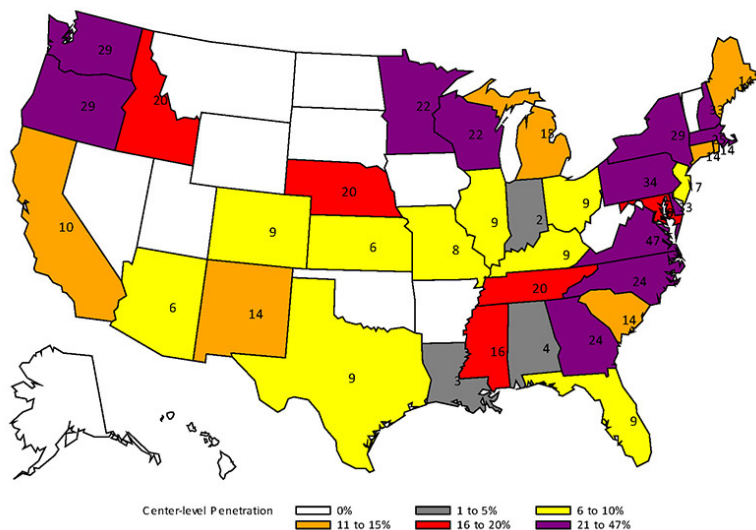


Table 1. Representativeness of GTSD for Lobectomy in 2013 when volume is greater than 5 per year

	CMS lobectomy not from STS site and not matched to GTSD N=6841	CMS lobectomy from STS site but not matched to GTSD N=937	CMS lobectomy matched to GTSD N=3240	P-Value
Age (years)	73.0 (69, 77)	73.0 (69, 77)	73.0 (69, 78)	0.9572
Gender				
Male	3,370 (49%)	436 (46%)	1,531 (47%)	0.0364
Female	3,471 (51%)	501 (53%)	1,709 (53%)	.
Race				
White	6,251 (91%)	815 (87%)	2,931 (90%)	0.0556
Black	365 (5.3%)	81 (8.6%)	180 (5.6%)	.
Other or unknown	225 (3.3%)	41 (4.4%)	129 (4.0%)	.
Operative mortality (in-hospital or 30-day)	225 (3.3%)	19 (2.0%)	58 (1.8%)	<.0001
Postoperative LOS (days)	6 (4, 8)	5 (3, 7)	5 (3, 7)	<.0001

8:45 AM

Grand Ballroom

**Abstract Presentation**

9:00 AM

**BREAK—Visit Exhibits and Scientific Posters**

*Complimentary coffee available in the Exhibit Hall*

9:40 AM

**Introduction of the President**

*Keith S. Naunheim, St Louis, MO*

9:50 AM

**Presidential Address: Eye of the Beholder: The Reinvention of Seeing**

*Richard L. Prager, Ann Arbor, MI*

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10:50 AM – 11:30 AM

**BREAK—Visit Exhibits and Scientific Posters**

*Complimentary coffee available in the Exhibit Hall*



11:30 AM – 12:30 PM

Floridian Ballroom A

**Adult Cardiac: Atrial Fibrillation/Arrhythmia***Moderators: T. Sloane Guy, New York, NY, and Patrick M. McCarthy, Chicago, IL***COMMERCIAL RELATIONSHIPS** T. S. Guy: Consultant/Advisory Board, Edwards Lifesciences, Verb Surgical; P. M. McCarthy: Ownership Interest, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Medtronic

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and case-based presentations. Questions from the audience will augment these competencies.*

11:30 AM

**Concomitant Atrial Fibrillation Made Simple: What Is the Right Lesion Set in Each Operation and What Is the Right Energy Source?***A. Marc Gillinov, Cleveland, OH***COMMERCIAL RELATIONSHIPS** A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure

11:40 AM

**Outcomes of Robotic-Assisted Surgical Ablation of Atrial Fibrillation Combined With Mitral Valve Surgery***M. Ju, J. Kim, J. Lee**Asan Medical Center, Seoul, South Korea*

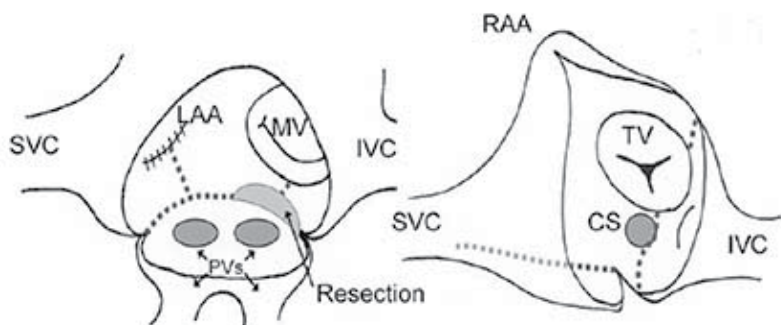
**Purpose:** In the era of expanding minimally invasive techniques in atrial fibrillation (AF) ablation surgery, data on robotic-assisted surgical AF ablation in patients undergoing mitral valve (MV) surgeries are scarce. The aim of this study is to evaluate early and late outcomes following robotic-assisted ablation of AF combined with MV surgery.

**Methods:** From 2007 through 2016, a total of 84 patients (54.0 years  $\pm$  13.1 years; 25 women) undergoing AF ablation using an argon-based flexible cryoablation system in the setting of MV operation under da Vinci robotic assistance were enrolled. Persistent (n=34, 40.5%) or longstanding persistent (n=37, 44.0%) AF was present in a majority of patients. Primary valve procedures were isolated mitral repair in 51, isolated mitral replacement in one, and combined mitral and tricuspid repair in 32.

**Results:** Fifty patients (59.5%) received left-side-only AF ablation, while the others (n=34, 40.5%) received biatrial ablation procedures. The time required for cardiopulmonary bypass and aortic cross clamping were 225 minutes  $\pm$  58.8 minutes and 133.2 minutes  $\pm$  29.3 minutes, respectively. There was no early mortality. Major early complications included neurologic injury in one and low cardiac output syndrome in two. There were no cases of surgical bleeding requiring reexploration, wound complication, or permanent pacemaker implantation. Early AF was identified in 20 patients (23.8%) during post-ablation blanking period (90 days). During a median follow-up duration of 47.5 months (quartile 1-3, 19.2-78.3 months; 86.9% complete), seven patients (8.3%) showed late recurrence of AF (after 90 days). One- and 5-year rates of freedom from late AF were 96.4%  $\pm$  2.1% and 92.6%  $\pm$

3.3%, respectively. There were two cases of late death (0.6%/patient-year), and one patient experienced stroke (0.3%/patient-year) during follow-up.

**Conclusions:** Surgical AF ablation using robotic assistance in the setting of cardiac valve surgeries showed excellent safety and favorable long-term clinical outcomes.



11:50 AM

Floridian Ballroom A

**Left Atrial Appendage: How Should I Treat and In What Setting?***Richard Lee, St Louis, MO*

12:00 PM

**Hybrid Thoracoscopic Approach Is Effective for the Treatment of Long-Standing Persistent Lone Atrial Fibrillation: 3-Year Clinical Update of the HISTORIC-AF Trial***C. C. Muneretto<sup>1</sup>, G. Bisleri<sup>2</sup>, F. Rosati<sup>1</sup>, L. L. Di Bacco<sup>3</sup>, A. A. Repossini<sup>1</sup>, A. A. Curnis<sup>4</sup>, M. Cerini<sup>1</sup>, G. G. Polvani<sup>4</sup>**<sup>1</sup>University of Brescia Medical School, Italy, <sup>2</sup>Queen's University, Kingston, Canada, <sup>3</sup>Paracelsus Medical University Nuremberg, Germany, <sup>4</sup>University of Milan, Italy***COMMERCIAL RELATIONSHIPS** G. Bisleri: Speakers Bureau/Honoraria, AtriCure; A. A. Repossini: Consultant/Advisory Board, LivaNova

**Purpose:** The HISTORIC-AF trial is a prospective, multicenter, single-arm study evaluating the outcomes of a hybrid staged thoracoscopic and transcatheter ablation in patients with persistent and long-standing persistent lone atrial fibrillation. We provide 3-year follow-up of the HISTORIC-AF trial population.

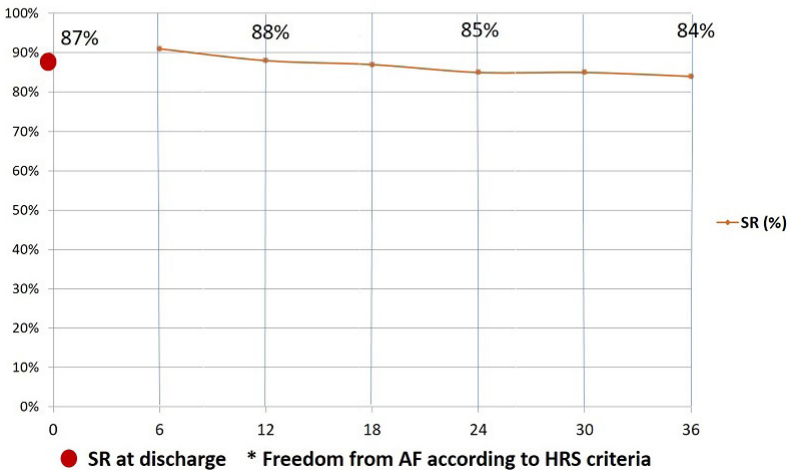
**Methods:** From 2012 to 2015, 100 consecutive patients were enrolled and underwent thoracoscopic left atrial epicardial isolation ("box lesion") followed by transcatheter ablation in case of AF recurrence. Primary efficacy endpoints were: freedom from AF and stable sinus rhythm following isolated thoracoscopic ablation >60%, while secondary efficacy endpoints were freedom from AF and stable sinus rhythm >80% following hybrid ablation (as per Heart Rhythm Society criteria). The primary safety endpoint was the composite outcome of freedom from major adverse cardiac and cerebrovascular events (MACCEs) at 30 days (stroke/transient ischemic attack [TIA], pacemaker [PM] implant, bleeding), while the secondary safety endpoint was freedom from serious adverse events (death, stroke/TIA, myocardial infarction, other embolic events) at 2 years.

**Results:** No death occurred and surgical thoracoscopic procedure was successfully completed in all patients. Survival free from MACCEs at 30 days was 94%: there were three permanent PM implants, two episodes of stroke, and one revision for bleeding. At discharge, 87% of patients were in sinus rhythm. A staged transcatheter ablation was carried out in all patients with AF recurrences at the end of a 3-month blanking period (18% of patients). At 12-month follow-up, a stable restoration of sinus rhythm was achieved in 75% of patients following isolated thoracoscopic ablation, while it was achieved in 88% of patients who underwent hybrid ablation. At 24- and 36-month follow-up, 85% and 84% of patients, respectively, were in sinus rhythm after hybrid treatment. During 3-year follow-up, no adverse events in terms of stroke/TIA and other embolic events occurred in the whole HISTORIC-AF population. In this timeframe, one patient underwent late PM implantation for atrioventricular block.

**Conclusions:** The HISTORIC-AF trial showed that thoracoscopic isolated surgical ablation reached both safety and efficacy endpoints, and the hybrid procedure steadily improved rhythm outcomes at 12, 24, and 36 months follow-up and may be considered the treatment of choice for patients with persistent and long-standing persistent AF in the future.

HISTORIC-AF Trial

Freedom from AF \*



12:10 PM

Floridian Ballroom A

**Robotic Biatrial Cryo-Maze Ablation for Persistent Lone Atrial Fibrillation***V. Badhwar, T. Murashita, J. S. Rankin, L. Wei**West Virginia University, Morgantown***COMMERCIAL RELATIONSHIPS** J. S. Rankin: Ownership Interest, BioStable Science and Engineering; Consultant/Advisory Board, AtriCure, BioStable Science and Engineering**REGULATORY DISCLOSURE** This presentation describes the use of the AtriCure cryoablation system, which is not FDA approved.

**Purpose:** The highest atrial fibrillation (AF) conversion rates are obtained with biatrial Cox-Maze ablation procedures. However, patients with lone AF frequently are recommended minimally invasive lesion sets that have lower success rates. A minimally invasive approach to full biatrial Cox-Maze ablation might be useful for these patients.

**Methods:** Videos are presented showing two patients with persistent symptomatic AF undergoing robotic biatrial cryo-Maze procedures for lone AF. Coronary sinus ablation lesions were created, along with inferior box lesions and cryoablation lines into the left atrial appendage. A superior box lesion was connected to the inferior lesion, anterior to the left pulmonary veins. The mitral isthmus lesion was placed down onto the mitral annulus, incorporating the coronary sinus lesion.

**Results:** A small incision was created in the lateral right atrium, and a tricuspid isthmus lesion was placed onto the tricuspid annulus. Then, superior vena caval, right atrial appendage, and inferior caval lesions were placed. The left atrial appendage was closed using a double layer of suture. Both patients recovered uneventfully and remain in sinus rhythm on no medications.

**Conclusions:** Techniques for robotic biatrial cryo-Maze are simple, well developed, and validated. Outcomes are equivalent to standard open Cox-Maze ablation procedures. Minimally invasive robotic biatrial cryoablation is ideal for application to symptomatic patients with refractory persistent lone AF.

12:20 PM

**Discussion**

11:30 AM – 12:30 PM

Rooms 301-302

**Basic Science Research: Adult Cardiac***Moderators: Arnar O. Geirsson, New Haven, CT, and Bo Yang, Ann Arbor, MI*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

11:30 AM

**Targeted Metabolomic Profiling Identifies Novel Circulating Biomarkers in Peripheral Blood in Nonsyndromic Thoracic Aortic Aneurysm****H. N. Wang<sup>1</sup>**, M. A. Wagner<sup>2</sup>, C. N. Haynes<sup>2</sup>, O. R. Ilkayeva<sup>2</sup>, S. H. Shah<sup>1</sup>, G. C. Hughes<sup>1</sup><sup>1</sup>Duke University Medical Center, Durham, NC, <sup>2</sup>Duke University School of Medicine, Durham, NC

**Purpose:** Thoracic aortic aneurysm (TAA) is associated with multiple diagnostic and therapeutic challenges. In addition, the molecular mechanisms underlying the pathogenesis of TAA is incompletely understood. We sought to test the hypothesis that profiling metabolites in patients with TAA would clarify the molecular mechanisms and identify novel biomarkers associated with TAA.

**Methods:** The study cohort consisted of 44 nonsyndromic proximal TAA patients and controls from the institutional biorepositories. Patients and controls were matched on age, gender, race, congestive heart failure, diabetes, renal function, and coronary disease. Targeted profiling of 60 metabolites in peripheral blood was conducted using flow injection tandem mass spectrometry. Metabolite levels between cases and controls were compared using paired Wilcoxon rank sum test (Bonferroni correction). A linear regression model was used to assess the association between metabolite levels and TAA, adjusted for all matched variables (Bonferroni correction). Subgroup analysis assessed the correlations between metabolites and aneurysm diameter in TAA.

**Results:** Median age for the entire cohort was 62 years (25th percentile/75th percentile: 52 years/72 years), and 82% (n=36) were male. All TAA patients were diagnosed with proximal (ascending aortic with or without aortic root) aneurysms and underwent surgical repair. The median aneurysm size for TAA patients was 5.5 cm (25th percentile/75th percentile: 5.1 cm/5.6 cm). Of the 60 metabolites profiled using mass spectrometry, seven metabolite levels were significantly lower in TAA patients compared to controls after Bonferroni correction (adjusted  $P < .05$ ): the amino acid arginine (44.6  $\mu\text{M}$  vs 70.2  $\mu\text{M}$ ), the short-chain dicarboxylacylcarnitine succinyl carnitine (0.03  $\mu\text{M}$  vs 0.04  $\mu\text{M}$ ), two short-chain acylcarnitines (tiglyl carnitine [0.04  $\mu\text{M}$  vs 0.18  $\mu\text{M}$ ] and octanoyl carnitine [0.06  $\mu\text{M}$  vs 0.08  $\mu\text{M}$ ]), and three long-chain acylcarnitines (decanoyl carnitine [0.08  $\mu\text{M}$  vs 0.18  $\mu\text{M}$ ], dodecenoyl carnitine [0.07  $\mu\text{M}$  vs 0.11  $\mu\text{M}$ ], and lauroyl carnitine [0.04  $\mu\text{M}$  vs 0.08  $\mu\text{M}$ ]). Six of these metabolites were significantly associated with TAA in the multivariable linear regression model (Table, adjusted  $P = 2.9 \times 10^{-10} - .04$ ). Subgroup analysis of TAA patients revealed significant negative correlations between seven long-chain acylcarnitines and aortic aneurysm diameter (Spearman's coefficients -0.46 to -0.56), where lower levels of these long-chain acylcarnitines were associated with larger aneurysm diameters.

**Conclusions:** We have identified novel circulating biomarkers in peripheral blood in non-syndromic TAA with the potential to aid in the diagnosis and surveillance of this deadly disease. These biomarkers report on dysregulated endoplasmic reticulum stress and mitochondrial dysfunction, both of which are potentially important pathways involved in the pathogenesis of TAA.

**Table.** Metabolites associated with TAA in multivariable linear regression analysis.

Class	Metabolite	$\beta$ (Slope)	Adjusted p-value
Short-chain acylcarnitine	Tiglyl carnitine	-0.43	$2.9 \times 10^{-10}$
	Octanoyl carnitine	-0.01	0.04
Short-chain dicarboxylacylcarnitine	Succinyl carnitine	-0.01	0.005
Long-chain acylcarnitine	Lauroyl carnitine	-0.07	0.0001
	Dodecenoyl carnitine	-0.10	0.0002
	Decanoyl carnitine	-0.13	0.0006

11:40 AM

Rooms 301-302

### Diazoxide Attenuates Spinal Cord Ischemia-Reperfusion Injury Through STAT3 Pathway

K. J. Yamana<sup>1</sup>, M. A. Eldeiry<sup>2</sup>, M. Aftab<sup>2</sup>, X. S. Meng<sup>1</sup>, M. J. Weyant<sup>3</sup>, J. C. Cleveland Jr<sup>1</sup>, D. A. Fullerton<sup>3</sup>, T. B. Reece<sup>1</sup>

<sup>1</sup>University of Colorado, Aurora, <sup>2</sup>University of Colorado Anschutz Medical Campus, Aurora,

<sup>3</sup>University of Colorado School of Medicine, Aurora

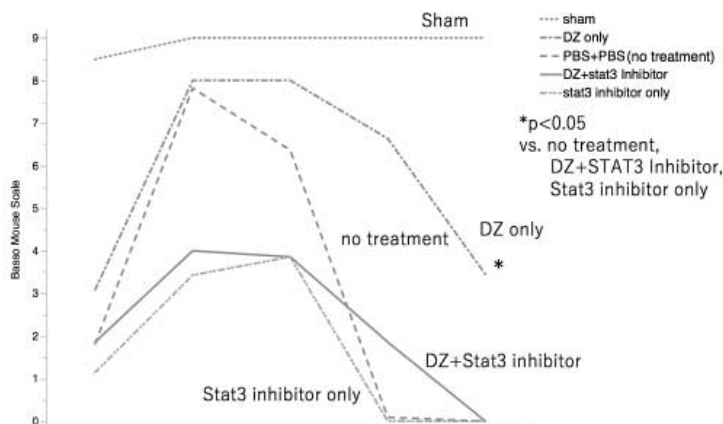
**COMMERCIAL RELATIONSHIPS** J. C. Cleveland Jr: Research Grant, Abbott; T. B. Reece: Research Grant, Medtronic, W. L. Gore & Assoc; Consultant/Advisory Board, McKesson

**Purpose:** Paraplegia remains the most feared complication of thoracoabdominal aortic intervention. Pharmacological preconditioning with diazoxide (DZ) (KATP channel opener) leads to the neuroprotection against ischemic insult. However, effects of DZ in spinal cord ischemia-reperfusion injury have not yet been elucidated. We hypothesized that DZ attenuates SCIRI through the STAT3 pathway.

**Methods:** For time trial of pSTAT3, adult male C57/BL6 received DZ (20 mg/kg) by oral gavage. After 0, 12, 24, 36, 48, and 60 hours of administration, spinal cords were harvested. The expression of pSTAT3 was analyzed by Western blot. Four groups were studied: DZ (DZ pretreatment, n=9), ischemic control (PBS pretreatment, n=11), DZ+STAT3 inhibitor (SI: LY5) (DZ pretreatment + SI, n=7), and SI (no pretreatment + SI, n=7). Spinal cord ischemia was induced by 4 minutes of thoracic aortic cross-clamp. Functional scoring (Basso Mouse Score) was done at 12-hour intervals. Spinal cords were harvested for the evaluation of BCL-2 expression and histological changes.

**Results:** Optimal upregulation of pSTAT3 occurred 36 hours after administration of DZ. The motor function in the DZ group was significantly preserved compared to all other groups at 48 hours after reperfusion, while motor function in the DZ+SI and SI groups as significantly worse than the ischemia control group (Figure). The expression of BCL-2 in the DZ group was significantly higher than that of the ischemic control and DZ+SI groups 48 hours after reperfusion.

**Conclusions:** DZ preserved motor function in spinal cord ischemia-reperfusion injury through the STAT3 pathway. Better understanding of this protective mechanism of DZ may serve to further prevent ischemic complications for high-risk aortic intervention.



## Group

Sham (n=4)	operation without cross-clamping
<u>Diazoxide</u> (n=9)	pretreatment with <u>diazoxide</u>
Ischemic Control (n=11)	no pretreatment
DZ+STAT3 inhibitor (n=7)	pretreatment with <u>diazoxide</u> + STAT3 inhibitor
STAT3 inhibitor (n=7)	no pretreatment + STAT3 inhibitor

(pretreatment: 36 hours before operation)

11:50 AM

Rooms 301-302

**Microvesicles Induce Reduction in Inflammatory and Increase in Angiogenic Signaling in Chronically Ischemic Myocardium**

L. A. Scrimgeour<sup>1</sup>, B. A. Potz<sup>1</sup>, V. I. Pavlov<sup>1</sup>, B. A. Colantuono<sup>1</sup>, R. M. Abid<sup>2</sup>, N. Sodha<sup>2</sup>, F. W. Sellke<sup>3</sup>

<sup>1</sup>Brown University, Providence, RI, <sup>2</sup>Brown University Alpert Medical School, Providence, RI,

<sup>3</sup>Brown Medical School/Rhode Island Hospital, Providence

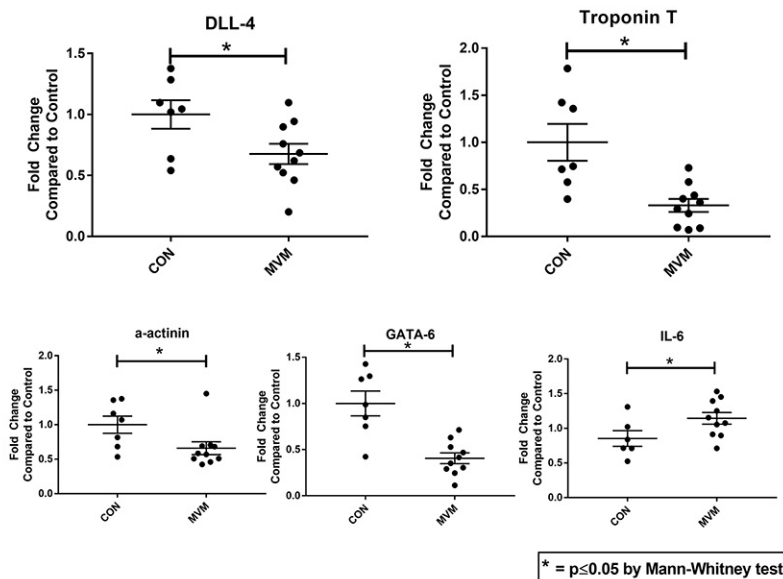
**COMMERCIAL RELATIONSHIPS** F. W. Sellke: Consultant/Advisory Board, Boehringer Ingelheim, Mallinckrodt, Stryker

**Purpose:** Mesenchymal stem cells are an exciting approach in the treatment of ischemic myocardial disease. Even more exciting are non-cellular-based treatment approaches with microvesicles, which contain miRNAs and proteins. We used a swine model of chronic myocardial ischemia to evaluate the efficacy of treatment by intramyocardial injection of microvesicles.

**Methods:** Seventeen Yorkshire swine (11 weeks old) had an ameroid constrictor placed on the left circumflex artery. They were divided into control (CON; n=7) or microvesicle myocardial injection group (MVM; n=10), with the microvesicle injections occurring 2 weeks after ameroid placement by direct injection into the ischemic myocardium. Microvesicles were cultured and isolated from human bone marrow mesenchymal stem cells. Seven weeks after ameroid placement, all animals underwent euthanasia, and ischemic myocardium was harvested for analysis. The tissue was analyzed via Western blot analysis.

**Results:** Injection of microvesicles was associated with decreased expression of DLL-4, troponin T,  $\alpha$ -actinin, and GATA-6 in the ischemic myocardium compared to the control group. Microvesicle administration was associated with an increase in IL-6 in the ischemic myocardium compared to the control group [Figure]. Microvesicles are thought to contain miRNAs, such as miRNA-125, which downregulate inhibitors of angiogenesis, such as DLL-4. Furthermore, decreased secretion of troponin T suggests decreased damage to the ischemic myocardium after treatment with microvesicle injection. Upregulation of IL-6 in the microvesicle-treated group suggests anti-inflammatory and pro-myokine function. GATA-6 is associated with cardiac hypertrophy, and  $\alpha$ -actinin is upregulated during cell differentiation. The decreased levels of these seen in the microvesicle-treated group suggests attenuation of overactive repair mechanisms to chronic ischemia, which would otherwise result in hypertrophy.

**Conclusions:** Intramyocardial injection of microvesicles appears to have a beneficial effect on chronically ischemic myocardium, likely via decreased DLL-4, which induces endothelial sprouting (angiogenesis), and via decreased inflammation. Overall, this study demonstrates a mechanism by which microvesicles isolated from stem cells may exert a beneficial effect on chronically ischemic myocardium.



12:00 PM

Rooms 301-302

### Tissue-Engineered Cardiac Patches Seeded With Human-Induced Pluripotent Stem Cell-Derived Cardiac Progenitor Cells Promote Short-Term Cardiac Function in Rat Left Ventricle Model

S. Miyamoto<sup>1</sup>, T. T. Sugiura<sup>2</sup>, H. H. Miyachi<sup>1</sup>, C. K. Breuer<sup>1</sup>, T. T. Shinoka<sup>1</sup>

<sup>1</sup>Nationwide Children's Hospital, Columbus, OH, <sup>2</sup>Texas Heart Institute/Baylor College of Medicine, Houston

**COMMERCIAL RELATIONSHIPS** C. K. Breuer: Research Grant, Gunze Ltd; Other Research Support, Gunze Ltd; T. T. Shinoka: Research Grant, Gunze Ltd

**Purpose:** Endoventricular patch plasty with a seeded, biodegradable, tissue-engineered patch is a potential novel solution. The purpose of the present study is to evaluate the feasibility of seeding human-induced pluripotent stem cell-derived cardiac progenitor cells (hiPS-CPCs) onto a biodegradable cardiac patch in the rat left ventricle.

**Methods:** The hiPS-CPCs were cultured on a biodegradable patch composed of a polyglycolic acid (PGA) and a 50:50 poly (l-lactic-co-ε-caprolactone) copolymer (PLCL) for 1 week. Male athymic rats were randomly divided into two groups of 10 animals each: (1) hiPS-CPCs seeded group and (2) unseeded group. After culture, the cardiac patch was implanted into the left ventricular wall. Hearts were followed by echocardiography at 4 (n=10), 8 (n=8), 24 (n=6), and 36 (n=3) weeks after patch implantation and explanted at 4 (n=2), 8 (n=2), 24 (n=3), and 36 (n=3) weeks. Explanted patches were assessed immunohistochemically.

**Results:** Seeded patch explants did not stain positive for anti-Human Nuclei and cardiac Troponin T (marker of cardiomyocytes) at the 4-week timepoint, suggesting that the cultured hiPS-CPCs evacuated the patch in the early phase of tissue remodeling. However, 8 weeks after implantation, the ejection fraction on echocardiography was significantly higher in the seeded group than in the unseeded group (seeded group:  $63.3\% \pm 4.7\%$  vs unseeded group:  $51.6\% \pm 8.07\%$ ,  $P = .0044$ ), suggesting cell seeding promoted the activity of host cardiomyocytes in the short term. At 36 weeks follow-up, there was no difference between the seeded and unseeded groups. There were no incidences of patch rupture or left ventricular calcification, suggesting this patch may be a feasible material for high-pressure systems.

**Conclusions:** Seeded hiPS-CPCs were not present in the patch after 4 weeks. However, we surmised that they influenced the activation of host cardiomyocytes via a paracrine mechanism. Seeding tissue-engineered cardiac patches with hiPS-CPCs affects short-term, but not long-term, cardiac function in ischemic heart disease.

12:10 PM

Rooms 301-302

### Decreased PGC-1 $\alpha$ Post-Cardiopulmonary Bypass Leads to Impaired Oxidative Stress Response in Diabetic Patients

M. S. Saraf<sup>f</sup>, J. Jeganathan<sup>1</sup>, F. Mahmood<sup>f</sup>, K. R. Khabbaz<sup>1</sup>, Z. Knio<sup>1</sup>, V. Senthilnathan<sup>2</sup>, D. Liu<sup>1</sup>, L. M. Chu<sup>1</sup>, R. N. Feng<sup>1</sup>, R. Matyal<sup>f</sup>

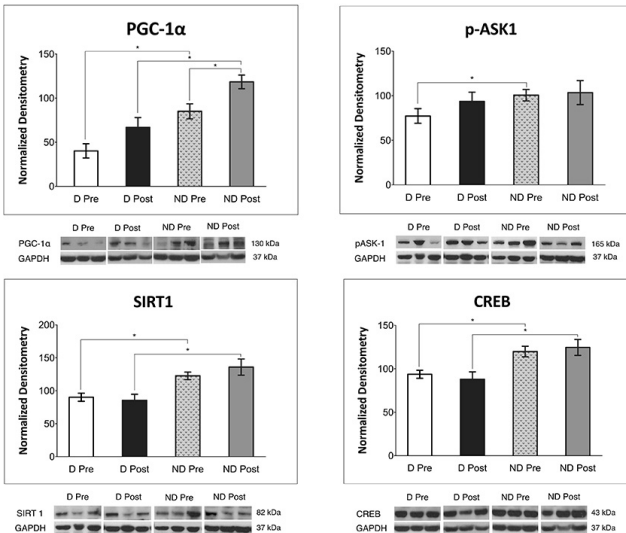
<sup>1</sup>Beth Israel Deaconess Medical Center, Boston, MA, <sup>2</sup>Harvard Medical School, Boston, MA

**Purpose:** The exact mechanism of mitochondrial dysfunction post-cardiopulmonary bypass (CPB) in diabetic patients is unknown. We hypothesized that altered beta-oxidation leads to impaired oxidative stress response in this patient population after cardiac surgery.

**Methods:** After Institutional Review Board approval, right atrial tissue samples were collected from 35 diabetic and 33 non-diabetic patients pre- and post-CPB. Patients with HbA1c  $\geq 5.6$  and a clinical diagnosis of diabetes mellitus were considered to be diabetic. Immunoblotting and microarray analysis were performed to assess changes at the cellular level and genetic expression. The blots were quantified with ImageJ and analyzed using one-way ANOVA and multiple t-test comparisons after normalization. *P* values  $< .05$  were considered significant. Immunohistochemistry was done for assessment of cellular lipid deposition.

**Results:** Diabetics had significantly lower levels of PGC-1 $\alpha$  pre- and post-CPB (*P*  $< .01$  for both) compared to non-diabetics. Upstream regulators of PGC-1 $\alpha$ : p-ASK1, SIRT1 and CREB were significantly higher in non-diabetics pre-CPB, thus offering cardioprotection (*P* = .037,  $< .01$ , and .0018, respectively). Antioxidant markers (NOX4 and GPX4), angiogenic factors (TGF- $\beta$ , NT3, and Ang1), and anti-apoptotic factor (Bcl-xL) were significantly lower in diabetics post-CPB (*P*  $< .05$ ) (Figure). On a genetic level, CREB5 and SLC25A40, genes supporting mitochondrial energy production, were significantly downregulated in diabetics post-CPB, along with anti-apoptotic and angiogenic genes (*P*  $< .05$ ) (Table). Immunohistochemistry results showed greater lipid deposition in diabetic myocardial tissue.

**Conclusions:** Decreased PGC-1 $\alpha$  in diabetic patients leads to impaired mitochondrial function, and decreased anti-apoptotic and anti-inflammatory response post-CPB. Thus, PGC-1 $\alpha$  could serve as a target for improving beta oxidation and post-cardiac surgery outcome in diabetic patients.



**Figure 1.** Representative immunoblotting and quantitative analysis of right atrial tissue from diabetic and non-diabetic patients before and after cardiopulmonary bypass (CPB). \*p < 0.05, (D Pre = atrial tissue from diabetic patients pre-CPB; D Post = atrial tissue from diabetic patients post-CPB; ND Pre = atrial tissue from non-diabetic patients pre-CPB; ND Post = atrial tissue from non-diabetic patients post-CPB.)

**Table 1.** Microarray results from atrial tissue of diabetic (D) and non-diabetic (ND) patients before and after cardiopulmonary bypass (CPB).

Genes of interest	D Fold Change	ND Fold Change	Overall Fold Change	P-value
<i>Oxidative Stress Marker</i>				
NOX1	-1.02	-1.32	-1.29	0.002
GSTA1	-1.04	-1.31	-1.26	0.045
<i>Metabolism</i>				
SLC25A40	1.14	1.30	-1.14	0.049
NFYC	1.02	-1.31	1.28	0.001
CHKB-CPT1B/CPT1B	1.33	-1.19	0.89	0.038
CREB5	1.78	2.76	-1.55	0.039
<i>Angiogenesis and Growth</i>				
FRS3	-1.25	-1.58	-1.26	0.039
SOS1	1.87	2.92	-1.56	0.015
<i>Pro-Apoptotic</i>				
CASP7	1.09	-1.04	0.95	0.043
BCL2L13	-1.07	1.10	1.03	0.042
<i>Anti-Apoptotic</i>				
PIAS1	2.56	3.59	-1.40	0.050
RICTOR	1.95	3.11	-1.59	0.007
PPM1A	1.73	2.63	-1.52	0.002
BAG1	-1.05	1.16	1.10	0.041

12:20 PM

Rooms 301-302

**Development of a Porcine Beating Heart Model of Self-Myocardial Retroperfusion: Evaluation of Hemodynamic and Cardiac Responses to Ischemia and Potential Clinical Applications**

*D. Grandmougin, J. Casse, A. Chalon, Y. Luo, F. Groubatch-Joineau, B. Mourer, M. Grandmougin, D. Grandmougin, G. Gauchotte, J. Maureira, N. Tran*

*University of Lorraine*

**Purpose:** Retrograde perfusion into the coronary sinus is used to deliver cardioplegia. We developed a drugless porcine beating heart model of self-myocardial retroperfusion (SMR) using the retrograde venous route to supply myocardial oxygenation and assessed hemodynamic and cardiac responses triggered by SMR before and after a prolonged period of left anterior descending (LAD) occlusion (>240 minutes).

**Methods:** In six pigs, a bypass line between the ascending aorta and the coronary sinus was made to perform a selective retrograde perfusion of the great cardiac vein with oxygenated blood (SMR). Cardiac output (CO), left ventricular maximal pressure (Pmax in-LV), stroke volume (SV), left ventricular ejection fraction (LVEF), diastolic durations (DD), heart rate, and arterial systemic pressure were evaluated with Millar catheters for the following periods: baseline, SMR with patent LAD, and SMR with occluded LAD. In order to assess systemic peripheral perfusion, patterns of sublingual microcirculation were analyzed. At the end of the procedures, the hearts were harvested for histology.

**Results:** In baseline conditions, echographic evaluation of LVEF was affected by sternotomy, but Millar catheter evaluation was not. Following sternotomy and pericardiotomy, CO decreased by 7.51% ( $P < .05$ ). In all procedures, SMR with patent LAD showed obvious inotropic properties with significant improvements in CO, SV, Pmax in-LV, and LVEF ( $P < .0001$ ) supported by adaptation of DD with a moderate chronotropic response. Following acute occlusion of the LAD, SMR showed capacities to supply myocardial oxygenation of the anterior wall of the left ventricle and preserve cardiac contractility, hemodynamic balance, capillary density, and peripheral perfusion. Troponin I release was negative ( $<1.5$  ng/mL). Histology showed no signs of myocardial infarction with a moderate superficial epicardial extravasation of red cells.

**Conclusions:** Selective SMR of the great cardiac vein produced interesting inotropic effects when associated with an antegrade physiological coronary perfusion and showed properties to protect from ischemic damage following a prolonged occlusion of the LAD, thus opening interesting clinical perspectives for off-pump coronary artery bypass surgery and extracorporeal membrane oxygenation.

11:30 AM – 12:30 PM

Room 304

**Basic Science Research: General Thoracic***Moderators: Jonathan D'Cunha, Pittsburgh, PA, and Arun K. Singhal, Longview, TX*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

11:30 AM

**PorphyrinHDL: A Novel Photosensitizing Nanoparticle for Lung Cancer Therapy**

**H. Ujiie<sup>1</sup>**, R. Fan<sup>2</sup>, L. Ding<sup>3</sup>, T. Kato<sup>1</sup>, D. Lee<sup>1</sup>, K. Fujino<sup>1</sup>, T. Kinoshita<sup>1</sup>, C. Lee<sup>1</sup>, J. Chen<sup>3</sup>, H. H. Chan<sup>3</sup>, R. Weersink<sup>3</sup>, B. C. Wilson<sup>3</sup>, T. K. Waddell<sup>1</sup>, S. Keshavjee<sup>1</sup>, G. Zheng<sup>3</sup>, K. Yasufuku<sup>1</sup>

<sup>1</sup>Toronto General Hospital, Canada, <sup>2</sup>University Health Network, Toronto, Canada, <sup>3</sup>TECHNA Institute, University Health Network, Toronto, Canada

**COMMERCIAL RELATIONSHIPS** T. K. Waddell: Employment, XOR-Labs; Ownership Interest, XOR-Labs

**REGULATORY DISCLOSURE** This presentation describes the use of porphyrinHDL, which is not FDA approved.

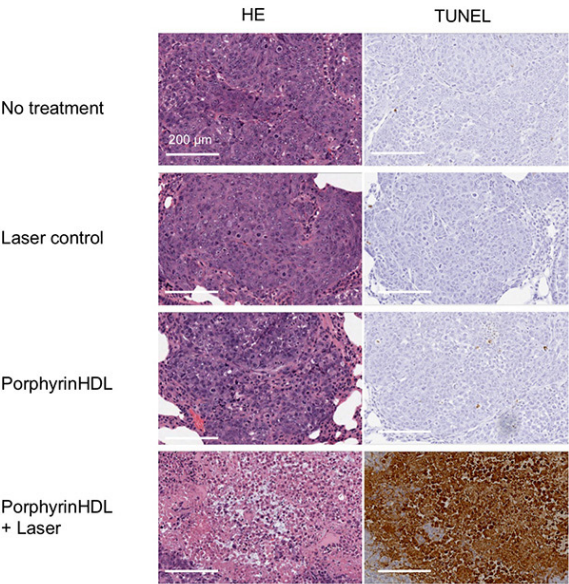
**Purpose:** We developed a novel, biomimetic, porphyrin lipoprotein-mimicking nanoparticle (porphyrinHDL), which incorporates multiple functional modalities, including positron emission tomography, near-infrared fluorescence imaging, and photodynamic therapy (PDT), into nanoscaffolds. Here, we investigated scavenger receptor class B type I (SR-BI) targeted/triggered porphyrinHDL nanoparticle-based PDT in a lung cancer model.

**Methods:** An SR-B1 expressing candidate lung cancer cell line was selected by Western blot analysis. The in vitro cellular uptake of porphyrinHDL in these cell lines was evaluated by confocal fluorescence microscopy. The in vitro PDT efficacy and dark toxicity were evaluated. The in vivo biodistribution and pharmacokinetics of porphyrinHDL were assessed in orthotopic tumor xenografts in mice. The porphyrinHDL accumulation in normal lung and tumor was visualized by ex vivo fluorescence and confocal microscopy. After confirming selective tumor accumulation of porphyrinHDL, we evaluated in vivo therapeutic efficacy of PDT enabled by porphyrinHDL using 100 J/cm<sup>2</sup> of 671 nm laser light.

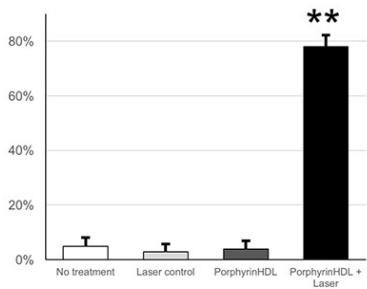
**Results:** The in vitro study demonstrated the specificity of SR-B1 mediated cellular internalization of porphyrinHDL and target-triggered activation of porphyrin fluorescence following cellular uptake. In vitro PDT treatment significantly decreased the cell viability (to 34%) as assessed by viability assay. In the biodistribution study, the porphyrinHDL fluorescence was clearly visible in the tumor, both in vivo and ex vivo. After laser irradiation, the PDT efficacy, assessed by H&E histologic analysis at 24 hours after treatment, showed that only the porphyrinHDL-PDT group experienced significant cellular damage, whereas the untreated control groups did not exhibit similar changes. Moreover, porphyrinHDL-PDT significantly increased cell apoptosis in tumor (73.2%) vs 6.5% in the untreated controls (Figure), with no detectible toxicity in normal tissues or damage to adjacent critical structures.

**Conclusions:** We have evaluated the targeting-specificity and efficacy of porphyrinHDL-mediated PDT in lung cancer with overexpressed SR-B1. This demonstrated SR-B1-mediated and activated fluorescence and PDT efficacy with porphyrinHDL as the photosensitizer, showing the potential of this approach for image-guided PDT in treating lung cancer with minimal damage to surrounding tissues.

Pathological evaluation after PDT



TUNEL apoptotic Index



\*\* : P< 0.001 (Student's t-test )

11:45 AM

Room 304

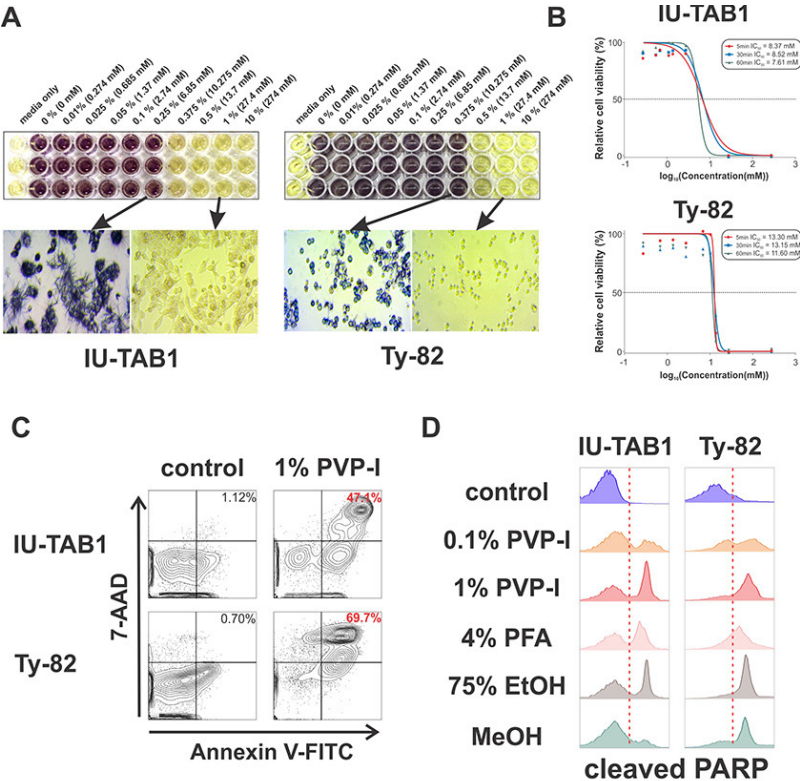
**Povidone Iodine Results in Rapid Killing of Thymic Epithelial Tumor Cells Through Cellular Fixation***H. Lee<sup>1</sup>, H. Jang<sup>1</sup>, S. Groth<sup>1</sup>, J. S. Friedberg<sup>2</sup>, D. J. Sugarbaker<sup>1</sup>, B. Burt<sup>1</sup>**<sup>1</sup>Baylor College of Medicine, Houston, TX, <sup>2</sup>University of Maryland, Baltimore***COMMERCIAL RELATIONSHIPS** B. M. Burt: Consultant/Advisory Board, Medtronic

**Purpose:** Hyperthermic pleural lavage with 1% povidone-iodine (PVP-I) is utilized in clinical practice to control micrometastatic disease following cytoreductive surgery for thymic epithelial tumors (TETs); however, there are few data to support its efficacy. Our objective was to investigate whether PVP-I has cytotoxicity against human TET cells.

**Methods:** Human IU-TAB1 (AB1 thymoma) and Ty-82 (thymic carcinoma) cell lines were treated with serial dilutions of PVP-I (0.01% to 10%) for 5, 30, and 60 minutes at 37°C. MTT assays evaluated cellular enzymatic activity and cell death. Flow cytometry was performed using Annexin V to examine membrane integrity and 7-AAD to evaluate cell death. Membrane permeability was investigated by intracellular staining of cleaved PARP (cPARP). Cellular fixation was examined by evaluating membrane disruption of dead cells by dimethylsulfoxide and by comparing cPARP staining following PVP-I with known cellular fixatives, including 4% paraformaldehyde and 75% ethanol.

**Results:** MTT assays demonstrated PVP-I concentrations greater than 0.5% reduced the yellow MTT to an insoluble purple formazan, which is driven by mitochondrial succinate dehydrogenase. Resistance of dead cells to membrane disruption by dimethylsulfoxide lysis for 4 hours suggested that the mechanism of cell death was cell fixation (Figure A). The Ty-82 cell line (thymic carcinoma) was more resistant to killing by PVP-I than the IU-TAB1 (thymoma) cell line. IC50 values immediately following 5 minutes of exposure to PVP-I were 8.37 mM and 13.30 mM in IU-TAB1 and Ty-82, respectively, and the extent of cell killing was similar regardless of exposure time (Figure B). Flow cytometry demonstrated that 5-minute exposure of both cell lines to 1% PVP-I resulted in significant disruption of membrane integrity and cell death (Figure C). Moreover, the extent of intracellular staining of cPARP after treatment with 1% PVP-I was similar to that following treatment with the known fixatives, paraformaldehyde and ethanol.

**Conclusions:** PVP-I results in rapid death of human thymoma and thymic carcinoma cells through a cellular fixation mechanism. These data suggest that normothermic 1% PVP-I for more than 5 minutes may favorably impact control of micrometastatic disease following resection of pleural disseminated TETs.



**Figure.** Povidone iodine results in rapid killing of thymic epithelial tumor cells through cellular fixation

A. MTT assays at 24 hours after PVP-I treatment for 5 minutes on IU-TAB1 and Ty-82 TET cell lines.

B. The half maximal inhibitory concentration ( $IC_{50}$ ) values of PVP-I for two TET cell lines according to three exposure times.

C. Cell viability and membrane integrity immediately after treatment of 1% PVP-I on TET cell lines.

D. The extent of intracellular staining of cPARP after PVP-I and other cellular fixatives.

EtOH denotes ethyl alcohol, MeOH methyl alcohol, PARP Poly(ADP-Ribose) Polymerase, PFA paraformaldehyde, and PVP-I povidone iodine.

12:00 PM

Room 304

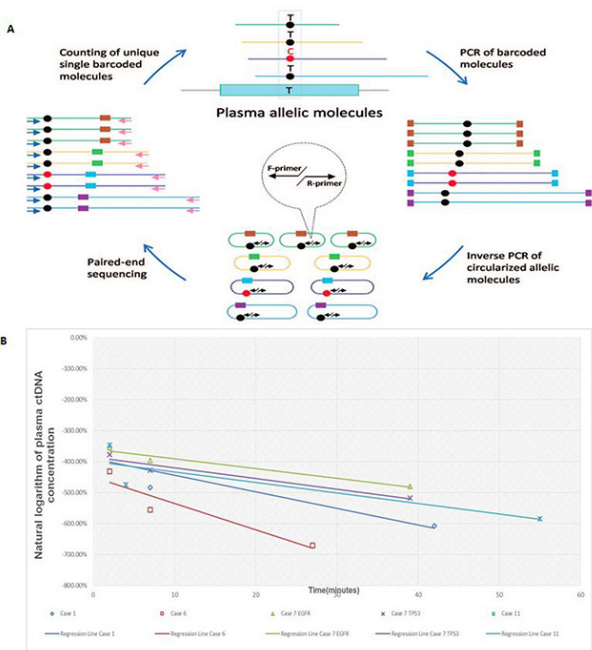
**Dynamic Changes of Circulating Tumor DNA in Surgical Lung Cancer Patients: A Prospective Cohort Study****K. Chen<sup>1</sup>, H. Zhao<sup>1</sup>, F. Yang<sup>1</sup>, T. Wang<sup>2</sup>, L. Wang<sup>2</sup>, J. Wang<sup>1</sup>**<sup>1</sup>Peking University People's Hospital, Beijing, China, <sup>2</sup>Berry Genomics Corp, Beijing, China

**Purpose:** Few studies have revealed dynamic changes of circulating tumor DNA in surgical lung cancer patients, and no criteria has been established on how to use it for surveillance. This is the first prospective study to evaluate the dynamic changes of ctDNA in surgical lung cancer patients.

**Methods:** Consecutive patients with suspected lung cancer who underwent curative-intent lung resection were enrolled prospectively in this study from November 2016. Plasma samples were obtained before surgery (time A) and at a series of scheduled timepoints (2 minutes to 72 hours, time B to F) after tumor resection. We designed a multiplex assay based on circulating single-molecule amplification and resequencing technology (cSMART) to simultaneously detect and quantitate hot spot gene variants. Positive plasma mutations were validated in tumor tissue by targeted sequencing.

**Results:** 131 patients were enrolled, of which 22 patients showed detectable driver mutations in the preoperative plasma sample (time A). Nine patients were excluded due to non-radical surgery (three), no plasma at other timepoints (two), non-somatic driver mutations (two), and no surgery performed (two). Finally, 13 patients (four stage I, three stage II, and six stage III) with 15 genetic alterations met the inclusion criteria, including four EGFR mutations, seven TP53 mutations, two PIK3CA mutations, one KRAS mutation, and one ALK rearrangement. In three cases, the ratio of ctDNA increased in time B than time A. The other 10 cases had a gradual decrease of mutation ratio as time went on. All the cases dropped to 0 after 72 hours of tumor resection. The average mutation ratio was 3.32%, 2.68%, 1.38%, 0.07%, 0.04%, and 0% at timepoints A to F, respectively. The evaluated half-life of ctDNA was 16.8 minutes (8.2-22.2).

**Conclusions:** The intraoperative manipulation may induce ctDNA releasing to plasma. The elimination of ctDNA in lung cancer patients is very rapid after surgical resection. Level of ctDNA 72 hours after surgery could be the reference value for postoperative surveillance.



No	Age	Sex	Tumor location	Histology
Case1	58	female	Right upper lobe	Adeno
Case2	75	female	Right lower lobe	Adeno
Case3	46	male	Right middle bronchus	Sarcomatoid cancer
Case4	74	female	Right lower lobe	Adeno
Case5	71	male	Right upper and middle lobe	Squamous
Case6	53	male	Right upper lobe	Squamous
Case7	66	female	Right lower lobe	Adeno
Case8	68	female	Left upper lobe	Adeno
Case9	52	female	Right upper lobe	Adeno
Case10	73	male	Right lower lobe	Squamous
Case11	74	male	Right middle lobe	Adeno
Case12	71	male	Left lower lobe	Squamous
Case13	57	male	Left upper and lower lobe	Large cell

12:15 PM

Room 304

**Mesenchymal Stem Cells Regulate Granulation Tissue Formation of Bioengineered Tracheal Grafts***A. M. Al-Ayoubi<sup>1</sup>, S. S. Rehman<sup>2</sup>, E. E. Lewis<sup>3</sup>, W. Raad<sup>4</sup>, R. M. Flores<sup>4</sup>, F. Bhora<sup>4</sup>**<sup>1</sup>University of Iowa, Iowa City, <sup>2</sup>Mount Sinai St Luke's Hospital, New York, NY, <sup>3</sup>Mount Sinai West and St Luke's Hospitals, New York, NY, <sup>4</sup>Mount Sinai Health System, New York, NY***COMMERCIAL RELATIONSHIPS** F. Bhora: Ownership Interest, CSA Medical; Consultant/Advisory Board, Boston Scientific, CSA Medical, Ethicon, Veran Medical

**Purpose:** To determine the role of mesenchymal stem cells (MSCs) in regulating granulation tissue formation of biologic extracellular matrix (ECM) collagen membranes used orthotopically for tracheal reconstruction.

**Methods:** Anterior cervical defects (4 cm length) were created in the tracheas of 4-week-old female Yorkshire pigs and reconstructed using size-matched bovine ECM. Animals were divided into two groups: a bioengineered group (ECM + MSCs, n=3) and a control group (ECM alone, n=3). Euthanasia was carried out at 3 months post-implantation, and the tracheas were harvested for further analysis. Tissue architecture was determined using hematoxylin and eosin (H&E) stains. Immunohistochemistry (IHC) was performed to measure expression of vWF, CD31, and alpha-SMA.

**Results:** Granulation tissue was significantly reduced in the bioengineered compared to the control group. On H&E, blood vessels in the bioengineered tracheal grafts were difficult to discern from the native vasculature and showed organized tissue pattern. In the ECM alone group, there was hyperemia and extensive blood vessel formation with abundant and disorganized fibroblasts, along with leukocyte invasion characteristic of granulation tissue. IHC showed expression of vWF, CD31, and alpha-SMA in both groups, but was significantly elevated in the control compared to the bioengineered group.

**Conclusions:** We show that mesenchymal stem cells regulate granulation tissue formation and angiogenesis of ECM for tracheal reconstruction in a large animal model. Further understanding the cellular and immunologic mechanisms that promote this phenotype is warranted.

11:30 AM – 12:30 PM

Room 316

**Congenital: Adult Congenital***Moderators: Joseph A. Dearani, Rochester, MN, and Kristine Guleserian, Miami, FL*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

11:30 AM

**Long-Term Growth of the Neo-aortic Root After the Arterial Switch Operation***S. Oda, T. Nakano, S. Fujita, S. Sakaguchi, H. H. Kado**Fukuoka Children's Hospital, Japan*

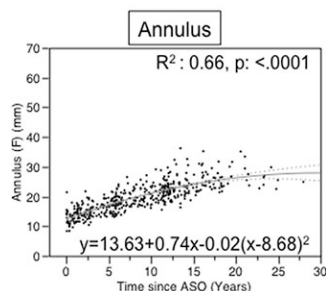
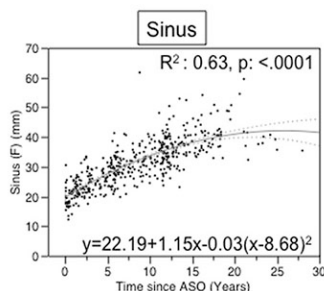
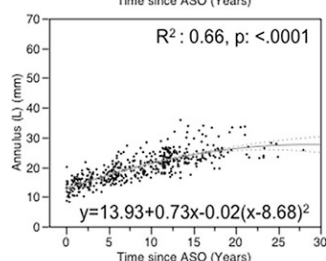
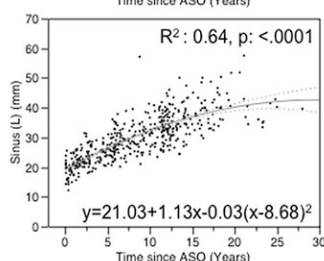
**Purpose:** The growth of the neo-aortic root after the arterial switch operation (ASO) for transposition of the great arteries (TGA) is unclear. The aim of this study was to describe the time course of progression of the neo-aortic root and determine risk factors for neo-aortic root dilation (ARD).

**Methods:** Serial angiographic measurements over 10 years of the annulus and sinus were evaluated in 145 patients who underwent the ASO at our institution. Median age at last angiography was 13.8 years. Simple TGA was present in 79 patients, and 46 had TGA with ventricular septal defect (VSD) and 20 had double outlet right ventricle (DORV). A total of 1876 measurements of annulus dimension at systolic phase and sinus dimension at diastolic phase in both frontal and lateral view were obtained.

**Results:** The absolute diameter revealed progressive growth of both annulus and sinus at the period of child and adolescent, after which both dimensions remained stable (Figure). In a linear mixed-effects model, the mean annulus z-score was 1.92 (frontal view) and 2.13 (lateral view), which increased at a rate of 0.030 ( $P < .0001$ ) (frontal view) and 0.019 ( $P = .004$ ) (lateral view) per year. The mean sinus z-score was 3.60 (frontal view) and 3.13 (lateral view), which increased at a rate of 0.005 ( $P = .33$ ) (frontal view) and 0.015 ( $P = .001$ ) (lateral view) per year. A multivariable analysis revealed that the presence of DORV and progressive neo-aortic valve regurgitation were risk factors for ARD, all  $P < .05$ . Twenty-one patients (14.5%) had moderate or more neo-aortic valve regurgitation. Eight patients (5.5%) required aortic valve replacement (two Bentall operation) during follow-up.

**Conclusions:** At the period of somatic growth, the neo-aortic root progressively grows without normalization. However, the root dimensions remain relatively stable after this period. Patients with DORV and neo-aortic valve regurgitation may be a higher risk for ARD. Long-term surveillance of this subgroup of patients is mandatory.

## Time course of sinus and annular size

Frontal  
viewLateral  
view

11:45 AM

Room 316

**Surgery for Anomalous Aortic Origin of the Coronary Arteries – Not Just for Kids!***A. Vinnakota<sup>1</sup>, R. D. Stewart<sup>2</sup>, H. K. Najm<sup>2</sup>, G. B. Pettersson<sup>2</sup>**<sup>1</sup>Case Western Reserve University School of Medicine, Cleveland, OH, <sup>2</sup>Cleveland Clinic, OH*

**Purpose:** Anomalous aortic origin of the coronary arteries (AAOCA) is associated with sudden cardiac death (SCD) and frequently treated with unroofing of an intramural segment. Most reports on AAOCA are in patients under 30. We have reviewed our older patients who have undergone surgical repair and report a novel unroofing technique.

**Methods:** A retrospective review was conducted of 41 patients who underwent surgical correction of AAOCA from June 2005 to June 2016. Patients underwent preoperative evaluation for ischemia related to their AAOCA, including ammonia positron emission testing (PET), stress echocardiography, technetium99 nuclear imaging studies, and/or dobutamine stress testing. During this period, our surgical approach changed from traditional sharp excision of the shared medial wall of the intramural segment to electrical fulguration of the same. We assessed our population for improvement in symptoms, resolution of ischemic changes, and need for reintervention. Follow-up beyond 6 months was available in 35 patients.

**Results:** Median age was 45 (14-67) years, and 37 were >30 years. Seventeen patients were female. The coronary anomaly was right from left in 35, left from right in five, and both coronaries from non-coronary sinus in one. 40/41 patients were symptomatic: SCD in two, chest pain in 32, and dyspnea in 22. Preoperatively, 22/31 patients tested positive for ischemia, including the asymptomatic. Patients testing positive for ischemia were older than those negative (48 years  $\pm$  10 years vs 37 years  $\pm$  11 years,  $P = .02$ ). The operation was an unroofing in 40/41 patients with 19 sharp excisions and 21 electrical fulguration, while one patient underwent side-to-side anastomosis. There were no operative mortalities, 30-day complications, or reinterventions. Comparing excision vs fulguration, cardiopulmonary bypass and cross-clamp times were similar, 62 minutes vs 46 minutes ( $P = .18$ ) and 44 minutes vs 34 minutes ( $P = .13$ ), respectively. At an average follow-up of 6.2 years, symptomatic improvement was reported by 29/35 patients, a similar rate when comparing sharp excision vs fulguration (11/15 vs 17/18,  $P = .09$ ).

**Conclusions:** Patients with positive testing for ischemia were older, as we most often require objective evidence of ischemia to recommend surgery in older patients. Traditional sharp excision and electrical fulguration were equally safe. Fulguration being technically easier, trends suggest that it also may be faster and more effective.

12:00 PM

Room 316

**360° Cone Reconstruction for Ebstein Anomaly***M. E. Mitchell<sup>1</sup>, P. Kouretas<sup>2</sup>**<sup>1</sup>Children's Hospital of Wisconsin, Milwaukee, <sup>2</sup>University of California San Francisco***COMMERCIAL RELATIONSHIPS** M. E. Mitchell: Ownership Interest, Ariosa Diagnostics, TAI Diagnostics; Research Grant, TAI Diagnostics; Consultant/Advisory Board, TAI Diagnostics

**Purpose:** Several modifications of the cone procedure as first described by da Silva have been reported. We have employed a complete 360° leaflet detachment coupled with a 60° counterclockwise rotation in performing the cone procedure in infants and adults with excellent results.

**Methods:** We have employed a technique that involves complete detachment of all tricuspid valve leaflets at the tricuspid valve annulus, reconstruction of a cone and 60° counterclockwise rotation in two patients, one infant and one adult, undergoing complete primary repair of Ebstein anomaly.

**Results:** Both patients had an uncomplicated postoperative course with mild or less tricuspid insufficiency and no stenosis at follow-up.

**Conclusions:** We feel that this complete mobilization coupled with the counterclockwise rotation provides for both better alignment of the leaflets and subvalvar apparatus, as well as a more symmetrical distribution of tension following leaflet reattachment, potentially resulting in better valve function and longevity of repair.



12:15 PM

Room 316

**Aortic Dissection Following the Ross Procedure****S. R. Richey<sup>1</sup>, A. C. Fiore<sup>2</sup>, C. B. Huddleston<sup>2</sup>***<sup>1</sup>Southern Illinois University School of Medicine, Carbondale, <sup>2</sup>Cardinal Glennon Children's Hospital, St Louis, MO*

**Purpose:** Aortic dissection may occur following the Ross procedure, but in nearly all cases involves the native ascending aorta. We present a patient with a dissection involving only the pulmonary autograft portion of the aorta. The patient was successfully treated with valve-sparing aortic root replacement.

**Methods:** This is a video demonstrating a valve-sparing aortic root replacement for aortic dissection of the pulmonary autograft several years following the Ross procedure.

**Results:** The patient is a 25-year-old woman born with a bicuspid aortic valve. She developed *Staphylococcus aureus* endocarditis on the valve with severe aortic insufficiency. She underwent the Ross procedure for this at 12 years of age. She did well following that procedure, but did have some aortic root dilatation (3 cm) and mild aortic valve insufficiency. She became pregnant, and during the third trimester of her pregnancy, the aortic root was noted to be dilated even further. She delivered a normal baby at term without complications and never complained of chest pain. Her post-delivery echocardiogram demonstrated an aortic root of 6 cm, and she was referred to our center. Computed tomography angiography demonstrated a type I aortic dissection, and she underwent valve-sparing aortic root replacement. The dissection was completely confined to the pulmonary autograft. Her postoperative course was uneventful, and follow-up echocardiogram shows no aortic insufficiency.

**Conclusions:** Aortic dissection involving only the pulmonary autograft has not been previously reported. It can be successfully treated with valve-sparing aortic root replacement.

11:30 AM – 12:30 PM

Room 315

**Critical Care***Moderators: Rainer G. H. Moosdorf, Marburg, Germany, and Joseph Rabin, Baltimore, MD*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

11:30 AM

### **Even Mild Acute Kidney Injury Adversely Affects Early Survival After Thoracoabdominal Aortic Aneurysm Repair**

**S. Chatterjee<sup>1</sup>**, **S. A. LeMaire<sup>2</sup>**, **H. Amarasekara<sup>2</sup>**, **S. Y. Green<sup>2</sup>**, **M. Price<sup>2</sup>**, **Q. Zhang<sup>2</sup>**,  
**O. Preventza<sup>2</sup>**, **R. Raghavan<sup>2</sup>**, **K. I. de la Cruz<sup>2</sup>**, **J. S. Coselli<sup>2</sup>**

<sup>1</sup>Baylor/Texas Heart Institute, Houston, <sup>2</sup>Baylor College of Medicine, Houston, TX

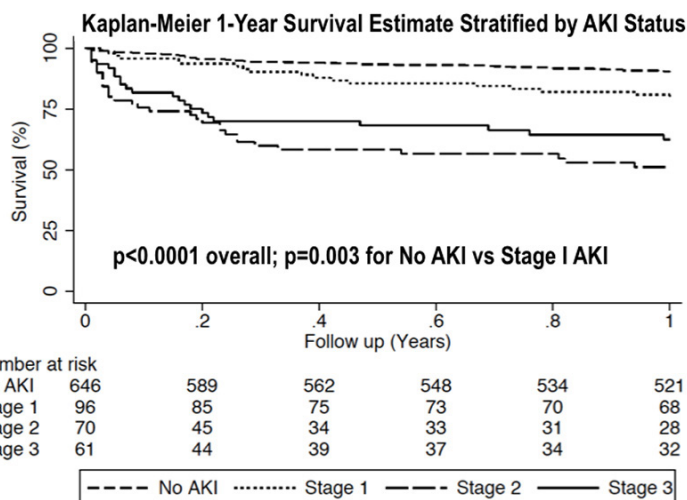
**COMMERCIAL RELATIONSHIPS** J. S. Coselli: Ownership Interest, Vascutek; Research Grant, Bolton Medical, Medtronic, Vascutek, W. L. Gore & Assoc; Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc; S. A. LeMaire: Research Grant, Baxter Healthcare, CytoSorbents, W. L. Gore & Assoc; Consultant/Advisory Board, Vascutek; O. Preventza: Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc

**Purpose:** Although it is well established that acute kidney injury (AKI) necessitating dialysis adversely affects outcomes after thoracoabdominal aortic aneurysm (TAAA) repair, the impact of less severe AKI is not well understood. We hypothesized that patients with subclinical AKI after TAAA repair have poorer early survival than those without AKI.

**Methods:** We analyzed prospectively collected data from 1056 consecutive TAAA repairs from our institution (2006–2016). We excluded patients <18 years of age, those with preexisting renal disease (cystic, prior nephrectomy, chronic kidney disease, or dialysis), and intraoperative deaths. Of the remaining 873 cases, 226 (26%) were Crawford Extent I repairs, 291 (33%) were Extent II, 154 (18%) were Extent III, and 202 (23%) were Extent IV. 206 patients (24%) had urgent/emergent repair, and 367 (42%) had chronic dissection. Kidney Disease Improving Global Outcomes (KDIGO) criteria were used to group patients into three AKI stages. Multivariable modeling identified operative mortality predictors. Early survival was assessed by Kaplan-Meier analysis.

**Results:** Postoperative AKI occurred in 227 patients (26.0%) and was classified as mild (KDIGO Stage 1) in 96 (11.0%), moderate (Stage 2) in 70 (8.0%), and severe (Stage 3) in 61 (7.0%). No AKI occurred in 646 patients (74.0%). Operative death occurred after 65 repairs (7.4%), with 18 deaths (2.8%) in patients without AKI and eight deaths (8.3%) in those with Stage 1 AKI ( $P < .02$ ). All stages of AKI were predictive of operative death (Table). One-year survival was  $90.3\% \pm 1.2\%$  for patients without AKI and  $79.7\% \pm 4.3\%$  for those with Stage 1 AKI ( $P = .003$ , Figure).

**Conclusions:** Although subclinical mild AKI may not be perceived as consequential, it has a negative early survival impact after TAAA repair. Careful attention to reducing the incidence of AKI, earlier detection of mild AKI, and rigorous medical management in follow-up may improve survival after TAAA repair.



## Independent predictors of operative death

Variable	Odds Ratio (CI)	p Value
Stage 1 AKI* (serum Cr increased to 1.5-1.9 times baseline in 7 d or to $\geq 0.3$ mg/dL in 48 h)	2.72 (1.07-6.96)	0.04
Stage 2 AKI* (serum Cr 2.0-2.9 times baseline)	11.56 (5.27-25.36)	<0.0001
Stage 3 AKI* (serum Cr 3.0 times baseline, Cr >4.0 mg/dL, or renal replacement therapy)	6.10 (2.67-13.97)	<0.0001
Urgent/Emergent Procedure	3.62 (1.66-7.87)	0.001
Right Renal Endarterectomy	2.46 (1.18-5.10)	0.02
Increasing patient age at admission, per y	1.06 (1.01-1.10)	0.0005
Increasing preoperative eGFR, per mL/min/1.73 m <sup>2</sup>	0.98 (0.97-1.00)	0.04

\*vs no AKI

11:45 AM

Room 315

**Variation in Platelet Transfusion Practices During Cardiac Operations Among Centers in Maryland: Results From a State Quality Improvement Collaborative**

X. N. Zhou<sup>1</sup>, C. D. Fraser III<sup>2</sup>, A. Suarez-Pierre<sup>1</sup>, T. C. Crawford<sup>2</sup>, C. N. Lui<sup>1</sup>, D. E. Alejo<sup>2</sup>, J. V. Conte<sup>2</sup>, J. Lawton<sup>1</sup>, C. E. Fonner<sup>3</sup>, B. S. Taylor<sup>4</sup>, G. J. Whitman<sup>2</sup>, R. Salenger<sup>5</sup>

<sup>1</sup>The Johns Hopkins University School of Medicine, Baltimore, MD, <sup>2</sup>The Johns Hopkins Hospital, Baltimore, MD, <sup>3</sup>Virginia Cardiac Services Quality Initiative, Virginia Beach, <sup>4</sup>University of Maryland Medical Center, Baltimore, <sup>5</sup>University of Maryland, Baltimore

**COMMERCIAL RELATIONSHIPS** J. V. Conte: Research Grant, Medtronic; Consultant/Advisory Board, Medtronic; B. S. Taylor: Nonremunerative Position of Influence, Medtronic

**Purpose:** Although the morbidity associated with red blood cell transfusion in cardiac surgery has been well described, the impacts of platelet transfusion are less clearly understood. Given the conflicting results of prior studies, we sought to investigate the impact of platelet transfusion on outcomes after cardiac surgery across institutions in Maryland.

**Methods:** Using a multi-institutional statewide database created by the Maryland Cardiac Surgery Quality Initiative, we retrospectively analyzed patient-level data from 10,478 patients undergoing isolated coronary artery bypass (CAB) across 10 centers. Rates of intra- and postoperative platelet transfusion were compared between institutions. A stepwise multivariate logistic regression model was used to adjust for patient comorbidities, perioperative risk factors, preoperative platelet count, and presence of antiplatelet therapy. Logistic regression also was applied to investigate differences in mortality and length of stay between those who did and did not receive platelet transfusions. Standardized STS Adult Cardiac Surgery Database definitions were used.

**Results:** Univariate comparison revealed that those who received platelet transfusion had higher operative mortality (3.85% vs 1.13%,  $P < .001$ ) and rates of prolonged length of stay (11.4% vs 3.83%,  $P < .001$ ). In multivariate regression analysis, platelet transfusion was associated with increased operative mortality (OR 2.07, 95% CI 1.38-3.10,  $P < .001$ ) and prolonged length of stay (OR 2.05, 95% CI 1.63-2.58,  $P < .001$ ). There was a significant difference in rates of platelet transfusion between institutions, which varied between 11.8% and 47.6%. After adjusting for patient demographics, comorbidities, bypass time, concomitant red blood cell transfusion, preoperative platelet count, and preoperative antiplatelet medications, transfusion rates ranged from 9.9% to 48.6% ( $P < .001$ ). Similar results were noted when the analysis was limited to intraoperative transfusions, postoperative transfusions, and total units of platelets transfused. There was no statistically significant relationship between institutional case volume and transfusion rates.

**Conclusions:** In this study, significant variation existed in platelet transfusion rates between institutions, even after controlling for various risk factors. This variation is associated with increased mortality and length of stay. Further study is warranted to better understand risks associated with platelet transfusion. Standardizing practice may help reduce risk and conserve resources.

12:00 PM

Room 315

**Pretreatment With Glucose-Insulin-Potassium Improves Ventricular Performance After Valve Replacement in Patients With Severe Aortic Valve Stenosis: A Randomized Controlled Trial***M. Licker, T. Sologashvili, J. Diaper, C. Ellenberger**Geneva University Hospital, Switzerland*

**Purpose:** Low cardiac output syndrome (LCOS) is a main cause of death following open heart surgery, and perioperative infusion of glucose-insulin-potassium (GIK) inconsistently improves functional and clinical outcomes. Using transesophageal echocardiography (TEE), we evaluated the effects of GIK in patients with critical aortic stenosis undergoing valve replacement.

**Methods:** In this single-center double-blind trial, 96 moderate-to-high risk patients (Parsonnet score >7) were randomly assigned to receive GIK (20 IU insulin with 10 mEq KCL in 50 ml glucose 40%) or saline infusion over 60 minutes upon anesthetic induction. The primary outcomes were changes in left ventricular ejection fraction (LVEF), transmitral flow propagation velocity (Vp), and global longitudinal strain (GLS) occurring after cardiopulmonary bypass. Postoperative peak cardiac troponin-I (cTnI), the incidence of LCOS, the need for inotropes (>1 drug, >120 minutes), and the length of stay in the intensive care unit (ICU) were considered secondary outcomes.

**Results:** After weaning from bypass, GIK pretreatment was associated with preserved LVEF (mean +3%, standard deviation [SD] 12%), unchanged GLS, (+5% [36%]), and higher Vp (+15% [23%]), whereas in the saline group, LVEF, GLS, and Vp all decreased after bypass (-14% [17%], -19% [15%], and -20% [32%], respectively). Postoperatively, peak plasma cTnI was significantly lower in the GIK group (4.9 ng/ml [3.5 ng/ml] vs 11.8 ng/ml [9.2 ng/ml] in saline group), and this was associated with a lower incidence of LCOS (5% vs 37% in saline group), a lesser requirement for inotropic therapy (9% vs 58% in saline group), and a shorter stay in the ICU (3 days [2 days] vs 6 days [5 days] in saline group).

**Conclusions:** Administration of GIK before aortic cross-clamping was associated with preservation of systolic and diastolic ventricular function following aortic valve replacement. These functional effects were associated with lesser myocardial injuries and facilitated postoperative recovery. Further studies should explore the mechanisms of myocardial protection and confirm the clinical impact of GIK infusion.

12:15 PM

Room 315

### Nutrition Support After Cardiac Surgery: A Prospective Study Resulting in Evident Lessons to Improve Its Delivery

C. Ong<sup>1</sup>, P. M. Brown<sup>1</sup>, R. Ohkuma<sup>1</sup>, P. X. Yesantharao<sup>2</sup>, A. Young<sup>1</sup>, J. K. Canner<sup>3</sup>, T. A. Brown<sup>6</sup>, T. C. Crawford<sup>1</sup>, M. S. Sussman<sup>1</sup>, G. J. Whitman<sup>1</sup>

<sup>1</sup>The Johns Hopkins Hospital, Baltimore, MD, <sup>2</sup>The Johns Hopkins Medical Institutions, Baltimore, MD, <sup>3</sup>The Johns Hopkins University School of Medicine, Baltimore, MD

**COMMERCIAL RELATIONSHIPS** P. M. Brown: Research Grant, Abbott

**Purpose:** Postoperative nutrition support (NS) after cardiac surgery is poorly described. The purpose of this study was to examine the delivery of NS and its associated morbidity.

**Methods:** We prospectively examined all patients requiring postoperative NS, enteral or parenteral, from January 2015 to January 2017, comparing outcomes to patients without NS. We examined indications for NS, variables affecting delivery of goal calories, and factors associated with postoperative diarrhea.

**Results:** 8.6% of patients (232/2701) required NS (see Table for comparison to no-NS cohort). The main indication for NS was mechanical ventilation (73%), followed by dysphagia (14%) and mental status (5%). Overall % daily caloric needs met was  $62\% \pm 39\%$ , but on days when tube feeds (TF) were held (mean 13 hours  $\pm$  8 hours), this dropped to  $44\% \pm 35\%$ , compared to  $88\% \pm 27\%$  when TF were not held ( $P < .0001$ ). The major reason for TF held was procedures (44% of all NS days, 60% of all reasons). If TF were supplemented with parenteral nutrition (PN), overall mean calorie needs met increased to 87% ( $P = .0003$ ), and on those days when TF held, it only dropped to 78% ( $P < .0001$ ), with no difference in hours held between groups. Diarrhea occurred in 17% of TF days (only 6% if TF+PN,  $P = .08$ ), and was twice as common with elemental/semi-elemental (E/SE) feeds vs intact formula (OR 1.90,  $P = .017$ ). In the E/SE patients, postpyloric feeds increased diarrhea by an odds ratio of 2.3, compared to gastric feeds ( $P = .009$ ).

**Conclusions:** NS patients have high morbidity and mortality. Combination therapy, TF+PN, yielded a 20% increase in goal calories met and a 40% increase if TF was held. Postoperative diarrhea occurred often, exacerbated by postpyloric and non-intact formula feeding, but decreased with combination TF+PN nutrition delivery.

Table 1: Patient characteristics (NS vs no-NS)

Characteristics	NS Cohort (N=232)	Non-NS Cohort (N=2,469)	p-value ¶
Intraoperative			
Urgent or Emergent Status	166 (72%)	929 (38%)	< 0.0001
Cardiopulmonary Bypass Time (minutes)	168 ± 75	118 ± 54	< 0.0001
Postoperative			
Total ICU hours	253 ± 241	56 ± 93	< 0.0001
Hospital Stay (days)	34 ± 25	11 ± 12	< 0.0001
Total Ventilation hours	205 ± 186	15 ± 54	< 0.0001
Discharged Home	63 (27%)	2047 (83%)	< 0.0001
Hospital Mortality	78 (34%)	72 (3%)	< 0.0001

¶ Based on Student's t test (parametric) or chi-square test (categorical variables). Parametric data are reported as mean ± standard deviation.

11:30 AM – 12:30 PM

Floridian Ballroom B-C

**! Diversity and Inclusion in Cardiothoracic Surgery: What's In It for Me?**

✓ At this new session, organized by the STS Task Force on Diversity and Inclusion, attendees will learn how diversity and inclusion can be valuable to their practice and service lines, training efforts, and relationships in the communities in which they practice. Speakers will address the role of diversity and inclusion in the cardiothoracic surgery workforce and explore why physicians who are underrepresented in medicine are important for the optimal delivery of cardiothoracic surgery specialty care without cultural bias.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Define diversity as it relates to the health care workforce and the care of diverse patient populations
- Define inclusion as it relates to the health care workforce, health care leadership, and the care of diverse patient populations
- Define underrepresented minority (URM)
- Discuss how a diverse cardiothoracic surgery workforce can improve patient outcomes through increasing cultural competency and mitigating implicit provider bias
- Explain how the inclusion of URM trainees and junior faculty and staff helps increase URM pipeline to the clinical workforce and make successful diversification efforts

*Moderator: David T. Cooke, Sacramento, CA*

*Panelists: Joanna Chikwe, New York, NY, Christopher M. Draft, Atlanta, GA, Luis Godoy, Sacramento, CA, Keith S. Naunheim, St Louis, MO, Jacqueline Olive, Houston, TX, and Africa F. Wallace, Atlanta, GA*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, interpersonal and communication skills, and professionalism. These physician competencies will be addressed through a series of lectures on the importance of diversity in the cardiothoracic surgery workforce for the optimal delivery of care without cultural bias. Questions from the audience and panel discussions will augment these competencies.*

11:30 AM

**Introduction**

*David T. Cooke, Sacramento, CA, and Richard L. Prager, Ann Arbor, MI*

11:35 AM

**Bridging the Cultural Divide in Cardiothoracic Surgery: The Value Proposition of Diversity and Inclusion Excellence**

*David A. Acosta, Washington, DC*

12:05 PM

**Introduction of Panelists**

*David T. Cooke, Sacramento, CA*

12:10 PM

**Panel Discussion**

11:30 AM – 12:30 PM

Floridian Ballroom D

**General Thoracic: New Technology***Moderator: Kazuhiro Yasufuku, Toronto, Canada*

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Presenting authors are listed in **bold**.

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11:30 AM

**Novel Thoracoscopic Surgical Navigation System Provides Augmented Real-Time Imaging for Minimally Invasive Resection of Chest Wall Tumors****C. Lee<sup>1</sup>, H. H. Chan<sup>2</sup>, H. Ujiie<sup>1</sup>, K. Fujino<sup>2</sup>, T. Kinoshita<sup>1</sup>, K. Yasufuku<sup>1</sup>**

<sup>1</sup>Toronto General Hospital, Canada, <sup>2</sup>TECHNA Institute, University Health Network, Toronto, Canada

**Purpose:** We developed a thoracoscopic surgical navigation system providing real-time augmented displays to assess the potential benefits during minimally invasive resection of chest wall tumors. The accuracy of localization, determination of resection margin, and the effort on task workload and confidence were evaluated in a chest wall tumor phantom.

**Methods:** The thoracoscopic surgical navigation system is composed of cone-beam computed tomography (CBCT), optical tracking system, conventional thoracoscope, and three-dimensional visualization software (Figure 1A). After scanning a realistic tumor phantom (Figure 1B) by CBCT and registering CT data into the system, three-dimensional contoured tumor and resection margin using segmentation software (ITK) were displayed (Figure 1C), in addition to a triplanar CT image. Twelve surgeons were asked to localize tumor margin, as well as surgical margins, with the thoracoscope alone. The same implementation was performed with the surgical navigation system (Figure 1D) and was compared between two implementations. A questionnaire and NASA task load index was completed.

**Results:** The localization precision was highly improved, especially at the medial tumor border (13.58 mm vs 3.51 mm,  $P = .005$ ) and the upper tumor border (12.41 mm vs 1.49 mm,  $P = .005$ ), which were obscured by the rib and could only be partly seen by the thoracoscope. Localization of all four surgical resection margins was more accurate with the aid of designated contoured images in the navigation system (Table). In the questionnaire, this system helped localization in 94%, and there was 100% agreement that the thoracoscopic navigation system increased confidence in identification of invisible area by thoracoscope. NASA-TLX response scores showed a statistically significant reduction in workload in all subscales (mental demand, physical demand, temporal demand, performance, effort, and frustration). There was a >50% mean reduction in workload for performance (9.3 vs 4.5,  $P = .005$ ) and frustration (13.0 vs 5.8,  $P = .003$ ).

**Conclusions:** Our novel thoracoscopic surgical navigation system providing real-time augmented image guidance improves localization precision, especially in thoracoscopic invisible areas. The navigation system decreases task workload and increases confidence during minimally invasive identification of chest wall tumors. This technology may be helpful during minimally invasive resection of chest wall tumors.

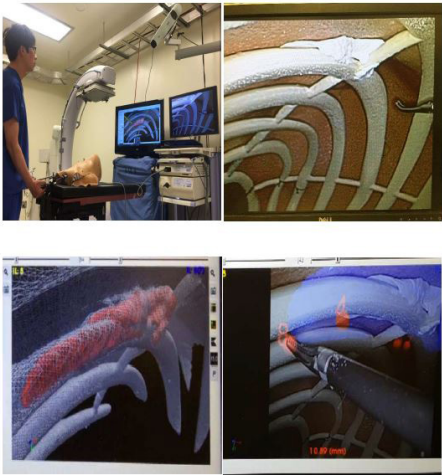


Fig.1 A. Novel thoracoscopic surgical navigation system consisting of cone beam CT, optical tracking system, conventional thoracoscope and navigation platform. B. Thoracoscopic view of chest wall tumor phantom. C. Three-dimensional contoured image of chest wall tumor based on CT data. D. Localization of resection margin with tracked instrument.

Table 1. Comparison between implementations with or without navigation system

	Thoracoscopy alone	Thoracoscopic navigation	P value
	Mean (SD)	Mean (SD)	
Localization Precision (mm)			
Lower tumor end	4.23 (3.03)	2.68 (2.12)	0.483
Lateral tumor end	3.63 (1.92)	2.34 (1.72)	0.472
Medial tumor end	13.58 (5.19)	3.51 (2.30)	0.005
Upper tumor end	12.41 (3.95)	1.49 (1.24)	0.005
Lower resection margin	5.71 (7.46)	1.56 (1.08)	0.020
Lateral resection margin	11.13 (11.16)	7.20 (1.97)	0.018
Medial resection margin	10.91 (5.84)	3.80 (3.03)	0.013
Upper resection margin	15.90 (5.37)	2.06 (1.92)	0.003
NASA-TLX domain			
Mental demand	12.8 (3.0)	7.4 (3.1)	0.007
Physical demand	10.6 (4.9)	7.9 (4.1)	0.027
Temporal demand	10.4 (3.5)	7.2 (3.2)	0.017
Performance	9.3 (4.2)	4.5 (3.2)	0.005
Effort	11.6 (3.3)	6.5 (2.6)	0.005
Frustration	13.0 (4.0)	5.8 (2.9)	0.003

11:45 AM

Floridian Ballroom D

**Digital Air Leak Monitoring for Patients Undergoing Lung Resection: A Randomized Controlled Clinical Trial***M. M. Plourde<sup>1</sup>, A. I. Jad<sup>1</sup>, A. A. Mujoomdar<sup>1</sup>, H. J. Henteleff<sup>2</sup>, D. C. Bethune<sup>2</sup>**<sup>1</sup>Dalhousie University, Halifax, Canada, <sup>2</sup>Victoria General Hospital, Halifax, Canada*

**Purpose:** Previous trials have compared digital pleural collection devices to non-digital devices. Most trials had the limitations of small sample sizes, inclusion of non-anatomical lung resections, and lack of follow-up following discharge from hospital. Our objective is to present data reflecting a Canadian perspective for comparison of these chest tube devices.

**Methods:** This is a single-center randomized trial comparing the use of digital chest tube devices to non-digital devices in patients undergoing anatomical lung resection from November 2013 to July 2016. We compared the mean number of days in hospital, chest tube duration, and number of chest x-rays (CXR) using a t-test. Chest tube clamping, post-chest tube removal pneumothorax, and need for chest tube reinsertion were compared using a chi-square test. A total of 214 patients were randomized, with 106 in the digital group and 108 in the non-digital group. Groups were well matched with regards to Charlson comorbidity index, age, and surgery type.

**Results:** We did not find a significant difference in outcomes for number of CXR performed ( $P = .299$ ), chest tube duration ( $P = .141$ ), and length of hospital stay ( $P = .211$ ). There also was no difference in post-chest tube removal pneumothorax ( $P = .279$ ) or need for chest tube reinsertion ( $P = .294$ ). The only significant finding was that of a higher number of patients having their chest tube clamped prior to removal, 47% in the non-digital group and 18% in the digital group ( $P < .001$ ).

**Conclusions:** The digital devices did not result in reduced chest tube duration or hospital length of stay. Almost half of cases in the non-digital group had their chest tube clamped prior to removal, likely a result of more subjectivity with the non-digital devices. This did not result in any change in clinical outcomes.

12:00 PM

Floridian Ballroom D

**Decreased Length of Stay Associated With Minimally Invasive Pulmonary Resection Does Not Translate to Functional Recovery Advantage**

*S. J. Kaplan<sup>1</sup>, P. A. Trottman<sup>1</sup>, G. H. Porteous<sup>1</sup>, R. A. Prusynski<sup>1</sup>, A. J. Morris<sup>2</sup>, E. A. Kauer<sup>2</sup>, D. E. Low<sup>1</sup>, M. Hubka<sup>1</sup>*

*<sup>1</sup>Virginia Mason Medical Center, Seattle, WA, <sup>2</sup>University of Washington, Seattle*

**REGULATORY DISCLOSURE** This presentation describes the off-label use of the Fitbit Zip, a personal activity tracker, in the perioperative setting.

**Purpose:** Postoperative recovery is an important measure in thoracic surgery. Personal fitness trackers can be used to capture and monitor progress in the pre- and postoperative settings. This study investigates the association of lung resection extent and operative approach on inpatient and outpatient functional recovery.

**Methods:** In this prospective observational cohort study, patients undergoing lung resection at a single institution were recruited between July 2015 and May 2017 to wear fitness trackers 30 days before through 30 days after surgery. Activity was recorded as steps per day and divided into three phases: preoperative, postoperative inpatient, and postoperative outpatient; each patient served as their own baseline. Cluster analysis was performed to identify groups based on preoperative activity levels: low, moderate, and high. Associations between activity phases, operative details, and short-term outcomes were assessed using generalized regression models with adjustment for patient demographics and clinical characteristics.

**Results:** Sixty-six patients composed the study cohort and were grouped by average preoperative activity: low, 21 (31.8%); moderate, 27 (40.9%); and high, 18 (27.3%). Gender, comorbidity, resection extent (sublobar vs lobectomy), and operative approach (open vs minimally invasive) did not differ between groups (Table). Patients with higher postoperative activity were younger, had better lung function, and had increased levels of preoperative activity (Table). Minimally invasive approach was associated with shorter inpatient stay: 4 days (IQR 2–5) vs 5 (5–6),  $P = .03$ . After adjustment for age, comorbidities, lung function, preoperative activity, operative approach, and resection extent, neither length of stay nor complications were associated with postoperative activity measures (Table).

**Conclusions:** Despite decreased length of stay, the minimally invasive approach was not associated with improved postoperative activity compared to thoracotomy. Postoperative activity, irrespective of operative approach, resection extent, and other factors, was independently predicted by preoperative activity. Thoracic surgeons performing pulmonary resections should expect equivalent functional recovery in their patients regardless of approach.

**Table 1. Patient and clinical characteristics stratified by preoperative activity group**

	Low n = 21	Moderate n = 27	High n = 18	p
Age, years	71.6 ± 11.7	65.9 ± 8.6	59.9 ± 12.8	.01
Female, n	11 (52.4)	12 (44.4)	9 (50.0)	.78
Charlson comorbidity index, score	1 (0 – 2)	2 (0 – 3)	1.5 (0 – 3)	.98
FEV1, L	2.4 ± 1.0	2.4 ± 0.6	2.9 ± 1.1	.17
FEV1, % predicted	90.2 ± 15.9	81.3 ± 18.1	88.7 ± 17.0	.17
DLCO, % predicted	63.4 ± 10.4	68.4 ± 14.5	72.7 ± 16.7	.12
Minimally-invasive approach, n	19 (90.5)	22 (81.5)	15 (83.3)	.69
Sub-lobar, n	8 (38.1)	6 (22.2)	7 (38.9)	0.36
Average Postoperative Inpatient Activity	898 ± 598	1620 ± 957	2231 ± 1400	.001
Average Postoperative Outpatient Activity	1815 ± 1427	3343 ± 1478	5350 ± 2449	<.001
Maximum Postoperative Activity	3044 ± 2396	6414 ± 2894	8834 ± 3689	<.001
Complications, n	8 (38.1)	5 (18.5)	3 (16.7)	.22
Length of stay, days	4 (2 – 6)	4 (4 – 5)	4 (2 – 6)	.80

12:15 PM

**Health Informatics in the Thoracic Surgery Arena***Susan D. Moffatt-Bruce, Columbus, OH*

11:30 AM – 12:30 PM

Room 305

### ✓ **STS/CATS/CSCS: Difficult Decisions in Thoracic Surgery—Advice From Canadian and American Experts**

This session represents the collaborative efforts of STS, the Canadian Association of Thoracic Surgeons, and the Canadian Society of Cardiac Surgeons and will provide current perspectives from the United States and Canada on difficult problems in general thoracic surgery. Expert thoracic surgeons from each country will discuss management of airway injuries post-esophagectomy, management of N2 disease in non-small cell lung cancer (NSCLC), and more.

#### **Learning Objectives**

Upon completion of this activity, participants should be able to:

- Discuss intraoperative measures to reduce the chance of airway injury during esophagectomy
- Review the options for management of airway-conduit fistulae and airway injuries post-esophagectomy
- Explain the potential role of extracorporeal membrane oxygenation in the repair of complex airway injuries post-esophagectomy
- Discuss inclusion and exclusion criteria for the surgical management of N2 disease in NSCLC
- List the potential neoadjuvant options in N2 disease

***Moderators:** Robert J. Cerfolio, New York, NY, and Janet P. Edwards, Calgary, Canada*

**COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are medical knowledge and patient care and procedural skills. These physician competencies will be addressed through a series of lectures and a panel discussion that is meant to enhance the understanding of implementing quality improvement in cardiothoracic surgery.*

11:30 AM

### **Case Presentation: Difficult Decisions Involving N2 Disease in NSCLC**

11:36 AM

#### **N2 Disease – US Perspective**

*Thomas A. D'Amico, Durham, NC*

**COMMERCIAL RELATIONSHIPS** T. A. D'Amico: Consultant/Advisory Board, Scanlan

11:43 AM

#### **N2 Disease – Canadian Perspective**

*Sean C. Grondin, Calgary, Canada*



11:50 AM

**Discussion**

12:00 PM

**Case Presentation: Airway Injuries and Fistulae in Esophageal Cancer Surgery**

12:06 PM

**Post Esophagectomy Airway Injuries/Fistulae – US Perspective**

*Cameron D. Wright, Boston, MA*

12:13 PM

**Post Esophagectomy Airway Injuries/Fistulae – Canadian Perspective**

*Moishe A. Liberman, Montreal, Canada*

**COMMERCIAL RELATIONSHIPS** M. A. Liberman: Research Grant, Boston Scientific, Cook Medical, Ethicon

12:20 PM

**Discussion**

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12:30 PM – 1:30 PM

**BREAK—Visit Exhibits and Scientific Posters**

1:15 PM – 5:15 PM

Floridian Ballroom B-C

 **Clinical Scenarios: Cardiologists and Surgeons Working Together**

This session will concentrate on a true collaborative “heart team” approach to treating complex issues facing the practicing physician or affiliate provider. Using a unique and innovative format highlighting the spectrum of adult cardiac diseases, speakers will discuss the multidisciplinary approach to mitral stenosis and regurgitation, tricuspid regurgitation, aortic stenosis and regurgitation, and surgical management of heart failure. Session components include invited technical videos, a critical review of the literature, case-based presentations describing difficult clinical scenarios, and an interactive panel discussion.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Discuss the controversies surrounding the management of tricuspid valve disease
- Describe the indications and contraindications for the treatment of mitral regurgitation
- Describe the construction and makeup of the multidisciplinary “heart team” and its influence in improving patient outcomes and fostering communication between specialties
- Explain the optimal management of patients with specific case scenarios who are evaluated for aortic stenosis, congestive heart failure, mitral regurgitation, and tricuspid regurgitation

**Moderators:** *Pavan Athuri, Philadelphia, PA, Vinay Badhwar, Morgantown, WV, James S. Gammie, Baltimore, MD, Michael J. Mack, Plano, TX, Ezequiel J. Molina, Chevy Chase, MD, Patrick T. O’Gara, Boston, MA, Paul Sorajja, Minneapolis, MN, and Vinod H. Thourani, Washington, DC*

**COMMERCIAL RELATIONSHIPS** J. S. Gammie: Ownership Interest, Edwards Lifesciences, Harpoon Medical; Consultant/Advisory Board, Edwards Lifesciences, Harpoon Medical; M. J. Mack: Research Grant, Abbott, Edwards Lifesciences, Medtronic; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc; P. T. O’Gara: Consultant/Advisory Board, Medtronic; P. Sorajja: Ownership Interest, Pipeline Technologies; Research Grant, Abbott Vascular, Boston Scientific, Medtronic; Consultant/Advisory Board, Abbott Vascular, Boston Scientific; Medtronic; Speakers Bureau/Honoraria, Abbott Vascular, Boston Scientific, Medtronic

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*The physician competencies addressed in this session are medical knowledge, patient care and procedural skills, and systems-based practice. These physician competencies will be addressed through a series of collaborative lectures by cardiothoracic surgeons and cardiologists.*

1:15 PM

**Introduction**

*Vinod H. Thourani, Washington, DC*

**COMMERCIAL RELATIONSHIPS** V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

**Heart Team Approach (Aortic Valve)****1:15 PM****Case Presentation***Christian Shults, Washington, DC***1:20 PM****Optimal Timing for Replacement of the Aortic Valve (SAVR or TAVR) for Severe, Asymptomatic Aortic Stenosis***Patrick T. O'Gara, Boston, MA***COMMERCIAL RELATIONSHIPS** P. T. O'Gara: Consultant/Advisory Board, Medtronic**1:30 PM****Lessons Learned From the STS/ACC TVT Registry™***Vinod H. Thourani, Washington, DC***COMMERCIAL RELATIONSHIPS** V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc**1:38 PM****The Rationale and Need for a National System of Valve Centers***Michael J. Mack, Plano, TX***COMMERCIAL RELATIONSHIPS** M. J. Mack: Research Grant, Abbott Vascular, Edwards Lifesciences, Medtronic**1:48 PM****When to Replace the Root in Patients With Trileaflet and Bileaflet Aortic Valve Disease***Joseph E. Bavaria, Philadelphia, PA***COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc**1:58 PM****Discussion and Case Wrap-Up****Heart Team Approach (Tricuspid Valve)****2:15 PM****Case Presentation***Steven F. Bolling, Ann Arbor, MI***2:23 PM****How I Decide When to Operate on Patients With Isolated Tricuspid Regurgitation and Those With Concomitant Mitral Valve Disease***James S. Gammie, Baltimore, MD***COMMERCIAL RELATIONSHIPS** J. S. Gammie: Ownership Interest, Edwards Lifesciences, Harpoon Medical; Consultant/Advisory Board, Edwards Lifesciences, Harpoon Medical

2:33 PM

**New Interventional Technology for Tricuspid Regurgitation***Paul Sorajja, Minneapolis, MN*

**COMMERCIAL RELATIONSHIPS** P. Sorajja: Ownership Interest, Pipeline Technologies; Research Grant, Abbott Vascular, Boston Scientific, Medtronic; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Medtronic; Speakers Bureau/Honoraria, Abbott Vascular, Boston Scientific, Medtronic

2:43 PM

**Discussion and Case Wrap-Up**

3:00 PM

**Break****Heart Team Approach (Mitral Valve Disease)**

3:15 PM

**Case Presentation***Tom C. Nguyen, Houston, TX*

**COMMERCIAL RELATIONSHIPS** T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott

3:20 PM

**When Should an Asymptomatic Patient With Severe Mitral Regurgitation Undergo Intervention?***Patrick T. O'Gara, Boston, MA*

**COMMERCIAL RELATIONSHIPS** P. T. O'Gara: Consultant/Advisory Board, Medtronic

3:30 PM

**Current Trials for Transcatheter Mitral Valve Replacement***Gorav Ailawadi, Charlottesville, VA*

**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic

**REGULATORY DISCLOSURE** This presentation describes the use of devices (Tendyne, Intrepid, Caisson) for TMVR, which is an off-label usage.

3:40 PM

**Current Trials for Transcatheter Mitral Valve Repair***Paul Sorajja, Minneapolis, MN*

**COMMERCIAL RELATIONSHIPS** P. Sorajja: Ownership Interest, Pipeline Technologies; Research Grant, Abbott Vascular, Boston Scientific, Medtronic; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Medtronic; Speakers Bureau/Honoraria, Abbott Vascular, Boston Scientific, Medtronic

3:50 PM

**My Worst Surgical Mitral Valve Case and How I Got Out of It***Tirone E. David, Toronto, Canada*

4:00 PM

**Discussion and Case Wrap-Up**

**Heart Team Approach (Congestive Heart Failure)****4:15 PM****Preferred Device for Post-Cardiotomy Temporary Support When IABP Is Not Effective: ECMO, Impella, or Tandem Heart***Pavan Atluri, Philadelphia, PA***4:25 PM****Preoperative Optimization for Right Ventricular Severe Dysfunction Prior to Cardiac Surgery***Patrick T. O'Gara, Boston, MA***COMMERCIAL RELATIONSHIPS** P.T. O'Gara: Consultant/Advisory Board, Medtronic**4:35 PM****My Worst LVAD Case and How I Got Out of It***Francis D. Pagani, Ann Arbor, MI***4:45 PM****Case-Based Scenarios for Choice of Durable Mechanical Support in Heart Failure***Nir Uriel, Chicago, IL***COMMERCIAL RELATIONSHIPS** N. Uriel: Research Grant, Abbott, HeartWare, Novartis; Consultant/Advisory Board, Medtronic, Novartis**4:55 PM****Discussion and Concluding Remarks**

1:30 PM – 3:30 PM

Floridian Ballroom A

**Adult Cardiac: Aorta I***Moderators: Thomas G. Gleason, Pittsburgh, PA, and T. Brett Reece, Aurora, CO***COMMERCIAL RELATIONSHIPS** T. G. Gleason: Research Grant, Medtronic; Nonremunerative Position of Influence, Medtronic; T. B. Reece: Research Grant, Medtronic, W. L. Gore & Assoc; Consultant/Advisory Board, McKesson

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures, including a debate, and a brief question-and-answer session after each topic.*

1:30 PM

**Outcomes of Elective Aortic Root Replacement Procedure in the United States:  
Analysis of the STS Adult Cardiac Surgery Database**

**P. Vallabhajosyula<sup>1</sup>, T. Wallen<sup>1</sup>, A. Habrtheuer<sup>2</sup>, G. C. Hughes<sup>3</sup>, L. G. Svensson<sup>4</sup>, V. Badhwar<sup>4</sup>, J. P. Jacobs<sup>5</sup>, B. A. Yerokun<sup>6</sup>, D. Thibault<sup>6</sup>, R. C. Milewski<sup>1</sup>, N. Desai<sup>1</sup>, W. Y. Szeto<sup>1</sup>, J. E. Bavaria<sup>1</sup>**

<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>Hospital of the University of Pennsylvania, Philadelphia, <sup>3</sup>Duke University Medical Center, Durham, NC, <sup>4</sup>Cleveland Clinic, OH, <sup>5</sup>West Virginia University, Morgantown, <sup>6</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL, <sup>6</sup>Duke University, Durham, NC

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; L. G. Svensson: Ownership Interest, Cardiosolutions; Other, Posthox; W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices

**Purpose:** Unlike coronary artery bypass grafting (CABG), aortic, and mitral valve procedures, there is no predictive risk model for aortic root replacement (ARR) procedures. As a first step toward development of a risk model, we analyzed the STS National Database to determine factors predictive of adverse outcomes in patients undergoing elective ARR.

**Methods:** The STS National Database was queried (July 2011 – June 2016) for elective ARR with the following exclusion criteria: urgent/emergent/salvage cases, endocarditis, redo cardiac surgery, circulatory arrest, and aortic arch surgery. Adjusted multivariate logistic regression models for outcomes of mortality and composite STS morbidity (stroke, prolonged ventilation, renal failure, reoperation for bleeding, deep sternal infection) were performed using covariates for the STS aortic valve risk set (expressed as odds ratio).

**Results:** Of 25,784 patients undergoing ARR at 983 centers, 8807 (77.6% male) met inclusion criteria. 33.7% (n=2965) had bicuspid aortic valve disease, and 3.7% (n=327) had Marfan syndrome. Median age was 58.0 (IQR 49–67) years. Preoperative parameters were: stroke (4%), myocardial infarction (6.2%), peripheral vascular disease (12%), diabetes (14.4%), and congestive heart failure (23.1%). Postoperative outcomes were: in-hospital/30-day mortality 2.2%, stroke 1.4%, renal failure 2%, reoperation for bleeding 3.6%, prolonged ventilation >24 hours 8.4%, and deep sternal infection 0.3%. Median ICU and hospital stay was 46 hours and 6 days, respectively. Significant predictors for mortality by multivariable regression included (Table): atrial fibrillation (odds ratio 2.06), body surface area (0.14), chronic obstructive pulmonary disease (1.2), NYHA class IV (2.53), diabetes (2.48), CABG

(2.77), mitral surgery (>2.18), and Bentall operation (2.08). Regression analysis for risk factors for STS morbidity yielded 14 significant parameters (Table). Glomerular filtration rate increase of 20 units was predictive of improved mortality (0.85) and morbidity (0.91).

**Conclusions:** Elective ARR is performed with excellent postoperative outcomes. Analysis of the STS National Database reveals several significant risk factors independently associated with increased mortality and morbidity. We anticipate that future studies inclusive of the non-elective ARR cases in the Database will facilitate development of a risk model for root replacement procedure.

Main	Mortality Odds ratio [95% CI]	P value	STS composite morbidity Odds ratio [95% CI]	P value
Glomerular filtration rate [20 unit increase]	0.85 [0.73, 0.99]	0.03373	0.91 [0.85, 0.97]	0.00455
Atrial fibrillation	2.06 [1.38, 3.08]	0.00043	1.36 [1.1, 1.68]	0.00432
Body surface area [BSA]	0.14 [0.06, 0.32]	<0.0001	0.35 [0.23, 0.55]	<0.0001
BSA [STS truncated] squared	2.3 [0.41, 13.08]	0.34676	5.1 [2.42, 10.78]	0.00002
NYHA not class IV	1.24 [0.89, 1.73]	0.20049	1.17 [1, 1.36]	0.04673
NYHA Class IV	2.03 [0.92, 4.47]	0.07940	0.94 [0.56, 1.55]	0.79663
Chronic lung disease	1.2 [1, 1.44]	0.05186	1.17 [1.07, 1.29]	0.00073
Diabetes requiring insulin	2.48 [1.37, 4.48]	0.00258	1.65 [1.18, 2.29]	0.00305
Diabetes under control not using insulin	1.87 [1.3, 2.71]	0.00083	1.4 [1.16, 1.68]	0.00037
Ejection fraction ≤50	1.03 [1, 1.06]	0.05598	0.99 [0.97, 1]	0.01993
Cardiogenic shock	4.16 [0.43, 39.86]	0.21614	1.31 [0.24, 7.34]	0.75562
Dialysis	2.79 [0.89, 8.76]	0.07806	0.87 [0.38, 2]	0.74281
Hypertension	1.56 [1.01, 2.4]	0.04427	1.15 [0.98, 1.36]	0.09544
Immunocompromised status	1.12 [0.53, 2.4]	0.76616	1.57 [1.1, 2.24]	0.01392
Peripheral vascular disease	1.12 [0.75, 1.69]	0.57642	1.2 [1, 1.45]	0.05453
Prior MI [1-21 days]	3.05 [0.99, 9.37]	0.05168	1.54 [0.72, 3.3]	0.26365
Left Main Disease ≥50%	1.66 [0.78, 3.51]	0.18578	1.26 [0.79, 2.01]	0.32690
Unstable MI	1.04 [0.55, 1.96]	0.91270	0.9 [0.64, 1.26]	0.53116
Mitral valve stenosis	1.63 [0.72, 3.67]	0.24139	1.35 [0.81, 2.26]	0.25311
Bentall ARR[versus valve sparing ARR]	2.08 [1.13, 3.81]	0.01791	1.33 [1.09, 1.62]	0.00513
Atrial fibrillation surgery	0.46 [0.23, 0.92]	0.02750	0.89 [0.66, 1.21]	0.46187
CABG	2.77 [2.02, 3.79]	<0.0001	2.32 [1.99, 2.69]	<0.0001
Mitral valve repair	2.18 [1.21, 3.93]	0.00973	1.48 [1.09, 2.03]	0.01300
Mitral valve replacement	3.25 [1.49, 7.12]	0.00317	2.81 [1.76, 4.48]	0.00002
Tricuspid repair/replacement	2.17 [0.92, 5.15]	0.07846	1.28 [0.7, 2.35]	0.42695

1:45 PM

Floridian Ballroom A

**Redo Aortic Valve Replacement in a Patient With Previous Aortic Root Replacement: Avoidance of Full Root Re-replacement on a Routine Basis***I. E. Wenger<sup>1</sup>, S. Y. Fukuhara<sup>2</sup>, M. A. Siki<sup>1</sup>, J. E. Bavaria<sup>1</sup>**<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>Hospital of the University of Pennsylvania, Philadelphia***COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc

**Purpose:** This video demonstrates our standard technique of redo aortic valve replacement (AVR) in a patient with previous aortic root replacement. With increasing bioprosthetic valve usage, even in relatively young patients, this technique has become more relevant in the context of high morbidity and mortality associated with aortic root re-replacement.

**Methods:** The footage used in this video was captured using overhead cameras in the operating room.

**Results:** The patient is a 46-year-old man with a history of Marfan syndrome and ascending aortic/sinus of Valsalva aneurysms who, 12 years prior, had undergone aortic root/ascending/hemiarch replacement using a composite graft with a 29 mm bovine pericardial aortic valve and a 32 mm Valsalva graft. Now, he presented with dyspnea on exertion and was diagnosed as having a failing prosthetic aortic valve. Severe eccentric aortic insufficiency directed toward the anterior mitral leaflet and moderate-to-severe aortic stenosis was evident on the transesophageal echocardiogram. The critical steps of this technique consist of: 1) inspection of the deteriorated bioprosthetic valve and native annulus; 2) sharp incision of the fabric covering the sewing cuff and detachment of the stent posts/circular wires; 3) meticulous debridement of the annulus; and 4) inclusion of the Dacron graft edge in each annular suture placement. The postoperative course was uneventful. The patient was discharged on postoperative day 5.

**Conclusions:** This video demonstrated our standard technique of redo AVR in a patient with previous aortic root replacement. This safe, reproducible, and useful technique should be utilized on a routine basis, considering the morbidity of a full aortic root re-replacement.

2:00 PM

Floridian Ballroom A

**DEBATE: Optimal Therapy for Failed Bioprosthetic Root Replacement in a 55-Year-Old Man: Redo Root/AVR vs Valve-in-Valve TAVR***Redo Root: Edward P. Chen, Atlanta, GA**Valve-in-Valve TAVR: Keith B. Allen, Kansas City, MO***COMMERCIAL RELATIONSHIPS** K. B. Allen: Research Grant, Abbott, Edwards Lifesciences, Medtronic, Zimmer Biomet; Consultant/Advisory Board, Zimmer Biomet; Speakers Bureau/Honoraria, Edwards Lifesciences

2:30 PM

**Long-Term Results of Valve-Sparing Aortic Root Replacement: A Comparison Between Middle-Aged and Elderly Patients***F. F. Settepani, A. H. Piloizzi, M. M. Villano, A. B. Basciu, L. L. Torracca**Humanitas Clinical and Research Center, Milan, Italy*

**Purpose:** Valve-sparing aortic root replacement has shown excellent results in young patients. Nevertheless, long-term results in older patients are not yet well defined. We aimed to review our experience with this procedure, while particularly focusing on the differences between middle-aged and older patients.

**Methods:** Between June 2002 and February 2017, 139 patients 50 years old or older with aortic root aneurysms underwent valve-sparing aortic root replacement according to the David technique. Patients were assigned to two groups according to age: between 50 and 65 years old, group 1 (n=71), greater than 65 years old, group 2 (n=68). Presence of bicuspid valve was significantly higher in group 1 (21.1% vs 5.9%  $P = .009$ ). Mean follow-up time was  $8.2\% \pm 4.3\%$  years for group 1 and  $7.5\% \pm 3.8\%$  for group 2 ( $P = .3$ ).

**Results:** In-hospital mortality showed no significant difference between the two groups (0% in group 1 and 1.5% in group 2;  $P = .3$ ). The cumulative 1-year, 5-year, and 13-year survival rates in groups 1 and 2 were 99%, 94%, 88% and 98%, 91%, 73%, respectively ( $P = .3$ ). The rate of new-onset atrial fibrillation during follow-up was significantly higher in group 2 (26.8% vs 6.6%;  $P = .003$ ), and, although not fully significant, there was a trend toward higher rate of stroke during follow-up in group 2 (5.4% vs 0%;  $P = .06$ ). There were two cases of aortic valve endocarditis (one for each group). Freedom from reoperation due to severe aortic regurgitation was 98% at 1 year, 93% at 5 years, and 91% at 13 years in group 1 and 98% at 1 year and 95% at both 5 and 13 years in group 2, with no significant difference ( $P = .4$ ).

**Conclusions:** Our results showed no significant differences between the two groups except for new-onset atrial fibrillation during follow-up that was more frequent in elderly patients. The long-term reoperation rate was similar between the two groups. Valve-sparing aortic root replacement can be safely performed in middle-aged and elderly patients.

2:45 PM

Floridian Ballroom A

## Preoperative Sarcopenia Portends Worse Outcomes After Descending Thoracic Aortic Aneurysm Repair

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**COMMERCIAL RELATIONSHIPS** K. M. Charlton-Ouw: Consultant/Advisory Board, W. L. Gore & Assoc; A. L. Estrera: Consultant/Advisory Board, W. L. Gore & Assoc

**Purpose:** Frailty has been shown to predict adverse outcomes following cardiac surgery. Sarcopenia, using total psoas mass area index (TPAI), is an objective indicator of frailty. We evaluated the effect of preoperative TPAI on outcomes of open vs endovascular repair for descending thoracic aortic aneurysm (DTAA).

**Methods:** All DTAA patients between 2007 and 2014 undergoing thoracic endovascular aortic repair (TEVAR) and open surgical repair (OSR) were reviewed, and those with available preoperative imaging were analyzed. TPAI was computed as psoas cross-sectional area (cm<sup>2</sup>) at the level of L3 on CT divided by body surface area (m<sup>2</sup>). Sarcopenia was defined as TPAI below 50th percentile. Poor outcome was defined as multiorgan failure, discharge to long-term care/skilled nursing/rehabilitation facility, or death. Data were analyzed by univariate and multivariable statistics.

**Results:** 248/341 DTAA repairs had preoperative CT scans. 46/248 (19%) underwent TEVAR and 202/248 (81%) OSR. Median TPAI was 6.1cm<sup>2</sup>/m<sup>2</sup>. Preoperative sarcopenia was significantly higher in OSR (53% vs 33%,  $P < .013$ ). Independent risk factors of sarcopenia included age >70, aortic dissection, connective tissue disorder, and peripheral vascular disease. Following adjustment for risk factors, association between sarcopenia and OSR remained significant ( $P < .025$ ). Propensity for TEVAR was higher among females (OR: 2.8,  $P < .013$ ), DTAA-extent A or B (OR: 7.4,  $P < .001$ ), chronic obstructive pulmonary disease (COPD; OR: 2.6,  $P < .025$ ), age >70 (OR: 8.6,  $P < .001$ ), and non-sarcopenia (OR: 4.7,  $P < .001$ ). After accounting for other determinants, higher TPAI significantly increased likelihood of TEVAR (1.2-fold odds/unit baseline-TPAI,  $P < .023$ ; Figure 1a). After adjusting for other prognosticators (glomerular filtration rate <45 mL/min, COPD, OSR), decreasing TPAI significantly increased poor outcomes ( $P < .003$ ). When stratified by management, the harmful effect of sarcopenia was significantly pronounced in OSR ( $P < .002$ , Figure 1b). Median follow-up was 4 years. At 1 year, risk-adjusted survival in sarcopenic patients was significantly higher following TEVAR compared to OSR (35% absolute risk reduction;  $P < .008$ ), although TPAI did not affect long-term mortality or reintervention-free survival.

**Conclusions:** Preoperative sarcopenia as a measure of frailty was significantly correlated with poor short-term outcomes following DTAA repair. TEVAR should be considered for patients with sarcopenia.

Fig 1a: Adjusted Effects of Preoperative TPAI on Propensity for TEVAR

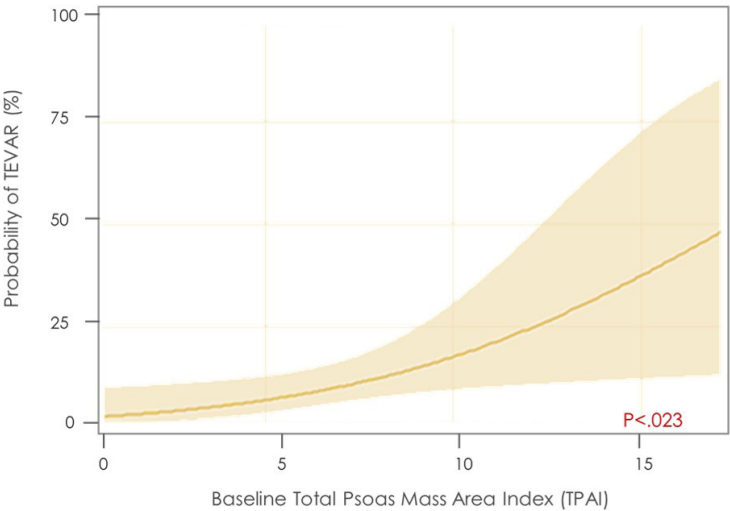
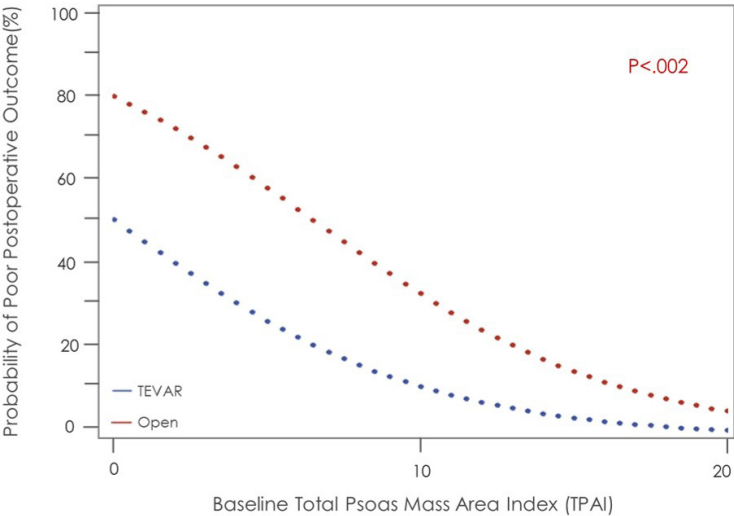


Fig 1b: Association between TPAI and Poor Outcomes by DTAA Management



3:00 PM

Floridian Ballroom A

### Distal Stent Graft-Induced New Entry After Endovascular Repair of Type B Aortic Dissection: Management Strategy, Recurrence, and Long-Term Outcomes

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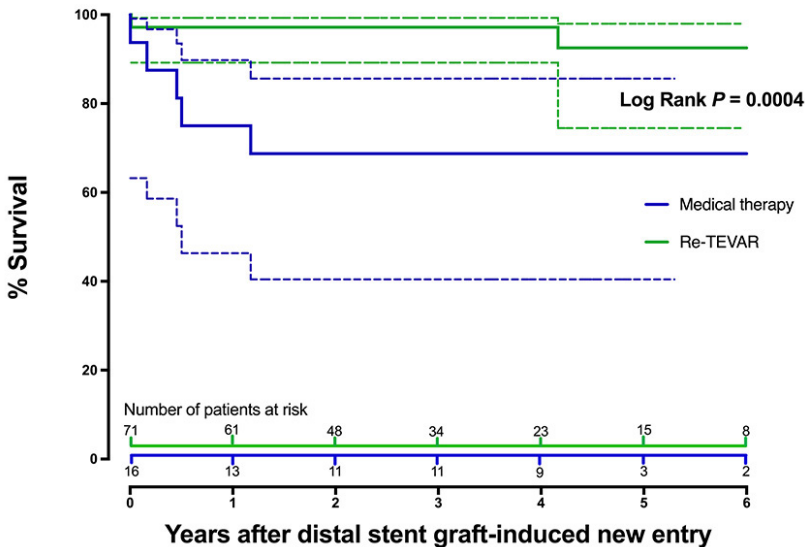
**Purpose:** Distal stent graft-induced new entry (SINE) has been increasingly observed following thoracic endovascular aortic repair (TEVAR) for type B aortic dissection (TBAD). Long-term experience with this complication in large patient series is limited. We report our experience with distal SINE regarding management strategy, recurrence, and long-term outcomes over a decade.

**Methods:** Between December 2002 and January 2015, we performed primary TEVAR for 1202 non-Marfan patients with TBAD (age 53.6 years  $\pm$  10.5 years; 1015 men, 84.7%) at our institution; among them, 57 developed distal SINE after initial TEVAR. Another 30 patients with TBAD were referred to us who sustained distal SINE after primary TEVAR elsewhere. Mean duration from initial TEVAR to distal SINE was 31 months  $\pm$  29 months (range, 0-120 months). Mean age was 53.5 years  $\pm$  11.1 years (range, 28-80 years), and 76 were male (87.4%). Clinical data of those 87 patients with distal SINE were retrospectively analyzed and compared between groups with optimized medical therapy and secondary TEVAR (re-TEVAR).

**Results:** Fifty-three patients (60.9%) presented with recurrent pain of the chest, back, or abdomen. Sixteen patients were managed with optimized medical therapy, and 71 underwent re-TEVAR using commercially available tapered stent grafts. Follow-up was available in 100% at mean 69 months  $\pm$  31 months (range, 9-145 months) after management, during which five patients with re-TEVAR and three with medical therapy expired. At 6 years, survival was 92.6% (95% confidence interval [CI], 75.5%-98.0%) vs 68.8% (95% CI, 51.9%-87.0%) in patients managed with re-TEVAR vs medical therapy ( $P < .001$ ), respectively (Figure). In patients managed with re-TEVAR, distal SINE recurred in 23.8% (5/71) at 5 years. To prevent recurrence of distal SINE, a self-designed extender graft was used for 10 patients (14.1%), which is 120 mm long and with a 10-mm diameter difference between proximal and distal ends (DDPDE). At the latest follow-up, no case of recurrent distal SINE was observed in those 10 patients.

**Conclusions:** In TBAD patients with distal SINE after TEVAR, medical therapy was associated with poor prognosis, while re-TEVAR could significantly improve long-term survival. Recurrence of distal SINE was high after re-TEVAR using currently available tapered stent grafts. More tapered stent grafts with larger DDPDE may help prevent recurrence of distal SINE after re-TEVAR.

# Kaplan-Meier Survival



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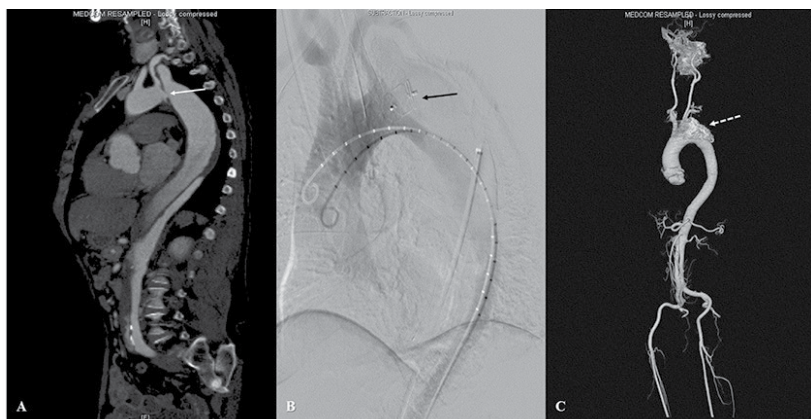
**Outcome of Stentless Thoracic Endovascular Aortic Repair in Chronic DeBakey IIb Aneurysm***T. T. Kim<sup>1</sup>, S. S. Song<sup>1</sup>, K. N. Lee<sup>1</sup>, W. Heo<sup>1</sup>, M. N. Baek<sup>1</sup>, K. Yoo<sup>1</sup>, B. N. Cho<sup>2</sup>**<sup>1</sup>Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, South Korea, <sup>2</sup>Korea Heart Foundation, Seoul*

**Purpose:** We introduce a new endovascular procedure concept for favorable aorta remodeling in chronic DeBakey IIb (CDIIb) aneurysm and present the early outcome.

**Methods:** From 2014 to 2017, 19 patients underwent stentless thoracic endovascular aortic repair (TEVAR) for CDIIb aneurysm. Stentless TEVAR is defined as an endovascular procedure with closure of communicating channels between true (TL) and false lumen (FL) or obliteration of FL itself using various materials (Figure). Stent graft was never deployed in all patients. Complete thrombosis was defined as no flow in FL of the thoracic aorta. Aortic diameter, including TL and FL, was measured at three levels (left subclavian artery [LSA], pulmonary artery bifurcation [PAB], and celiac axis).

**Results:** Fifteen of 19 patients (78.9%) demonstrated complete thrombosis. There was no mortality, and mean follow-up duration was 16.8 months. One patient had transient paraplegia, but completely recovered. Four patients needed reintervention during follow-up, and complete thrombosis was achieved in three patients. The FL and TL diameter at LSA and PAB level were significantly changed after procedure (FL: 22.6 mm  $\pm$  16.6 mm vs 16.1 mm  $\pm$  14.4 mm, 23.2 mm  $\pm$  14.6 mm vs 18.0 mm  $\pm$  13.2 mm,  $P = .001$  and  $P = .001$ , respectively; TL: 22.7 mm  $\pm$  8.7 mm vs 27.9 mm  $\pm$  6.3 mm, 19.0 mm  $\pm$  8.3 mm vs 24.3 mm  $\pm$  6.7 mm,  $P = .001$  and  $P = .001$ , respectively). The number of head vessels from FL and preoperative FL diameter at PAB were independent risk factors for complete thrombosis (HR [95% CI]: 0.214 [0.060-0.755],  $P = .017$  and 0.530 [0.341-0.823],  $P = .005$ , respectively).

**Conclusions:** Stentless TEVAR seems to be a safe procedure and shows favorable aorta remodeling. We suggest that this technique can be useful in a select group of patients with CDIIb aneurysms.



**Figure 1.** (A) Preoperative CT scan; Large intima tear was demonstrated between distal arch and proximal DTA (white solid arrow). (B) Intraoperative angiogram; After vascular plug insertion (black solid arrow), FL flow was blocked. (C) postoperative 3D CT reconstruction image; Complete thrombosis was achieved and inserted plug and coils were demonstrated (white dashed arrow). *CT*; computed tomography, *DTA*; descending thoracic aorta, *FL*; false lumen.

1:30 PM – 3:30 PM

Floridian Ballroom D

**Adult Cardiac: Ischemic***Moderators: Richard Lee, St Louis, MO, and Brett C. Sheridan, San Francisco, CA*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and videos and a brief question-and-answer session after each topic.*

1:30 PM

**Long-Term Patency of Individual Segments of Different Internal Thoracic Artery Graft Configurations**

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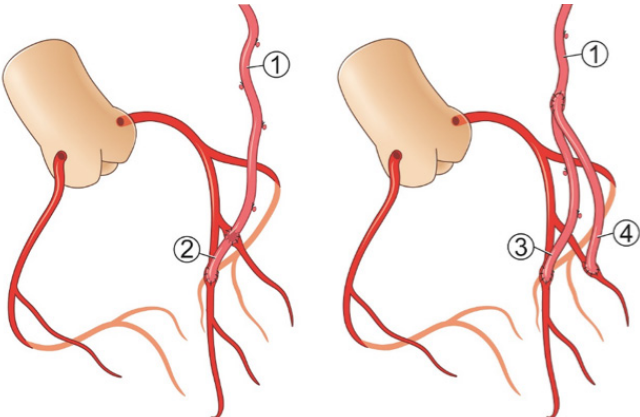
**COMMERCIAL RELATIONSHIPS** F. G. Bakaen: Speakers Bureau/Honoraria, JACE Medical; J. F. Sabik: Research Grant, Abbott; Consultant/Advisory Board, Medtronic; L. G. Svensson: Ownership Interest, Cardiosolutions; Other, Postthorax Royalties

**Purpose:** To determine the patency of individual segments of internal thoracic artery (ITA) grafts used in either sequential or y-configuration.

**Methods:** From January 1972 to August 2016, 60,500 patients underwent primary isolated coronary artery bypass grafting (CABG). Among these, 326 ITA grafts placed in sequential or y-configuration were studied angiographically (median 4.8 years post-CABG). Each sequential or y segment was studied individually (Figure). Segment 1 (n=331) represents inflow from subclavian artery (in situ ITA) or aorta (free ITA), segment 2 (n=222) a sequential graft from segment 1 to coronary artery, segment 3 (n=109) the ITA portion beyond anastomosis of a y-graft, and segment 4 (n=109) the y-graft. Graft segments were considered patent if not occluded.

**Results:** At 1, 5, 10, and 15 years, patency of segment 1 was 99%, 99%, 99%, and 99%; patency of segment 2: 97%, 97%, 97%, and 97%; patency of segment 3: 99%, 99%, 99%, and 99%; and patency of segment 4: 93%, 92%, 91%, and 90%. After adjusting for proximal stenosis and graft location, segment 4 (y-graft) was associated with higher occlusion compared to both segment 1 (inflow ITA; odds ratio: 51; 95% confidence limits, 6.1-422;  $P = .003$ ) and segment 2 (sequential graft; odds ratio: 12; 95% confidence limits, 1.14-120;  $P = .04$ ).

**Conclusions:** Long-term patency of ITA grafts in either sequential or y-configuration is similar to the known patency of single ITA-to-LAD grafts. Sequential or y-grafting does not compromise patency of inflow ITA graft. Y-graft patency is lower than sequential graft patency, but is still better than known patency of saphenous vein grafts.



Studied segments of different ITA configurations

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Floridian Ballroom D

## One Is Never Enough: Incremental Value of Three or More Arterial Grafts in Coronary Artery Bypass Grafting—The Effect of Native Coronary Disease

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M. R. Bonnell<sup>1</sup>, K. M. Klein<sup>1</sup>, R. H. Habib<sup>6</sup>

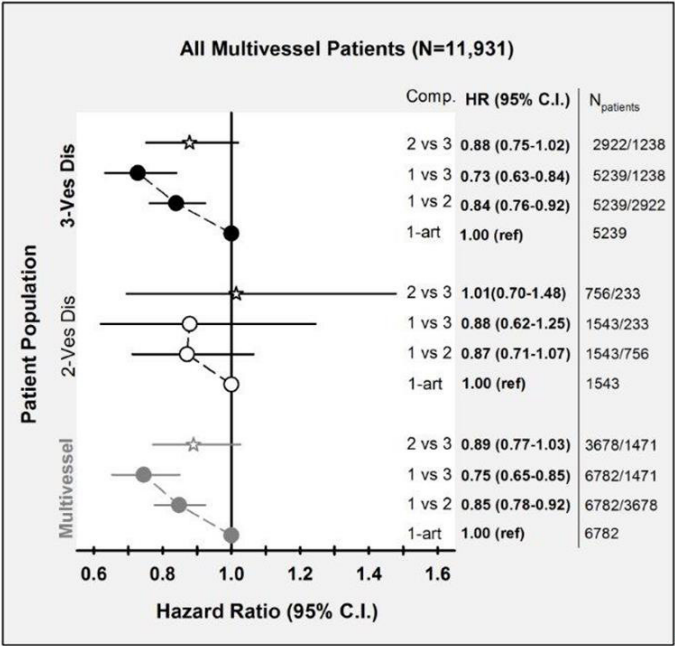
<sup>1</sup>University of Toledo Medical Center, OH, <sup>2</sup>American University of Beirut, Lebanon, <sup>3</sup>Mount Sinai Hospital, New York, <sup>4</sup>Cornell School of Medicine, New York, <sup>5</sup>University of Michigan, Ann Arbor, <sup>6</sup>The Society of Thoracic Surgeons, Chicago, IL

**Purpose:** Recent evidence has consistently documented improved coronary artery bypass grafting (CABG) survival with two vs one arterial grafts, yet the incremental value of a higher number of arterial grafts beyond two has not been well studied. This analysis aims to investigate whether extended arterial grafting further improves survival and whether this is impacted by the degree of native coronary artery.

**Methods:** We analyzed late CABG mortality data in 11,931 patients (64.3 years  $\pm$  10.5 years; 3484 [29.2%] women; 4377 [36.7%] had diabetes mellitus) derived from three US institutions (1994–2011) who underwent primary isolated LITA-LAD CABG with  $\geq 2$  grafts and one or more arterial grafts: 1-art (n=6782; 56.9%); 2-art (n=3678; 30.8%); and 3-art (n=1471; 12.3%). Comprehensive covariate adjustments (Cox regression) were used to quantify risk-adjusted effects of increasing number of arterial grafts in the overall study group and separately in patients with three vessel (3VD) and two vessel (2VD) coronary artery disease.

**Results:** Radial artery (94%) and right internal thoracic artery (6%) were used as additional arterial grafts in multiarterial bypass grafting (MABG). In a multivariate analysis, increasing number of arterial grafts was associated with improved survival (1-art: HR 1.0 [ref], 2-art: HR 0.87 [0.80–0.95], 3-art: HR 0.83 [0.72–0.95]). In binary comparisons, MABG was associated with significantly better 15-year survival advantage compared to single-arterial bypass grafting (SABG) with incrementally lower mortality hazard ratios: 2-art vs 1-art (HR [95% CI] = 0.85 [0.78–0.92]) and 3-art vs 1-art (HR = 0.75 [0.65–0.95]). The 3-art vs 2-art comparison was consistent, even if not significant (HR = 0.89 [0.77–1.03]). Importantly, the benefit of the increasing number of arterial grafts was more apparent among patients with 3VD (2-art vs 1-art [HR = 0.84 (0.76–0.92)], 3-art vs 1-art [HR = 0.73 (0.63–0.84)], 3-art vs 2-art [HR = 0.88 (0.75–1.02)]) compared to 2VD (2-art vs 1-art [HR = 0.87 (0.71–1.07)], 3-art vs 1-art [HR = 0.88 (0.62–1.25)], 3-art vs 2-art [HR = 1.01(0.70–1.48)]) as evidenced by lower mortality HR (Figure).

**Conclusions:** These data document the value of increasing the number of arterial grafts as evidenced by improved long-term survival and supports the use of two or more arterial grafts for multivessel CABG, especially in patients with 3VD, as a superior grafting strategy compared to SABG.



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Floridian Ballroom D

**Bilateral Internal Mammary Artery Utilization in Diabetics: Friend or Foe?**

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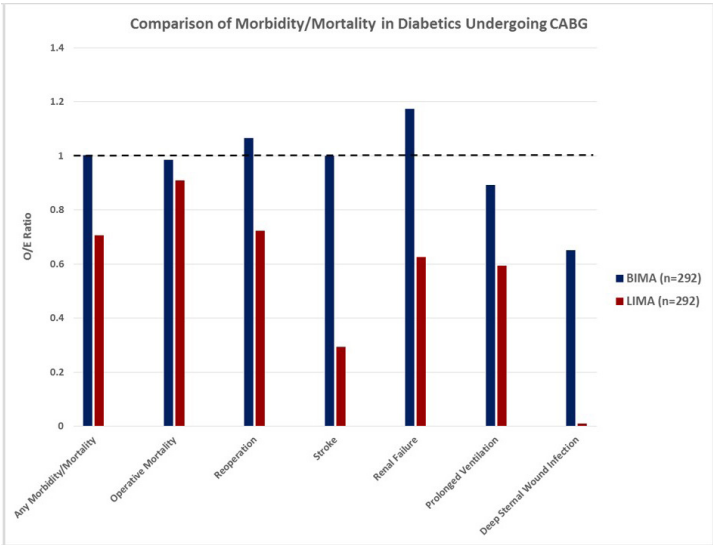
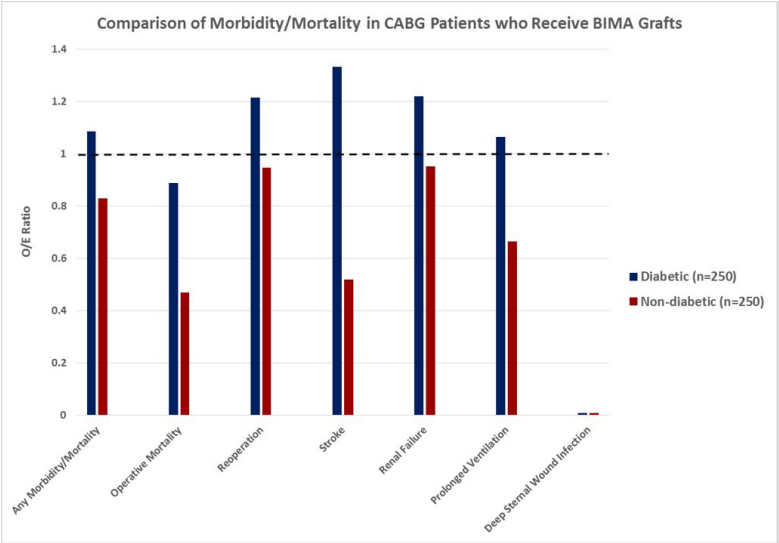
**COMMERCIAL RELATIONSHIPS** J. V. Conte: Research Grant, Medtronic; Consultant/Advisory Board, Medtronic; B. S. Taylor: Nonremunerative Position of Influence, Medtronic

**Purpose:** Bilateral internal mammary artery (BIMA) utilization in diabetic patients undergoing coronary artery bypass grafting (CABG) remains controversial. The purpose of our study was to compare morbidity and mortality between diabetic and non-diabetic patients who received BIMA grafting, and diabetic patients who received BIMA vs left internal mammary artery (LIMA) grafting.

**Methods:** We identified all patients who underwent isolated CABG from July 2011 to June 2016 across any of the 10 centers in Maryland. Patients were then propensity scored based on 16 variables. Diabetic BIMA patients were matched to non-diabetic patients 1:1 by nearest neighbor matching and were separately matched 1:1 to diabetic LIMA patients. We calculated observed to expected (O/E) ratios for composite morbidity/mortality, operative mortality, and the five major STS complications (reoperation, stroke, renal failure, prolonged ventilation, and deep sternal wound infection) and compared ratios among matched populations (diabetic vs non-diabetic BIMA and diabetic BIMA vs diabetic LIMA).

**Results:** Over the study period, 785 patients underwent CABG with BIMA grafting, including 293 patients (37%) with diabetes. In total, 5058 diabetic patients underwent CABG, which included 302 patients (6%) who received BIMA grafts and 4533 (90%) who received only LIMA grafts. We matched 250 diabetic to non-diabetic BIMA patients with minimal imbalance. Mortality rates were low overall (0.8%) with an O/E ratio <1.0 for both groups. However, O/E ratios were substantially higher in matched diabetic (vs non-diabetic) BIMA patients when comparing composite morbidity/mortality, reoperation, stroke, renal failure, and prolonged ventilation (all O/E >1.0 (Figure, left). We additionally matched 292 diabetic BIMA to diabetic LIMA patients. Again, O/E ratios for mortality were <1.0, but diabetic BIMA patients had a higher O/E (1.00 vs 0.71) for composite morbidity/mortality, which was driven by substantially higher O/E for reoperation (1.07 vs 0.72), stroke (1.00 vs 0.29), and renal failure (1.17 vs 0.63) (Figure, right).

**Conclusions:** In this statewide analysis, diabetics who received BIMA grafts had an O/E ratio >1 for combined morbidity/mortality, reoperation, stroke, renal failure, and prolonged ventilation. Non-diabetic BIMA and diabetic LIMA patients had O/E ratios <1 for all major complications. Our study suggests enthusiasm for BIMA grafting must be tempered in diabetics.



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Floridian Ballroom D

**Which Diabetics Should Have Bilateral Internal Mammary Artery Grafting?***Joseph F. Sabik III, Cleveland, OH***COMMERCIAL RELATIONSHIPS** J. F. Sabik: Research Grant, Abbott; Consultant/Advisory Board, Medtronic

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**A Multi-Institutional Analysis of Patients Undergoing Hybrid Coronary Revascularization for Multivessel Coronary Artery Disease***N. M. Ndobisi<sup>1</sup>, M. C. Wertan<sup>2</sup>, F. P. Sutter<sup>2</sup>, J. J. DeRose<sup>3</sup>, P. Teeff<sup>4</sup>, B. Kiaii<sup>5</sup>, J. McGinn<sup>5</sup>, T. A. Vassiliades<sup>6</sup>, H. A. Liberman<sup>7</sup>, J. D. Puskas<sup>8</sup>, W. A. Jaber<sup>4</sup>, M. E. Halkos<sup>7</sup>**<sup>1</sup>Emory University School of Medicine, Atlanta, GA, <sup>2</sup>Lankenau Medical Center, Wynnewood, PA, <sup>3</sup>Montefiore Medical Center, Bronx, NY, <sup>4</sup>Western University, London Health Sciences Centre, Canada, <sup>5</sup>Carolinas HealthCare System, Charlotte, NC, <sup>6</sup>Medtronic Inc., Mounds View, MN, <sup>7</sup>Emory University, Atlanta, GA, <sup>8</sup>Mount Sinai Saint Luke's, New York***COMMERCIAL RELATIONSHIPS** B. Kiaii: Consultant/Advisory Board, Johnson & Johnson; Speakers Bureau/Honoraria, Johnson & Johnson, LivaNova, Medtronic, Symetis; J. T. McGinn: Speakers Bureau/Honoraria, Medtronic; F. P. Sutter: Speakers Bureau/Honoraria, Intuitive Surgical; P. Teeff: Research Grant, Medtronic; Speakers Bureau/Honoraria, Medtronic; T. A. Vassiliades: Employment, Medtronic

**Purpose:** Hybrid coronary revascularization (HCR) studies have been limited to single-surgeon, single-institution reports. Despite successful results, HCR approaches for multivessel coronary artery disease (CAD) have not been widely adopted. The purpose of this study was to examine the short-term outcomes and angiographic results of HCR among institutions with expertise in minimally invasive coronary surgery.

**Methods:** From 2003 to 2015, 992 patients underwent HCR procedures at five different institutions by seven surgeons in North America, of which 51% (505/992) occurred in the last 5 years of the study period. The surgical portion of the HCR was robotically assisted in 97% (868/899) of cases. Routine postoperative angiography was performed in patients undergoing percutaneous coronary intervention (PCI) of non-left anterior descending (LAD) vessels as part of the second stage of HCR and selectively otherwise. Clinical and angiographic outcomes were compared among groups. Patients were classified as HCR according to intention to treat. High-risk patients, defined as having an STS predicted risk of mortality (STS-PROM) score of  $>2\%$  ( $n=196$ ), underwent subset analysis.

**Results:** Mean patient age was  $64.1 \text{ years} \pm 11.7 \text{ years}$ , 74% were male (733/992), 76% (650/862) had  $\geq$ three-vessel disease, and mean STS-PROM score was 1.75%. The operative mortality rate was 0.8% (8/992), with an O/E ratio of 0.46. Postoperative angiography revealed a LIMA-LAD Fitzgibbon A patency rate of 97.0% (513/530). The right coronary artery was stented in 48% of cases (433/902), the circumflex in 41% (374/902), and diagonal in 8% (71/902). Patients had their PCI prior to surgery in 29% ( $n=269/910$ ) of cases, 15% ( $n=136/910$ ) concurrently, and 55% ( $n=505/910$ ) following. Postoperative stroke occurred in 0.4% (4/992) of patients, repeat revascularization occurred in 1.9% (19/992), postoperative myocardial infarction (MI) in 0.8% (8/975), and reexploration for bleeding in 1.6% (16/992) (Table). Mean high-risk cohort STS-PROM was 5.1%, operative mortality was rate 1.5% (3/196), and O/E ratio was 0.29. The postoperative stroke rate was 0.5% (1/196), renal failure occurred in 3.6% of cases (7/196), and postoperative MI occurred in 0.8% (2/193).

**Conclusions:** Excellent short-term clinical and angiographic results can be achieved with HCR and minimally invasive coronary surgery for patients with multivessel CAD. Broader adoption of this treatment should be encouraged to ensure LIMA-LAD revascularization for patients with multivessel CAD who may otherwise be treated with multivessel PCI.

Variable	Entire Cohort	High Risk Cohort (STS PROM >2%)
Incomplete Revascularization (n=902)	8.64%	18.4%
Conversion to sternotomy (n= 347)	2.88%	4.1%
Re-exploration for Bleeding (n= 992)	1.61%	2.0%
Renal Failure (n= 992)	1.11%	3.60%
Renal Failure Requiring Hemodialysis (n= 992)	0.40%	1.50%
Number of Patients Receiving Blood Product (n=863)	19.10%	43.90%
Mean Postop Vent Hours - Total (n= 684)	10hrs±82.3hrs	25.0hrs±163.3hrs
Median Ventilation Time (range) (n= 684)	0hrs (0-1,789)	0hrs (0-1,789)
Prolonged Ventilation (n= 992)	2.72%	5.60%
Median ICU Length of Stay (range) (n =487)	28.5hrs (0-1,685)	47.8hrs (0-1,685)
Median Hospital Length of Stay (range) (n =863)	4 days (1-90)	6 days (1-90)

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Floridian Ballroom D

**Del Nido Cardioplegia in Adult Coronary Artery Bypass Grafting Surgery**

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M. R. Goebler<sup>1</sup>, F. S. Fanning<sup>1</sup>, T. Boeve<sup>1</sup>, E. T. Murphy<sup>1</sup>, J. C. Heiser<sup>1</sup>

<sup>1</sup>Spectrum Health, Grand Rapids, MI, <sup>2</sup>Michigan State University College of Human Medicine, Grand Rapids

**COMMERCIAL RELATIONSHIPS** T. Timek: Research Grant, Medtronic

**Purpose:** Prolonged myocardial protection with single dose del Nido cardioplegia (DC) has been demonstrated in pediatric cardiac surgery. We set out to evaluate the efficacy of myocardial protection and clinical outcomes of del Nido cardioplegia vs blood cardioplegia in adult coronary artery bypass grafting (CABG) patients.

**Methods:** The study included all 1024 consecutive isolated CABG surgeries performed at our center between May 2014 and November 2016 with either del Nido (DC, n=397) or blood (BC, n=627) cardioplegia. Two surgeons used DC exclusively and four used BC exclusively over the study period. BC was delivered antegrade and retrograde in multidose fashion, while DC was delivered antegrade only and predominantly as a single 1000-cc dose. Propensity matching of preoperative characteristics yielded 380 well-matched pairs. Clinical data were extracted from our local STS database and mortality data from the Michigan State Social Security Death Index.

**Results:** Preoperative characteristics are shown in Table. Single dose was used in 85% (322/380) of DC patients and aortic clamp time was shorter (104 minutes ± 40 minutes vs 70 minutes ± 20 minutes,  $P = .001$ ). Postop mean (0.77 ng/mL ± 1.28 ng/mL vs 0.49 ng/mL ± 0.67 ng/mL;  $P = .001$ ) and median (0.42 ng/mL vs 0.28 ng/mL,  $P = .001$ ) troponin T levels were lower for DC patients. The rate of new Q waves or left bundle branch block on postop electrocardiography did not differ (14/288 [4.8%] and 13/289 [4.5%] for BC and DC, respectively;  $P = .9$ ). Postop echocardiography was available in 202/380 (53.2%) BC and 196/380 (51.6%) DC with no difference in ejection fraction observed (54% ± 13% and 53% ± 13% for BC and DC, respectively;  $P = .44$ ). Perioperative mortality (1.1% vs 0.8%), atrial fibrillation (29.6% vs 31.7%), stroke (0.8% vs 1.6%), reoperation (2.1% vs 1.1%), renal failure (2.1% vs 2.9%), and prolonged intubation (5.8% vs 5.5%) did not differ between BC and DC. Short-term survival was similar (Figure).

**Conclusions:** In adult isolated CABG patients, del Nido cardioplegia provided equivalent myocardial protection, clinical outcomes, and short-term survival to blood cardioplegia. Del Nido cardioplegia demonstrated feasibility of single-dose administration for CABG. Randomized studies are needed to further explore the safety and efficacy of del Nido cardioplegia in adult cardiac surgery.

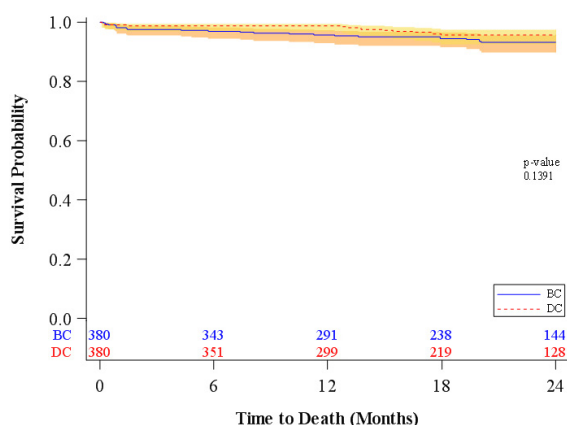


Table 1.		Unmatched		Matched	
*p<0.05		BC (n=627)	DC (n=397)	BC (n=380)	DC (n=380)
Age (yrs)		65.1 ± 10.2	<b>66.3 ± 10.2*</b>	65.4 ± 10.2	65.9 ± 10.1
Male		470(75)	308(77.6)	300(78.9)	294(77.4)
Diabetes		283(45.3)	169(42.7)	168(44.4)	161(42.5)
MI		301(48.2)	181(45.7)	183(48.4)	174(45.9)
HTN		555(88.8)	347(87.6)	330(87.3)	332(87.6)
Status	Elective	266(42.5)	<b>203(51.1)*</b>	188(49.5)	195(51.3)
	Urgent	341(54.5)	<b>182(45.8)*</b>	182(47.9)	176(46.3)
	Emergent	19(3)	12(3)	10(2.6)	9(2.4)
EF (%)		52.1±12.5	52.0±12.4	52.2±12.6	52.2±12.2
Number of grafts		3.5±0.9	<b>3.1±0.8*</b>	3.2±0.8	3.1±0.8
BMI (kg/m <sup>2</sup> )		30.6±5.6	30.2±5.6	30.6±5.6	30.2±5.2
STS Score (%)		1.8±2.9	2.0±3.1	1.9±3.3	1.9±2.8

**Legend:** BC= blood cardioplegia, DC= del Nido cardioplegia, MI= myocardial infarction, HTN= hypertension, EF= left ventricular ejection fraction, BMI= body mass index, STS= Society of Thoracic Surgeons. \*p<0.05

3:00 PM

Floridian Ballroom D

### Coronary Artery Bypass Surgery Compared to Percutaneous Coronary Intervention in Patients Younger Than 50 Years of Age: Long-Term Outcomes

A. M. Shafi<sup>1</sup>, A. A. Dhanji<sup>2</sup>, A. Habib<sup>2</sup>, W. I. Awad<sup>3</sup>

<sup>1</sup>Barts Health NHS Trust, London, United Kingdom, <sup>2</sup>Castle Hill Hospital, Bradford, United Kingdom, <sup>3</sup>St Bartholomew's Hospital, London, United Kingdom

**Purpose:** An increasing number of young patients with coronary artery disease are being offered percutaneous coronary intervention (PCI) primarily, with a view to deferring coronary artery bypass grafting (CABG). This study investigates the validity of this approach by comparing procedural outcomes of young patients ( $\leq 50$  years) undergoing CABG or PCI at a single cardiac center in the United Kingdom.

**Methods:** A total of 200 patients (100 consecutive patients undergoing PCI and 100 consecutive patients undergoing CABG between January 2004 and December 2004) were retrospectively studied. Data were collected from clinical notes and a telephone survey with patients or their general practitioners in December 2009 and again in December 2016 to allow for 5- and 12-year follow-up, respectively. A comparison of the two groups was performed for the primary endpoints of major adverse cardiac or cerebrovascular event (MACCE): death from any cause, stroke, myocardial infarction, or repeat revascularization.

**Results:** Patient characteristics were similar in both groups except for diabetes (35% vs 22%) and left ventricular ejection fraction  $< 50\%$  (19% vs 9%), which were higher in the CABG group. At 5 years follow-up, the rates of myocardial infarction (MI; 9% vs 1%,  $P = .03$ ), repeat revascularization (31% vs 7%,  $P < .01$ ), and total MACCE (44 vs 11,  $P < .01$ ) all were significantly greater in the PCI group compared to the CABG group. Similarly, at 12 years follow-up ( $n=56$  in each group), the rates of MI (35.7% vs 16%,  $P < .01$ ), repeat revascularization (50% vs 17.8%,  $P < .01$ ), and total MACCE (57 vs 33,  $P < .01$ ) all were significantly greater in the PCI group compared to the CABG group. There were no differences between the two groups in rates of death, MI, stroke, repeat revascularization, or MACCE in patients with one- or two-vessel coronary artery disease at 5 or 12 years follow-up. Rates of MI, revascularization, and MACCE only were significantly higher in patients with three-vessel disease undergoing PCI ( $n=15$  patients; MI 53.3%, revascularization 73.3%, and MACCE 22 events) vs CABG ( $n=46$ ; MI 17.4%, revascularization 17.4%, and MACCE 28 events);  $P < .01$ , for all endpoints.

**Conclusions:** MACCE was significantly lower in young patients undergoing CABG vs PCI at both 5 and 12 years follow-up, primarily as a consequence of patients with three-vessel coronary artery disease (3VD) undergoing PCI and requiring repeat revascularization. CABG should remain the preferred method of revascularization in young patients with 3VD.

3:15 PM

### Updates on Trials of Percutaneous Coronary Intervention vs Coronary Artery Bypass Grafting Surgery

Stuart Head, Rotterdam, Netherlands

1:30 PM – 3:30 PM

Room 305

**Congenital: Pediatric Congenital I***Moderators:* Carl L. Backer, Chicago, IL, and James S. Tweddell, Cincinnati, OH**COMMERCIAL RELATIONSHIPS** C. L. Backer: Consultant/Advisory Board, W. L. Gore & Assoc

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

1:30 PM

**Richard E. Clark Memorial Paper for Congenital Heart Surgery****Development of a Congenital Heart Surgery Composite Quality Measure: An Analysis of the STS Congenital Heart Surgery Database**

**S. K. Pasquali<sup>1</sup>, D. M. Shahian<sup>2</sup>, S. O'Brien<sup>3</sup>, M. L. Jacobs<sup>4</sup>, J. W. Gaynor<sup>5</sup>, J. E. Mayer<sup>6</sup>, J. C. Romano<sup>7</sup>, K. Hill<sup>8</sup>, M. Gaies<sup>1</sup>, J. P. Jacobs<sup>9</sup>**

<sup>1</sup>University of Michigan, Ann Arbor, <sup>2</sup>Massachusetts General Hospital, Boston, <sup>3</sup>Duke University Medical Center, Durham, NC, <sup>4</sup>The Johns Hopkins University School of Medicine, Newtown Square, PA, <sup>5</sup>The Children's Hospital of Philadelphia, PA, <sup>6</sup>Boston Children's Hospital, MA, <sup>7</sup>Michigan Congenital Heart Center, Ann Arbor, <sup>8</sup>Duke Clinical Research Institute, Durham, NC, <sup>9</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL

**COMMERCIAL RELATIONSHIPS** K. Hill: Research Grant, Gilead; Consultant/Advisory Board, Myokardia; J. E. Mayer: Consultant/Advisory Board, Medtronic

**Discussant:** Charles D. Fraser Jr, Houston, TX

**Purpose:** Current congenital heart surgery quality measures focus on operative mortality. More comprehensive measures incorporating additional components of quality are important to numerous stakeholders. We describe the conceptual framework, methodology, and results related to the development of the first composite quality measure in the field.

**Methods:** A multidisciplinary panel selected candidate metrics for inclusion in the composite, which was developed using the STS Congenital Heart Surgery Database (2012–2015, 100 centers, 78,425 operations). Case-mix adjustment utilized standard STS variables and Bayesian hierarchical modeling. We evaluated different weighting schemes for individual metrics included in the composite, reliability (proportion of variation attributable to true differences between centers vs random statistical noise) of the composite vs individual metrics, proportion of centers in various composite measure performance categories (same, better, or worse than expected based on 95% credible interval vs population aggregate), and aggregate outcomes data across composite measure categories.

**Results:** The final composite measure comprised a mortality domain (operative mortality) and morbidity domain (the six STS/CHSS-endorsed major complications plus cardiac arrest and postoperative length of stay [PLOS]). Structure and process metrics were considered but excluded due to limited/variable evidence regarding their relationship with outcomes. Several schemes for weighting the individual metrics were evaluated. In the final scheme chosen, mortality had the greatest influence on the composite measure, followed by major

complications, and finally PLOS (correlation with overall composite score of 0.87, 0.69, and 0.47, respectively). Reliability of the composite measure was high (0.73) and better than reliability for mortality alone (0.59). The overall distribution of centers across composite measure performance categories was: 75% (same as expected), 9% (worse than expected), and 16% (better than expected). The table displays summary outcomes data across these composite measure categories.

**Conclusions:** This congenital heart surgery composite quality measure incorporates aspects of both morbidity and mortality. The composite measure has clinical face-validity and enhances our understanding of quality and variation across centers beyond mortality alone. Ongoing efforts will support the use of the composite measure in benchmarking and quality improvement activities.

**Table. Summary Outcomes Data Across Centers Within Each Composite Measure Performance Category**

Outcome	Composite Measure Performance Categories		
	Better than Expected (n=16 centers)	As Expected (n=75 centers)	Worse than Expected (n=9 centers)
Adjusted Operative Mortality Rate (%)	2.3% (2.1-2.6)	3.3% (3.1-3.5)	4.2% (3.7-4.9)
Adjusted Major Complications Rate (%)*	10.0% (9.1-10.9)	14.1% (13.1-15.2)	20.7% (18.6-23.2)
Proportion of centers in highest PLOS quartile (%)*	4.1% (0-12.5)	22.7% (20.0-25.3)	48.0% (33.3-55.6)
Data are presented as averages for the centers within the specified category and 95% credible interval. *In survivors			



1:45 PM

Room 305

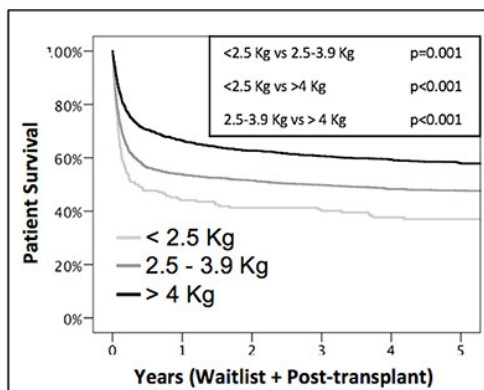
**Listing Low Weight Infants for Heart Transplantation: Is It Prudent?***R. Rizwan, F. Zafar, C. Chin, J. S. Tweddell, R. O. Bryant III, D. L. Morales**Cincinnati Children's Hospital Medical Center, OH***COMMERCIAL RELATIONSHIPS** D. L. Morales: Consultant/Advisory Board, Berlin Heart, HeartWare, SynCardia

**Purpose:** Infants awaiting heart transplantation (HTx) have the highest waitlist mortality compared to other HTx patients. As weight <2.5 kg has been associated with poor outcomes after cardiac surgery, this study aims to analyze the impact of low weight on waitlist and post-transplant outcomes in infants listed for cardiac transplantation.

**Methods:** The United Network of Organ Sharing database was used to identify all infants listed for HTx from October 1987 to June 2016. The population was then divided into three groups based on weight at the time of listing: <2.5 kg group, 2.5-3.9 kg group, and ≥4 kg group. Combined waitlist and post-transplant outcomes were compared between the groups. Impact of congenital heart disease diagnosis, extracorporeal membrane oxygenation (ECMO), and inotropic and ventilator support at the time of listing on survival among the weight groups also was assessed. Negative waitlist outcomes represent all patients who died or became too ill for transplant while on waitlist.

**Results:** Out of 4711 infants listed for HTx, 250 (5.3%) were <2.5 kg, 1993 (42%) were 2.5-3.9 kg, and 2468 (52%) were ≥4 kg. Median time on waitlist was similar between <2.5 kg and 2.5-3.9 kg groups (28 days vs 31 days,  $P = .423$ ), while ≥4 kg group waited longer (42 days) ( $P = .027$  and  $P < .001$ , respectively). Infants <2.5 kg had the worst combined overall waitlist and post-HTx survival compared to other weight groups (vs 2.5-3.9 kg:  $P = .001$ , vs ≥4 kg:  $P < .001$ ), Figure. For infants <2.5 kg on a ventilator, 1-year survival is 35%, while those on ECMO have a 1-year survival of 10% (Table).

**Conclusions:** Survival of infants after being listed for HTx is significantly affected by weight, with less than 50% of infants <2.5 kg surviving to 1 year. Listing infants <2.5 kg for heart transplantation who are on a ventilator and especially those on ECMO may not be prudent.



**Figure:** Kaplan-Meier survival comparison of total survival (waitlist + post-transplant, if applicable) between the weight groups

**Table:** Cumulative survivals (waitlist + post-transplant, if applicable) at 1 and 5 years for overall and at-risk cohorts

	<2.5 Kg	2.5-3.9 Kg	≥4 Kg
Overall	43%, 37%	54%, 47%	66%, 57%
CHD	45%, 40%	52%, 47%	58%, 49%
IV inotropic support	51%, 44%	51%, 45%	65%, 57%
Ventilator support	35%, 28%	45%, 39%	54%, 46%
ECMO support	10%, 10%	23%, 20%	41%, 34%
The two values in each box represent 1 and 5 year survival respectively			

2:00 PM

Room 305

**Complex Orthotopic Heart Transplantation in a Neonate With Cardiomyopathy, Dextrocardia, and Heterotaxy Syndrome***U. S. Boston, C. J. Knott-Craig**Le Bonheur Children's Hospital, Memphis, TN*

**Purpose:** Orthotopic heart transplantation (OHT) in infants with complex congenital heart disease poses a major reconstructive challenge. Here, we illustrate OHT in a 2-month old with severe biventricular dysfunction related to non-compaction and complex congenital disease with dextrocardia-heterotaxy syndrome. Systemic-pulmonary artery palliation was performed and the patient listed for OHT.

**Methods:** Pertinent diagnostic features included dextrocardia, interrupted inferior vena cava (IVC) with azygous continuation to the left superior vena cava (SVC), left-sided hepatic vein confluence joining the left-sided atrium, ipsilateral pulmonary veins, L-malposed great vessels, and pulmonary stenosis. Preoperative computed tomography for virtual fitting garnered critical information on optimal donor size for implantation. Technical considerations included fitting the levocardia donor heart into a dextrocardia recipient's chest, providing adequate drainage of the left SVC/azygous venous return, and channeling the left-sided hepatic venous confluence to the right-sided donor IVC.

**Results:** Surgical techniques for successful OHT in an infant with dextrocardia and heterotaxy syndrome are illustrated. Leaving recipient atrial tissue in situ was critical for reconstruction of systemic and pulmonary veins. Adequate fitting of the donor heart was accomplished by opening the left pleura widely and taking down the pericardium at the level of the diaphragm. Creating adequate drainage of the systemic veins required a large conduit to drain the left SVC/azygous venous junction to the right-sided right atrium of the donor. Baffling the left-sided confluence to the right-sided donor IVC utilized an atrial flap.

**Conclusions:** OHT in neonates and infants with dextrocardia-heterotaxy congenital heart disease can be successfully performed. This patient continues to do well 2 months following OHT. Preoperative virtual fitting facilitates choosing the optimal size of donor. Surgical techniques for adequate systemic venous drainage is critical to success.

2:15 PM

Room 305

**Long-Term Results Comparing the Use of Artificial Chordae to Other Chordal Procedures for Mitral Valve Repair in Children**

*S. Sivalingam, M. A. Yakub, P. S. Krishna Moorthy, J. J. Dillon, P. K. Kiew Kong, I. B. Gaaffar*  
*National Heart Institute Malaysia, Kuala Lumpur*

**Purpose:** Durability and growth potential is not well established among children following mitral valve repair using artificial chordae. This study compares the long-term outcomes of mitral valve repair using artificial chordae and other chordal procedures with natural chordae in children.

**Methods:** This is a retrospective review of 154 patients who underwent mitral valve repair using chordal procedures from 1992 to 2012. 102 patients (66.2%) underwent repair using artificial chordae (Group A) and 52 patients (33.8%) had either chordal transfer or shortening (Group B). The mean age at repair was 11.1 years  $\pm$  4.5 years. Mitral regurgitation was predominant in 150 patients (97.4%). Thirty-four patients (22%) had congenital mitral valve lesions. Associated cardiac anomalies were found in 89 patients (59%).

**Results:** There were two hospital deaths (1.3%). The mean follow-up was 6.1 years  $\pm$  5.3 years, with five late deaths (3.2%). There was no significant difference in the 10-year survival between Group A (93%) and Group B (97.2%) ( $P = .17$ ). The rate of reoperation for the entire group was 7.8% with no significant difference between Group A (78.5%) and Group B (96.9%) ( $P = .07$ ). The rate of valve failure was significantly more in Group A (49.6%) than Group B (87.1%) ( $P = .006$ ). The significant factors for valve failure were advanced NYHA (class II and more), annuloplasty without a ring, and postoperative residual moderate mitral regurgitation. In Group B, the freedom from reoperation was significantly less for congenital lesions (80%) than acquired lesions (100%) ( $P = .02$ ).

**Conclusions:** Mitral valve repair using artificial chordae can be successfully applied for children. The long-term durability of artificial chordae repair can be achieved by using ring annuloplasty and avoidance of significant residual mitral regurgitation in the postoperative period.

2:30 PM

Room 305

## Impact of Total Anomalous Pulmonary Venous Connection Repair on Left Ventricular Function

Y. N. Nakamura, T. Hoashi, T. N. Nakata, M. S. Shimada, H. Ichikawa

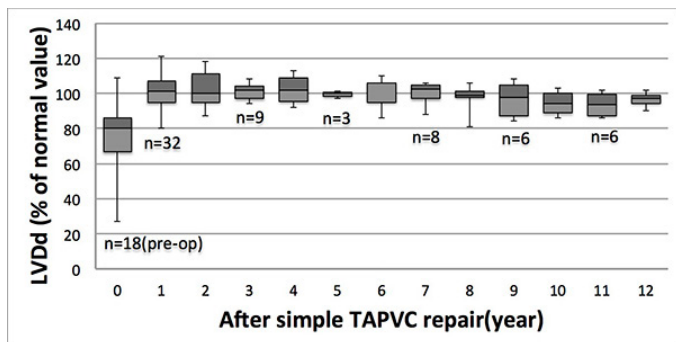
National Cerebral and Cardiovascular Center, Suita, Japan

**Purpose:** Poor left ventricular growth and diastolic dysfunction long after simple total anomalous pulmonary venous connection (TAPVC) repair has been documented and believed to be derived from insufficient preoperative volume preload. Herein, this study aimed to confirm such a finding.

**Methods:** Of 61 patients undergoing simple TAPVC repair between 1996 and 2016, 37 patients undergoing postoperative catheter examination were enrolled. Median duration from repair to catheter examination was 1.1 years (range, 0.4–6.0 years). The evaluated valuables were 1) left ventricular end-diastolic volume (LVEDV) calculated by biplane left ventriculography, left ventricular end-diastolic pressure (LVEDP), and mean pulmonary arterial pressure (mPAP) at postoperative catheter examination, 2) risk factors for high LVEDP, 3) the influence of pulmonary vein occlusion (PVO) at birth and after TAPVC repair, and 4) relationship between LVEDV and left ventricular end-diastolic diameter (LVDd) measured by 2D echocardiography, and serial changes of LVDd.

**Results:** The mean follow-up period was 10.3 years (1.0–17.6 years). LVEDV, LVEDP, and mPAP were  $101\% \pm 16\%$  of the normal value,  $10.2 \text{ mm Hg} \pm 2.8 \text{ mm Hg}$ , and  $19.3 \text{ mm Hg} \pm 7.0 \text{ mm Hg}$ , respectively. Seventeen patients (47.2%) had LVEDP of 10 mm Hg or higher, and LVEDP was linearly correlated to mPAP ( $R^2 = 0.14$ ,  $P = .03$ ) but not to LVEDV. Patients born with PVO showed higher LVEDP and mPAP, as opposed to patients without it (LVEDP:  $11.4 \text{ mm Hg} \pm 2.9 \text{ mm Hg}$  vs  $9.5 \text{ mm Hg} \pm 2.6 \text{ mm Hg}$ ,  $P = .05$ , mPAP:  $24 \text{ mm Hg} \pm 8 \text{ mm Hg}$  vs  $17 \text{ mm Hg} \pm 5 \text{ mm Hg}$ ,  $P = .003$ ), and also had higher LVEDV ( $109\% \pm 21\%$  of normal value vs  $97\% \pm 11\%$ ,  $P = .03$ ). Postoperative PVO was related to higher postoperative mPAP ( $P < .001$ ), but didn't affect LVEDP and LVEDV. LVEDV was strongly correlated to LVDd ( $R^2 = 0.29$ ,  $P = .005$ ), and LVDd was normalized 1 year after the repair, then maintained normal range (Figure).

**Conclusions:** LVEDV was strongly correlated to LVDd and normalized after simple TAPVC repair, but not related to LVEDP. LVEDV maintained normal range thereafter. High LVEDP was frequently seen at 1 year after the repair, and it was related to pulmonary hypertension. PVO at birth was a risk factor for high LVEDP.



2:45 PM

Room 305

**One-Stage Unifocalization for Pulmonary Atresia/Ventricular Septal Defect (VSD)/ Major Aortopulmonary Collaterals: Is Concomitant VSD Closure Associated With a Better Outcome Compared to Delayed Repair?***M. Trezzi, C. D'Anna, G. Rinelli, G. Brancaccio, E. E. Cetrano, S. B. Albanese, A. Carotti**Bambino Gesù Children's Hospital, Rome, Italy*

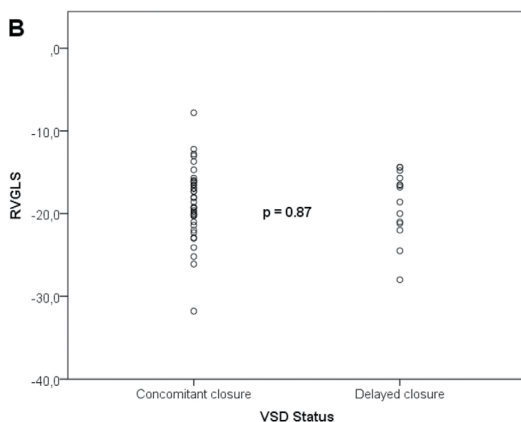
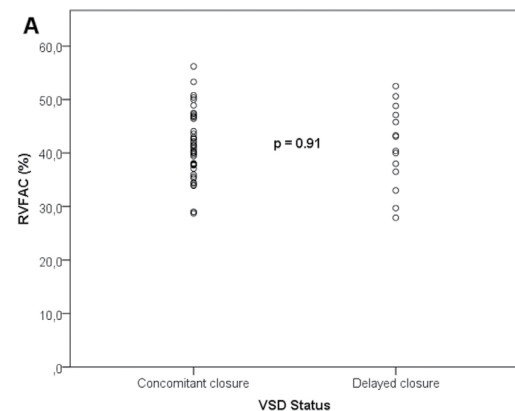
**Purpose:** Patients with an open VSD following repair of pulmonary atresia, ventricular septal defect, and major aortopulmonary collaterals (PA/VSD/MAPCAs) have been traditionally considered the most vulnerable subgroup. The purpose of this study was to analyze the impact of concomitant vs delayed VSD closure on survival and mid-term right ventricular (RV) function.

**Methods:** Between October 1996 and February 2017, 96 patients underwent pulmonary flow study aided repair of PA/VSD/MAPCAs with a cutoff mean pressure of 30 mm Hg utilized for tolerability of VSD closure. In those who underwent either concomitant or delayed intracardiac repair, RV systolic function was retrospectively analyzed, assessing 2D fractional area change (RVFAC) and 2D global longitudinal strain (RVGLS). Cine-loops recordings were reviewed and functional parameters were calculated offline by an experienced pediatric cardiologist (blinded to surgical management) based on the last echocardiographic dataset.

**Results:** Sixty-four patients underwent concomitant VSD closure. Out of the 32 patients with VSD left open, 16 underwent delayed intracardiac repair at a median of 2.3 years (range, 3 days-7.4 years) after unifocalization. The average intraoperative RV to aortic pressure ratio was  $0.49 \pm 0.15$  for concomitant repair group vs  $0.50 \pm 0.15$  for delayed repair group ( $P = .81$ ), respectively. Actuarial overall survival was  $95\% \pm 2\%$ ,  $90\% \pm 3\%$ ,  $86\% \pm 4\%$  and  $78\% \pm 6\%$  at 1, 5, 10, and 15 years, respectively, with no difference between the two groups (log-rank  $P = .93$ ). At a median follow-up of 8.1 years (range, 0.1-19.5 years) for the concomitant repair group vs 11.2 years (range, 0.7-16.1 years) for the delayed repair group, no differences in RVFAC and RVGLS were observed (RVFAC =  $41.0\% \pm 6.2\%$  vs  $41.2\% \pm 7.6\%$ ,  $P = .91$ ; RVGLS =  $-18.7 \pm 4.3$  vs  $-18.9 \pm 4.0$ ,  $P = .87$ ).

**Conclusions:** 83% of patients with PA/VSD/MAPCAs underwent complete repair, with an intraoperative average RV pressure ~50% systemic. Delayed VSD closure can be successfully accomplished in 50% of the patients initially deemed unsuitable for repair. No differences in survival, mid-term RVFAC, and RVGLS were observed between concomitant and delayed VSD closure.





3:00 PM

Room 305

**DEBATE: Vascular Ring Surgery**

*Open Technique: Carl L. Backer, Chicago, IL*

*Thoracoscopic Technique: Kristine Guleserian, Miami, FL*

**COMMERCIAL RELATIONSHIPS** C. L. Backer: Consultant/Advisory Board, W. L. Gore & Assoc

3:20 PM

**Discussion**

1:30 PM – 3:30 PM

Room 315

**General Thoracic: Lung Cancer I***Moderators: Robert E. Merritt, Columbus, OH, and Betty C. Tong, Durham, NC*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures, including a debate, and a brief question-and-answer session after each topic.*

1:30 PM

**Factors Associated With New Persistent Opioid Use After Lung Resection**

**A.A. Brescia<sup>1</sup>, C. A. Harrington<sup>2</sup>, A. Mazurek<sup>1</sup>, S. Ward<sup>1</sup>, J. Lee<sup>1</sup>, H. Hu<sup>1</sup>, P.A. Lagisetty<sup>1</sup>, C. M. Brummett<sup>1</sup>, J. F. Waljee<sup>1</sup>, K. H. Lagisetty<sup>1</sup>**

<sup>1</sup>University of Michigan, Ann Arbor, <sup>2</sup>Oregon Health & Science University, Portland

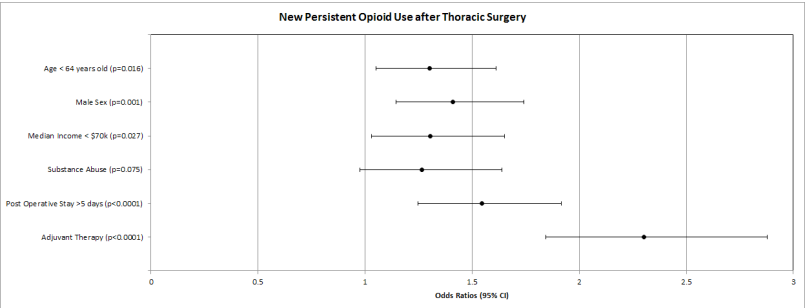
**COMMERCIAL RELATIONSHIPS** C. M. Brummett: Research Grant, National Institute on Drug Abuse, National Institutes of Health, Michigan Department of Health and Human Services, University of Michigan; Consultant/Advisory Board, Tonix; Other Research Support, Neuros Medical

**Purpose:** Opioid dependence, misuse, and abuse in the United States continue to rise. Prior studies indicate an important risk factor for persistent opioid use includes elective surgical procedures, though the probability following thoracic procedures remains unknown. We analyzed the incidence and factors associated with new persistent opioid use after lung resection.

**Methods:** We evaluated data from opioid naïve cancer patients undergoing lung resection between January 2010 and June 2014 using insurance claims drawn from the Truven Health MarketScan database, which encompasses more than 100 health plans in the United States. New persistent opioid use was defined as continued opioid prescription fills between 90 and 180 days following surgery. Variables found to have  $P < .05$  by univariable analysis chi-square testing were selected for inclusion in a multivariable binary logistic regression analysis performed for risk adjustment. Multivariable results were reported with odds ratio (OR) and confidence interval (CI) for each.

**Results:** A total of 3026 patients (44.8% male, 55.2% female) were opioid naïve and underwent lung resection. Mean age was 64 years  $\pm$  11 years and mean postoperative length of stay (LOS) was 5.2 days  $\pm$  3.3 days. 6.5% (196/3026) underwent neoadjuvant therapy, while 21.7% (657/3026) underwent adjuvant therapy. Among opioid naïve patients, 14% (424/3026) continued to fill opioid prescriptions following lung resection. Multivariable binary logistic regression showed that age  $< 64$  years (OR 1.3, CI 1.05-1.61;  $P = .016$ ), male sex (OR 1.4, CI 1.14-1.74;  $P = .001$ ), median income  $< \$70,000$  (OR 1.3, CI 1.03-1.65;  $P = .027$ ), postoperative LOS (OR 1.5, CI 1.25-1.92;  $P < .0001$ ), and adjuvant therapy (OR 2.3, CI 1.84-2.88;  $P < .0001$ ) were independent risk factors for persistent opioid use (Figure).

**Conclusions:** Persistent opioid use (14%) following lung resection is as prevalent as other postoperative complications, including atrial fibrillation. Adjuvant therapy and postoperative LOS were the two greatest risk factors for persistent use. Future studies should elucidate whether surgical procedure (open vs video-assisted thoracoscopic surgery) and specific adjuvant therapies mediate these associations.



1:45 PM

Room 315

**The Thoracic Surgeon's Role in the Opioid Epidemic***David T. Cooke, Sacramento, CA*

2:00 PM

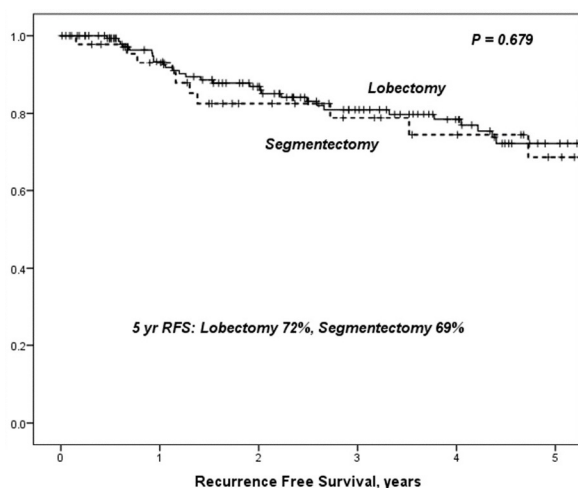
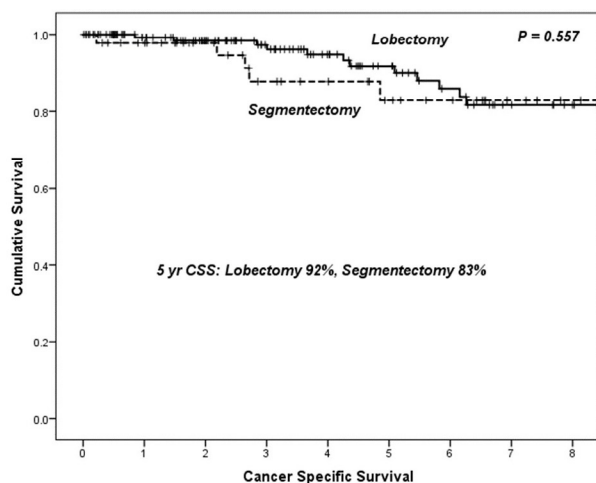
**Segmentectomy Is Equivalent to Lobectomy in Hypermetabolic Clinical Stage IA Lung Adenocarcinomas***M. K. Kamel, M. Rabouma, P. J. Kneuert, J. E. Jurado, B. E. Lee, S. W. Harrison, A. Nasar, B. M. Stiles, N. K. Altorki, J. Port**New York-Presbyterian Hospital, Weill Cornell Medical College, NY***COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest, Angiocrine Bioscience, Nanocyte; B. M. Stiles: Employment, Pfizer - wife employed by Pfizer; Consultant/Advisory Board, Merck

**Purpose:** Recent studies suggested that lobectomy and segmentectomy are associated with equivalent oncologic outcomes, particularly for small, peripheral, subsolid nodules. However, for hypermetabolic nodules (associated with higher rates of nodal disease/recurrence/mortality), the optimum procedure has never been evaluated. We hypothesize that for hypermetabolic cT1N0-adenocarcinoma, lobectomy and segmentectomy have comparable oncologic outcomes.

**Methods:** A prospectively collected single-institution database was queried for patients with clinical stage IA lung adenocarcinoma who underwent lobectomy or segmentectomy (2000-2016) for hypermetabolic tumors (SUVmax  $\geq 3$  g/dl). To obtain balanced groups of patients undergoing lobectomy and segmentectomy, a propensity-matching analysis was done (1:4, caliper 0.2, controlling for age, gender, percent FEV1, comorbidity index, cT-stage, and tumor SUVmax). Demographics, clinical, and pathological data were reviewed. Recurrence-free survival (RFS) and cancer-specific survival (CSS) were estimated using the Kaplan-Meier method and differences compared using log-rank test.

**Results:** 1380 patients with clinical stage IA adenocarcinoma underwent resection in the study period. 414 patients (30%) had hypermetabolic tumors (SUVmax  $\geq 3$  g/dl). Patients were propensity matched (4:1) (lobectomy, n=156; segmentectomy, n=46). The adequacy of matching was ascertained by the lack of statistical differences in the demographics and clinical characteristics between the patients in the two groups (Table). Although statistically not significant, patients undergoing lobectomy had a higher rate of pathological nodal upstaging (17% vs 7%,  $P = .085$ ) and overall pathological upstaging (38% vs 26%,  $P = .143$ ), compared to those who had segmentectomy. Also, lobectomy had a statistically significant higher median number of lymph nodes (LN) resected compared to segmentectomy (14 [8-17] vs 7 [4-11],  $P < .001$ ). There were no differences in 5-year RFS (72% vs 69%,  $P = .679$ ), nor in 5-year CSS (92% vs 83%,  $P = .557$ ) between patients who underwent lobectomy and segmentectomy, respectively (Figure).

**Conclusions:** Our data show that lobectomy and segmentectomy are comparable oncologic procedures for carefully (PET-CT) staged cT1N0 lung adenocarcinoma patients with hypermetabolic tumors (SUVmax  $\geq 3$  g/dl). While a lobectomy was associated with a more thorough LN dissection, this did not translate into a higher rate of RFS or CSS compared to a segmentectomy.



Demographic and Clinical Data	Lobectomy (n= 156 )	Segmentectomy (n= 46 )	P value
Age (years)	72 (66-79)	75 (66-78)	0.666
Gender (Female)	90 (58%)	25 (54%)	0.687
Comorbidity index (Charlson) $\geq 2$	40 (26%)	16 (35%)	0.224
FEV1 (%)	80 (68-98)	79 (51-100)	0.819
Clinical tumor size (cm)	2 (1.5-2.4)	2 (1.5-2.5)	0.877
Clinical T			
T1a	92 (59%)	27 (59%)	0.973
T1b	64 (41%)	19 (41%)	
PET SUV max	5.1 (3.8-7.4)	5.1 (3.6-7.5)	0.887

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Room 315

### Does the Use of Incentive Spirometry in Addition to Physiotherapy Reduce Postoperative Pulmonary Complications in the Thoracic Population? A Randomized Controlled Trial

P. R. Malik<sup>1</sup>, C. Fahim<sup>1</sup>, J. Vernon<sup>2</sup>, P. Thomas<sup>1</sup>, C. J. Finley<sup>1</sup>, C. Schieman<sup>3</sup>, Y. D. Shargall<sup>1</sup>, F. Farrokhyar<sup>1</sup>, W. C. Hanna<sup>1</sup>

<sup>1</sup>McMaster University, Hamilton, Canada, <sup>2</sup>University of Toronto, Canada, <sup>3</sup>University of Calgary, Canada

**COMMERCIAL RELATIONSHIPS** C. Fahim: Research Grant, Intuitive Surgical; W. C. Hanna: Research Grant, Intuitive Surgical

**Purpose:** Incentive spirometry (IS) is thought to reduce the incidence of postoperative pulmonary complications (PPC) after lung resection. The purpose of this trial was to determine whether the addition of IS to standard physiotherapy following lung resection results in a lower rate of PPC, as compared to standard physiotherapy alone.

**Methods:** A single-blind, parallel, prospective randomized controlled trial was conducted at a tertiary center for thoracic oncology. Adults undergoing lung resection were eligible to participate. Individuals who had previous lung surgery or who were on home oxygen were excluded. Participants randomized to the control arm (PHY) received standard physiotherapy alone, which included deep breathing and shoulder exercises. Those in the intervention arm (PHY/IS) received IS in addition to standard physiotherapy. The trial was powered to detect a 10% difference in the rate of PPC (beta=80%). Student's t-test and chi-square were utilized for continuous and categorical variables, respectively, with significance level of  $P = .05$ .

**Results:** A total of 389 participants (n=194 PHY; n=195 PHY/IS) were randomized between August 2014 and March 2017. Baseline characteristics were comparable for both arms, and there were no significant differences in diffusing capacity of the lungs for carbon monoxide ( $P = .28$ ), FEV1 ( $P = .41$ ), history of chronic obstructive pulmonary disease ( $P = .71$ ), or smoking status ( $P = .85$ ). The majority of patients in both arms underwent a pulmonary lobectomy (PHY 60.1%, PHY/IS 59.5%,  $P = .79$ ), with no difference in the rates of minimally invasive and open procedures (PHY 34% open vs PHY/IS 32% open,  $P = .52$ ). There were no significant differences in the incidence of overall PPC at 30 days postoperatively (PHY 18%, PHY/IS 14.7%,  $P = .38$ ). Specifically, there were no differences in the incidence of pneumonia (PHY 7.7%, PHY/IS 4.6%,  $P = .20$ ), use of mechanical ventilation (PHY 1.0%, PHY/IS 2.1%,  $P = .41$ ), home oxygen (PHY 15.0%, PHY/IS 13.8%,  $P = .76$ ), hospital length of stay (PHY 4.8 days, PHY/IS 5.0 days,  $P = .59$ ), or rate of readmission to hospital (PHY 9.8%, PHY/IS 10.3%  $P = .89$ ).

**Conclusions:** The addition of IS to standard postoperative physiotherapy does not reduce the incidence of PPC after lung resection.

2:30 PM

Room 315

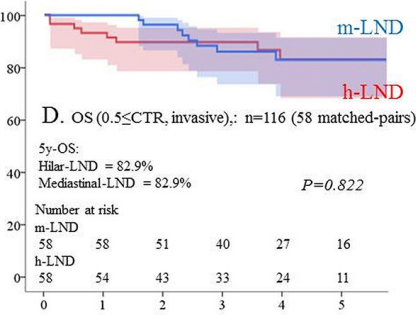
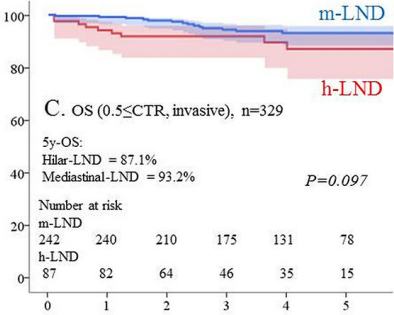
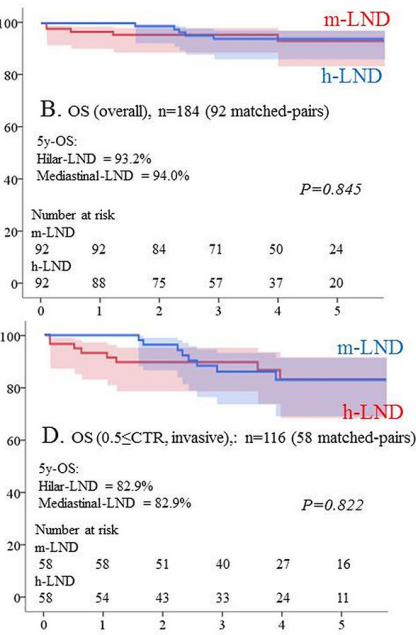
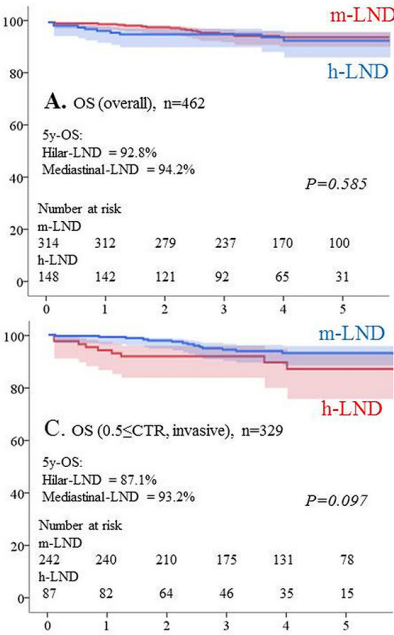
**Prognostic Impact of the Extent of Lymph Nodal Dissection in Clinical Stage I Radiological Part-Solid Lung Adenocarcinoma: Propensity Score-Matched Analysis***A. A. Hattori, T. Y. Matsunaga, K. K. Takamochi, S. O. Oh, K. Suzuki**Juntendo University, Tokyo, Japan*

**Purpose:** Prognostic significance of lymph node dissection (LND) in resectable lung cancer is controversial. Unlike a radiological pure-solid lung cancer without any ground glass opacity (GGO) component, it is evident that the frequency of nodal metastasis in part-solid one is significantly lower, which is found only in 3%-5% despite the solid component size.

**Methods:** We reviewed 462 clinical stage I radiological part-solid lung adenocarcinoma patients who underwent lobectomy or segmentectomy with lymphadenectomy. Based on a consolidation tumor ratio (CTR), part-solid tumor was defined as a tumor with focal nodular opacity and GGO ( $0 < \text{CTR} < 1.0$ ), which were divided into two groups: GGO-dominant ( $0 < \text{CTR} < 0.5$ ) and Solid-dominant ( $0.5 \leq \text{CTR} < 1.0$ ). The extent of LND was classified into systematic/selective mediastinal-LND (m-LND) and hilar-LND only (h-LND). Prognostic impact of LND was assessed using multivariate analyses. Propensity score matching was applied to balance the assignments of the eligible patients using clinicopathological covariates. Survivals were calculated by Kaplan-Meier methods using log-rank test.

**Results:** The m-LND was performed in 314 (68%) and the h-LND in 148 (32%). Oncological outcomes were not significantly different between m-LND and h-LND (Figure A; 94.2% vs 92.8%,  $P = .585$ ), which were shown in 92 matched pairs (Figure B; 94.0% vs 93.2%,  $P = .845$ ) with a median follow-up period of 49 months. Cox proportional hazard model revealed SUVmax was an independently significant factor of the survival ( $P = .001$ ), but the extent of LND was not ( $P = .731$ ). Nodal involvement was found in 16, which was exclusive in Solid-dominant group (4.9%). A multivariate analysis revealed carcinoembryonic antigen (CEA) and SUVmax were significant predictors of nodal metastasis among the Solid-dominant group ( $P = .002$ , respectively). Among the 329 (71%) Solid-dominant lesions, however, the survivals were similar between m-LND and h-LND (Figure C; 93.2% vs 87.1%,  $P = .098$ ), which were proven in 58 matched pairs (Figure D; 82.9% vs 82.9%,  $P = .822$ ). Lung cancer recurrence has never been found in GGO-dominant lesion despite the extent of lymphadenectomy.

**Conclusions:** The extent of LND was not associated with the overall survival of GGO-dominant lung adenocarcinoma. Furthermore, it did not influence the prognosis even in Solid-dominant lesion by propensity-score analysis, which could be possibly omitted based on the findings on preoperative CEA, SUVmax, or frozen diagnosis of the lymph nodes.



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Room 315

## Spread Through Air Spaces Is a Prognostic Factor in Sublobar Resection of Non-Small-Cell Lung Cancer

S. S. Shiono, N. Yanagawa, M. M. Endo, K. K. Suzuki, K. K. Yarimizu, K. K. Hayasaka  
Yamagata Prefectural Central Hospital, Japan

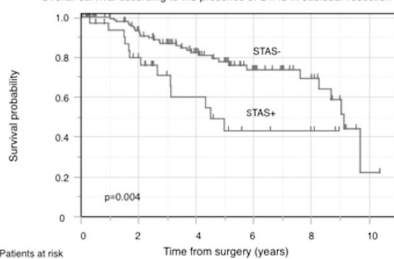
**Purpose:** Spread through air spaces (STAS) involves the presence of tumor clusters lying freely within the alveolar space microscopically. Because of short surgical margins, STAS might be a poor prognosticator in sublobar resections. The purpose of this study is to clarify the prognostic impact of STAS in sublobar resections.

**Methods:** We used our institution's prospectively collected patient database. From May 2004 to May 2017, a total of 1071 non-small-cell lung cancer (NSCLC) patients underwent a complete resection. After excluding cases with pure ground glass opacity, multiple lung cancers, or preoperative therapy, we studied 549 patients with clinical stage IA cancers. Lobectomies were performed in 353 patients and sublobar resections (segmentectomy or wedge resection) in 196 patients. TNM staging followed the classification in the 7th edition. We assessed the prognostic impact of STAS in the cases with a sublobar resection for stage IA lung cancer vs the cases with a lobectomy.

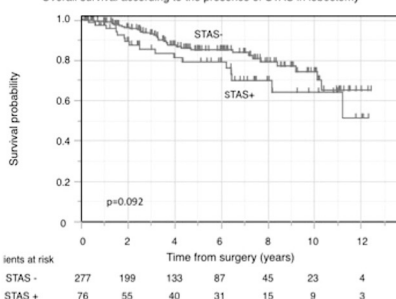
**Results:** STAS was found in 76 of 353 cases (21.5%) undergoing lobectomy and 32 of 196 cases (16.3%) undergoing sublobar resection ( $P = .137$ ). In the lobectomy vs the sublobar resection groups, overall 5-year survival was 83.7% and 70.9% ( $P = .001$ ), respectively. For overall survival, univariate analysis revealed STAS was not a significant prognostic factor in the lobectomy group ( $P = .106$ ), but it was significant for the sublobar resection group in both univariate ( $P = .009$ ) and multivariate ( $P = .013$ ) analyses. For the recurrence-free rate, multivariate analysis showed STAS was not a significant risk factor in the lobectomy group ( $P = .090$ ), but it was significant for the sublobar resection group in both univariate ( $P < .002$ ) and multivariate ( $P = .008$ ) analyses. In the lobectomy group, 12 of 76 cases with STAS developed locoregional recurrences (15.8%), but in the sublobar resection group, 12 of 32 cases with STAS (37.5%) developed locoregional recurrences ( $P = .026$ ).

**Conclusions:** STAS is a prognosticator of poor outcomes for sublobar resection in patients with NSCLC. We speculated that NSCLC with STAS tends to spread easily, and it is possible that sublobar resection may not get a sufficient surgical margin in NSCLC with STAS.

Overall survival according to the presence of STAS in sublobar resection



Overall survival according to the presence of STAS in lobectomy



3:00 PM

Room 315

**Synchronous Multiple Lung Adenocarcinomas: Surgery Yields Favorable Outcomes for Select Patients****Y. N. Zhang, H. I. Chen***Fudan University Shanghai Cancer Center, China*

**Purpose:** Synchronous multiple lung adenocarcinomas (SMLA) has been increasing due to the widespread computed tomography (CT) screening for lung cancer. However, there is no universally accepted treatment strategy for this disease. This study was aimed to investigate surgical efficacy for SMLA and define the predictors that affect tumor recurrence and overall survival.

**Methods:** We prospectively enrolled SMLA patients eligible for surgery. An individualized surgical program was performed for each patient based on comprehensive consideration of the CT feature, intraoperative frozen-section diagnosis, and patients' performance status.

**Results:** Between January 2008 and August 2016, 582 consecutive patients were included in this study. Patient demographics, tumor characteristics, and surgical procedures were closely related to three CT features: multifocal ground glass nodules (multi-GGN), one solid nodule plus one or more GGN (Solid-GGN), and multiple solid tumors (multi-Solid). The 5-year recurrence-free survival (RFS) rate was 88.5%, 51.8%, and 22.9%, respectively. The 5-year overall survival (OS) rate was 96.0%, 92.3%, and 39.0%, respectively. Multivariate analysis demonstrated that multi-Solid (HR=3.957, 95% CI, 1.533 to 10.22;  $P = .004$ ), dominant subtype (HR=5.198, 95% CI, 1.359 to 19.89;  $P = .016$ ), and pathologic N2 disease (HR=2.379, 95% CI, 1.256 to 4.506;  $P = .008$ ) were independent factors that affect tumor recurrence. Only multi-Solid was indicated as an independent predictor of poor OS (HR=20.54, 95% CI, 6.089 to 69.25;  $P < .001$ ) after adjusting all the survival-associated factors.

**Conclusions:** It is feasible to develop a surgical strategy that yields favorable outcomes for selective SMLA patients based on preoperative CT findings.

3:15 PM

Room 315

**Thoracoscopic Management of a Major Vascular Injury During Uniportal Video-Assisted Lingulectomy****R. Oliveira, A. Vieira, P.A. Ugalde***Institut Universitaire de Cardiologie et de Pneumologie de Québec, Canada*

**Purpose:** Vascular injury during video-assisted thoracoscopic surgery is an important cause of morbidity and conversion to thoracotomy. Thoracoscopic bleeding control and vascular repair are challenging and stressful procedures. This video demonstrates a pulmonary artery injury during a uniportal thoracoscopic left upper lobe anatomic segmentectomy managed without conversion to thoracotomy and acceptable blood loss.

**Methods:** A 72-year-old woman with a past history of an anatomic bisegmentectomy of the right lower and upper lobe for two synchronous early stage adenocarcinomas presented with a 3.9-cm left upper lobe partial-solid lesion suspicious for a new primary adenocarcinoma. The patient was scheduled for a uniportal thoracoscopic left upper lobe anatomic lingulectomy.

**Results:** During the dissection of the fissure with an energy device, a vascular injury occurred to the lower lobe pulmonary artery (PA). The bleeding was initially controlled through the uniportal access. Thereafter, an accessory 20-mm incision was performed to allow compression away from the working incision. Once the bleeding was under control, the oncologic resection could be performed without conversion to thoracotomy. A posterior PA branch was additionally divided for complete exposure of main PA. After the specimen was removed, the PA was clamped proximally and distally to the vascular injury. Primary repair was accomplished with two interrupted 4-0 Prolene sutures. Operative time was 180 minutes and total bleeding was 670 cc. There was no postoperative complication. Patient was discharged on postoperative day 3. Final pathology reported pT1aN0M0 adenocarcinoma. At 30-day follow-up, the patient was doing well.

**Conclusions:** Thoracoscopic control and primary repair of major PA injury is technically feasible.

1:30 PM – 3:30 PM

Room 316

**General Thoracic: Lung Transplantation***Moderators: Marcelo Cypel, Toronto, Canada, and Daniel Kreisel, St Louis, MO*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures, including a debate, and a brief question-and-answer session after each topic.*

1:30 PM

**Health Disparities in Lung Transplantation***Errol L. Bush, Baltimore, MD*

1:45 PM

**Lung Transplantation From Donors After Circulatory Death: Single Center and United States Experience**

*M.A. Villavicencio, A. A. Osbo, N. Roy, M. I. Funamoto, A. L. Todd, N. M. DalPozzal, S. E. Kilmarx, S. I. Melnitchouk, D. D'Alessandro, G. Tolis, Y. Raz, I. P. Neuringer, T. M. Sundt III*  
*Massachusetts General Hospital, Boston*

**Purpose:** Lung transplantation (LTx) from donors after circulatory death (DCD) have been scarcely used in the United States. Concerns about the warm ischemic injury, resource malutilization, and public scrutiny might be some of the factors involved. We sought to compare DCD with the donors before circulatory death (DBD) experience at our center and within the US.

**Methods:** The United Network for Organ Sharing Thoracic Transplant Database was queried for the US (1997-2016) and for our institution (2013-2016). DCD vs DBD survival was compared (Kaplan-Meier, log-rank). A Cox regression multivariate analysis of survival was performed for a total of 17 donor/recipient characteristics, including DCD utilization. Primary graft dysfunction metrics at 72 hours were compared in our institution.

**Results:** During this period, 244 out of 24,607 (1%) LTx were performed from DCDs in the US, and in our institution 14 out of 112 (12.5%). Five- and 10-year survival in DCD were  $75\% \pm 4\%$  and  $73\% \pm 4\%$ , respectively, and in DBD were  $63\% \pm 0.4\%$  and  $43\% \pm 0.5\%$ , respectively ( $P = .001$ ). In our institution, 1-year survival in DCD was  $82\% \pm 12\%$  and in DBD was  $98\% \pm 1\%$  ( $P = .839$ ). At 72 hours, PaFiO<sub>2</sub> ratio: DCD  $328 \pm 150$ , DBD  $363 \pm 152$  ( $P = .412$ ), intubation: DCD one (7%), DBD 28 (29%) ( $P = .110$ ), and extracorporeal membrane oxygenation: DCD zero (0%), DBD three (3%) ( $P = .507$ ). In Cox regression, DCD LTx was not associated with survival. Male gender and double lung transplant was associated with better outcome. Donor smoking more than 20 pack-years, pulmonary fibrosis, higher creatinine, high carbon dioxide, and ventilator support had worse prognosis.

**Conclusions:** DCD LTx remains underutilized in the US. Nevertheless, survival is comparable to DBD. Overall better survival in US univariate analysis suggests LTx are performed mainly in selected cases. Initial primary graft dysfunction metrics are encouraging.

2:00 PM

Room 316

**Predictors of Vocal Cord Dysfunction in Lung Transplantation Recipients**

**K. D. Joubert<sup>1</sup>, L. W. Schabeen<sup>2</sup>, R. C. Baird<sup>2</sup>, M. Tuff<sup>2</sup>, J. W. Hayanga<sup>2</sup>, J. D. Luketich<sup>2</sup>, J. D'Cunha<sup>2</sup>, N. Shigemura<sup>2</sup>**

<sup>1</sup>University of Arkansas, Little Rock, <sup>2</sup>University of Pittsburgh Medical Center, PA

**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, P&G; Research Grant, Accuray; Other, Elsevier Patent from University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor

**Purpose:** Pulmonary complications are increased following vocal cord dysfunction (VCD) from a variety of cardiothoracic surgical procedures. Vocal cord medialization (VCM) decreases pneumonia rates in many of these settings. The aim of this study was to establish the associated morbidity of vocal cord dysfunction (VCD) following lung transplantation (LTx).

**Methods:** A retrospective review of LTx recipients between December 2005 and July 2016 was performed at our institution. Data were obtained from the electronic medical record in conjunction with an established prospective lung transplant outcomes database. Dysphonia and/or signs and symptoms of dysphagia prompted otolaryngology consultation and subsequent direct laryngoscopy. Findings of paralysis, paresis, atrophy, or other pathology preventing apposition of the vocal folds were indications for vocal cord injection (VCI). Analysis of postoperative hospital length of stay (LOS), mechanical ventilation (MV) requirement, pulmonary complications, and in-hospital survival was performed.

**Results:** A total of 1092 LTx recipients were eligible for analysis. Common indications for LTx were chronic obstructive pulmonary disease, idiopathic fibrosis, and cystic fibrosis. Sixty-two patients (5.7%) were identified with VCD within the first 90 days post-LTx, and 35 underwent vocal cord injection (VCI). Left-sided vocal cord paralysis was present in 24 of these patients (68.6%). The incidence of VCD was related to intraoperative central venoarterial extracorporeal membrane oxygenation ( $P = .003$ ) and cardiopulmonary bypass ( $P = .002$ ). The difference in hospital mortality was not statistically significant when comparing patients with and without VCD. Of those patients who underwent VCI, an analysis of predictive factors associated with length of time to VCI was carried out. Linear regression of hospital LOS, ICU LOS, and mechanical ventilation duration were significantly related to timing of VCI and increased with each day to VCI ( $P = .038$ ,  $P = .042$ ,  $P = .022$ ). There were fewer readmissions for recurrent pneumonia in patients who underwent VCI; however, this did not reach statistical significance ( $P = .271$ ).

**Conclusions:** Higher rates of pulmonary complications were observed in LTx recipients diagnosed with VCD, and greater LOS and duration of MV was observed in the VCD group with increasing time to VCI. These data suggest that studies designed to test earlier intervention to reestablish laryngeal function are warranted.

2:15 PM

Room 316

**The Impact of Donor-Recipient Age Mismatch on Lung Transplantation Outcomes***D. J. Hall, E. I. Jeng, J. A. Gregg, A. F. Pelaez, M. E. Pipkin, T. M. Beaver, T. N. Machuca**University of Florida, Gainesville***COMMERCIAL RELATIONSHIPS** T. M. Beaver: Research Grant, Edwards Lifesciences

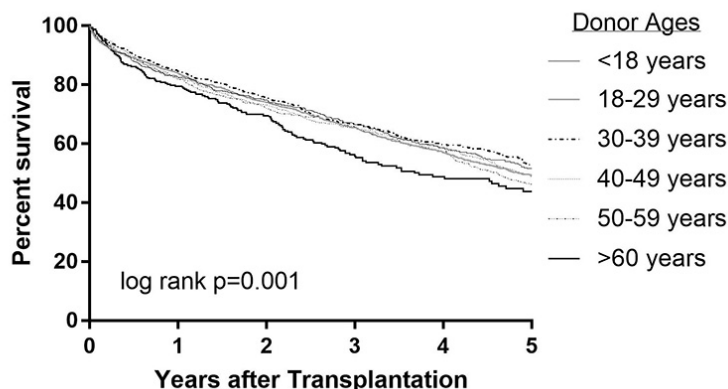
**Purpose:** The average age for lung transplant recipients and donors has increased over the last three decades. Despite these increasing ages, lung transplant outcomes continue to improve. The relationship between donor and recipient age and its effect on outcomes remain unclear and is investigated in the current study.

**Methods:** A retrospective review of the United Network for Organ Sharing Standard Transplant Analysis and Research Dataset was performed for the period between May 2005 and February 2015. All lung transplant recipients older than 18 years were included for analysis. Variables examined included donor age, recipient age, listing diagnosis, number of episodes of acute cellular rejection in the first year, and patient survival. Both donors and recipients were stratified according to the following age ranges: <18, 18-29, 30-39, 40-49, 50-59, and ≥60. Overall survival was estimated with the Kaplan-Meier analysis and compared with the log-rank test.

**Results:** During the period from May 2005 through February 2015, 15,844 patients underwent lung transplantation. Log-rank analysis for recipients aged 60-69 years old stratified by donor age range showed a statistically significant difference in survival (Figure,  $P = .001$ , matching donor age with recipient age provided the lowest survival). There were no significant differences in the other recipient age groups with regard to overall patient survival. The significantly decreased survival in the 60-69 years old recipient group receiving lungs from donors older than 60 years was not related to increased episodes of acute rejection or worse 1-year survival. Multivariate comparison and logistic regression identified multiple important covariates that may be relevant with regard to patient survival following lung transplantation (Table).

**Conclusions:** Our results show that the combination of donor and recipient age is important in lung transplantation. Specifically, for the growing population of recipients 60-69 years old, transplanting lungs from donors under 60 shows improved outcomes relative to other recipient ranges. Further studies are warranted to identify mechanisms behind such association.

## Survival for Lung Tx Recipients Aged 60-69 years



Covariate	Group	Comparison Group	Odds Ratio (95% Confidence Interval)	P value
Recipient Gender	Female	Male	0.945 (0.881, 1.013)	0.1122
Recipient Race	Black	White	1.088 (0.961, 1.231)	0.1821
	Other	White	0.815 (0.716, 0.927)	0.0019*
Recipient Age Group	18-29	30-39	1.591 (1.322, 1.916)	0.0001*
	40-49	30-39	1.123 (0.941, 1.340)	0.1978
	50-59	30-39	1.224 (1.034, 1.449)	0.0191*
	60-69	30-39	1.480 (1.248, 1.756)	0.0001*
	>70	30-39	1.719 (1.385, 2.132)	0.0001*
Recipient Body Mass Index	<18.5	18.5 to 25	1.212 (1.063, 1.382)	0.0041*
	25 to 30	18.5 to 25	1.028 (0.950, 1.112)	0.4868
	>30	18.5 to 25	1.189 (1.072, 1.318)	0.0010*
Recipient Diagnosis	COPD/Emphysema	Other diagnosis	1.120 (1.014, 1.238)	0.0258*
	Cystic Fibrosis	Other diagnosis	0.844 (0.712, 0.999)	0.0490*
	Primary Pulm HTN	Other diagnosis	1.279 (0.988, 1.655)	0.0616
	ILD/Pulm Fibrosis	Other diagnosis	0.978 (0.890, 1.075)	0.6479
Recipient Diabetes Status	Type 1	Not diabetic	1.200 (1.002, 1.438)	0.0476*
	Type 2	Not diabetic	1.102 (0.995, 1.221)	0.0632
Recipient Ventilator Pre-op	Yes	No	1.323 (1.154, 1.518)	0.0001*
Lung Allocation Score	30 to 60	0 to 30	1.058 (0.915, 1.224)	0.4449
	>60	0 to 30	1.056 (0.878, 1.270)	0.5619
Transplant Type	Single	Bilateral	1.440 (1.332, 1.558)	0.0001*
Retransplantation	Yes	No	1.929 (1.609, 2.313)	0.0001*
Cold Ischemia Time	>6 hours	0-6 hours	1.028 (0.950, 1.113)	0.4915
Donor Race	Black	White	1.140 (1.046, 1.244)	0.0030*
	Other	White	1.027 (0.940, 1.121)	0.5593
Donor Age Group	<18	30-39	1.163 (1.018, 1.329)	0.0264*
	18-29	30-39	1.042 (0.947, 1.148)	0.3994
	40-49	30-39	1.106 (0.991, 1.234)	0.0721
	50-59	30-39	1.191 (1.060, 1.338)	0.0032*
	>60	30-39	1.368 (1.145, 1.635)	0.0006*
D/R CMV Status	D+R+	D-R-	1.265 (1.141, 1.401)	0.0001*
	D-R+	D-R-	1.099 (0.982, 1.231)	0.0996
	D+R-	D-R-	1.326 (1.191, 1.476)	0.0001*
	Undetermined	D-R-	1.640 (1.380, 1.950)	0.0001*

2:30 PM

Room 316

# Physical Health-Related Quality of Life Decreases Significantly Over Time in Single Lung Transplant Recipients as Compared With Double Lung Transplant Recipients

D. M. Gilmore<sup>1</sup>, E. L. Grogan<sup>1</sup>, I. D. Feuer<sup>1</sup>, H. M. Hoy<sup>1</sup>, J. M. Barnes<sup>1</sup>, R. M. Park<sup>1</sup>, M. M. Via<sup>1</sup>, M. B. Staykov<sup>1</sup>, C. M. Shaver<sup>1</sup>, E. S. Lambricht<sup>2</sup>

<sup>1</sup>Vanderbilt University Medical Center, Nashville, TN, <sup>2</sup>Vanderbilt University, Nashville, TN

**Purpose:** While single (SLT) vs double lung transplantation (DLT) is associated with differences in short- and long-term morbidity and ethical considerations regarding organ allocation, effects of transplant type on patient-reported outcomes has not been widely reported. This study evaluates physical health-related quality of life (HRQOL) over time following SLT vs DLT.

**Methods:** Patients transplanted at a single institution were surveyed using the Short Form 36 Health Survey, with longitudinal physical component summary (PCS) scores as the primary outcome. Demographic and clinical data were extracted from the medical record. Multivariable mixed-effects models evaluated the effect of transplant type (SLT vs DLT) and time post-transplant (months) on longitudinal PCS scores after adjusting age, diagnosis, rejection, Lung Allocation Score quartile, and intubation duration (hours). The time by transplant type interaction effect tested whether temporal trajectories differed between SLT and DLT recipients, and PCS scores were referenced to general population norms (40-60).

**Results:** Postoperative surveys were available for 136 patients (71 male, 65 female; 23% SLT, 77% DLT) who underwent lung transplantation between 2005 and 2016. The mean age at transplant was 52 years  $\pm$  13 years and mean LAS score was 41.1  $\pm$  10.8. Follow-up time over 345 PCS measurement points averaged 31 months  $\pm$  27 months (range, 0.6 to 133 months). After adjusting for model covariates, tests of main effects indicated an overall downward long-term trajectory of post-transplant PCS scores ( $P < .001$ ) and no overall effect of SLT vs DLT ( $P = .760$ ). However, the statistically significant time by transplant type interaction effect ( $P = .002$ ) indicated that post-transplant single and double PCS trajectories differ. At 60 months, DLT recipients' long-term scores remain within general population norms, and those of SLT recipients drop below the minimally important difference threshold ( $\frac{1}{2}$  standard deviation) for HRQOL measures.

**Conclusions:** The trajectory of physical HRQOL declines in patients receiving SLT compared to DLT, indicating that, in the longer-term, SLT recipients are more likely to have physical HRQOL scores that fall substantively below general population norms. HRQOL after 5 years may be a consideration when choosing SLT or DLT.

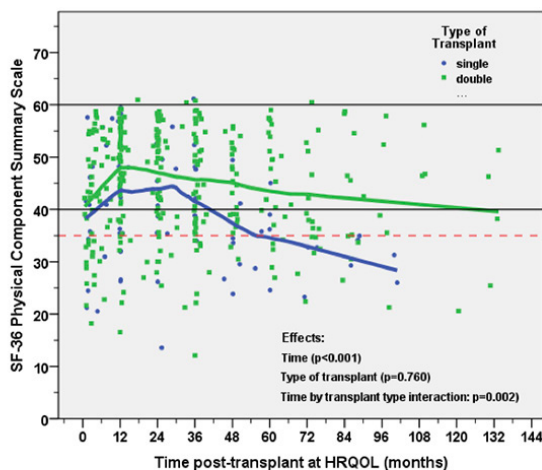


Figure 1. There is a significant effect of time by transplant type interaction with a downward trajectory of single lung transplant below the general population normal. The solid lines indicate standard deviation of population normal scores (40-60). The red dashed line represents the minimally important difference line ( $\frac{1}{2}$  SD threshold for HRQOL).

2:45 PM

Room 316

**Prevalence and Natural History of Barrett's Esophagus in Lung Transplant Recipients: A Single-Center Experience**

S. Biswas Roy<sup>1</sup>, P. N. Banks<sup>2</sup>, T. N. Masuda<sup>1</sup>, M. N. Kunz<sup>1</sup>, T. R. Ipsen<sup>3</sup>, S. K. Mittal<sup>1</sup>,  
M. A. Smith<sup>1</sup>, R. M. Bremner<sup>1</sup>

<sup>1</sup>Norton Thoracic Institute, St Joseph's Hospital and Medical Center, Phoenix, AZ, <sup>2</sup>Midwestern University, Glendale, AZ, <sup>3</sup>St Joseph's Hospital and Medical Center, Phoenix, AZ

**COMMERCIAL RELATIONSHIPS** M. A. Smith: Research Grant, Ethicon

**Purpose:** Barrett's esophagus (BE)—intestinal metaplasia in the esophagus—may progress to low-grade dysplasia (LGD), high-grade dysplasia (HGD), and ultimately, invasive esophageal adenocarcinoma (EAC). Progression to cancer of non-dysplastic BE is generally low: just 0.3%–0.4% annually. The course of BE in patients undergoing lung transplantation in the setting of immunosuppression is unknown.

**Methods:** We retrospectively reviewed the records of all patients who underwent lung transplantation at our center between January 1, 2010, and October 31, 2016 (n=466). All transplant candidates at our institution undergo a full foregut workup that includes esophagram, esophagogastroduodenoscopy (EGD), 24-hour pH monitoring, high-resolution manometry, and a gastric emptying study. Patients with BE diagnosed during the pre-transplant evaluation were included in the study. Patient demographics, development of dysplasia or EAC, findings of surveillance endoscopies, and treatment rendered were reviewed.

**Results:** Of the 466 patients who underwent transplantation during the study period, BE was identified on pre-transplant EGD in 33 patients (7.0%). Of these, one patient had HGD pre-transplant. The mean patient age was 63 years ± 9 years; 76% were men. Mean follow-up duration was 35 months ± 20 months. The mean interval for surveillance EGDs was 9 months ± 5 months. Antireflux surgery was performed post-transplant in 15/33 patients (45.4%). Three patients (9.4%; 3/32) developed LGD or EAC during post-transplant surveillance (Table). One patient was diagnosed with EAC (T1a, N0) 24 months post-retransplant. She was treated with endoscopic mucosal resection and radiofrequency ablation for subsequent HGD and remained dysplasia-free for 9 months but recently experienced recurrence of subepithelial intramucosal carcinoma. The other two patients experienced LGD 7 and 13 months after transplantation and were successfully treated with radiofrequency ablation.

**Conclusions:** BE seems more prevalent in these lung transplant recipients than in the general population. 3/32 patients (9.4%) with pre-transplant non-dysplastic BE developed LGD or EAC, suggesting that patients with BE have high risk of BE-to-EAC progression after lung transplantation. Serial surveillance EGD may identify dysplasia and adenocarcinoma in BE post-transplantation.

**Table 1.** Characteristics of patients with Barrett's esophagus who developed LGD or EAC post-transplantation.

Variable	Patient 1 (EAC)	Patient 2 (LGD)	Patient 3 (LGD)
Age, years	31	69	71
Sex	Female	Male	Male
Primary pulmonary diagnosis	BOS: graft failure	COPD	COPD
Follow-up, months	34	54	51
Surveillance endoscopies post-transplant (n)	13	5	5
Interval between BE diagnosis and dysplasia/EAC, months	36	7	13
Interval between transplant and dysplasia/EAC, months	24	6	12
Interval between transplant and antireflux surgery, months	1	16	-1
Treatment	EMR, RFA	RFA	RFA
Length of esophageal segment with BE*	Long	Short	Long
Pre-transplant reflux profile			
DeMeester score	120.2	41.4	34.9
Distal channel % time pH<4			
Total	7.4	10.1	7.4
Upright	7.2	13.4	9.9
Supine	92	3.1	3.8
Pre-transplant manometric profile			
LESP, mmHg	2.1	14.8	11.5
LES total length, cm	2	3.4	1.8
LES abdominal length, cm	0	2.9	0
Type of EGJ morphology	IIIa	I	IIIa
Median IRP, mmHg	0	5.9	0
Esophageal amplitude 7 cm above LES, mmHg	80.5	53	41.4
Esophageal amplitude 3 cm above LES, mmHg	76.2	41.8	47.7
Esophageal motility classification**	Normal	Normal	IEM
Survival, days	1,049	1,654	1,581

\*“Long” segment defined as portion of the esophagus of 3 cm or longer.

\*\*Classified according to Chicago Classification v3.0.

**Abbreviations:** BE, Barrett's esophagus; BOS, bronchiolitis obliterans syndrome; COPD, chronic obstructive pulmonary disease; EAC, esophageal adenocarcinoma; EGJ, esophagogastric junction; EMR, endoscopic mucosal resection; IEM, ineffective esophageal motility; LESP, lower esophageal sphincter resting pressure; LES, lower esophageal sphincter; LGD, low-grade dysplasia; IRP, integrated relaxation pressure; RFA, radiofrequency ablation.

3:00 PM

Room 316

### Traumatically Brain-Injured Donors and the Impact on Lung Transplant Survival: We Can Breathe a Sigh of Relief

T. C. Crawford<sup>1</sup>, X. N. Zhou<sup>2</sup>, J. T. Magruder<sup>1</sup>, C. N. Lu<sup>2</sup>, Y. N. Terasaki<sup>2</sup>, R. S. Higgins<sup>3</sup>, S. R. Broderick<sup>2</sup>, E. L. Bush<sup>1</sup>

<sup>1</sup>The Johns Hopkins Hospital, Baltimore, MD, <sup>2</sup>The Johns Hopkins University School of Medicine, Baltimore, MD, <sup>3</sup>The Johns Hopkins University School of Public Health, Baltimore, MD

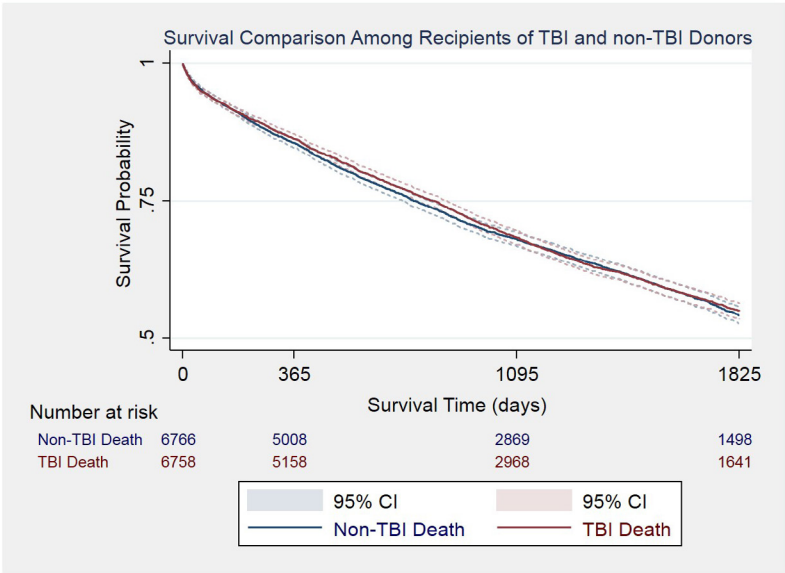
**COMMERCIAL RELATIONSHIPS** S. R. Broderick: Consultant/Advisory Board, Bristol Meyers Squibb

**Purpose:** Concern has been raised over inferior post-lung transplant survival associated with the use of traumatic brain injury (TBI) organ donors; however, most of this data has been limited to single-institution studies. Our purpose was to explore the relationship between TBI donors and lung transplant survival.

**Methods:** We queried the United Network for Organ Sharing Scientific Registry of Transplant Recipients and identified all adult ( $\geq 18$  years) lung transplants performed from May 4, 2005, to December 31, 2015. Recipients were dichotomized based on donor cause of death, TBI vs non-TBI, and then propensity scored and matched 1:1 without replacement based on eight variables: final Lung Allocation Score, pre-transplant ICU admission, pre-transplant extracorporeal membrane oxygenation, donor age  $\geq 50$  years, cytomegalovirus antibody recipient-/donor+, ischemia time, annual center transplant volume, and single vs double lung transplant. Our primary outcomes were survival at 1, 3, and 5 years. Survival was compared between groups by the Kaplan-Meier method.

**Results:** 17,610 patients underwent isolated lung transplant over the study period at 75 different transplant centers. TBI was the leading cause of death in the donor population: 8214 donors (47%). Average donor age was significantly lower in the TBI group vs other causes of death (28 years vs 40 years,  $P < .01$ ). Unadjusted survival analysis revealed a trend towards increased survival at 1 year in recipients of TBI donors (86% TBI vs 85% non-TBI, log-rank  $P = .09$ ), but not at 3 or 5 years. Propensity score matching generated 6782 well-matched donor TBI vs non-TBI pairs (all covariate  $P$  values  $> .2$ ). Risk-adjusted survival was similar between recipients of TBI donors vs non-TBI donors at 1 year (86% vs 86%, log-rank  $P = .27$ ), 3 years (68% vs 68%, log-rank  $P = .47$ ), and 5 years (55% vs 54%, log-rank  $P = .40$ ) (Figure).

**Conclusions:** In the largest analysis of TBI donors and the impact on lung transplant survival to date, we found similar survival out to 5 years in lung transplant recipients of TBI vs non-TBI donors, alleviating concerns over continued transplantation with this unique donor population.



3:15 PM

**Ex-Vivo Lung Perfusion: Current Status**

*Pablo Sanchez, Seattle, WA*

1:30 PM – 3:30 PM

Room 304

### International Symposium: Confronting Infectious Diseases in Young Adults Undergoing Cardiac Surgery

As increasing numbers of young adults are treated for infectious heart disease (especially as a result of the current opioid epidemic), there are practice gaps in relation to both the ethics of repetitively operating on opioid addicts for infectious heart disease, as well as the optimal approaches for carrying out cardiac surgical procedures on young adults afflicted with such disease. By providing an international perspective on the surgical treatment of infectious heart disease, the symposium will give learners valuable insights into related cardiac surgical strategies utilized in a range of different countries and different scenarios.

#### Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe optimal approaches for conducting a variety of cardiac surgery procedures on young adults
- Explain central challenges involved in treating infectious heart disease in the young adult population
- Discuss ethical and disease management dilemmas implicated in the treatment of infectious heart disease in young adults

**Moderator:** Juan P. Umaña, Bogotá, Colombia

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are professionalism, medical knowledge, and patient care and procedural skills. These physician competencies will be addressed through a series of lectures and case-based presentations on the treatment of infectious diseases in young adult cardiac surgery patients.*

**1:30 PM Introduction**

**1:40 PM The Scope of Repairing Infective Mitral Valves in the Current Era**  
*Taweesak Chotivatanapong, Nonthaburi, Thailand*

**1:55 PM The Impact of Mechanical Support in Infectious Diseases**  
*Enrico R. Ferrari, Lugano, Switzerland*

**2:10 PM Repairs of the Bicuspid Aortic Valve on the Prognosis of Infected Young Adults**

*Joseph E. Bavaria, Philadelphia, PA*

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc

**2:25 PM A Case of Endocarditis With Neurological Complications**  
*Michele De Bonis, Milan, Italy*

**2:45 PM Redo Transcatheter Interventions for Failing Repairs**  
*Enrico R. Ferrari, Lugano, Switzerland*

**3:00 PM      Diagnosis and Treatment of Thrombosis Affecting the Left and Right Side Valves**

*Darshan Reddy, Durban, South Africa*

**3:15 PM      Diagnosis and Treatment of Aortic Infection Prostheses**

*Joseph S. Coselli, Houston, TX*

**COMMERCIAL RELATIONSHIPS** J. S. Coselli: Ownership Interest, Vascutek; Research Grant, Bolton Medical, Medtronic, Vascutek, W. L. Gore & Assoc; Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc

1:30 PM – 3:30 PM

Rooms 301-302

**SVS @ STS: Sharing Common Ground for Cardiovascular Problems**

Many cardiac surgeons continue to incorporate the care of patients with vascular disease into their practices, while many vascular surgeons are now treating pathology that previously was purely in the domain of cardiovascular surgeons. This session from STS and the Society for Vascular Surgery will offer topics relevant to both fields and provide each perspective.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Formulate a plan based on published data and expert recommendations for the management of malperfusion in the setting of type A dissection
- Describe the current state of open and endovascular repair of thoracoabdominal aneurysms

**Moderators:** Keith R. Allen, Sioux City, IA, and Ali Azizzadeh, Houston, TX

**COMMERCIAL RELATIONSHIPS** A. Azizzadeh: Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of collaborative lectures by members of The Society of Thoracic Surgeons and the Society for Vascular Surgery.*

1:30 PM

**Introduction**

1:35 PM

**What Cardiac Surgeons Can Learn From Vascular Surgeons**

Alan B. Lumsden, Houston, TX

**COMMERCIAL RELATIONSHIPS** A. B. Lumsden: Other, Siemens Imaging

2:20 PM

**Discussion**

2:30 PM

**Type A Aortic Dissection With Malperfusion: Initial Management From a Cardiac Surgeon's Perspective**

Wilson Y. Szeto, Philadelphia, PA

**COMMERCIAL RELATIONSHIPS** W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices

- 2:40 PM**      **Type A Aortic Dissection With Persistent Malperfusion Following Repair: Vascular Surgery Options**  
*Joseph V. Lombardi, Camden, NJ*  
**COMMERCIAL RELATIONSHIPS** J. V. Lombardi: Research Grant, Cook Medical  
**REGULATORY DISCLOSURE** This presentation describes the use of the Cook dissection stent, which has an FDA status of investigational.
- 2:50 PM**      **Discussion**
- 3:00 PM**      **Thoracoabdominal Aneurysm: Pearls for Successful Open Repair**  
*Hazim J. Safi, Houston, TX*
- 3:10 PM**      **Discussion**
- 3:20 PM**      **Branched Endografting Techniques in the Arch and Thoracoabdominal Aorta**  
*Adam W. Beck, Birmingham, AL*

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**3:30 PM – 4:15 PM**

**BREAK—Visit Exhibits and Scientific Posters**

*Complimentary coffee available in the Exhibit Hall*

4:15 PM – 5:15 PM

Floridian Ballroom A

**Adult Cardiac: VAD Transplant/ECMO***Moderators: Brett C. Sheridan, San Francisco, CA, and Ibrahim Sultan, Pittsburgh, PA*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and videos and a brief question-and-answer session after each topic.*

4:15 PM

**Risk Factors for All-Cause Mortality Following Post-Cardiotomy Venoarterial Extracorporeal Membrane Oxygenation: Analysis of the STS Adult Cardiac Surgery Database**
**C. L. Taroila<sup>1</sup>, M. Hamidi<sup>1</sup>, B. A. Yerokun<sup>2</sup>, S. N. Zhang<sup>2</sup>, M. Brennan<sup>2</sup>, M. Rueß, D. Nagpal<sup>1</sup>**
<sup>1</sup>London Health Sciences Center, Canada, <sup>2</sup>Duke University, Durham, NC, <sup>3</sup>University of Ottawa Heart Institute, Canada

**COMMERCIAL RELATIONSHIPS** M. Rueß: Research Grant, Abbott, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Abbott, Medtronic

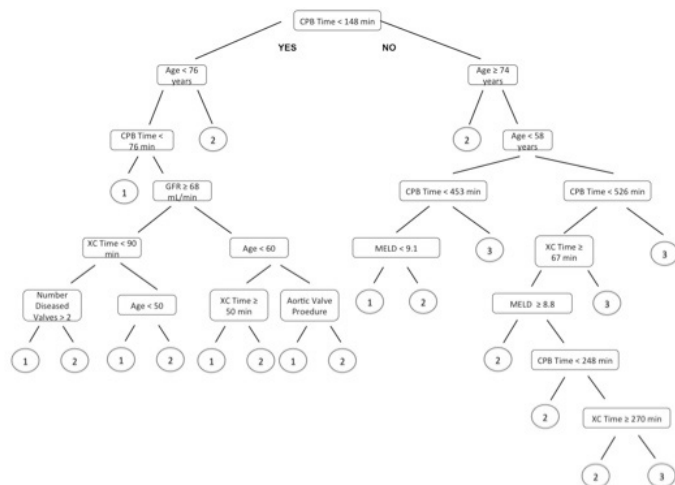
**Purpose:** Venoarterial extracorporeal membrane oxygenation (VA-ECMO) is required postoperatively in 0.5%-1.5% of cardiac surgical cases and carries a considerable risk of morbidity and mortality. We evaluated the risk factors for morbidity and mortality in the post-cardiotomy VA-ECMO patient population to develop a clinically relevant risk prediction model.

**Methods:** Using the STS Adult Cardiac Surgery Database, we identified all adult patients who underwent open cardiac surgery procedures, excluding heart transplantation, requiring postoperative VA-ECMO between 2014 and 2016. Univariate analysis identified key variables that could contribute to postoperative morbidity (8-variable composite: deep sternal wound infection, renal failure, stroke, prolonged postoperative ventilation, reoperation for bleeding/valvular dysfunction/graft occlusion/other) and mortality. After multivariable adjustment for potential confounders, we isolated variables correlating with survival to hospital discharge and composite morbidity. We developed a risk prediction model for discharge disposition among survivors (home, extended/nursing home care, or other acute care facility).

**Results:** We identified 1701 patients, 583 female (34.3%), who required post-cardiotomy VA-ECMO, of whom 730 (42.9%) survived to discharge. Mean [SD] age was 61 [13.6] years. Univariate analysis revealed age, glomerular filtration rate, cardiopulmonary bypass (CPB), and cross-clamp (XC) time, model for end-stage liver disease (MELD) score, number of red blood cell (RBC) transfusions, need for preoperative resuscitation, emergent surgery, and presence of peripheral vascular disease as correlates of mortality. After multivariable adjustment, CPB time, MELD score, age, and number of RBC transfusions remained statistically significant correlates of mortality (Table). Multivariable adjustment for a composite morbidity demonstrated XC time, preoperative balloon pump insertion, and MELD score as predictors of morbidity (Table). Recent coronary bypass surgery, higher

baseline ejection fraction, and nonemergent case status reduced the likelihood of morbidity (Table). A decision tree demonstrating factors correlating with discharge disposition is given in the Figure.

**Conclusions:** The decision to initiate post-cardiotomy VA-ECMO is dependent upon patient and clinical presentation factors. We have identified key patient and procedural characteristics predictive of hospital morbidity and mortality, as well as correlates of patient discharge disposition, in order to assist with the decision to pursue VA-ECMO in the post-cardiotomy setting.



CPB, cardiopulmonary bypass time; GFR, glomerular filtration rate; XC, Cross-Clamp; MELD, model for end-stage liver disease.

**Figure 1:** Decision tree identifying discharge destination based on patient demographic and operative risk factors. Destination 1: home; 2: extended care/nursing home; 3: other acute care facility. Leftward paths identify a “yes” decision, rightward paths identify a “no” decision.

**Table:** Adjusted odds ratios for demographic and operative variables that correlate with post-cardiotomy VA-ECMO mortality and composite morbidity.

Outcome	Odds Ratio	95% Confidence Interval	p-value
<b>Mortality</b>			
CPB Time (min)	1.004	1.001, 1.01	0.005
MELD Score	1.05	1.02, 1.08	< 0.001
Age	1.02	1.02, 1.03	0.001
No. intraoperative RBC transfusions	1.05	1.01, 1.08	0.009
<b>Morbidity</b>			
XC Time (min)	1.02	1.01, 1.02	< 0.001
Coronary Bypass Surgery	0.65	0.48, 0.88	0.005
Ejection Fraction	0.99	0.98, 0.99	0.002
Tricuspid Valve Surgery	3.01	1.05, 8.66	0.041
Pre-operative IABP	3.17	1.39, 7.25	0.006
Non-emergent Status	0.34	0.14, 0.85	0.021
MELD Score	1.14	1.08, 1.20	< 0.001

\*CPB, cardiopulmonary bypass time; MELD, model for end-stage liver disease; RBC, red blood cell; XC, cross-clamp; IABP, intra-aortic balloon pump

4:27 PM

Floridian Ballroom A

**Predictors of Early and Mid-Term Outcomes After Bridge to Left Ventricular Assist Device by Extracorporeal Life Support***D. A. Tsyganenko, E. V. Potapov, F. C. Kaufmann, V. Falk, T. N. Krabatsch, F. Schönrrath**Heart Institute Berlin, Germany***COMMERCIAL RELATIONSHIPS** V. Falk: Research Grant, Boston Scientific, HeartWare; Speakers Bureau/Honoraria, Edwards Lifesciences, Abbott

**Purpose:** The purpose of this study was to evaluate predictors of early and mid-term outcomes after bridge to left ventricular assist device (VAD) by extracorporeal life support.

**Methods:** Between 2012 and 2016, 574 patients were supported at our institution with an implantable long-term continuous-flow VAD. Of these, 100 received implantation while on extracorporeal life support (ECLS), which had been installed in accordance with our institutional policy. Severe neurological deficits and evident hepatic failure are excluding criteria for VAD support. We retrospectively analyzed data collected before LVAD implantation using multivariate analysis and compared patients regarding survival.

**Results:** The mean age was 53.6 years  $\pm$  11.7 years, 68 male; mean time on ECLS was 6.2 days  $\pm$  4.9 days. Thirty-one patients were resuscitated before and 78 were still on respirator at the time of VAD implantation. The 30-day and 1-year survival after VAD implantation was 61.3% and 41.1%, respectively. In 33 patients, a temporary right ventricular assist device (tRVAD) was necessary postoperatively. The predictors for 30-day mortality were older age (OR 1.05 [95% CI 1.01-1.1],  $P = .0178$ ), body mass index  $>30$  kg/m<sup>2</sup> (OR 3.1 [CI 1.15-8.79],  $P = .0278$ ), and need for tRVAD. The need for tRVAD remained a sole predictor for 6-month mortality (OR 2.89 [CI 1.12-7.43],  $P = .028$ ).

**Conclusions:** LVAD implantation from ECLS remains high-risk surgery. Biventricular failure carries additional risk for mortality.

4:39 PM

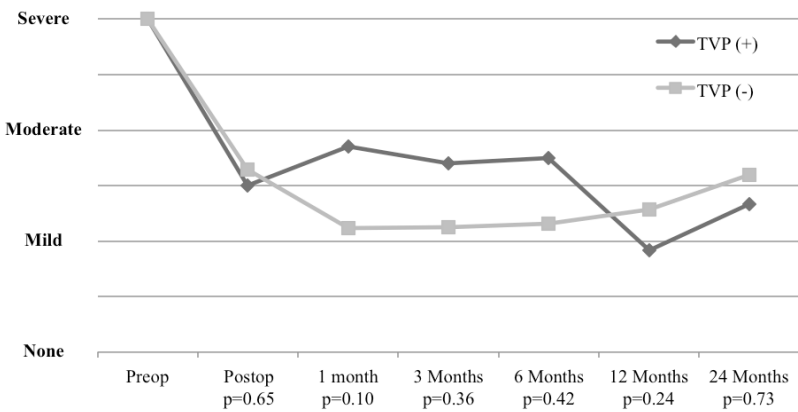
Floridian Ballroom A

**Mini-Access Central Extracorporeal Membrane Oxygenation Cannulation***Ashok N. Babu, Nashville, TN***REGULATORY DISCLOSURE** This presentation describes the off-label use of ECMO circuitry for longer than the 6-hour approval.

4:51 PM

**Severe Tricuspid Valve Regurgitation in Patients Who Undergo Continuous-Flow Left Ventricular Assist Device Implantation: Concomitant Tricuspid Valve Procedures Do Not Reduce Recurrence of Regurgitation or Improve the Rate of Survival***A. C. Critsinelis, C. Kurihara, M. Kawabori, T. T. Sugiura, G. N. Loor, M. Ono, A. B. Civitello, R. M. Delgado III, L. N. Simpson, J. K. George, S. B. Oberton, A. P. Nair, H. O. Frazier, J. A. Morgan**Texas Heart Institute/Baylor College of Medicine, Houston***COMMERCIAL RELATIONSHIPS** G. Loor: Ownership Interest, Synaptic Design; Research Grant, Transmedics; T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott**Purpose:** This study was designed to analyze whether there was a clinical benefit associated with performing a concomitant tricuspid valve procedure (TVP) in patients with preoperative severe tricuspid regurgitation (TR) who underwent continuous-flow left ventricular assist device (CF-LVAD) implantation.**Methods:** Between November 2003 and March 2016, 526 patients with end-stage heart failure underwent primary implantation of a CF-LVAD at our center. We reviewed patients with preoperative severe TR at the time of implantation to determine the effect of performing a TVP. Overall survival, perioperative complications, and short- and long-term postoperative echocardiogram data were compared between patients who underwent a TVP vs those patients who did not undergo a concomitant TVP at the time of LVAD implantation.**Results:** Fifty-nine patients had preoperative severe TR. Fourteen of those underwent concomitant TVPs, including tricuspid valve repair and tricuspid valve replacement. Patients with TR had a significantly lower survival rate and a higher incidence of postoperative right heart failure than did patients without TR ( $P = .04$  and  $P = .005$ , respectively). Cox proportional hazard analysis demonstrated TR to be an independent predictor of mortality (hazard ratio 1.57, 95% confidence interval 1.03-2.41,  $P = .03$ ). Patients with TR who underwent a TVP had a lower 30-day readmission rate ( $P = .002$ ) than patients who did not, but no significant differences were observed in the rate of postoperative TR, incidence of right heart failure, or rate of survival between these patient groups ( $P = .65$ ,  $P = .26$ , and  $P = .51$ , respectively). Echocardiography up to 2 years postoperatively did not reveal any significant difference in recurrence of TR in those who did and did not undergo TVP (Figure).**Conclusions:** Our data suggest a lack of clinical benefit associated with performing a concomitant TVP for patients with severe TR undergoing LVAD implantation.

### Postoperative Tricuspid Regurgitation



5:03 PM

Floridian Ballroom A

### Combined Heart-Kidney and Heart-Liver Transplantation Provide Improved Immunoprotection of the Cardiac Allograft

A. S. Chou<sup>1</sup>, A. Habertbeuer<sup>2</sup>, A. A. Chin<sup>1</sup>, I. Sultan<sup>3</sup>, M. A. Acker<sup>4</sup>, M. L. Williams<sup>1</sup>,  
C. A. Bermudez<sup>1</sup>, P. Vallabhajosyula<sup>1</sup>

<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>Hospital of the University of Pennsylvania, Perelman School of Medicine, Philadelphia, <sup>3</sup>University of Pittsburgh, PA, <sup>4</sup>University of Pennsylvania Medical Center, Philadelphia

**Purpose:** Combined heart-liver and heart-kidney transplants are increasingly being performed. It is well known that liver and kidney allografts are more tolerogenic than cardiac allografts. We studied whether simultaneous transplantation of liver or kidney in patients undergoing heart transplantation confers improved immunoprotection to the cardiac allograft.

**Methods:** The United Network for Organ Sharing database for heart transplantation was retrospectively queried from 1987 to 2015 and stratified into three groups by patients undergoing heart-liver (HLT; n=192), heart-kidney (HKT; n=1174), and isolated heart (HT; n=61,471) transplantation. Preoperative and perioperative data were compared between HT vs HLT and HT vs HKT groups using ANOVA (continuous) and chi-square test (categorical). Cox regression method was used to determine predictors of improved freedom from immunologic rejection and mortality due to allograft failure. Kaplan-Meier method was used to assess long-term survival.

**Results:** HKT patients were older (51.2 years  $\pm$  13.4 years) compared to HLT (46.0 years  $\pm$  15.4 years;  $P < .0001$ ) and HT (45.6 years  $\pm$  19.2 years;  $P < .0001$ ) patients, with higher rate of diabetes (33.8% vs 10.4% vs 14.8%;  $P < .0001$ ) and dialysis (49.7% vs 6.3% vs 2.1%;  $P < .0001$ ). HKT (46.2%) and HLT (49.5%) patients had more urgent need for transplantation (status 1A), compared to HT (32%;  $P < .0001$ ). Ten-year actuarial survival was similar between HT (53.6%), HKT (56.7%;  $P = .13$ ), and HLT (60.4%;  $P = .09$ ). Treatment for immunologic rejection during the first post-transplant year was significantly lower in HLT (2.1%) and HKT (8.43%) compared to HT (17.4%;  $P < .0001$  for both). Cardiac allograft survival was significantly improved in HLT ( $P = .018$ ) and HKT ( $P = .014$ ) patients. Incidence of re-transplantation was lower in HLT (0%;  $P < .01$ ) and HKT (0.6%;  $P < .01$ ) groups compared to HT (3%). Cox regression analysis showed that HLT (HR 0.51, CI 0.41-0.64) and HKT (HR 0.63, CI 0.58-0.68) were associated with improved freedom from immunologic rejection (Figure).

**Conclusions:** Combined heart-liver and heart-kidney transplantation are safe with equivalent postoperative outcomes as isolated heart transplantation. Combined liver or kidney transplantation prolongs cardiac allograft survival via protection from immune-mediated rejection. It will be important to understand why this benefit does not translate to improved long-term survival compared to isolated heart transplantation.

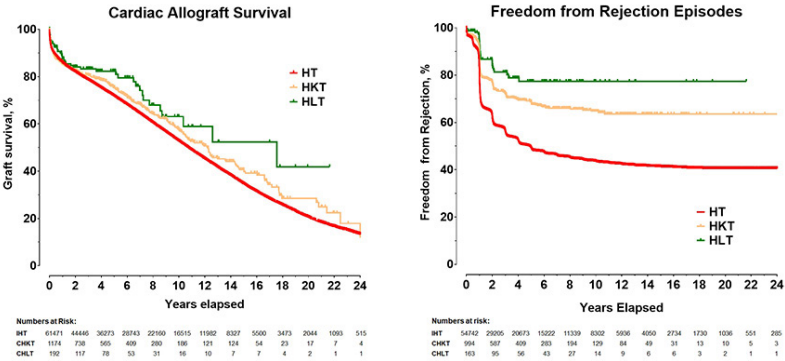


Figure 1. Long-term cardiac allograft survival and freedom from rejection episodes are shown for HT, HKT, and HLT groups.

Table 1: Post-Operative Graft Follow-up and Adverse Events

		IHT		CHKT		CHLT	
				p		p	
Patient Survivals (percents)							
	30-day	93.9		95.2		95.2	
	1-year	86.5		85.5		87.5	
	3-year	79.4		80.4		82.6	
	5-year	72.8		75.2		81.6	
	10-year	53.6		56.7		60.4	
	Median Survival (years)	10.9		11.8	0.13	12.6	0.09
Graft Survivals							
	30-day	93.5		95.0		95.2	
	1-year	86.0		85.3		87.5	
	3-year	78.5		80.5		83.3	
	10-year						
	5-year	71.7		75.3		82.3	
	Median Survival (years)	10.7		12.2	0.018	17.6	0.014
Acute Rejection (Prior to Discharge)		7.1%		5.8%	0.08	3.1%	0.03
Treated for Rejection Within 1 Year		17.4%		8.4%	<0.0001	2.1%	<0.0001
Later Re-transplanted		3.0%		0.6%	<0.0001	0.0%	0.01
Graft Failure							
	Primary Non-function	2.2%		1.6%	0.15	0.5%	0.11
	Acute Rejection	1.3%		0.4%	0.007	0.0%	0.11
	Chronic Rejection	2.5%		0.9%	0.0006	0.0%	0.03
	Unknown	1.5%		1.9%	0.29	0.0%	0.09
Cause of Death due to Graft Failure, % of deaths		15.3%		6.9%	<0.0001	2.4%	0.02

4:15 PM – 5:15 PM

Room 315

**Ethics Debate: Neighborly Help or Itinerant Surgery?**

There is a growing trend of cardiothoracic surgeons operating at remote hospitals. However, postoperatively, these patients are sometimes left in the care of surgeons who are not trained in cardiothoracic surgery. According to the American College of Surgeons, this is unethical. The central question of this Ethics Debate is whether any level of training other than completed cardiothoracic surgical training is acceptable for providing postoperative care when the operating surgeon is not available.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the requirements for postoperative care when the operating surgeon is not available
- Structure outreach cardiac surgical programs in a way that is ethically acceptable
- Discuss the ethical boundaries for surgery in remote locations

*Facilitator: Robert M. Sade, Charleston, SC*

*Pro – General Surgeon Postoperative Coverage Is Acceptable: James S. Allan, Marblehead, MA*

*Con – Only Thoracic Surgeon Postoperative Coverage Is Acceptable: Alberto Ferreres, Buenos Aires, Argentina*

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, interpersonal and communication skills, practice-based learning and improvement, and professionalism. These physician competencies will be addressed through a debate and questions from the audience.*

4:15 PM – 5:15 PM

Room 305

**Research Using the STS National Database**

The STS National Database is a valuable tool for both quality improvement and research, and research utilizing the Database has grown exponentially in recent years. Still, many researchers may not be familiar with the different methods available for performing such research. This session will cover several Database-related research programs, including the new Participant User File (PUF) Research Program. In addition, speakers will discuss opportunities to pursue funded research using STS National Database data.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the process for creating a data request to access data from the STS National Database for research
- Discuss the differences between major data requests and minor data requests
- Explain the process of developing a hypothesis, specific aims, and a research plan
- Discuss research options for longitudinal follow-up or linking to other registries
- List available options, rules, and policies for obtaining investigator access to de-identified patient-level data for analysis at their own institutions

*Moderator: Felix G. Fernandez, Atlanta, GA*

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*The physician competencies addressed in this session are medical knowledge and professionalism. These physician competencies will be addressed through a series of lectures on research methods. Questions from the audience and a panel discussion will augment these physician competencies.*

**4:15 PM Introduction to STS Research**

*Felix G. Fernandez, Atlanta, GA*

**4:20 PM PUF Research Program: Policies and Procedures**

*Kevin W. Lobdell, Charlotte, NC*

**COMMERCIAL RELATIONSHIPS** K. W. Lobdell: Consultant/Advisory Board, Medtronic

**4:28 PM PUF Research Program: Early Experience**

*Robert H. Habib, Chicago, IL*

**4:36 PM Investigator Experience With the PUF Research Program**

*Malcolm M. DeCamp, Chicago, IL*

**COMMERCIAL RELATIONSHIPS** M. M. DeCamp: Consultant/Advisory Board, Boston Scientific, Holaira, Intuitive Surgical

**4:43 PM Access and Publications Research Program**

*Jeffrey P. Jacobs, St Petersburg, FL*

**4:51 PM Longitudinal Follow-Up and Linked Registries Research Program**

*Matthew L. Williams, Philadelphia, PA*

**5:01 PM Panel Discussion**

4:15 PM – 5:15 PM

Rooms 220-221

**STS Key Contacts: Advocates for Cardiothoracic Surgery**

One way that cardiothoracic surgeons can have a direct impact on federal policy affecting the specialty is by participating in the STS Key Contact program, which offers grassroots advocacy opportunities. This session will explain how the program works, discuss the current health care debate, and describe how STS-PAC enhances these advocacy efforts. In addition, experienced Key Contacts will role-play a meeting with a member of Congress, the Key Contact of the Year and other awards will be announced, and attendees will be able to socialize and network.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe how to meet or speak with their members of Congress
- Discuss the Society's legislative priorities
- Explain how to utilize their peer Key Contacts as resources

*Moderator: Madeleine Stirling, Washington, DC*

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*The physician competencies addressed in this session are interpersonal and communication skills and professionalism. These physician competencies will be addressed through individual lectures, panel discussions, and role playing.*

**4:15 PM      Key Contacts Overview**  
*Madeleine Stirling, Washington, DC*

**4:25 PM      STS-PAC Overview**  
*Frederick L. Grover, Aurora, CO*  
**COMMERCIAL RELATIONSHIPS** F. L. Grover: Consultant/Advisory Board, Somhalution

**4:35 PM      Health Care Debate**  
*Stephen J. Lahey, Ipswich, MA*

**4:50 PM      Mock Congressional Meeting**  
*Malini P. Daniel, Philadelphia, PA, and Keith A. Horvath, Washington, DC*

4:15 PM – 5:15 PM

Room 316

**The Annals Academy: Preparation and Interpretation of National Database Research**

The publication of research using national databases has risen exponentially over the past decade. Unfortunately, common methodological mistakes are made when preparing manuscripts and interpreting the results from published manuscripts. This session will address common limitations and errors made with national database research.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Explain the difference between association and causality in observational research
- Explain the difference between statistical and clinical significance in large databases
- Describe common performance metrics for multivariable modeling
- Discuss options for merging STS National Database data with other longitudinal databases to obtain long-term outcomes

**Moderator:** Benjamin D. Kozower, St Louis, MO

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*The physician competencies addressed in this session are interpersonal and communication skills. These physician competencies will be addressed through individual lectures and panel discussions as they pertain to presenting data in a manuscript.*

4:15 PM

**Introduction**

Benjamin D. Kozower, St Louis, MO

4:20 PM

**Using the STS National Database in Longitudinal Follow-Up**

Mark W. Onaitis, La Jolla, CA

4:35 PM

**Common Pitfalls of Observational Database Research**

Graham A. Colditz, St Louis, MO

4:50 PM

**Incorporating Long-Term Outcomes and Patient-Reported Outcomes into the STS National Database**

Benjamin D. Kozower, St Louis, MO

5:05 PM

**Panel Discussion**

4:15 PM – 5:15 PM

Rooms 301-302

**! The Importance of Physician Documentation in Reimbursement**

This session will address how physician documentation drives reimbursement. Attendees will learn how to efficiently and effectively capture the key aspects of patient encounters to accurately communicate why a service was provided, define the services rendered, support the medical necessity, and capture relevant quality elements for an encounter. The session also will highlight the increasing importance of creating an active partnership between cardiothoracic surgeons and hospitals to enable maximal reimbursement for both.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Identify the documentation necessary to support relevant diagnoses, services rendered, medical necessity, and quality measures for a patient encounter
- Describe how hospitals utilize physician documentation for reimbursement
- Explain the role that diagnosis coding plays in hospital reimbursement (CC and MCC)
- Recognize the importance of specificity and identification of services provided in a patient encounter
- Identify coding and reimbursement criteria so that they can identify and capture relevant documentation elements efficiently
- List the global periods relevant to cardiothoracic surgical procedures and the implications those global periods have on reimbursement

**Moderators:** *Francis C. Nichols, Rochester, MN, and Scott C. Silvestry, Orlando, FL*

**COMMERCIAL RELATIONSHIPS** S. C. Silvestry: Consultant/Advisory Board, Abbott, Medtronic; Other, Medtronic, Proctor

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*The physician competencies addressed in this session are interpersonal and communication skills and professionalism. These physician competencies will be addressed through lectures and demonstrations about physician documentation and reimbursement. A question-and-answer session will augment these competencies.*

4:15 PM

**Reimbursement Overview**

*Scott C. Silvestry, Orlando, FL*

4:30 PM

**Documentation for Medical Necessity and Diagnoses**

*V. Seenu Reddy, Nashville, TN*

**COMMERCIAL RELATIONSHIPS** V. S. Reddy: Consultant/Advisory Board, Acelity, Medtronic

4:45 PM

**Documentation for Services Rendered**

*Sanjay A. Samy, Albany, NY*

4:55 PM

**Summary: Putting It All Together**

*Francis C. Nichols, Rochester, MN*

5:05 PM

**Q&A**

4:15 PM – 5:15 PM

Floridian Ballroom D

## Women in Thoracic Surgery: How to Successfully Implement Surgical Innovations and New Technologies Into Practice

A growing number of new technologies are becoming available in cardiothoracic surgery to improve quality of care, reduce costs, and/or improve treatment. The introduction of innovations and cutting-edge technologies by established surgeons or recent trainees can pose problems in institutions not familiar with these newer surgical techniques. This session will cover the important aspects relevant to the successful introduction and use of surgical innovations in a health system and practice.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe the framework of privileging and credentialing as it pertains to new technology
- Discuss the importance of monitoring outcomes
- State strategies to identify multidisciplinary partners in developing or augmenting service lines that would benefit from new technology
- Recognize their need for new technology acquisition

*Moderator: Shanda H. Blackmon, Rochester, MN*

**COMMERCIAL RELATIONSHIPS** S. H. Blackmon: Ownership Interest, Boston Scientific; Consultant/Advisory Board, Dexter; Other Research Support, Medtronic; Other; Boston Scientific, Patent co-developing for esophageal anastomotic device

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*The physician competencies addressed in this session are medical knowledge, patient care and procedural skills, and practice-based learning and improvement. These physician competencies will be addressed by lectures and a panel discussion on successfully integrating new technologies into surgical practice.*

4:15 PM

### Introduction

*Shanda H. Blackmon, Rochester, MN*

**COMMERCIAL RELATIONSHIPS** S. H. Blackmon: Ownership Interest, Boston Scientific; Consultant/Advisory Board, Dexter; Other Research Support, Medtronic; Other; Boston Scientific, Patent co-developing for esophageal anastomotic device

4:20 PM

### Privileging, Credentialing, and Monitoring of New Technology

*Shanda H. Blackmon, Rochester, MN*

**COMMERCIAL RELATIONSHIPS** S. H. Blackmon: Ownership Interest, Boston Scientific; Consultant/Advisory Board, Dexter; Other Research Support, Medtronic; Other; Boston Scientific, Patent co-developing for esophageal anastomotic device

4:40 PM

### Developing Multidisciplinary Partnerships to Facilitate Approval for New Technology

*David T. Cooke, Sacramento, CA*

5:00 PM

### Q&A

5:15 PM – 6:30 PM



Scientific Posters and Wine

*Floridian Ballroom Lobby*

5:30 PM – 6:30 PM

Business Meeting (STS Members Only)

*Room 316*

6AM	6:30 AM – 4:30 PM Registration							
7AM								
8AM	7:30 AM – 8:30 AM Meet the Experts Sessions				7:30 AM – 8:30 AM Health Policy Forum			
9AM	9:00 AM – 3:30 PM Exhibit Hall		9:00 AM – 5:00 PM Scientific Posters		9:00 AM – 10:00 AM Thomas B. Ferguson Lecture			
10AM								
11AM	10:45 AM – 11:00 AM Award Presentations							
	11:00 AM – 12:00 PM C. Walton Lillehei Lecture							
12PM	12:00 PM – 1:00 PM Residents Luncheon 							
1PM	1:00 PM – 3:00 PM						1:00 PM – 5:30 PM	
	Adult Cardiac General	Adult Cardiac: Mitral and Tricuspid Valves	Congenital: Pediatric Congenital II	EACTS @ STS	STS/ISHLT Joint Symposium	General Thoracic: Lung Cancer II	General Thoracic: Mediastinal/Pulmonary	Patient Safety Symposium 
2PM								
3PM								
4PM	3:30 PM – 4:30 PM Cardiothoracic Surgical Education		3:30 PM – 5:30 PM					
			Adult Cardiac: Aorta II	Adult Cardiac: Aortic Valve/Novel Technologies	Advanced Therapies for End-Stage Cardiopulmonary Disease	Congenital: Pediatric Congenital III	ESTS @ STS	General Thoracic: Esophageal
5PM	4:30 PM – 5:30 PM Quality Improvement							
6PM								
7PM								
8PM								
9PM								

6:30 AM – 4:30 PM	Registration
9:00 AM – 3:30 PM	Exhibit Hall
9:00 AM – 5:00 PM	Scientific Posters
7:30 AM – 8:30 AM	Meet the Experts Sessions
7:30 AM – 8:30 AM	Health Policy Forum
9:00 AM – 10:00 AM	Thomas B. Ferguson Lecture
10:45 AM – 11:00 AM	Award Presentations
11:00 AM – 12:00 PM	C. Walton Lillehei Lecture
12:00 PM – 1:00 PM	 Residents Luncheon
1:00 PM – 3:00 PM	Adult Cardiac: General
	Adult Cardiac: Mitral and Tricuspid Valves
	Congenital: Pediatric Congenital II
	EACTS @ STS: Bicuspid Aortic Valve Repair With Aortic Valve Insufficiency and Proximal Aortic Aneurysm Repair
	 STS/ISHLT Joint Symposium: LVAD Therapy in 2018—Worldwide Perspectives
	General Thoracic: Lung Cancer II
	General Thoracic: Mediastinal/Pulmonary
1:00 PM – 5:30 PM	 Patient Safety Symposium: Biases and Errors—Why We Do What We Do
3:30 PM – 4:30 PM	Cardiothoracic Surgical Education
3:30 PM – 5:30 PM	Adult Cardiac: Aorta II
	Adult Cardiac: Aortic Valve/Novel Technologies
	Advanced Therapies for End-Stage Cardiopulmonary Disease
	Congenital: Pediatric Congenital III
	ESTS @ STS: Controversial Issues in General Thoracic Surgery—Perspectives From Europe and North America
	General Thoracic: Esophageal
4:30 PM – 5:30 PM	Quality Improvement

6:30 AM – 4:30 PM

Atrium Lobby, First Floor

**Registration**

7:30 AM – 8:30 AM

Various locations; see below

**Meet the Experts Sessions**

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The physician competencies addressed in these sessions are patient care and procedural skills, medical knowledge, practice-based learning and improvement, professionalism, and systems-based practice. These physician competencies will be addressed through conversational lectures on the specific course topic.

**MEET THE EXPERTS SESSION 1**

Room 223

**Management of Esophageal Leaks**

This session will explore the diagnosis and management of esophageal leaks following surgical procedures. Through case examples and a panel discussion, attendees will be shown when conservative measures are appropriate and when reoperation is indicated.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe current data on the incidence of anastomotic leaks associated with esophagogastric resection
- Assess diagnostic modalities for identifying anastomotic leak or focal conduit necrosis
- Discuss the evolving pattern of treatment options for leaks and regional conduit necrosis
- Outline the short- and long-term ramifications of anastomotic leak following esophageal resection
- Discuss the presentation, diagnosis, and outcomes of esophageal leaks and fistula following surgical procedures

*Moderator: Michael J. Weyant, Aurora, CO*

*Panelists: Mark S. Allen, Rochester, MN, and Mark Orringer, Ann Arbor, MI*

**COMMERCIAL RELATIONSHIPS** M. S. Allen: Ownership Interest, Medtronic; Consultant/Advisory Board, Medtronic; Nonremunerative Position of Influence, Chair of STS Finance Committee, General Thoracic Surgical Club Executive Committee

7:30 AM

**Leaks Following Esophageal Resection**

*Donald E. Low, Seattle, WA*

7:40 AM

**Leaks and Fistulas after Benign Esophageal and Esophagogastric Procedures**

*Ross M. Bremner, Phoenix, AZ*

**COMMERCIAL RELATIONSHIPS** R. M. Bremner: Other, Ethicon, Endostim

**MEET THE EXPERTS SESSION 2****Room 113****Minimally Invasive and Robotic Mitral Valve Repair**

This session will explore patient selection issues and circulatory management strategies for different minimally invasive approaches to mitral valve repair. Additionally, experts will review postoperative care pathways through case examples and a panel discussion.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Discuss patient selection issues for different minimally invasive approaches
- Outline different circulatory management and myocardial protection strategies
- Describe when and how to convert to an open procedure
- Review postoperative care pathways to facilitate shorter length of hospital stay
- Discuss early and late outcomes for different minimally invasive approaches

*Panelists: Joseph A. Dearani, Rochester, MN, James S. Gammie, Baltimore, MD, and A. Marc Gillinov, Cleveland, OH*

**COMMERCIAL RELATIONSHIPS** J. S. Gammie: Ownership Interest, Edwards Lifesciences, Harpoon Medical; Consultant/Advisory Board, Edwards Lifesciences, Harpoon Medical

**MEET THE EXPERTS SESSION 3****Room 122****Universal Conundrums in ECMO: Tips and Tricks for Veno-Arterial ECMO in Cardiogenic Shock**

Venoarterial extracorporeal membrane oxygenation (ECMO) is an established platform that provides mechanical pulmonary and circulatory support for patients with cardiogenic shock from multiple etiologies refractory to standard medical therapy. ECMO, unlike definitive mechanical support systems, presents myriad unique therapeutic challenges that require optimization to advance the patient to the next management platform.

This session will focus on the major problems associated with ECMO through four clinical scenarios. An expert panel will delineate how the clinical challenges demonstrated by patients on ECMO are addressed regionally and internationally, and therapeutic tips will be presented for each management platform.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Identify methods of weaning a patient recovering from ventricular function off ECMO to recovery
- Describe methods for transitioning a patient from ECMO to a stable temporary or permanent platform
- Outline new technologies that can be utilized as adjuncts to the ECMO platform
- Discuss futility in the ECMO platform

**MEET THE EXPERTS SESSION 4****Room 222****Advanced Surgical Techniques in Ischemic Heart Disease**

This session will focus on advanced techniques in the surgical treatment of ischemic heart disease that routinely can be applied by practicing adult cardiac surgeons. Speakers will present their techniques and tips in a video-rich format, followed by a Q&A with the audience. Best practices in the management of diffuse coronary artery disease, arterial grafting, and off-pump coronary artery bypass grafting (CABG) surgery will be discussed in detail, with a focus on providing attendees with useful skills and technical tips that they can take home to their practices.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Identify the alternative techniques to revascularize a diffusely diseased coronary artery, including full metal jacket
- Recall surgical techniques of all-arterial grafting, including bilateral internal thoracic artery and radial artery combinations
- Explain how to do off-pump CABG safely, reliably, and precisely

**MEET THE EXPERTS SESSION 5****Room 123****How to Be Successful in a Small-to-Mid Size Congenital Heart Program**

Small-to-moderate sized congenital heart programs can be successful in achieving optimal outcomes for their patients, but their resources may be limited. This session will provide expert opinion from successful practitioners at small-to-moderate programs that will help attendees learn how to manage limited resources.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Compare patient complexity with program resources
- Identify the complex, high-risk patient that may overutilize scarce resources or require additional expertise not available
- Manage limited resources, including human resources, in order to maximize performance

**Moderator:** James S. Tweddell, Cincinnati, OH

**Panelists:** Petros V. Anagnostopoulos, Madison, WI, S. Adil Husain, San Antonio, TX, John L. Myers, Hershey, PA, and Joseph W. Turek, Iowa City, IA

**MEET THE EXPERTS SESSION 6****Room 118****End-Stage Heart Failure**

Mechanical circulatory support is a complex and evolving field. There are certain clinical scenarios for which diverging approaches exist within the ventricular assist device community. Examples include biventricular heart failure in destination therapy populations, left ventricular thrombus, recurrent ventricular dysrhythmias, patients with multiple prior sternotomies, existing mechanical aortic valves, and patients with a history of thrombophilia.

## Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe the best approaches for right ventricular performance assessment and the different options in managing right ventricular dysfunction following durable left ventricular assist device implantation
- Recall the implications, severity, and approaches to left ventricular thrombus in patients undergoing left ventricular assist device implantation, highlighting the limitations and merits of each
- Explain evidence suggesting adverse events associated with in situ mechanical aortic valves in patients undergoing left ventricular assist device implantation and different strategies that can be employed in this setting
- Describe the preoperative, intraoperative, and postoperative strategies to mitigate recurring arrhythmias in patients with refractory ventricular dysrhythmia
- Identify the different strategies employed in implantation procedures for patients with multiple sternotomies

**Moderators:** *Marzia Leacche, Grand Rapids, MI, Jay D. Pal, Aurora, CO, and John M. Stulak, Rochester, MN*

**COMMERCIAL RELATIONSHIPS** J. D. Pal: Consultant/Advisory Board, HeartWare

**Panelists:** *Jack G. Copeland, Redlands, CA, Yoshifumi Naka, New York, NY, Francis D. Pagani, Ann Arbor, MI, and Martin Strueber, Grand Rapids, MI*

## MEET THE EXPERTS SESSION 7

Room 119

### Management of the Small Aortic Root

Standard practice for aortic valve replacement (AVR) aims to use the largest possible valve without enlarging or replacing the root. The literature documents that small valves reduce life expectancy, but measures to alter or replace the aortic root have been underused and actively discouraged because of perceived (and actual) increase in risk. This session aims to identify patients who could benefit from more aggressive surgery and encourage development of the skills to do this safely.

## Learning Objectives

Upon completion of this activity, participants should be able to:

- Identify patients at risk for poor outcomes because of small aortic roots
- Explain when aortic root enlargement should be considered and its limitations
- Choose appropriate patients for aortic root replacement to avoid hemodynamic mismatch
- Discuss the importance of surgical valve size for future valve-in-valve options
- Select patients who might be best served by primary transcatheter AVR for hemodynamic reasons
- Describe the principles of sutureless AVR implantation and how to choose appropriate patients for this procedure

**Moderators:** *Michael J. Mack, Plano, TX, and Paul Stelzer, New York, NY*

**COMMERCIAL RELATIONSHIPS** M. J. Mack: Research Grant, Abbott, Edwards Lifesciences, Medtronic

7:30 AM

**Introduction**

7:35 AM

**Aortic Root Replacement***Paul Stelzer, New York, NY*

7:45 AM

**The Role of Aortic Annular Enlargement During Surgical Aortic Valve Replacement***Robert K. Salley, Lexington, KY*

7:55 AM

**The Current Role of TAVR in Aortic Root Procedures***Vinod H. Thourani, Washington, DC***COMMERCIAL RELATIONSHIPS** V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

8:05 AM

**Sutureless Valves***Kevin D. Accola, Orlando, FL***COMMERCIAL RELATIONSHIPS** K. D. Accola: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Edwards Lifesciences

8:15 AM

**Panel Discussion****MEET THE EXPERTS SESSION 8****Room 114****Minimally Invasive Esophageal and Pulmonary Procedures, Including Robotics and POEM**

This session will present novel ways to perform minimally invasive lung surgery robotically, posterior to anterior.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Choose ideal candidates for minimally invasive lung surgery
- Describe optimal methods to perform the posterior approach to minimally invasive surgery (MIS), anterior approach to minimally invasive surgery, minimally invasive esophagectomy, and esophageal-gastric anastomosis

7:30 AM

**MIS Robotic Lung Lobectomy***Robert J. Cerfolio, New York, NY***COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher

7:45 AM

**MIS VAD Lung Lobectomy***James D. Luketich, Pittsburgh, PA*

**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, P&G; Research Grant, Accuray; Other, Elsevier Patent from University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor

8:00 AM

**MIS Robotic Esophageal Resection***Robert J. Cerfolio, New York, NY*

**COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien Teacher

8:15 AM

**MIS VAD Esophagectomy***James D. Luketich, Pittsburgh, PA*

**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, P&G; Research Grant, Accuray; Other, Elsevier Patent from University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor



7:30 AM – 8:30 AM

**HEALTH POLICY FORUM****Rooms 220-221****The Changing Medicare Quality Reporting and Payment Landscape**

The Medicare Access and CHIP Reauthorization Act changed the way physicians are paid under the Medicare program. As the Centers for Medicare & Medicaid Services (CMS) works to implement provisions of the new policy over the next few years, cardiothoracic surgeons will need to stay apprised of changes in reporting requirements and performance benchmarks. At this session, attendees will learn how they can be successful under either aspect of the Medicare Quality Payment Program: the Merit-Based Incentive Payment System (MIPS) or Alternative Payment Models (APMs).

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- List new quality reporting requirements under MIPS
- State new advancing care information reporting requirements under MIPS
- Describe new clinical practice improvement reporting requirements under MIPS
- Recognize how to successfully participate in an APM that prioritizes value over volume of services
- Discuss what STS is doing to advocate for cardiothoracic surgeons participating in these programs

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and professionalism. These competencies will be addressed through a lecture focusing on the Merit-Based Incentive Payment System and Alternative Payment Models.*

**Moderator:** *Stephen J. Labey, Farmington, CT*

7:30 AM

**The Changing Medicare Quality Reporting and Payment Landscape Update**

*Robert Jasak, Washington, DC*

8:10 AM

**Panel Discussion**

*Robert Jasak, Washington, DC, Stephen J. Labey, Farmington, CT, and Courtney Yohe, Washington, DC*

9:00 AM – 3:30 PM

**Halls ABC, First Floor****Exhibit Hall**

9:00 AM – 5:00 PM

**Third Floor Concourse****Scientific Posters**

9:00 AM – 12:00 PM

Grand Ballroom

**General Session II***Moderators: Richard L. Prager, Ann Arbor, MI, and Joseph F. Sabik III, Cleveland, OH***COMMERCIAL RELATIONSHIPS** J. F. Sabik: Research Grant, Abbott; Consultant/Advisory Board, Medtronic

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*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and focused discussion on key points of presentations.*

9:00 AM **Thomas B. Ferguson Lecture**10:00 AM **BREAK—Visit Exhibits and Scientific Posters**10:45 AM **Award Presentations**11:00 AM **C. Walton Lillehei Lecture: The Philosophical Breakfast Club and the Invention of the Modern Scientist***Laura J. Snyder, New York, NY*

In 1812, four men at Cambridge University met for breakfast. What began as an impassioned meal grew into a new scientific revolution, in which these men—who called themselves “natural philosophers” until they later coined “scientist”—introduced four major principles into scientific inquiry. Award-winning author and former philosophy professor Laura J. Snyder will tell their intriguing story and show how medical science was transformed by their revolution.

12:00 PM – 1:00 PM

**BREAK—Visit Exhibits and Scientific Posters**

12:00 PM – 1:00 PM

Palm Ballroom A, Second Floor

 **Residents Luncheon**

1:00 PM – 3:00 PM

Room 315

**Adult Cardiac: General***Moderators: Kendra J. Grubb, Louisville, KY, and Jennifer S. Lawton, Baltimore, MD*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

1:00 PM

**Tricuspid Valve Reconstruction for Infective Endocarditis**

**F. Bakaeen**, J. L. Navia, E. G. Soltesz, D. R. Johnston, S. L. Mick, K. R. McCurry, N. G. Smedira, A. M. Gillinov, M. Z. Tong, L. G. Svensson, G. B. Pettersson  
Cleveland Clinic, OH

**COMMERCIAL RELATIONSHIPS** F. Bakaeen: Speakers Bureau/Honoraria, JACE Medical; A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure; D. R. Johnston: Ownership Interest, JACE Medical; Research Grant, Edwards Lifesciences; Consultant/Advisory Board, LivaNova, Abbott; E. G. Soltesz: Ownership Interest, JACE Medical; Speakers Bureau/Honoraria, Abbott, Abiomed, AtriCure; L. G. Svensson: Ownership Interest, Cardiosolutions; Other, Posthorax

**Purpose:** Opioid addiction is now a national epidemic, and the incidence of infective tricuspid valve (TV) endocarditis related to intravenous (IV) drug abuse is on the rise. This video outlines the technical aspects of a surgical strategy of valve debridement and reconstruction for a TV extensively damaged by infection.

**Methods:** Starting with a median sternotomy, a piece of autologous pericardium is harvested and kept moist. A right atriotomy is performed on an arrested heart, exposing the TV. Grossly infected and devitalized tissue is completely excised, preserving leaflet margins and cords if free of infection to act as a reference for reconstructive repair. Valve reconstruction is then undertaken with the general principles of using a generous piece of pericardium and polytetrafluoroethylene cords of appropriate length to avoid leaflet restriction or prolapse. The cords are tied after placing a slightly undersized annuloplasty band, with frequent saline testing to fine-tune their length.

**Results:** The video demonstrates a successful repair of the TV in a 29-year-old female with infective endocarditis related to IV drug abuse. The indication for surgery was persistent bacteremia, large valve vegetations, septic pulmonary emboli, and severe tricuspid regurgitation. The TV was extensively damaged by the infection, and thorough debridement necessitated excision of the septal and posterior leaflets in their entirety, as well as a portion of the anterior leaflet. The remaining part of the anterior leaflet acted as a reference for the subsequent repair. The valve was tested and found to be competent, and intraoperative transesophageal echocardiography after coming off cardiopulmonary bypass demonstrated trace tricuspid regurgitation and a 2-mm Hg gradient across the valve. The patient recovered well and was discharged to a skilled nursing facility to complete a 6-week course of IV antibiotics and rehabilitation. At 3 months, she was drug free, and imaging showed no regurgitation and improved lung function.

**Conclusions:** Extensive TV reconstruction is a useful option for IV drug users with severely damaged valves that avoids the challenges associated with the high risk of prosthetic valve infection and right heart failure associated with valve excision without replacement or reconstruction.

1:15 PM

Room 315

## Contemporary Surgical Management of Hypertrophic Cardiomyopathy in the United States

L. Wei<sup>1</sup>, J. S. Rankin<sup>1</sup>, M. Alkhouli<sup>2</sup>, D. Thibault<sup>2</sup>, B. A. Yerokun<sup>2</sup>, N. Ad<sup>3</sup>, H. V. Schaff<sup>4</sup>, N. G. Smedira<sup>4</sup>, H. Takayama<sup>5</sup>, T. Murashita<sup>1</sup>, P. M. McCarthy<sup>6</sup>, S. Vemulapalli<sup>7</sup>, V. H. Thourani<sup>8</sup>, G. Ailawadi<sup>9</sup>, J. P. Jacobs<sup>10</sup>, V. Badhwar<sup>1</sup>

<sup>1</sup>West Virginia University, Morgantown, <sup>2</sup>Duke University, Durham, NC, <sup>3</sup>Mayo Clinic, Rochester, MN, <sup>4</sup>Cleveland Clinic, OH, <sup>5</sup>Columbia University, New York, NY, <sup>6</sup>Northwestern University, Chicago, IL, <sup>7</sup>Duke Clinical Research Institute, Durham, NC, <sup>8</sup>Emory University, Atlanta, GA, <sup>9</sup>University of Virginia, Charlottesville, <sup>10</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL

**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; N. Ad: Ownership Interest, Left Atrial Appendage Occlusion; Consultant/Advisory Board, LivaNova, Medtronic, Nido Surgical; Speakers Bureau/Honoraria, AtriCure, LivaNova; P. M. McCarthy: Ownership Interest, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Medtronic; J. S. Rankin: Ownership Interest, BioStable Science and Engineering; Consultant/Advisory Board, AtriCure, BioStable Science and Engineering; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, Gore Vascular; S. Vemulapalli: Research Grant, Abbott Vascular

**Purpose:** Septal myectomy remains the primary surgical therapy for hypertrophic cardiomyopathy (HCM) with obstruction, although its role in contemporary US practice remains poorly defined. The STS National Database was analyzed to determine the current experience and surgical outcomes of myectomy with and without concomitant mitral operations.

**Methods:** From July 2014 through December 2016, 3452 septal myectomy operations were performed. Emergency status, endocarditis, aortic stenosis, and planned aortic valve operations were excluded. Concomitant coronary artery bypass grafting was included. In the final cohort of 2038 patients, 1315 (65%) received myectomy alone (Group 1), and 723 (35%) had myectomy with concomitant mitral operations (Group 2). Group 2 was further subdivided into mitral valve repair (MVR, n=425) and mitral valve replacement (MVR, n=298). Baseline characteristics were compared and logistic regression analyses evaluated risk-adjusted differences in the composite of operative mortality and morbidity between Groups 1 and 2, and also between MVR vs MVR.

**Results:** The median number of annual cases per center was two (range, 1-435). Baseline comorbidity was lower in Group 1 vs Group 2, as it was for MVR vs MVR (Table). In Group 2, MVR was performed in 60% of mitral operations (425/723). For patients with both pre- and postoperative echocardiograms, myectomy alone was effective in reducing preoperative 3-4+ mitral regurgitation (MR) in 86.5% (321/371), and MVR+myectomy was effective in 88.6% (156/176). MR grade worsened postoperatively in 8.1% (34/420) following myectomy alone, and in 2.3% (2/87) following MVR+myectomy. Operative mortality and major morbidity were lower for Group 1 vs 2 (1.5% vs 3.0%,  $P = .03$ ; and 10.6% vs 21.4%,  $P < .001$ , respectively). Pacemakers and ventricular septal defects were rare in all. Following risk adjustment, the odds ratio for composite mortality and morbidity was significant for Group 2 vs Group 1 at 1.91 [1.4-2.5] ( $P < .0001$ ), but not significant for MVR vs MVR at 1.43 [0.9-2.2] ( $P = .0991$ ).

**Conclusions:** Septal myectomy is a safe treatment for HCM. There is a near doubling of risk when concomitant mitral operations are required. Myectomy alone and mitral repair may provide effective MR reduction in select cases, but further longitudinal analyses are required to define therapeutic efficacy and outcomes in selected risk groups.

Variable	Group 1 (65%) (N = 1,315)	Group 2 (18%) (n=723)	p-value	MVr (60%) (n=425)	MVR (40%) (n=298)	p-value
Median Age [25 <sup>th</sup> -75 <sup>th</sup> ]	57 [47-66]	61 [52-70]	<0.0001	58 [48-66]	66 [57-75]	<0.0001
Male (%)	51.1	44.3	0.0033	52.5	32.6	<0.0001
Elective Status (%)	92.0	84.4	<0.0001	88.5	78.5	0.0003
Hypertension (%)	65.4	75.0	<0.0001	66.4	87.2	<0.0001
Atrial Fibrillation (%)	16.4	27.5	<0.0001	23.5	33.2	0.0041
Previous MI (%)	8.5	12.4	0.0054	9.5	16.6	0.0042
NYHA III-IV (%)	41.2	35.4	<0.0001	32.5	40.3	0.0083
Median EF [25 <sup>th</sup> -75 <sup>th</sup> ]	0.68 [.63-.72]	0.66 [.60-.70]	0.0012	0.68 [.60-.70]	0.65 [.60-.70]	0.1883
Mitral Stenosis (%)	1.5	9.1	<0.0001	2.4	18.4	<0.0001
Grade 3-4 TR (%)	3.3	7.8	<0.0001	4.7	12.1	<0.0001
Preop Grade 3-4 MR (%)	44.0	73.3	<0.0001	65.7	84.2	<0.0001
CABG (%)	12.2	12.1	0.9381	8.7	16.8	0.0011
Mortality (%)	1.5	3.0	0.0297	2.0	4.5	0.0502
Morbidity (%)	10.6	21.5	<0.0001	17.0	27.9	0.0005
Postop Grade 3-4 MR	10.6	5.8	<0.0001	8.3	0.0	<0.0001
Postop VSD	0.8	1.8	0.0339	0.7	3.3	0.0085
Postop Pacemaker (%)	3.4	4.1	0.4042	5.2	2.7	0.0984

1:30 PM

Room 315

### Model for End-Stage Liver Disease Score Independently Predicts Mortality in Cardiac Surgery

**B. Young<sup>6</sup>, R. B. Hawkins<sup>1</sup>, J. H. Mehaffey<sup>2</sup>, C. E. Fonner<sup>3</sup>, A. M. Speir<sup>4</sup>, M. A. Quader<sup>5</sup>, J. B. Rich<sup>3</sup>, G. Ailawadi<sup>1</sup>**

<sup>1</sup>University of Virginia, Charlottesville, <sup>2</sup>University of Virginia Health System, Charlottesville, <sup>3</sup>Virginia Cardiac Services Quality Initiative, Virginia Beach, <sup>4</sup>Cardiac, Vascular & Thoracic Surgery Associates, Falls Church, <sup>5</sup>Virginia Commonwealth University, Richmond, <sup>6</sup>Eastern Virginia Medical School, Norfolk

**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; A. M. Speir: Consultant/Advisory Board, Medtronic

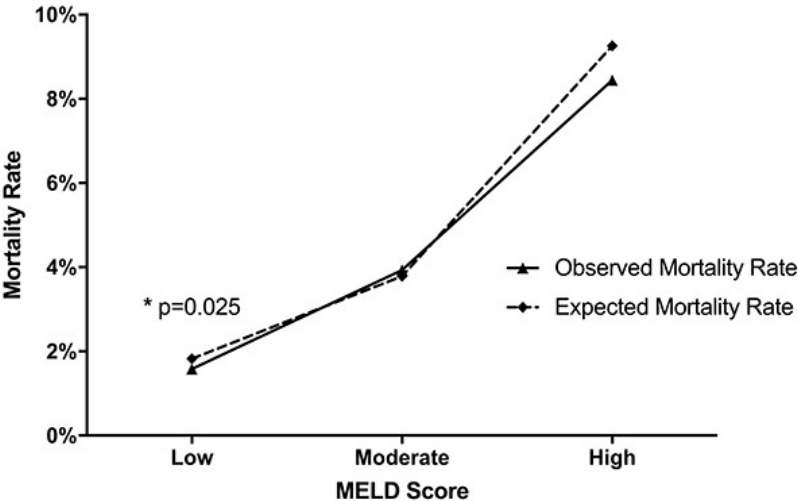
**Purpose:** While liver disease is known to increase surgical risk, current risk assessment tools do not account for liver function. This study assessed whether the Model for End-Stage Liver Disease (MELD) score adds additional predictive value to the STS risk scores.

**Methods:** Deidentified patient records were extracted from a regional collaborative adult cardiac surgery STS database. Inclusion criteria were any cardiac surgery with a risk score available from 2011 to 2016. Exclusion criteria included missing MELD or preoperative anticoagulation. Patients were stratified into three categories, MELD <9 (low), MELD 9–15 (moderate), and MELD >15 (high). Preoperative risk, intraoperative factors, and short-term outcomes were evaluated by univariate analysis. Logistic regression modeled the association between MELD and operative mortality or major morbidities accounting for preoperative risk, liver disease, hospital volume, and year.

**Results:** A total of 21,230 patients demonstrated increasing MELD scores correlated with greater comorbid disease, mitral surgery, and prior cardiac surgery. Higher MELD also was associated with higher STS predicted risk of mortality (1.1%, 2.3%, and 6.0%,  $P < .0001$ ) and operative mortality rate (1.6%, 3.9%, and 8.4%,  $P < .0001$ ). Observed-to-expected ratios demonstrate STS models do not adequately account for risk across the spectrum of MELD scores (Figure). By logistic regression, MELD score was an independent predictor of operative mortality (OR 1.03,  $P < .0001$ ). Of the components of MELD, international normalized ratio (INR; 1.38,  $P < .0001$ , Wald 23.6) was a more important predictor of mortality than total bilirubin (OR 1.20,  $P < .0001$ , Wald 7.4). Liver disease also is a significant predictor of operative mortality (OR 2.06,  $P < .0001$ ). Finally, MELD score was independently associated with STS major morbidity (OR 1.02,  $P = .0009$ ) and the component morbidity renal failure (OR 1.12,  $P < .0001$ ).

**Conclusions:** STS risk models do not accurately account for risk across the range of MELD scores. Both INR and total bilirubin are significant predictors of mortality, although the former has more predictive power. The addition of bilirubin and INR to STS risk models should be considered to improve risk adjustment.

Observed and Expected Mortality by MELD Score



1:45 PM

Room 315

### Ideal Therapeutic Approach for Mitral Valve Prolapse in Patients With Previous Cardiac Surgery: Open vs MitraClip Repair

S. Maltais<sup>1</sup>, L. A. Anwer<sup>1</sup>, R. C. Daly<sup>1</sup>, J. A. Dearani<sup>1</sup>, J. M. Stulak<sup>1</sup>, H. D. Toeg<sup>2</sup>, H. Akbayrak<sup>1</sup>, H. V. Schaff<sup>1</sup>, S. Said<sup>1</sup>, K. L. Greason<sup>1</sup>, M. Cicek<sup>1</sup>, H. I. Michelena<sup>1</sup>, C. S. Rihal<sup>1</sup>, M. F. Eleid<sup>1</sup>

<sup>1</sup>Mayo Clinic, Rochester, MN, <sup>2</sup>University of Ottawa Heart Institute, Canada

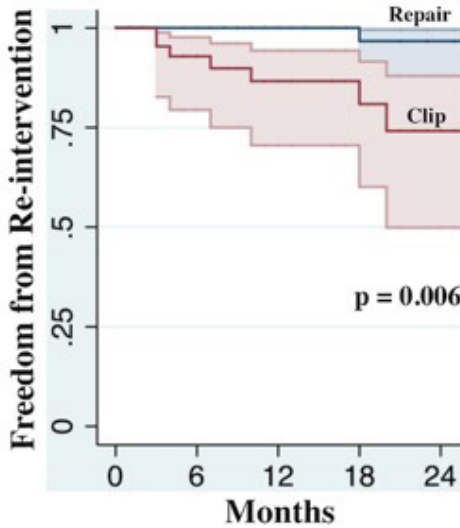
**COMMERCIAL RELATIONSHIPS** R. C. Daly: Ownership Interest, NeoChord; C. S. Rihal: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences

**Purpose:** Surgical mitral valve repair is the conventional treatment for severe degenerative mitral regurgitation (MR). MitraClip therapy has emerged as a viable option in high-risk surgical patients with severe MR. We sought to assess treatment of severe degenerative mitral valve prolapse (MVP) comparing conventional surgery or MitraClip in patients with previous cardiac interventions.

**Methods:** From January 2012 to May 2016, 131 patients with previous cardiac surgery and subsequent intervention for degenerative MVP were retained for this analysis: 75 patients (57%) underwent a reoperation with open surgical repair, while 56 (43%) underwent MitraClip placement. Follow-up was available in all early survivors for a median of 11 (0, 32) months for surgery and 11 (3-21) months for MitraClip patients.

**Results:** MitraClip patients were older (75.7 years  $\pm$  8.6 years vs 68.6 years  $\pm$  13.1 years,  $P < .001$ ), had a higher STS risk score (5.8  $\pm$  2.4 vs 2.7  $\pm$  2.3,  $P < .001$ ), lower left ventricular ejection fraction (47.2  $\pm$  13.3 vs 57.9  $\pm$  9.8,  $P = .006$ ) and higher prevalence of diabetes (77% vs 12%,  $P < .001$ ) and chronic obstructive pulmonary disease (57% vs 11%,  $P < .001$ ). Surgical patients were more likely to have multiple (two or more) sternotomies (97% vs 29%,  $P < .001$ ) and previous myocardial infarction (77% vs 52%,  $P = .004$ ) (Table). Median length of stay was 7 days (IQR: 5-11 days) for the surgery group, while it was 2 days (IQR: 2-4 days) for MitraClip patients ( $P < .001$ ). Thirty-day mortality was 2.7% for the surgery group and 3.6% for the MitraClip cohort ( $P = .77$ ). Recurrent MR (moderate or greater) at discharge (71% vs 5.4%,  $P < .001$ ) and at 1 year (67% vs 33%,  $P = .02$ ) was significantly higher for MitraClip patients. Estimated survival at 1 year was comparable between cohorts: 85% for the surgical cohort and 76% for the MitraClip cohort ( $P = .24$ ). Freedom from mitral reintervention at 1 year was significantly higher for surgical patients, 100% vs 87.5% ( $P = .006$ ) (Figure). While univariable analysis demonstrated the use of MitraClip to be a predictor of reintervention (HR=10.9 [1.32, 89.5]), no independent association was found significant on multivariable analysis.

**Conclusions:** In patients with previous cardiac interventions and development of severe degenerative MVP, treatment with conventional surgery is safe and durable. MitraClip repair can provide an alternative for higher-risk patients, but remains associated with greater residual MR. A heart team approach is recommended to evaluate the best treatment option for this challenging population.



	Surgery (n=75)	Mitral Clip (n=56)	p-value
Age (mean ± SD)	68.6 ± 13.1	75.7 ± 8.6	<0.001
Male (%)	77.3	80.4	0.68
Previous Sternotomy (%)			<0.001
1	2.7	71.4	
2	88	25	
3	8	3.5	
4	1.3	0	
Diabetes (%)	12	77	<0.001
COPD (%)	11	57	<0.001
Previous MI (%)	77.3	52.1	0.004
AF (%)	81.4	71.4	0.25
LVEF (%)	57.9 ± 9.8	47.2 ± 13.3	<0.001
Pre-op MR ≥ 3 (%)	97	100	0.11
STS score (mean ± SD)	2.7 ± 2.3	5.8 ± 2.4	<0.001
LOS (median[IQR])	7 [5, 11]	2 [2, 4]	<0.001
Post-op MR ≥ 3 (%)			
Discharge	5.4	71	<0.001
1 year	33	67	0.02
30-day mortality (%)	2.7	3.6	0.77

Table 1: Preoperative and Perioperative Outcomes

2:00 PM

Room 315

### Evolving Technique for Pericardiectomy: Safety, On-Pump Surgery, and Complete Resection

**D. R. Johnston<sup>1</sup>, K. N. Gopal<sup>2</sup>, E. G. Soltesz<sup>1</sup>, N. G. Smedira<sup>1</sup>, G. B. Pettersson<sup>1</sup>, F. Bakaeen<sup>1</sup>, M. Y. Desai<sup>1</sup>, A. L. Klein<sup>1</sup>, P. L. Houghtaling<sup>1</sup>, E. Blackstone<sup>1</sup>**

<sup>1</sup>Cleveland Clinic, OH, <sup>2</sup>Amrita Institute of Medical Sciences, Kochi, India

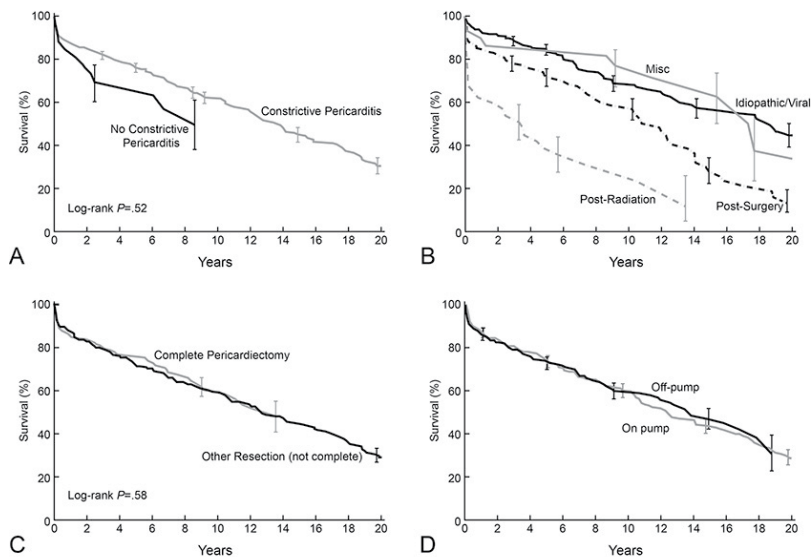
**COMMERCIAL RELATIONSHIPS** F. Bakaeen: Speakers Bureau/Honoraria, JACE Medical; M. Y. Desai: Consultant/Advisory Board, Myokardia; D. R. Johnston: Ownership Interest, JACE Medical; Research Grant, Edwards Lifesciences; Consultant/Advisory Board, LivaNova, Abbott; E. G. Soltesz: Ownership Interest, JACE Medical; Speakers Bureau/Honoraria, Abbott, Abiomed, AtriCure

**Purpose:** Pericardiectomy, in particular for constrictive pericarditis (CP), has been considered a high-risk procedure for which a limited anterior “phrenic to phrenic” off-pump approach has been advocated. We reviewed a 35-year single institution experience to determine whether complete resection and cardiopulmonary bypass affected short- and long-term outcomes.

**Methods:** From 1977 to 2013, 601 patients underwent pericardiectomy at a single institution, of whom 493 (82%) were diagnosed with CP. Pericardiectomy was classified as complete if the pericardium adjacent to the diaphragm and posterior to the left phrenic nerve was resected in addition to the anterior pericardium. 324 operations (54%) were performed on-pump. Data for preoperative patient characteristics, surgical technique, in-hospital outcomes, and survival were analyzed for the entire population. Pre- and postoperative hemodynamic data were available for a subset of patients (n=336) who underwent surgery between 2000 and 2013, for whom survival was assessed to 10 years.

**Results:** Complete pericardiectomy was performed in 259 patients (43%) in the overall cohort, 233 (94%) of which were performed since 2000. There were 36 hospital deaths (6%). Long-term survival for the overall cohort at 1, 5, 10, 15, and 20 years was 89%, 87%, 73%, 60%, 45%, and 30%, respectively. There was no difference in survival for the overall cohort based on the completeness of resection or use of cardiopulmonary bypass (Figure A and B). Rather, survival was related to indication for operation and etiology of constriction. Survival was best for patients with idiopathic or viral etiology and worst for patients with post-radiation CP (Figure C and D). Patients with low postoperative cardiac index (<2.2 l/min/m<sup>2</sup>) had inferior long-term survival ( $P = .02$ ).

**Conclusions:** Complete, on-pump pericardiectomy with resection of the diaphragmatic and posterior pericardium does not increase operative or long-term risk. Risk of pericardiectomy is associated with disease etiology and myocardial reserve. Further study is necessary to determine whether complete resection may improve outcomes in selected patients.



- A. Survival after pericardiectomy stratified by constrictive pericarditis (CP)  
 B. Survival after pericardiectomy stratified by Etiology of CP (n=493)  
 C. Survival after pericardiectomy stratified by complete pericardiectomy (n=601)  
 D. Survival after pericardiectomy stratified by CPB use (n=601)

2:15 PM

**Image-Guided Mitral Valve Surgery***Daniel Drake, Traverse City and Ann Arbor, MI*

2:30 PM

**TBD**

1:00 PM – 3:00 PM

Floridian Ballroom A

**Adult Cardiac: Mitral and Tricuspid Valves***Moderators: Gorav Ailawadi, Charlottesville, VA, and T. Sloane Guy, New York, NY***COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; T. S. Guy: Consultant/Advisory Board, Edwards Lifesciences, Verb Surgical

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

1:00 PM

**National Outcome Benchmarks for Mitral Valve Reoperations in the United States**

**A. Kilić<sup>1</sup>, M. A. Acker<sup>2</sup>, S. Vemulapalli<sup>3</sup>, D. Thibault<sup>4</sup>, G. Ailawadi<sup>5</sup>, V. Badhwar<sup>6</sup>, V. H. Thourani<sup>7</sup>, A. Kilić<sup>8</sup>**

<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>University of Pennsylvania Medical Center, Philadelphia, <sup>3</sup>Duke Clinical Research Institute, Durham, NC, <sup>4</sup>Duke University, Durham, NC, <sup>5</sup>University of Virginia, Charlottesville, <sup>6</sup>West Virginia University, Morgantown, <sup>7</sup>Emory University, Atlanta, GA, <sup>8</sup>The Ohio State University Wexner Medical Center, Columbus

**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; V. H. Thourani: Research Grant, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc; S. Vemulapalli: Research Grant, Abbott Vascular

**Purpose:** With the ongoing development and increasing utilization of transcatheter technology for mitral valve disease, an appraisal of current outcomes with open surgical approaches particularly in higher-risk subsets is warranted. The purpose of this study was to evaluate outcomes of reoperative mitral valve surgery (MVS) in the United States.

**Methods:** Adults 18 years or older undergoing isolated reoperative MVS with prior open heart surgery in the STS Adult Cardiac Surgery Database between July 2011 and September 2016 were included. Primary outcomes were operative mortality and STS major morbidity rates. Multivariable models were used for risk adjustment, incorporating variables from the STS Valve Risk Model, as well as type of prior operation and reoperative approach. STS Predicted Risk of Mortality (STS-PROM) also was used to evaluate observed-to-expected mortality ratios (O/E).

**Results:** 17,195 patients underwent isolated reoperative MVS at 962 centers. STS-PROM was 8.0%, with 27% (n=4619) having an STS-PROM of 5%-10%, and 20% (n=3404) having an STS-PROM of >10%. Mitral valve disease included moderate or severe mitral insufficiency (78%), mitral stenosis (32%), and endocarditis (15%). Prior cardiac operations included previous mitral valve surgery (61%), coronary artery bypass (39%), aortic valve surgery (18%), and tricuspid valve surgery (6%). Most patients were operated on electively (67%) via redo sternotomy (80%). Operative mortality was 6.6% (n=1008), and major morbidity occurred in 27% (n=4678). O/E for the overall cohort was 0.82. Complications included prolonged ventilation (23%), all-cause reoperation (6%), new-onset renal failure (6%), stroke (2%), and deep sternal wound infection (0.3%). Median length of hospitalization was 8 days (interquartile range, 6-12 days). Multivariable analysis identified risk factors for operative mortality (Table). Redo sternotomy was not associated with increased mortality compared to other operative approaches.

**Conclusions:** These data provide a benchmark for comparison of transcatheter therapies to treat mitral valve disease. Despite a high-risk patient profile, surgical outcomes are laudable, particularly in elective cases with prior mitral valve surgery and without endocarditis. Re-sternotomy is safe and does not increase mortality risk compared to other operative approaches.

#### Risk Factors for Operative Mortality in the Multivariable Model

Variable	Adjusted Odds Ratio (95% Confidence Interval)*	P-value
Age >50 Years	1.03 (1.02, 1.05)	<.0001
<b>Comorbidities</b>		
Congestive Heart Failure and NYHA IV	1.72 (1.23, 2.41)	0.0014
Chronic Lung Disease	1.21 (1.06, 1.37)	0.0034
Creatinine (increasing, per 1 mg/dL)	1.46 (1.28, 1.65)	<0.001
Diabetes Mellitus (insulin-dependent)	1.48 (1.04, 2.12)	0.0314
Dialysis Dependence	4.04 (2.44, 6.69)	<0.001
Ejection Fraction (decreasing)	1.01 (1.01, 1.02)	0.0020
Immunosuppression	1.35 (1.06, 1.72)	0.0156
Recent Myocardial Infarction (within 21 days)	1.59 (1.12, 2.26)	0.0102
Peripheral Vascular Disease	1.21 (1.02, 1.44)	0.0293
Active Endocarditis	1.67 (1.31, 2.13)	<0.0001
Mitral Insufficiency	0.80 (0.65, 0.98)	0.0319
Tricuspid Insufficiency	1.26 (1.07, 1.49)	0.0061
<b>Operative Variables</b>		
Mitral Valve Repair	0.21 (0.09, 0.52)	0.0006
More than 1 Prior Open-Heart Surgery	1.25 (1.10, 1.38)	0.0020
Urgent Status	1.28 (1.09, 1.50)	0.0024
Salvage Status	4.80 (1.21, 19.0)	0.0254
Redo Sternotomy (Versus Alternative Approaches)	0.82 (0.57, 1.02)	0.0756
<b>Type of Prior Operation</b>		
Coronary Artery Bypass Grafting	1.19 (0.97, 1.47)	0.0964
Aortic Valve Replacement	1.52 (1.26, 1.85)	<0.001
Mitral Valve Replacement	0.81 (0.65, 1.00)	0.0513
Mitral Valve Repair	0.74 (0.61, 0.90)	0.0022
Tricuspid Valve Replacement	1.21 (0.51, 2.88)	0.6725
Tricuspid Valve Repair	0.86 (0.62, 1.20)	0.3715

\* risk adjusted for all variables in the STS Valve Risk Model

1:15 PM

Floridian Ballroom A

**Mitral Valve Repair vs Replacement With Complete Preservation of the Subvalvular Apparatus in the Elderly With Degenerative Disease: An Analysis of the STS Adult Cardiac Surgery Database***C. M. Vassileva<sup>1</sup>, R. A. Bello<sup>1</sup>, N. N. Kakouros<sup>1</sup>, J. F. Keaney<sup>1</sup>, W. D. Hoffman<sup>1</sup>, J. D. Walker<sup>2</sup>**<sup>1</sup>University of Massachusetts, Worcester, <sup>2</sup>UMass Memorial Medical Center, Worcester*

**Purpose:** Mitral valve repair is underutilized in the elderly. It has been postulated that mitral repair in this population does not confer an additional benefit over mitral replacement with complete preservation of the chordal apparatus. Our purpose was to test this hypothesis using data from the STS Adult Cardiac Surgery Database (ACSD).

**Methods:** Patients  $\geq 70$  years undergoing elective primary isolated mitral valve repair (MVP) and complete chordal-sparing replacement (ccsMVR) (including concomitant TVP/TVR and Afib ablation) for degenerative disease were obtained from the ACSD version 2.81. The two treatment groups were further stratified by age (70-79 and 80-90). The propensity for MVP vs ccsMVR was estimated using logistic regression derived from 30 preoperative variables. The operative mortality odds ratio for MVP vs MVR was estimated using logistic regression adjusting for differences in baseline characteristics using the propensity score. The same analysis was repeated in the age subgroups.

**Results:** The study included 4818 patients, of whom 83% underwent mitral repair and 17% underwent complete chordal-sparing replacement. Observed operative mortality for repair was lower than replacement (2.3% vs 5.4%,  $P < .0005$ ). This also was true for age 70-79 years (2.2% vs 5.9%,  $P < .0005$ ), but not for age 80-90 years (2.8% vs 4.1%,  $P = .266$ ). The survival benefit for mitral repair persisted following risk adjustment. Using mitral repair as reference, mortality was higher for replacement in the overall cohort (OR 1.98,  $P = .001$ ), as well as in the age group 70-79 (OR 1.98,  $P = .006$ ) and trended toward significance for age 80-90 (OR 2.03,  $P = .065$ ). Within the subset of patients undergoing replacement, adjusted operative mortality was not different among complete, partial, and no chordal-sparing replacement. Of the replacement patients included in the study, 15.1% had failed repair. The mortality for these patients was 7.7%. When the failed repairs were included in the repair group as intention-to-treat analysis, the survival benefit of repair over replacement did not persist.

**Conclusions:** In the elderly patients, mitral repair has lower operative mortality compared to replacement, even with complete sparing of the chordal apparatus. Chordal preservation strategy does not seem to impact operative mortality rates. The percentage of failed repairs is substantial and diminishes the overall benefit of mitral repair.

1:30 PM

Floridian Ballroom A

**Robotic Mitral Valve Repair: Does Indication for Surgery Affect Outcomes?**

S. Maltais, L. A. Anwer, A. Taggarse, H. Akbayrak, R. C. Daly, M. Sarano, H. I. Michelena, J. A. Dearani

Mayo Clinic, Rochester, MN

**COMMERCIAL RELATIONSHIPS** R. C. Daly: Ownership Interest, NeoChord

**Purpose:** Robotic mitral valve repair (MVR) is increasingly becoming a popular alternative to the conventional approach in expert centers with high volumes. Nonetheless, uncertainties persist regarding efficacy of the robotic technique in asymptomatic patients. We sought to evaluate outcomes for robotic MVR by primary indication for surgery.

**Methods:** From January 2008 to September 2016, 603 patients underwent robotic MVR for severe primary mitral regurgitation (MR). Medical records of 576 consenting patients were retrospectively reviewed to determine primary indication for surgery. Patients were stratified into class I or asymptomatic IIA indications per American Heart Association guidelines for surgery, and intraoperative and postoperative variables were analyzed accordingly.

**Results:** Out of 516 patients who formed the contemporary cohort for analysis, 428 patients had a class I indication, while 88 patients had a class IIA indication for surgery. Preoperatively, besides respective indications, no significant differences were observed between both cohorts. Importantly, a significantly higher number of class I indication patients underwent MVR for bileaflet prolapse; 40.3% (172/428) vs 24.7% (21/88) of patients ( $P = .03$ ). Early MVR outcomes demonstrated recurrent MR (moderate or greater) in only 2% (12/576) of patients, and no significant differences were observed between classes ( $P = .23$ ). Besides parameters for ventricular size, all other intraoperative and postoperative variables were comparable between both cohorts.

**Conclusions:** Comparable outcomes were demonstrated across all classes of indications for MVR surgery. These results support the utilization of this less invasive strategy, even in less sick patients. Early referral, along with improvements in robotic technology, will continue to improve long-term outcomes and increase widespread application of the robotic technique outside of high-volume referring centers.

	Class I (N=428)	Class IIA (N=88)	P- value
Age (years)	57 (18.4-84.9)	56 (33.2-80.3)	0.6944
Male Gender	306 (71.5%)	68 (77.3%)	0.2691
Pre-op MR Grade			0.8796
2	13 (3.4%)	3 (3.4%)	
3	60 (15.8%)	12 (13.6%)	
4	307 (80.8%)	73 (83.0%)	
Pre-op TR Grade			0.5607
< 3	364 (92.4%)	81 (94.2%)	
≥ 3	30 (7.6%)	5 (5.8%)	
Prolapse Category			0.0306
Posterior Leaflet	239 (56.0%)	60 (70.6%)	
Anterior Leaflet	15 (3.5%)	4 (4.7%)	
Bileaflet	172 (40.3%)	21 (24.7%)	
Repair Type			0.1810
Simple	248 (58.1%)	56 (65.9%)	
Complex	179 (41.9%)	29 (34.1%)	
Cross Clamp Time, mins	54 (14-199)	51 (21-110)	0.0550
Perfusion Time, mins	79 (46-249)	76 (44-161)	0.3994
Post-op AF	85 (19.9%)	13 (14.8%)	0.2678
MR Grade Post-op			0.2344
< 3	416 (97.2%)	88 (100.0%)	
≥ 3	12 (2.8%)	0 (0.0%)	
Mean Length of Stay (SD)	3.6 (2.8)	3.4 (0.9)	0.8963
30-day Readmission Rate	3.7% (14)	0% (0)	0.1413

Table 1: Comparison between class I &amp; IIA MVR patients.

1:45 PM

Floridian Ballroom A

### A Comparison of Early Postoperative Results Between Conventional Mitral Valve Repair and Transapical NeoChord Implantation

A. Lipnevicius<sup>1</sup>, K. Rucinskas<sup>1</sup>, V. Janusauskas<sup>1</sup>, A. A. Zorinas<sup>1</sup>, G. Speziali<sup>2</sup>, A. A. Drasutiene<sup>1</sup>, D. Zakarkaite<sup>1</sup>, A. S. Aidietis<sup>1</sup>

<sup>1</sup>Vilnius University, Lithuania, <sup>2</sup>Pittsburgh, PA

**COMMERCIAL RELATIONSHIPS** A. A. Drasutiene: Consultant/Advisory Board, NeoChord; G. Speziali: Ownership Interest, NeoChord; Consultant/Advisory Board, NeoChord

**REGULATORY DISCLOSURE** This presentation describes off-pump transapical NeoChord implantation with the NeoChord DS1000, which is not FDA approved.

**Purpose:** Conventional mitral valve repair (CMVR) with cardiopulmonary bypass is accepted as standard treatment in patients with degenerative mitral valve regurgitation (MR). Off-pump transapical NeoChord implantation (TA) is a new alternative approach. In this study, early postoperative results were compared between these two treatment methods.

**Methods:** In this retrospective observational study, we included 169 patients who, in the period from 2011 to 2016, underwent mitral valve repair for the degenerative mitral valve (MV) disease. Patients with leaflet restriction were not included. Patients were divided in two groups. There were 91 patients in the CMVR group and 78 in TA NeoChord implantation group. Outcomes were compared at discharge or at 30 days.

**Results:** Preoperative risk value according to STS score was 0.47% in TA group vs 0.43% in CMVR patients ( $P = .142$ ). Patients in the CMVR group were older (59.5 years  $\pm$  12.8 years vs 54.2 years  $\pm$  11.1 years,  $P = .005$ ) and more frequently had moderate tricuspid regurgitation (35% vs 14%,  $P = .002$ ). Postoperatively, patients in the TA group had lower need for red blood cell transfusion (7.8% vs 42.9%,  $P = .001$ ), lower rate of postoperative atrial fibrillation (11.7% vs 25.3%,  $P = .031$ ), and less frequent renal failure (2.6% vs 15.4%,  $P = .007$ ). Median surgery duration in CMVR was longer: 312 minutes vs 120 minutes ( $P = .001$ ). One patient died in the TA group, and there were no deaths in the CMVR group ( $P = .277$ ). Two patients in the CMVR group had postoperative stroke, and one has developed wound infection; none of these complications occurred in the TA group. At 30 days, none of the patients in the CMVR group had severe mitral regurgitation; in the TA group, nine patients had moderate or severe mitral regurgitation ( $P = .001$ ).

**Conclusions:** Off-pump transapical MV repair is a feasible and safe procedure. It is related with a lower rate of complications. However, compared to the conventional repair, it has a higher rate of moderate or higher mitral regurgitation recurrence. Therefore, careful and thorough selection of the patients by a highly experienced team must be carried out.

2:00 PM

Floridian Ballroom A

## Update on World Experience With Transapical NeoChords and Predictions for the Future

*Gilbert H. L. Tang, New York, NY*

**COMMERCIAL RELATIONSHIPS** G. H. L. Tang: Consultant/Advisory Board, Abbott Vascular, NeoChord; Speakers Bureau/Honoraria, Abbott Vascular, Edwards Lifesciences, Medtronic

**REGULATORY DISCLOSURE** This presentation describes the use of the NeoChord for transapical chordal repair for mitral regurgitation, which has an FDA approval status of investigational.

2:15 PM

## Transcatheter Mitral Valve Replacement With LAMPOON Procedure

*J. J. Kelly<sup>1</sup>, V. C. Babaliaros<sup>1</sup>, J. M. Iturbe<sup>1</sup>, J. Forcillo<sup>1</sup>, S. Lerakis<sup>1</sup>, F. E. Corrigan<sup>1</sup>, K. O. Mavromatis<sup>1</sup>, A. Greenbaum<sup>2</sup>, J. M. Khan<sup>3</sup>, R. J. Lederman<sup>3</sup>, V. H. Thourani<sup>1</sup>*

<sup>1</sup>Emory University, Atlanta, GA, <sup>2</sup>Henry Ford Hospital, Detroit, MI, <sup>3</sup>National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, MD

**COMMERCIAL RELATIONSHIPS** V. C. Babaliaros: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Edwards Lifesciences; A. Greenbaum: Consultant/Advisory Board, Transmural Systems; Speakers Bureau/Honoraria, Edwards Lifesciences; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

**Purpose:** Left ventricular outflow tract (LVOT) obstruction is a serious potential complication of transcatheter mitral valve replacement (TMVR). This video demonstrates TMVR utilizing the novel LAMPOON procedure, in which the A2 portion of the anterior mitral leaflet (AML) is divided percutaneously using electrocautery prior to valve deployment to prevent LVOT obstruction.

**Methods:** A 69-year-old male with prior mitral annuloplasty ring underwent TMVR for mitral stenosis. Preoperative imaging predicted LVOT obstruction following TMVR. Access was obtained via the Seldinger technique. Two coronary guiding catheters were advanced retrograde from the femoral artery into the LVOT and left atrium (LA). A guidewire from the LVOT catheter was electrified, advanced through the A2 portion of the AML, and captured by a snare on the catheter in the LA. The A2 region of the AML was then split longitudinally via electrocautery. The transcatheter valve, which had previously been advanced into the LA via septostomy, was then deployed.

**Results:** This patient underwent successful TMVR with a 29-mm valve. Post-implantation echocardiography demonstrated no paravalvular leak, no mitral regurgitation, a mean mitral gradient of 3 mm Hg, and mean LVOT gradient of 5 mm Hg. The atrial septostomy was closed using a septal occluder. All devices were removed and access sites closed. The patient was extubated on the cath lab table and discharged on postoperative day 7. Echocardiography at 30-day follow-up showed continued excellent valve function and mean LVOT gradient of 11 mm Hg.

**Conclusions:** The LAMPOON procedure is a safe and effective method to prevent LVOT obstruction following TMVR. Further investigation is needed to assess the viability of this novel therapy. This case highlights the importance of preoperative planning with the heart team to develop an optimal treatment strategy for each patient.

2:30 PM

Floridian Ballroom A

**DEBATE: Transcatheter vs Minimally Invasive Mitral Valve Procedures**

*Transcatheter Mitral Valve Repair and Replacement Is Our Future:*

*Michael A. Borger, New York, NY*

*Minimally Invasive Mitral Valve Procedures Will Prevail Over Transcatheter Techniques:*

*James S. Gammie, Baltimore, MD*

**COMMERCIAL RELATIONSHIPS** J. S. Gammie: Ownership Interest, Edwards Lifesciences, Harpoon Medical; Consultant/Advisory Board, Edwards Lifesciences, Harpoon Medical

1:00 PM – 3:00 PM

Room 305

**Congenital: Pediatric Congenital II***Moderators: Michael E. Mitchell, Milwaukee, WI, and Christian Pizarro, Wilmington, DE***COMMERCIAL RELATIONSHIPS** M. E. Mitchell: Ownership Interest, Ariosa Diagnostics, TAI Diagnostics; Research Grant, TAI Diagnostics; Consultant/Advisory Board, TAI Diagnostics

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

1:00 PM

**Outcomes After Bidirectional Cavopulmonary Shunt in Infants Less Than 120 Days Old***N. Ota, T. A. Asou, Y. Takeda, M. Kobayashi, H. Okada, Y. Onakatomi**Yokohama Kanagawa Children's Medical Center, Japan*

**Purpose:** Although bidirectional shunt (BCPS) has played an important role in the staged Fontan approach, the optimal timing of BCPS, especially at the younger end of the spectrum, remains controversial. Therefore, we examined the outcomes of BCPS in infants less than 120 days old.

**Methods:** A retrospective review (November 2004 to March 2017) of our database identified 307 consecutive patients who underwent BCPS at a single institution. Among them, 85 patients (27.7%) were defined as the younger age group at ages of less than 120 days, including 13 patients less than 90 days. There were 22 patients with heterotaxy, 10 with pulmonary atresia and intact atrial septum, six with hypoplastic left heart syndrome, and six with other conditions. Data were obtained on retrospective review of patient records, and follow-up was conducted by means of record review. The mean follow-up period was 5.8 years  $\pm$  2.7 years.

**Results:** The age (median) and body weight at BCPS were 102 days (32–119 days) and 4.5 kg (2.2–8.1 kg), respectively. The median duration of ICU stay and hospital stay were 3 days (1–104 days) and 9 days (4–123 days). The hospital mortality rate was 5.8% (5/85). Although five patients required extracorporeal membrane oxygenation (ECMO) support preoperatively due to hemodynamic instability, all of them successfully weaned off ECMO through hemodynamic benefits after BCPS. A multivariate analysis identified significant atrioventricular valve regurgitation (AVVR;  $P = .006$ ) as a factor associated with hospital mortality, but not younger age at BCPS. None of the patients needed take-down. There were two late deaths. The 10-year actuarial survival rate was 91.3%. Pre-Fontan cardiac catheter study showed acceptable hemodynamics (Table), and 70 patients (82%) successfully completed Fontan circulation (14.9 months  $\pm$  5.0 months postoperatively). The remaining patients are waiting for Fontan.

**Conclusions:** The present study shows that BCPS at the earlier stage of life can be safely performed with advantageous effects in patients with hemodynamic instabilities, while significant AVVR is a risk factor of hospital mortality.

Table: Data from pre-Fontan catheter study

	Pre Fontan (n=70)
PAP (mmHg)	10.1 ± 2.5
Rp (U $m^2$ )	1.5 ± 0.5
VeDP (mmHg)	6.7 ± 2.0
CI (L/min/ $m^2$ )	3.4 ± 1.0
PA index ( $mm^2/m^2$ )	211 ± 81

PAP: pulmonary artery pressure, Rp: pulmonary resistance

VeDP: systemic ventricular end diastolic pressure, CI: Cardiac index

PA: pulmonary artery

1:15 PM

Room 305

**Optimal Timing of Stage 2 Palliation for Hypoplastic Left Heart Syndrome***Robert D. B. Jaquiss, Dallas, TX*

1:30 PM

**External Stenting for Vascular Compression Syndrome***M. Ando**Sakakibara Heart Institute, Tokyo, Japan*

**Purpose:** Airway obstruction in children may be caused by several conditions, including vascular compression and congenital tracheobronchomalacia. Many of these patients have coexisting congenital heart disease and may develop obstructive pulmonary vascular disease. In this video, we present our own original external stenting technique as a treatment option for these patients.

**Methods:** The patient was a 15-month-old male with a history of repairs for type B interrupted aortic arch (direct anastomosis) and ventricular septal defect. He developed vascular compression syndrome of the left bronchus, requiring readmission for recurrent respiratory infections, and finally, mechanical ventilator support. Prior to operation, a computed tomography (CT) scan revealed a left bronchus compressed by the retracted descending aorta.

**Results:** A left thoracotomy was performed, and the descending aorta was suspended to the posterior part of the rib. A piece of ringed polytetrafluoroethylene prosthesis was cut longitudinally, creating two semicircular pieces: a larger one for the stabilization of the cartilage and a smaller one for the membrane. The cartilage sutures were placed along three lines: midline and both lateral ends. The midline stitches were first placed and passed through the graft. The graft was then placed around the airway and the sutures tied down. The redundant ends of the graft were trimmed off and lateral ends of the cartilage sutured to the graft. The other graft piece was fixed to the membrane by stitches placed along the midline. Both ends of the membrane stent were then trimmed off so that it overlapped the cartilage stent by a few millimeters.

**Conclusions:** Postoperative bronchoscopy and CT scan confirmed the full expansion of the stented airway segment. External stenting is a reliable method to relieve airway compression in small children. It may allow an age-proportional growth of the airway due to the non-circumferential and oversized design of the prosthesis.

1:45 PM

Room 305

**Characterizing Outcomes of Isolated and Complex Complete Atrioventricular Septal Defect Repair: An All-Encompassing Experience**

C. M. Mery, R. A. Zea-Vera, M. A. Chacon-Portillo, H. Zbu, W. B. Kyle, I. Adachi, L. C. Kane, J. Heinle, C. D. Fraser Jr

*Texas Children's Hospital/Baylor College of Medicine, Houston*

**COMMERCIAL RELATIONSHIPS** I. Adachi: Consultant/Advisory Board, Berlin Heart, HeartWare

**Purpose:** Do isolated and complex forms of complete atrioventricular septal defect (CAVSD) have the same long-term prognosis after surgical repair? The goal of this study is to report one of the largest all-inclusive, single-institution contemporary experiences of biventricular CAVSD repair using a consistent surgical approach.

**Methods:** All patients undergoing biventricular repair of isolated or complex forms of CAVSD between 1995 and 2016 were retrospectively studied. Significant left atrioventricular valve (LAVV) anomaly was defined as having one of the following: single papillary muscle, double orifice LAVV, or deficient left lateral leaflet tissue. Cardiac reoperation for any cause and survival were evaluated for the entire cohort. Reoperation for LAVV (regurgitation or stenosis) and left ventricular outflow tract obstruction (LVOTO) were assessed for patients with isolated CAVSD. Risk factors were analyzed using log-rank and Gray's test with mortality as a competing outcome, as appropriate. Cox regression was used for multivariable analysis.

**Results:** 407 patients underwent repair: 362 (89%) isolated CAVSD and 45 (11%) complex CAVSD (tetralogy of Fallot: 35, double outlet right ventricle: seven, total anomalous pulmonary venous return: three). Median age at repair was 5 months (10 days-22 years); 340 (84%) had trisomy 21. LAVV anomalies were present in 52 patients (13%). A two-patch repair was used in 375 (97%), and the cleft was completely closed in 305 (75%). Perioperative mortality was 2% (8/362) and zero in the isolated and complex groups, respectively. Median follow-up was 7 years (8 days-21 years). Overall survival and incidence of any reoperation at 10 years were 92% and 10%, respectively (Figure). On multivariable analysis, complex anatomy was not a risk factor for mortality, but it was for reoperation (Table). For the isolated CAVSD group, incidence of reoperation for LAVV and LVOTO at 10 years were 9% and 2.5%, respectively. Preoperative moderate or greater atrioventricular valve regurgitation was a risk factor for LAVV reoperation (hazard ratio: 3, 95% confidence interval: 1.1-5.5,  $P = .02$ ).

**Conclusions:** In this large, all-inclusive, single-center cohort with almost exclusive use of a two-patch technique, short- and long-term mortality is low, but need for reoperation remains significant. Repair of complex anatomies, such as tetralogy of Fallot and double outlet right ventricle, has similar mortality compared to isolated CAVSD repair.

Figure. Kaplan-Meier curve for survival (A) and competing risk curves for any reoperation in the isolated (B) and complex (C) groups

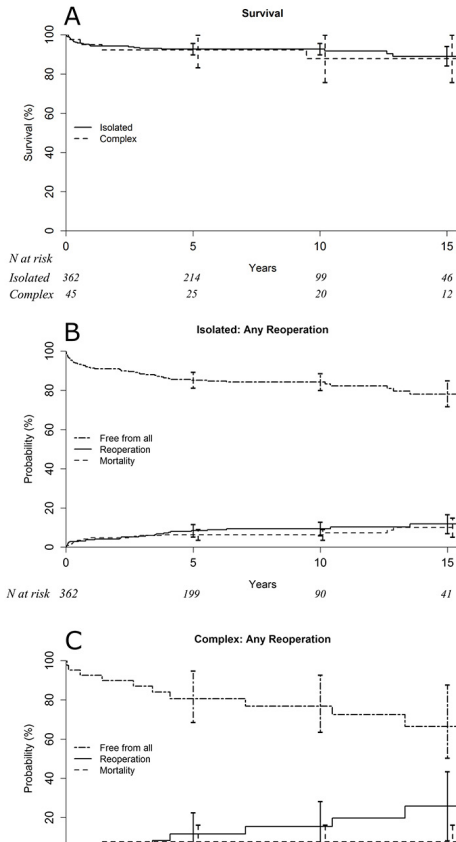


Table. Multivariable analysis for the entire cohort

Survival			
	p-value	HR	95% CI
Era (2006-2016 vs 1995-2005)	<0.01*	0.3	0.11-0.65
Preoperative ventilatory support	<0.01*	4.3	1.80-10.11
Any prior arch intervention	<0.01*	4.6	1.55-13.53
Deficient left lateral leaflet	0.06	2.7	0.92-7.97
CPB time (every 10 min)	0.01*	1.1	1.01-1.13
Any Reoperation			
	p-value	HR	95% CI
Preoperative moderate or greater AVV regurgitation	0.045*	1.9	1.02-3.60
Common atrium	0.05	2.8	0.98-7.73
Second CPB run, anatomic reason	0.02*	3.1	1.22-8.03
Concomitant LVOT chordal resection	0.02*	2.9	1.22-6.84
Complex	0.03*	2.4	1.12-5.21

\*p-value<0.05. CPB: Cardiopulmonary bypass. AVV: atrioventricular valve. LVOT: Left ventricular outflow tract. HR: Hazard ratio. 95% CI: 95% Confidence interval.

2:00 PM

Room 305

### Detachment of the Tricuspid Valve in Perimembranous Ventricular Septal Defect Closure Does Not Impact Tricuspid Valve Function at Long-Term Follow-Up

C. D. Fraser III<sup>1</sup>, S. Palepu<sup>1</sup>, A. Suarez-Pierre<sup>2</sup>, X. N. Zhou<sup>2</sup>, T. C. Crawford<sup>1</sup>, J. T. Magruder<sup>1</sup>, C. N. Lu<sup>2</sup>, M. L. Jacobs<sup>3</sup>, D. E. Cameron<sup>1</sup>, N. Hibino<sup>2</sup>, L. A. Vricella<sup>2</sup>

<sup>1</sup>The Johns Hopkins Hospital, Baltimore, MD, <sup>2</sup>The Johns Hopkins University School of Medicine, Baltimore, MD, <sup>3</sup>The Johns Hopkins University School of Medicine, Newtown Square, PA

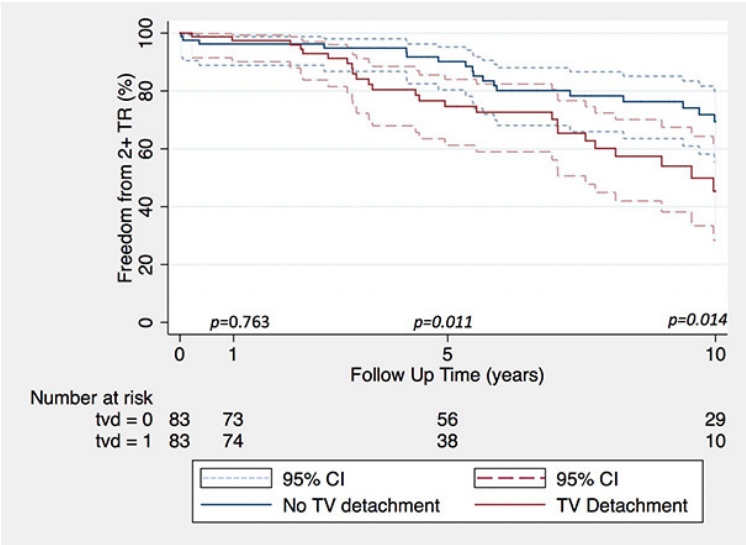
**COMMERCIAL RELATIONSHIPS** N. Hibino: Research Grant, Secant; Speakers Bureau/Honoraria, Secant; Other Research Support, Nanofibersolutions, Secant

**Purpose:** Although tricuspid valve detachment (TVD) facilitates improved exposure during transatrial ventricular septal defect (VSD) closure, few have analyzed the impact of TVD on long-term valve durability. The purpose of this study was to review our institutional outcomes, comparing VSD closure with and without TVD.

**Methods:** Pediatric patients undergoing VSD closure at our institution from 1997 to 2016 were identified, and charts were retrospectively reviewed. Patients were separated into groups based on utilization of TVD in VSD closure. Propensity score matching was then performed using a non-parsimonious logistic regression model involving seven variables and matched 1:1 by the nearest-neighbor principle. Primary outcome was residual TV dysfunction at long-term follow-up, defined as mild (2+) and moderate (3+) TV regurgitation (TR) on follow-up echocardiography. Secondary outcomes included reoperation, postoperative arrhythmia, and residual VSD at follow-up.

**Results:** Over the study period, 247 patients underwent VSD closure; 164 (66.4%) without TVD and 83 (33.6%) with TVD. Median follow-up time was 2343 days (IQR: 1237-3963.5 days) in the group without TVD vs 1606 days (IQR: 826-3017 days) in those with TVD. Median bypass time was similar between groups, but cross-clamp time was significantly longer in the group with TVD, 60 minutes (IQR: 51-81 minutes) vs 51 minutes (IQR: 40.5-70.5 minutes) ( $P = .001$ ). After successfully matching 83 patients, 29/83 (34.9%) in the non-TVD group had mild TR vs 28/83 (33.7%) in the TVD group ( $P = .87$ ). Freedom from TVR at 1, 5, and 10 years was analyzed using the Kaplan-Meier method. While the TVD cohort had a significantly higher incidence of mild (2+) TR at 5- and 10-year follow-up ( $P = .0275$  and  $.0174$ ), there was no significant difference in moderate TR. No significant VSDs were identified at latest echocardiographic follow-up, and no patients required reintervention for TV regurgitation.

**Conclusions:** Tricuspid valve detachment did not compromise long-term valve durability and did not impose increased morbidity. Patients who underwent TVD had a higher prevalence of mild TR but a similar prevalence of moderate TR compared to patients without TVD. When exposure is difficult, TVD is a safe and effective technical adjunct.



2:15 PM

Room 305

**Mid-Term Outcomes of Common Atrioventricular Valve Repair in Patients With Single Ventricular Physiology***H. F. Fengpu, S. A. Li, M. Kai, Z. Sen, Q. Lei, Q. Chen**National Center for Cardiovascular Diseases, Beijing Fuwai Hospital, Chinese Academy of Medical Sciences, and Peking Union Medical College*

**Purpose:** Common atrioventricular valve (CAVV) regurgitation is a significant risk factor for death after Fontan completion. CAVV repair concomitant to single ventricular palliative procedures, including bidirectional Glenn shunt (BDG) and total cavopulmonary connection (TCPC), remains a great challenge and refractory issue for pediatric cardiac surgeons. We aimed to report institutional outcomes of CAVV repairing patients with single ventricular physiology.

**Methods:** From January 2007 to December 2016, 37 consecutive patients with single ventricular physiology underwent CAVV repair in our center. Patients were divided into two groups by repair techniques: 19 patients with the modified Alfieri technique in group 1; 18 patients with other AVV repair techniques (partial annuloplasty in 10 patients, cleft closure in three patients, prosthetic rigid annuloplasty ring in three patients, valve replacement in two patients) in group 2. There were 12 patients with right atrial isomerism, 15 patients with heterotaxy syndrome, and four patients with total anomalous pulmonary venous connection (TAPVC). The CAVV regurgitation was moderate in 25 patients and severe in 12 patients preoperatively. The initial CAVV repair was performed concomitant to BDG in 10 patients, at duration between BDG and TCPC in two patients, and concomitant to TCPC in 25 patients. Two patients required reintervention. The baseline data were similar between two groups.

**Results:** Hospital and follow-up mortality was 8.1% (3/37) and 8.8% (3/34), respectively. After valvular procedures, CAVV regurgitation improved to absent in four patients, trivial in eight patients, mild in 21 patients, and moderate in one patient. After 48.8 months  $\pm$  30.1 months (range, 5-125 months) follow-up, CAVV regurgitation was documented as absent in two patients, trivial in two patients, mild in 20 patients, and moderate in seven patients. Estimated overall survival at 1, 5, and 10 years was 91.9%, 82.3%, and 70.6%, respectively. Freedom from CAVV failure was 94.1%, 74.9%, and 67.4%, at 1, 5, and 10 years, respectively. In multivariate analysis, the independent factor for CAVV failure was repair technique ( $P = .013$ ), heterotaxy syndrome ( $P = .02$ ), and polysplenia or asplenia syndrome ( $P = .036$ ). In patients who had TCPC, CAVV regurgitation at discharge ( $P = .025$ ) and at last follow-up ( $P = .017$ ) was significantly better in the modified Alfieri technique group. Thirty patients reached the stage of Fontan completion. Among the 31 survivors, one patient had a pacemaker implantation, one patient developed protein-losing enteropathy, and one patient was listed as awaiting transplantation. Twenty-four of 31 patients were in New York Heart Association classes I and II at the latest follow-up.

**Conclusions:** Outcomes of CAVV repair in patients who are palliated by single ventricular surgery are favorable. Patients in specific valvular anatomy may benefit from modified Alfieri technique.

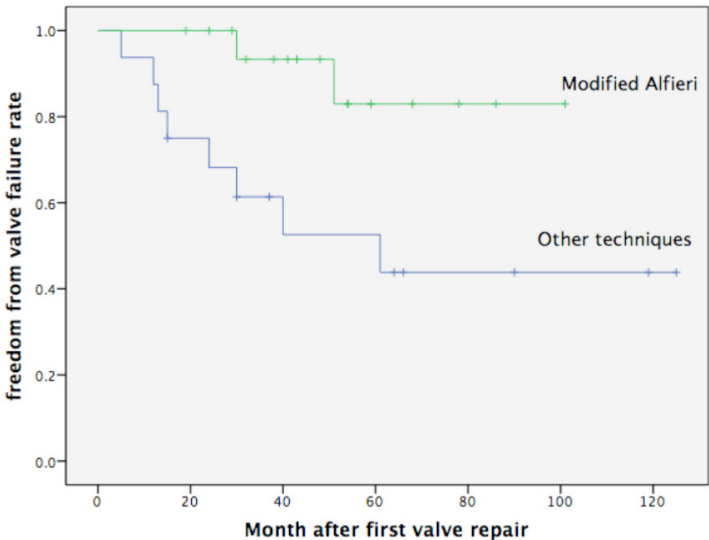


Figure 1. Actuarial survival rate freedom from valve failure rate

2:30 PM

Room 305

**Near-Normothermic Goal-Directed Innominate and Femoral Perfusion for Norwood Palliation of Hypoplastic Left Heart Syndrome***G. M. Hoffman, V. Hraska, J. P. Scott, M. E. Mitchell, R. K. Woods, E. E. Stuth**Children's Hospital and Medical College of Wisconsin, Milwaukee***COMMERCIAL RELATIONSHIPS** M. E. Mitchell: Ownership Interest, Ariosa Diagnostics, TAI Diagnostics; Research Grant, TAI Diagnostics; Consultant/Advisory Board, TAI Diagnostics

**Purpose:** Perfusion strategies for arch reconstruction of hypoplastic left heart syndrome (HLHS) continue to evolve. We sought to characterize our early experience with a goal-directed innominate and femoral artery perfusion strategy for whole-body organ preservation that minimized exposure to hypothermia and total support time by summarizing indices of cerebral and somatic perfusion.

**Methods:** Under opioid-volatile-balanced general anesthesia and cardiopulmonary bypass (CPB) at alpha-stat 32°C target temperature, extracorporeal perfusion was initiated via the innominate artery and a percutaneously placed 4Fr femoral artery sheath, with independent adjustment of flows targeting perfusion pressure 40-50 and organ-specific regional oxygen extraction by NIRS calculated from synchronous measures of arterial minus regional saturation. Physiologic data were extracted from anesthesia and perfusion records from all patients who underwent stage 1 palliation of HLHS utilizing innominate and femoral perfusion techniques.

**Results:** Data were available from nine patients, age 6 [4] days, 3.4 kg ± 0.6 kg. Patients were supported with CPB for total time of 111 [8] minutes, antegrade perfusion time of 44 [12] minutes, and aortic clamp time of 46 [9] minutes, at minimum temp of 30.3°C ± 1.3°C. Antegrade flow of 60 ml/kg/min ± 10 ml/kg/min achieved mean radial artery pressure of 41 mm Hg ± 7.7 mm Hg, with cerebral extraction of 15% ± 14% and somatic (renal) extraction of 15% ± 13%. After arch reconstruction, whole-body perfusion was continued, while an innominate-pulmonary artery graft was placed and selectively reduced from initial 4 [3-4] mm to 3.5 [3-3.5] mm with clips as necessary. After hemostasis and weaning from CPB, chest closure was performed selectively. Hemodynamic support at entry to the cardiac intensive care unit included milrinone 0.53 mcg/kg/min ± 0.08 mcg/kg/min, epinephrine 0.08 mcg/kg/min ± 0.04 mcg/kg/min, and norepinephrine 0.04 mcg/kg/min ± 0.02 mcg/kg/min, yielding atrial pressure 8 mm Hg ± 2.2 mm Hg, mean arterial pressure 49 mm Hg ± 7.4 mm Hg, arterial saturation 82% ± 2.7%, cerebral extraction 29% ± 12%, and somatic extraction 20% ± 8% at end-tidal pCO<sub>2</sub> of 40 ± 5 torr. All patients have achieved early survival or to bidirectional Glenn.

**Conclusions:** A modified perfusion strategy provides cerebral and somatic organ flow during arch reconstruction with good indices of perfusion. The technique avoids prolonged and deep hypothermia. Early results are encouraging but await mid- and late-term assessments of organ function, neurodevelopmental status, and survival.

2:45 PM

Room 305

## Surgical Management and Outcomes of Ebstein Anomaly in Neonates and Infants: An Analysis of the STS Congenital Heart Surgery Database

K. A. Holst<sup>1</sup>, J. A. Dearani<sup>2</sup>, S. Said<sup>3</sup>, R. R. Davies<sup>2</sup>, C. Pizarro<sup>3</sup>, C. J. Knott-Craig<sup>4</sup>, V. A. Starnes<sup>5</sup>, S. Kumar<sup>5</sup>, S. K. Pasquali<sup>6</sup>, D. Thibault<sup>7</sup>, J. M. Meza<sup>8</sup>, K. Hill<sup>9</sup>, K. E. Chiswell<sup>9</sup>, J. P. Jacobs<sup>10</sup>, M. L. Jacobs<sup>11</sup>

<sup>1</sup>Mayo Clinic, Rochester, MN, <sup>2</sup>University of Texas Southwestern Medical Center/Children's Medical Center Dallas, <sup>3</sup>Nemours/Alfred I. duPont Hospital for Children, Wilmington, DE, <sup>4</sup>Le Bonheur Children's Hospital, Memphis, TN, <sup>5</sup>University of Southern California, Los Angeles, <sup>6</sup>University of Michigan, Ann Arbor, <sup>7</sup>Duke University, Durham, NC, <sup>8</sup>Duke University Medical Center, Durham, NC, <sup>9</sup>Duke Clinical Research Institute, Durham, NC, <sup>10</sup>Johns Hopkins All Children's Hospital, St Petersburg, FL, <sup>11</sup>The Johns Hopkins University School of Medicine, Newton Square, PA

**COMMERCIAL RELATIONSHIPS** K. Hill: Research Grant, Gilead; Consultant/Advisory Board, Myokardia

**Purpose:** Ebstein anomaly (EA) encompasses a broad spectrum of morphology and clinical presentation. Those who are symptomatic early in infancy are generally at highest risk, but there are limited data regarding multicentric practice patterns and outcomes. We analyzed multi-institutional data concerning operations and outcomes in neonates and infants with EA.

**Methods:** Index operations reported in the STS Congenital Heart Surgery Database (2010-2016) were potentially eligible for inclusion. Analysis was limited to patients with diagnosis of Ebstein anomaly and age at surgery less than 1 year. Centers with >10% missing data for mortality and operations with missing data for key variables were excluded. Baseline characteristics and procedural factors were analyzed. Endpoints assessed included operative mortality, composite mortality/morbidity (based on six STS major complications, including unplanned reoperation), and postoperative length of stay.

**Results:** Among 255 neonates and 239 infants (surgery at 95 centers), prenatal diagnosis was common (n=318, 66%). Median age at operation was 7 days (IQR: 4, 13) for neonates and 179 days (108, 234) for infants; 25% (123/494) had premature birth. Preoperative risk factors included mechanical ventilation (n=190, 38%), mechanical circulatory support (n=18, 3.6%), and shock persistent at time of surgery (n=16, 3.2%). Most commonly performed operation was Ebstein repair (including tricuspid valve repair ± repositioning; 103/255 neonates, 40.4%; 37/239 infants, 15.5%,  $P < .001$ ). Tricuspid valve closure (univentricular palliation) was more frequent in neonates (33/255, 12.9%) than infants (4/239, 1.7%),  $P < .0001$ . Systemic-to-pulmonary artery shunt was performed in 118/255 (46.3%) neonates and 31/239 (13.0%) infants,  $P < .0001$ . Only infants underwent superior cavopulmonary connection (111/239, 46.4%). Six infants underwent heart transplant. Overall operative mortality was 18.6% (92/494) and was significantly higher among neonates than infants, as was mortality/major morbidity composite outcome. See Table for detailed outcomes report.

**Conclusions:** EA with symptomatic presentation in early infancy is a very high-risk group. Increased morbidity/mortality among neonates compared to infants highlights the importance of a judicious approach to timing of operative intervention. A dedicated prospective study is required to more fully understand optimal selection of treatment pathways and associations with outcomes.

**Table: Outcomes from Surgical Management of Ebstein Anomaly in Neonates and Infants**

Table: Outcomes from Surgical Management of Ebstein Anomaly in Neonates and Infants								
Variable		Overall (N=494)		Neonates (N=255)		Infants (N=239)		P-value <sup>+</sup>
Outcomes								
Operative Mortality		92	18.62	70	27.45	22	9.21	<.0001
Major Morbidity/Mortality		179	36.23	131	51.37	48	20.08	<.0001
Acute postoperative renal failure		25	5.06	23	9.02	2	0.84	<.0001
Neurological Deficit Persisting at Discharge		10	2.02	6	2.35	4	1.67	0.5925
Arrhythmia Requiring Permanent Pacemaker		11	2.23	6	2.35	5	2.09	0.8445
Mechanical Circulatory Support		58	11.74	48	18.82	10	4.18	<.0001
Phrenic Nerve Injury/Paralyzed Diaphragm		12	2.43	6	2.35	6	2.51	0.9096
Unplanned reoperation or interventional catheter procedure for cardiac reasons		99	20.04	72	28.24	27	11.30	<.0001
Postoperative Length of Stay (days)*	Median	493	16.00	254	26.00	239	8.00	<.0001
	25th		7.00		13.00		6.00	
	75th		39.00		56.00		21.00	
	Mean		32.44		45.23		18.85	
	STD		44.43		53.77		25.44	
	Min		0.00		0.00		0.00	
	Max		320.00		320.00		236.00	

+ P-values are based on Pearson chi-square tests for all categorical row variables.

\* P-values are based on chi-square rank based group means score statistics for all continuous/ordinal row variables (designated by \*).

1:00 PM – 3:00 PM

Floridian Ballroom D

### **EACTS @ STS: Bicuspid Aortic Valve Repair With Aortic Valve Insufficiency and Proximal Aortic Aneurysm Repair**

In this session, presented by STS and the European Association for Cardio-Thoracic Surgery (EACTS Vascular Domain), international experts will examine the treatment options available for bicuspid aortic valve (BAV) disease associated with pure aortic valve insufficiency (AI) and root dilation. Technical considerations, conduct of operation, surgical decision making, and the most up-to-date data will be presented.

#### **Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the reconstructive options available for repair of bicuspid aortic valve insufficiency with aortic root aneurysm
- Identify all bicuspid aortic valve phenotypes and consider which surgical treatment should be utilized

**Moderators:** *Joseph E. Bavaria, Philadelphia, PA, and Ruggero De Paulis, Rome, Italy*

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; R. De Paulis: Consultant/Advisory Board, Edwards Lifesciences

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, and interpersonal and communication skills. These physician competencies will be addressed through a series of collaborative lectures by members of The Society of Thoracic Surgeons and the European Association for Cardio-Thoracic Surgery.*

1:00 PM

### **Introduction: BAV Repair with Proximal Aortic Aneurysm: Essential Controversies Revealed**

*Joseph E. Bavaria, Philadelphia, PA*

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc

1:12 PM

### **David V Valve-Sparing Aortic Root Replacement Provides Equivalent Long-Term Outcomes in Patients With Bicuspid and Trileaflet Aortic Valves**

*M. O. Kayatta, B. G. Leshnower, L. McPherson, J. Binongo, C. Zhang, Y. Q. Lasanajak, E. P. Chen*

*Emory University, Atlanta, GA*

**COMMERCIAL RELATIONSHIPS** B. G. Leshnower: Speakers Bureau/Honoraria, Medtronic

**Purpose:** Valve-sparing aortic root replacement (VSRR) is an established treatment for aortic root pathology in the setting of trileaflet valves. However, the safety and durability of VSRR in bicuspid aortopathy is unclear. In this study, the long-term results of performing VSRR in patients with bicuspid and trileaflet valves were compared.



**Methods:** An institutional database of a US academic center identified 283 patients who underwent David V VSRR from 2005 to 2016. Of these patients, 217 patients had trileaflet valves and 66 had bicuspid valves. Patients were followed prospectively and had annual postoperative echocardiograms. Comparisons were made between the trileaflet valve group and bicuspid valve patients. Competing risk analysis was conducted to calculate and compare the risk of developing >2+ or the need for aortic valve replacement (AVR) between groups.

**Results:** The average age of patients with trileaflet valves was 46.1 years  $\pm$  13.5 years vs 43.0 years  $\pm$  11.7 years for bicuspid patients ( $P = .09$ ). There was a higher presence of preoperative >2+ aortic insufficiency (AI) present in bicuspid patients (62.1%) compared with trileaflet patients (31.8) ( $P < .01$ ). Otherwise, there were no significant differences in the preoperative demographics between groups, including reoperations (15.2% vs 12%,  $P = .5$ ) or emergent cases (37.9% vs 38.7%,  $P = .9$ ). Operative outcomes were similar between groups (Table). Echocardiographic follow-up was 91.2% complete and averaged 38.1 months  $\pm$  37.9 months (range, 1–137 months). At 9 years, freedom from >2+ AI and AVR was 94.4% and 92.7% in trileaflet patients and 92.9% ( $P = .24$ ) and 93.1% ( $P = .8$ ) in bicuspid patients. Preoperative >2+ AI did not predict >2+ postoperative AI in either trileaflet ( $P = .69$ ) or bicuspid patients ( $P = .39$ ), nor did it predict AVR in trileaflet ( $P = .62$ ) or bicuspid patients ( $P = .39$ ). Nine-year survival was no different between groups (trileaflet: 85.6%, bicuspid: 84.4%,  $P = .62$ ).

**Conclusions:** The David V VSRR can be safely and effectively performed in patients with trileaflet as well as bicuspid valves. Operative outcomes and valve function were equivalent in bicuspid and trileaflet patients in long-term follow-up. Performance of VSRR is a viable long-term option in the setting of bicuspid aortic valve aortopathy.

Table: Perioperative Outcomes of Propensity Matched Bicuspid and Trileaflet Patients

	Trileaflet	Bicuspid	p-value
Operative Mortality	3 (4.8%)	1 (1.6%)	0.62
Renal Failure	4 (6.3%)	1 (1.6%)	0.36
Stroke	1 (1.6%)	0 (0%)	0.99
Ventilator Hours (IQR)	6.5 (5, 9.5)	5 (4, 9)	0.16
Hospital Length of Stay	7.8 $\pm$ 8.7	6.2 $\pm$ 3.9	0.18

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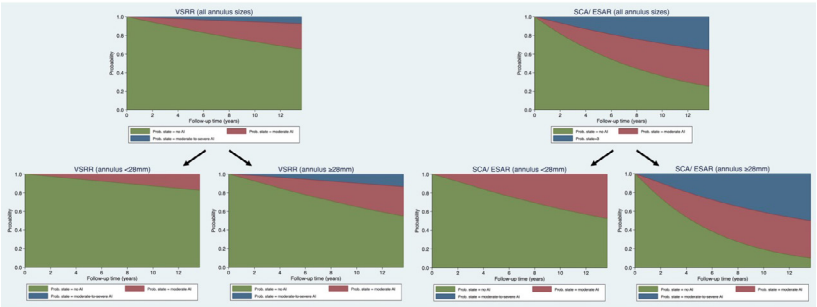
Floridian Ballroom D

**DEBATE: What Is the Best Operation for BAV AI With Root Aneurysm?***Remodeling with External Subannular Ring: Emmanuel Lansac, Paris, France**Reimplantation Root Procedure: Michael P. Fischbein, Stanford, CA***COMMERCIAL RELATIONSHIPS** E. Lansac: Ownership Interest, Coroneo; Consultant/Advisory Board, Coroneo; M. P. Fischbein: Research Grant, National Institutes of Health; Speakers Bureau/Honoraria, Abbott**REGULATORY DISCLOSURE** This presentation describes the use of the Coroneo Extra Aortic Ring, which has an FDA status of investigational.

1:54 PM

**Predictors of Long-Term Functional Outcomes in Type I Bicuspid Aortic Valve Repair***A. Haberbauer<sup>1</sup>, C. Komlo<sup>2</sup>, J. E. Bavaria<sup>2</sup>, M. A. Siki<sup>2</sup>, M. Freas<sup>1</sup>, R. C. Milerowski<sup>1</sup>, N. Desai<sup>2</sup>, W. Y. Szeto<sup>2</sup>, P. Vallabhajosyula<sup>2</sup>*<sup>1</sup>Hospital of the University of Pennsylvania, Philadelphia, <sup>2</sup>University of Pennsylvania, Philadelphia**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices**Purpose:** Annular stabilization techniques in bicuspid aortic valve (BAV) repair include valve-sparing root reimplantation (VSRR), external subannular aortic ring (ESAR), and subcommissural annuloplasty (SCA). Unlike VSRR, which offers neoroot creation, latter techniques offer annular reduction only. We compared long-term functional outcomes with these techniques to understand BAV repair durability.**Methods:** From 2004 to 2017, 139 patients underwent type I BAV repair, of whom 60 patients had VSRR and 79 patients underwent ESAR/SCA. A prospectively maintained BAV repair database was analyzed for clinical and functional outcomes. Cox regression analysis was performed to understand predictors of recurrent aortic insufficiency (AI). Multistate transition model for recurrent AI was generated to understand BAV repair durability over the long term (AI  $\geq 2+$ ). A threshold regression model was constructed to calculate a threshold for increased risk of recurrent AI ( $\geq 1+$ ). Subgroup analysis also was performed to understand the functional effects of preoperative annulus on recurrent AI.**Results:** VSRR patients had larger preoperative sinus dimension, but lower AI grade ( $1.7 \pm 1.4$  vs  $3.5 \pm 1.0$ ;  $P < .0001$ ). Overall, 30-day/in-hospital mortality, stroke, reoperation for bleeding, and pacemaker rates were zero in entire cohort. Postoperative freedom from AI  $\geq 1+$  was 100% in both groups. By Kaplan-Meier, freedom from aortic reoperation was significantly lower in VSRR compared to SCA/ESAR: 93%  $\pm$  3% vs 100% at 5 years and 75%  $\pm$  17% vs 100% at 10 years ( $P = .04$ ). By Cox regression, significant predictors of recurrent AI  $\geq 2+$  were preoperative annulus  $\geq 28$  mm (HR 3.314,  $P = .037$ ) and annular stabilization technique (HR 2.872,  $P = .038$ ) (Table). Multistate transition model demonstrated that ESAR/SCA patients had increased probability of AI  $\geq 2+$  over follow-up compared to VSRR patients (HR 3.425,  $P = .026$ , Figure). Two separate probability estimations are shown for hypothetical preoperative annulus dimensions of  $< 28$  mm vs  $\geq 28$  mm. Threshold regression for ESAR/SCA subgroup showed that preoperative annulus  $\geq 28$  mm was associated with greater likelihood of recurrent AI.**Conclusions:** VSRR is associated with improved BAV durability over long-term follow-up compared to ESAR/SCA. Preoperative annulus diameter of  $\geq 28$  mm is associated with increased recurrent AI, especially in ESAR/SCA patients. Further follow-up will help

delineate the role of each annular stabilization technique in BAV repair.



**Table 1 Cox proportional-hazards regression. Risk factors for recurrent AI (≥2)**

Variable	HR±Std. error	95% CI	P value
Age	0.987±0.017	0.995-1.020	0.432
SCA/ ESAR vs. VSRR	2.872±1.463	1.059-7.794	0.038
Preoperative annulus (≥28mm)	3.314±1.904	1.075-10.217	0.037
Preoperative AI	1.085±0.378	0.548-2.149	0.815
Preoperative AI (time-varying covariate)	1.000±0.000	1.000-1.001	0.295

Data are presented as Hazard Ratio (HR) ± Standard Error (Std. error). CI = Confidence interval, SCA = subcommissural annuloplasty, ESAR = external subannular ring, AI = aortic insufficiency

2:06 PM

Floridian Ballroom D

**Reimplantation and Valve Repair in BAV AI With Dilated Root: Evolution of the Procedure and Decision Making***Gebrine El-Khoury, Brussels, Belgium*

2:26 PM

**Fundamental Controversies in BAV Repair With Root Aneurysm***Joseph E. Bavaria, Philadelphia, PA***COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Edwards Lifesciences, Medtronic, Abbott, Gore Medical

2:46 PM

**Association Between Symmetric BAV Phenotypes and the Pattern of Valvular Dysfunction and Bicuspid Aortopathy***Z. Z. Huang**Peking Union Medical College, Beijing, China*

**Purpose:** To characterize aortic valve dysfunction and thoracic aortic dimensions over patients with symmetric bicuspid aortic valve using multidetector computed tomography (MDCT), gated coronary computed tomography angiography (CCTA), and surgical findings. An association between symmetric BAV phenotypes and the pattern of valvular dysfunction or bicuspid aortopathy has yet to be definitively established.

**Methods:** The study included 136 symmetric BAV patients (79 men, age 59.26 years  $\pm$  11.07 years) who underwent transthoracic echocardiogram, MDCT, and gated CCTA from 2010 to 2017. BAVs were classified as anterior-posterior (BAV-AP) or lateral (BAV-LA) orientation of the cusps. Thoracic aortic dimensions from the aortic root to the descending aorta were measured by gated CCTA at six levels.

**Results:** The prevalence of BAV-LA and BAV-AP was 80.6% and 19.4%, respectively. Comparing BAV-LA and BAV-AP, no differences in age, prevalence of male sex, or prevalence of moderate-to-severe aortic regurgitation were determined. However, significant differences in the valvular dysfunction pattern were noted, with moderate-to-severe aortic stenosis predominating in patients with BAV-AP (77.9% vs 52% in BAV-LA;  $P = .009$ ). Except ascending aortic dilation, dilation of aortic arch was the most common phenotype in BAV-LA patients (76.69% vs 56.0% in BAV-RL;  $P = .035$ ).

**Conclusions:** The patterns of valvular dysfunction and bicuspid aortopathy differed significantly between the two symmetric BAV phenotypes, suggesting the possibility of etiologically different entities. Symmetric BAV patients have a very high incidence of aortic valve stenosis rather than aortic valve insufficiency, especially in patients with BAV-AP.

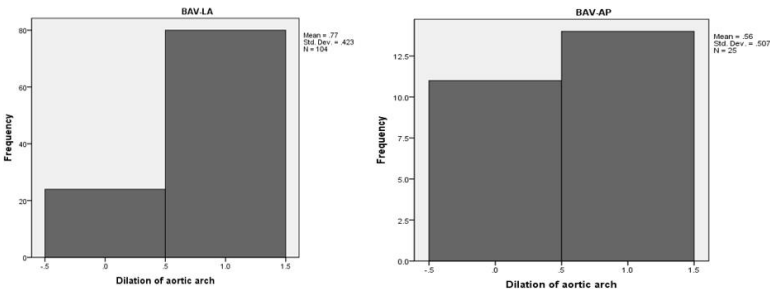


Fig 1 The frequency of dilation of aortic arch in BAV-LA and BAV-AP

1:00 PM – 3:00 PM

Room 304

**! STS/ISHLT Joint Symposium: LVAD Therapy in 2018—Worldwide Perspectives**

This joint symposium between STS and the International Society for Heart and Lung Transplantation will feature contemporary experience with left ventricular assist device (LVAD) therapy around the globe. The latest clinical trials and registry data will be presented, and areas of ongoing advanced research will be highlighted. This session also will cover innovative approaches to LVAD therapy, including minimally invasive implantation and LVAD decommissioning.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Explain the results of recent multicenter clinical trials of LVAD therapy, including survival and expected complications of the most commonly used pumps
- Describe the data provided by international LVAD registries and further questions that may be addressed through registry data
- Discuss the advantages and disadvantages of minimally invasive LVAD implantation and minimally invasive LVAD decommissioning
- Identify differences and commonalities among European, Asian, and American experiences with LVAD therapy

*Moderators: Jiri Maly, Prague, Czech Republic, and Gabriel Sayer, Chicago, IL*

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*The physician competencies addressed in this session are medical knowledge and patient care and procedural skills. These physician competencies will be addressed through a series of lectures and panel discussions on left ventricular assist device therapy in a global context.*

1:00 PM

**On the Horizon: Recent LVAD Clinical Trial Results and Emerging Data**

*Nir Uriel, Chicago, IL*

**COMMERCIAL RELATIONSHIPS** N. Uriel: Research Grant, Abbott, HeartWare, Novartis; Consultant/Advisory Board, Medtronic, Novartis

1:15 PM

**The HeartMate 3 LVAD in Europe: CE Mark and the ELEVATE Registry**

*Finn Gustafsson, Copenhagen, Denmark*

**COMMERCIAL RELATIONSHIPS** F. Gustafsson: Research Grant, Abbott; Speakers Bureau/Honoraria, Abbott

1:30 PM

**IMACS: What Can Registries Teach Us About LVADs?**

*James K. Kirklin, Birmingham, AL*

1:45 PM

**Panel Discussion**

2:00 PM

**Minimally Invasive Approach to LVAD Implantation***Nabush A. Mokadam, Seattle, WA*

2:15 PM

**Alternative Anticoagulation Strategies in LVAD Patients***Ivan Netuka, Prague, Czech Republic***COMMERCIAL RELATIONSHIPS** I. Netuka: Research Grant, Abbott; Consultant/Advisory Board, Abbott

2:30 PM

**Durable Biventricular Support Options in 2018***Gert D. Pretorius, San Diego, CA*

2:45 PM

**Panel Discussion**

1:00 PM – 3:00 PM

Floridian Ballroom B-C

**General Thoracic: Lung Cancer II***Moderators: Lisa M. Brown, Sacramento, CA, and Robert A. Meguid, Aurora, CO*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

1:00 PM

**Database Studies: Are They Worth the Paper They're Printed On?***Felix G. Fernandez, Atlanta, GA*

1:15 PM

**Richard E. Clark Memorial Paper for General Thoracic Surgery: Use of Invasive Mediastinal Staging for Lung Cancer by STS National Database Participants**

**S. B. Krantz<sup>1</sup>, J. A. Horwington<sup>2</sup>, D. E. Wood<sup>3</sup>, K. Kim<sup>4</sup>, A. S. Kosinski<sup>5</sup>, M. Cox<sup>5</sup>, S. Kim<sup>4</sup>, M. S. Mulligan<sup>6</sup>, F. Farjah<sup>6</sup>**

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**COMMERCIAL RELATIONSHIPS** M. S. Mulligan: Consultant/Advisory Board, Covidien; D. E. Wood: Consultant/Advisory Board, GRAIL, Spiration

**Discussant:** Mark S. Allen, Rochester, MN

**COMMERCIAL RELATIONSHIPS** M. S. Allen: Ownership Interest, Medtronic; Speakers Bureau/Honoraria, Medtronic; Nonremunerative Position of Influence, STS Finance Chair, GTSC Executive Committee

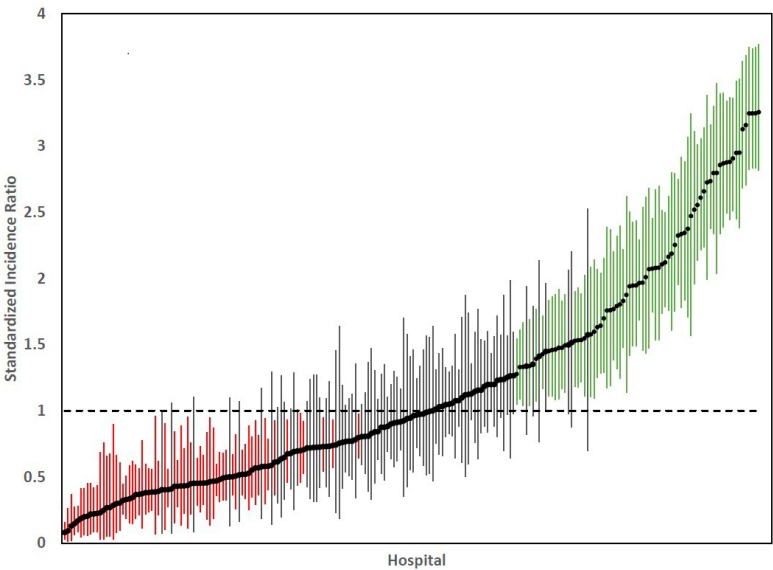
**Purpose:** Studies suggest gaps in the quality of lung cancer care with underutilization of invasive mediastinal staging. We sought to identify predictors of invasive staging and hypothesized that utilization would be greater and more uniform amongst STS General Thoracic Surgery Database (GTSD) participants compared to previously reported rates.

**Methods:** A retrospective study (2012-2016) was conducted of lung cancer patients staged by computed tomography and positron-emission tomography and treated with an anatomic resection without induction therapy. We measured invasive staging procedures that occurred within 180 days of resection. We evaluated variability in invasive mediastinal staging rates across database participant sites with the standardized incidence ratio (SIR)—the participant rate relative to the “average” participant rate—using a Bayesian random effects logistic regression. Poisson regression was used to identify patient-level predictors of invasive mediastinal staging.

**Results:** Among 29,015 patients (median age 68 years, 55% women, 56% clinical stage IA, 84% lobectomy) across 256 participating GTSD sites, 9797 underwent invasive mediastinal staging. The rate of invasive mediastinal staging was significantly higher among GTSD participants (all stages 34%, stage ≥IB 43%) compared to prior reports (20%-27%). However, this rate was significantly lower than expected invasive staging rates among a population of operable lung cancer patients receiving guideline concordant care (77%-79%). As expected,

patient-level factors independently associated with invasive mediastinal staging included increasing clinical stage and centrally located tumors (Table), though still below expectation (only 52% for patients with central tumors). The Figure shows substantial variability in the use of invasive mediastinal staging across 216 participant sites that performed at least 10 cases. Sixty-five sites (30%) performed invasive mediastinal staging significantly less often than average, and 69 sites (32%) performed invasive mediastinal staging significantly more often than average.

**Conclusions:** GTSD participants performed invasive mediastinal staging more frequently than previously reported but below the expectation predicted by guideline concordant care. This finding, along with significant variability in practice patterns across sites, is consistent with either a quality gap, clinical uncertainty over the indications for invasive mediastinal staging, or both.



**Table 1. Factors Associated with Undergoing Invasive Mediastinal Staging**

<i>Risk Factor</i>	<i>Adjusted RR (95% CI) of Invasive Mediastinal Staging</i>	<i>Adjusted P value</i>
Age per 5-years increase	1.00 (0.99,1.01)	0.8364
<b>Female vs. Male</b>	<b>0.93 (0.90,0.96)</b>	<b>&lt;.0001</b>
Race-Black vs. White	1.04 (0.99,1.09)	0.1282
Race-Other vs. White	1.04 (0.97,1.11)	0.2924
CHF	0.98 (0.90,1.07)	0.6730
CAD	0.97 (0.94,1.01)	0.1801
Hypertension	1.00 (0.97,1.04)	0.8140
PVD	1.01 (0.95,1.06)	0.7873
CVD	1.01 (0.95,1.07)	0.8514
<b>COPD</b>	<b>1.05 (1.01,1.10)</b>	<b>0.0078</b>
Diabetes	1.01 (0.97,1.05)	0.6845
Dialysis	1.00 (0.82,1.24)	0.9659
Cr $\geq 2$	0.95 (0.85,1.07)	0.4004
Steroid	0.98 (0.91,1.06)	0.6949
ASA II vs. I	1.07 (0.79,1.44)	0.6782
ASA III vs. I	1.10 (0.80,1.50)	0.5595
ASA IV/V vs. I	1.07 (0.78,1.46)	0.6915
Zubrod-Symptoms, fully ambulatory vs. Normal	1.04 (0.99,1.09)	0.1359
Zubrod-Symptoms, bed less than 50% of the time vs. Normal	1.07 (0.98,1.17)	0.1471
Zubrod-Symptoms, in bed $>50\%$ /Bedridden/Moribund vs. Normal	0.90 (0.71,1.14)	0.3724
<b>Prior CTS</b>	<b>1.18 (1.10,1.26)</b>	<b>&lt;.0001</b>
Preop Radiation	0.97 (0.89,1.06)	0.5208
FEV per 5% increase	1.00 (0.99,1.00)	0.6774
DLCO per 5% increase	<b>0.99 (0.99,0.99)</b>	<b>&lt;.0001</b>
Clinical Stage II vs. I	<b>1.57 (1.47,1.68)</b>	<b>&lt;.0001</b>
Clinical Stage IIIA vs. I	<b>1.54 (1.42,1.66)</b>	<b>&lt;.0001</b>
Clinical Stage IIIB vs. I	<b>1.86 (1.63,2.12)</b>	<b>&lt;.0001</b>
Clinical Stage IV vs. I	<b>1.38 (1.15,1.66)</b>	<b>0.0006</b>
<b>Central Feature</b>	<b>1.35 (1.26,1.44)</b>	<b>&lt;.0001</b>
Surgery Year 2013 vs. 2012	1.06 (0.96,1.18)	0.2426
Surgery Year 2014 vs. 2012	1.11 (0.98,1.26)	0.0976
<b>Surgery Year 2015 vs. 2012</b>	<b>1.14 (1.01,1.28)</b>	<b>0.0334</b>
Surgery Year 2016 vs. 2012	1.07 (0.93,1.23)	0.3567

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Floridian Ballroom B-C

## Significant Variation in Compliance With Lung Cancer Quality Measures Exists Across US Hospitals

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<sup>1</sup>Northwestern University, Chicago, IL, <sup>2</sup>Northwestern Memorial Hospital, Chicago, IL

**COMMERCIAL RELATIONSHIPS** M. M. DeCamp: Consultant/Advisory Board, Boston Scientific, Holaira, Intuitive Surgical

**Purpose:** Interventions at the hospital level are a promising avenue to improve the delivery of lung cancer care. We sought to: 1) examine hospital-level adherence to the American College of Surgeons Commission on Cancer (CoC) lung cancer quality measures, and 2) identify factors that predispose to non-adherence.

**Methods:** The National Cancer Data Base (NCDB) was queried to identify patients with non-small-cell lung cancer (NSCLC) treated between 1997 and 2012. Hospital-level adherence to each of three CoC-defined quality measures (sampling of at least 10 regional lymph nodes at the time of surgery; surgery not used as primary therapy in patients with N2 disease; surgery performed within 90 days of neoadjuvant chemotherapy and 120 days of adjuvant chemotherapy) was assessed. Measure adherence was calculated at the hospital level, and logistic regression was used to identify factors independently impacting hospital adherence to each measure.

**Results:** During the study period, a total of 386,866 patients underwent surgery for NSCLC at 2473 hospitals. The CoC has established a minimum threshold of 80% compliance with each quality measure. The majority of hospitals fell below this performance threshold in operative nodal staging (77.4% failure) and referral for adjuvant chemotherapy (68.2% fail) (Figure). However, most hospitals appropriately avoided surgery as first-line treatment in N2 disease (2.6% fail) and had a short interval between neoadjuvant chemotherapy and surgery (1.0% fail). Higher-volume hospitals were more likely to meet thresholds for operative nodal sampling (32.7% vs 20.2%,  $P < .0001$ ) and referral for adjuvant chemotherapy (34.8% vs 29.8%,  $P < .0001$ ). Appropriate nodal sampling ( $P < .001$ ), timely referral for adjuvant chemotherapy ( $P = .02$ ), and neoadjuvant treatment of N2 disease ( $P < .0001$ ) also were more likely to occur in academic hospitals than in non-teaching hospitals. Measure adherence did not demonstrate improvement over time.

**Conclusions:** Understanding performance in cancer care delivery allows for targeted interventions, which may improve patient outcomes. Currently, most US hospitals are well below defined quality standards in surgical lymph node sampling and referral for adjuvant chemotherapy, representing a significant opportunity to improve lung cancer care nationally.

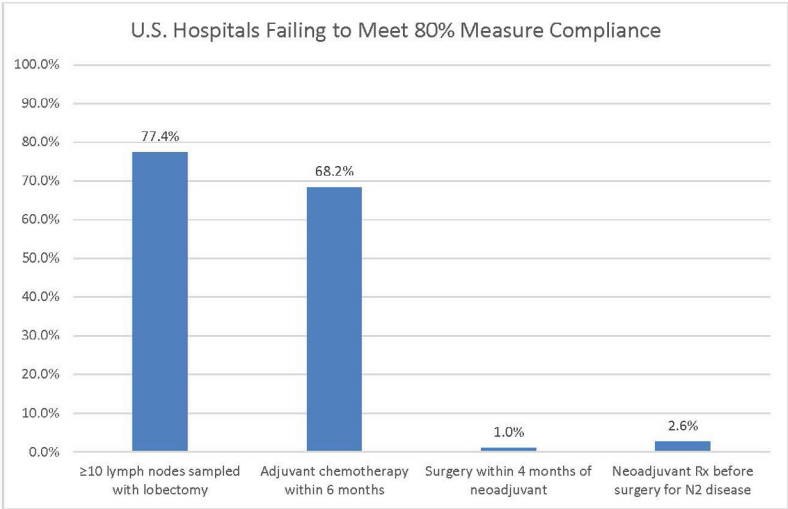


Figure 1: Percentage of US hospitals which do not meet a threshold of 80% compliance in each of the evaluated Commission on Cancer quality measures for lung cancer care.



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Floridian Ballroom B-C

## Defining Proficiency for STS National Database Participants Performing Thoracoscopic Lobectomy

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<sup>1</sup>Washington University, St Louis, <sup>2</sup>University of Washington Medical Center, Seattle, <sup>3</sup>Rush University Medical Center, Chicago, IL, <sup>4</sup>CNY Thoracic Surgery, PC, Jamesville, NY, <sup>5</sup>Massachusetts General Hospital, Boston, <sup>6</sup>University of California, Davis Medical Center, Sacramento, <sup>7</sup>Medical City Dallas, TX, <sup>8</sup>St Louis University, MO, <sup>9</sup>Beaumont, Auburn Hills, MI, <sup>10</sup>The Johns Hopkins University, Baltimore, MD, <sup>11</sup>University of Michigan, Ann Arbor, <sup>12</sup>Vanderbilt University Medical Center, Nashville, TN, <sup>13</sup>Emory University, Atlanta, GA, <sup>14</sup>Cleveland Clinic, OH, <sup>15</sup>Duke Clinical Research Institute, Durham, NC

**COMMERCIAL RELATIONSHIPS** S. R. Broderick: Consultant/Advisory Board, Bristol Myers Squibb; D. P. Raymond: Ownership Interest, Bristol Myers Squibb

**Purpose:** Parameters that define attainment and maintenance of proficiency in thoracoscopic (VATS) lobectomy remain unknown. To address this knowledge gap, we investigated the institutional performance curve for VATS lobectomy using risk-adjusted Cusum analysis, an analytic methodology that monitors outcomes continuously, providing signals of trends toward greater than expected morbidity and mortality.

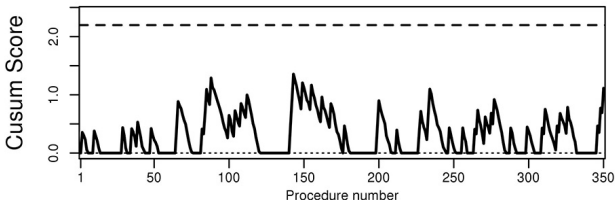
**Methods:** Using the STS General Thoracic Surgery Database, we identified centers that had performed a total of 30 or more VATS lobectomies. Major morbidity, mortality, and blood transfusion were each deemed a primary outcome, with expected incidence derived from risk-adjusted regression models. In Cusum analysis, occurrence of an event is defined as a failure. Acceptable and unacceptable failure rates for each outcome were set a priori based upon clinical relevance and informed by regression model output. Performance curves were generated for primary outcomes for the entire cohort and for each participating center.

**Results:** Between 2001 and 2016, 24,196 patients underwent VATS lobectomy at 159 centers with a median volume of 103 (range, 30-760). Overall rates of operative mortality, major morbidity, and transfusion were 1% (244/24,189), 17.1% (4145/24,196), and 4% (975/24,196), respectively. During the study period, operative mortality (earliest vs most recent decile, 1.6% vs 0.7%,  $P = .009$ ) and transfusion (earliest vs most recent decile, 5.4% vs 2.5%,  $P < .001$ ) declined, while major morbidity remained unchanged. Of the highest-volume centers (>100 cases), 84.4% (65/77) and 81.8% (63/77) ( $P = .48$ ) were proficient by major morbidity standards by their 50th and 100th cases, respectively. Similarly, 92.2% (71/77) and 89.6% (69/77) ( $P = .41$ ) of centers showed proficiency by transfusion standards by their 50th and 100th cases. Three performance patterns were observed: A) Initial and sustained proficiency; B) Crossing unacceptability thresholds with subsequent improved performance; and C) Crossing unacceptability thresholds without subsequent improved performance (Figure shows performance for major morbidity).

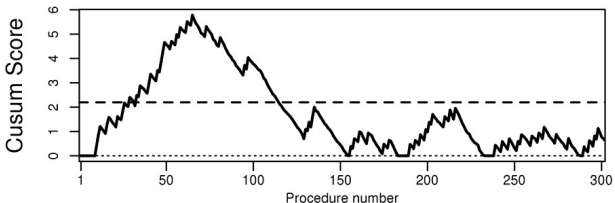
**Conclusions:** VATS lobectomy outcomes have improved with lower mortality and transfusion rates. The majority of high-volume centers demonstrate proficiency after 50 cases; however, some centers never achieved proficiency. Cusum methodology provides a simple yet powerful evaluative tool that can trigger internal audits and performance improvement initiatives.

CUSUM ANALYSIS FOR MAJOR MORBIDITY

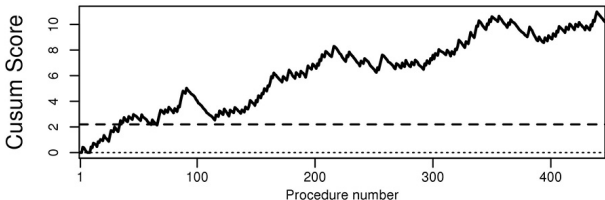
Initial and  
sustained  
proficiency



Proficiency  
achieved  
with  
experience



Proficiency  
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achieved



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Floridian Ballroom B-C

**Postoperative Radiation Therapy Does Not Improve Survival When Added to Chemotherapy in Patients With Clinical N0, Pathological N2 Non–Small-Cell Lung Cancer After Resection***J. A. Drake<sup>1</sup>, D. C. Portnoy<sup>2</sup>, B. Weksler<sup>2</sup>**<sup>1</sup>University of Tennessee Health Science Center, Memphis, <sup>2</sup>University of Tennessee/West Cancer Center, Memphis***COMMERCIAL RELATIONSHIPS** D. C. Portnoy: Speakers Bureau/Honoraria, Eli Lilly; B. Weksler: Speakers Bureau/Honoraria, Intuitive Surgical

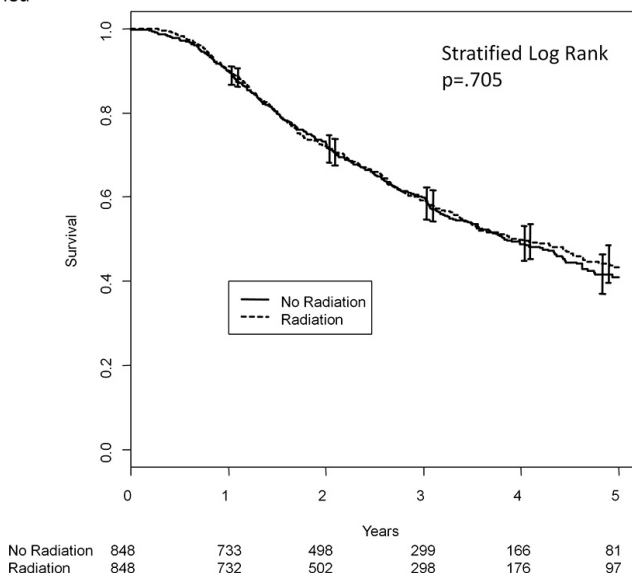
**Purpose:** The management of N2 disease found at operation is controversial. Current guidelines recommend adjuvant chemotherapy alone (AC) or adjuvant chemoradiation therapy (CRT). The aim of the current study was to evaluate whether CRT provided superior survival compared to AC in patients with clinical N0, pathological N2 disease after complete resection.

**Methods:** The National Cancer Database (NCDB) was queried for all patients with clinical N0, pathological N2 non–small-cell lung cancer (NSCLC) who did not receive preoperative therapy and underwent complete (R0) surgical resection followed by AC or CRT. Propensity matching was then utilized to create a well-balanced cohort of patients who received AC or CRT, with respect to age, sex, race, Charleston Comorbidity Score (CCS), treating facility, tumor size, year of diagnosis, and number of positive nodes. Standardized difference less than 10 was considered a well-balanced cohort. Survival was examined using the Kaplan-Meier method with log-rank analysis. Significance was set at  $P \leq .05$ .

**Results:** We identified 2031 eligible patients; 882 patients (43.4%) received CRT and 1149 patients (56.6%) received AC alone. In the unmatched cohort, patients receiving CRT tended to be younger (64.2 vs 65.4) and to have a CCS of 0 (57.5% vs 52.1%). There was no difference in median survival between those receiving CRT and those receiving AC (3.9 years vs 3.8 years,  $P = .518$ ). We then identified 848 well-matched pairs (Table) and did not detect differences in median survival between patients receiving CRT or AC (3.9 years vs 3.8 years,  $P = .705$ , Figure).

**Conclusions:** In a large database study, the addition of radiation to adjuvant chemotherapy after resection of N2 NSCLC does not improve survival. Until more definitive data confirm our findings, patients with N2 disease detected at surgery should be treated with AC alone.

## Matched



	RT after Surg n = 848	No RT n = 848	Standardized Difference
Age	64.5 ± 9.5	64.5 ± 9.6	0.1
Sex			
Male	381 (44.9%)	386 (45.5%)	1.2
Female	467 (55.1%)	462 (54.5%)	
Race			
Caucasian	736 (86.8%)	743 (87.6%)	2.5
Black	80 (9.4%)	75 (8.8%)	2.0
Other	32 (3.8%)	30 (3.5%)	1.3
Type of facility			
Academic	285 (33.6%)	282 (33.3%)	0.7
Other	563 (66.4%)	566 (66.7%)	
Charlson Comorbidity Score			
Score = 0	479 (56.5%)	470 (55.4%)	2.1
Score = 1	274 (32.3%)	278 (32.8%)	1.0
Score > 1	95 (11.2%)	100 (11.8%)	1.8
AJCC Clinical T stage			
1	474 (55.9%)	469 (55.3%)	1.2
2	335 (39.5%)	340 (40.1%)	1.2
3	39 (4.6%)	38 (4.5%)	0.8
4	0 (0.0%)	1 (0.1%)	4.9
Histology			
Large cell carcinoma	20 (2.4%)	17 (2.0%)	2.4
Squamous cell carcinoma	129 (15.2%)	135 (15.9%)	2.0
Adenocarcinoma	669 (78.9%)	668 (78.8%)	0.3
Neuroendocrine	5 (0.6%)	5 (0.6%)	0.0
Non-small cell carcinoma	25 (2.9%)	23 (2.7%)	1.4
Size of Tumor (Median, IQR)	28.0 (20.0, 40.0)	28.0 (20.0, 40.0)	0.8
Number of Positive Nodes (Median, IQR)	2.0 (1.0, 4.0)	2.0 (1.0, 4.0)	1.0

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Floridian Ballroom B-C

**The Role of Lymph Node Dissection in Carcinoids: A National Cancer Database Analysis**

*P.J. Kneuert, M. K. Kamel, B. E. Lee, M. Rabouma, J. E. Jurado, S. W. Harrison, B. M. Stiles, N. K. Altorki, J. Port*

*NewYork-Presbyterian Hospital, Weill Cornell Medical College, NY*

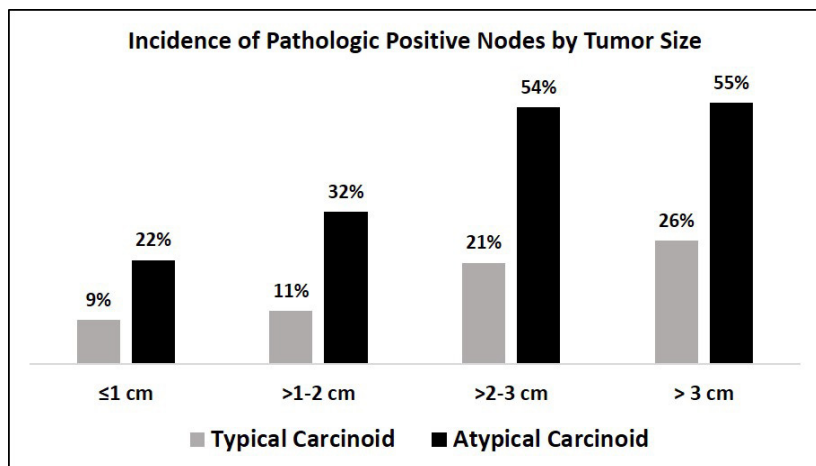
**COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest: Angiocrine Bioscience, Nanocyte; B. M. Stiles: Employment, Pfizer - wife employed by Pfizer; Consultant/Advisory Board, Merck

**Purpose:** Pulmonary carcinoid tumors are often considered indolent tumors. The prognostic significance of lymph node (LN) metastases and the need for routine mediastinal dissection is controversial. We sought to determine the incidence and prognosis of lymph node metastases in resected carcinoid patients and determine risk factors for LN involvement.

**Methods:** The National Cancer Database (NCDB) was queried for patients who underwent primary resection of bronchopulmonary carcinoid tumors between 2004 and 2014. We included patients with typical (TC) and atypical (AC) carcinoids who underwent lung resection and had  $\geq 10$  LNs removed. Clinical and pathologic LN status was assessed. Overall survival (OS) was analyzed using log-rank test and Cox hazard regression analysis.

**Results:** A total of 3335 patients (2893 TC, 442 AC), underwent resection (lobectomy/bilobectomy 84%, pneumonectomy 8%, sublobar resection 8%). Pathologic LN involvement was present in 21% of patients (N1 15%, N2 6%). The incidence of LN involvement increased with tumor size and AC histology (Figure). LN upstaging was evident in 13% of patients (TC 11%, AC 24%). Factors influencing OS on multivariate analysis were AC type (HR 2.47 [95% CI 2.11-2.78]), positive LNs (HR 1.72 [95% CI 1.53-1.94]), and tumor size (per cm, HR 1.009 [95% CI 1.001-1.017]). LN metastases was associated with worse survival in TC patients with tumors  $> 2$  cm (5-year OS 87% vs 93%,  $P = .005$ ) and in AC patients (5-year OS 58% vs 87%,  $P = .001$ ). LN involvement was not associated with worse survival in small ( $< 2$  cm) TC patients (5-year OS 93% vs 92%,  $P = .67$ ).

**Conclusions:** In this large dataset of well-staged patients with carcinoids, a significant number had LN metastases. LN involvement was an independent predictor of worse survival. Nodal dissection in tumors  $> 2$  cm and in atypical subtype can yield important prognostic information and may help identify patients for novel therapeutics.



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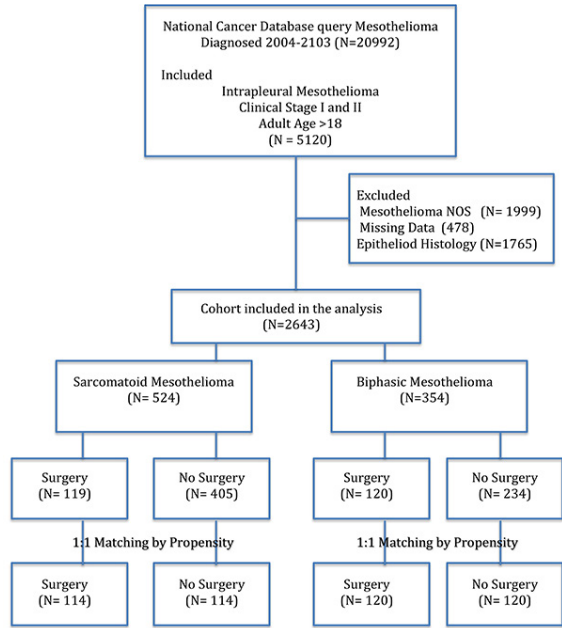
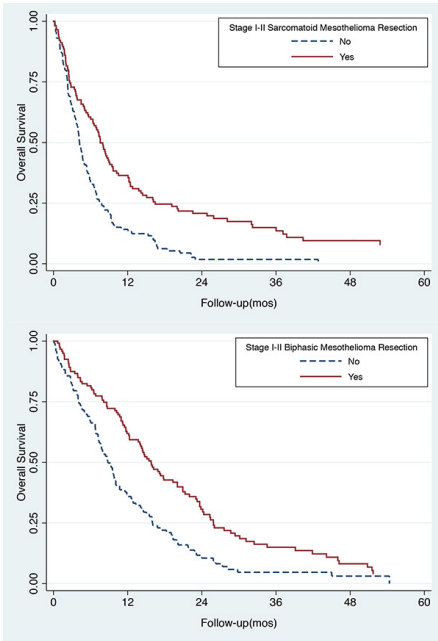
**Is There a Role for Surgical Resection in Early Stage Sarcomatoid or Biphasic Mesothelioma? Result of a Propensity-Matched Analysis***S. S. Kim, L. L. Garland, C. C. Hsu**University of Arizona, Tucson*

**Purpose:** The purpose of this study was to compare overall survival between patients who underwent surgical resection and those who did not receive surgery for early stage sarcomatoid or biphasic mesothelioma.

**Methods:** Adult patients with clinical stage I or II pleural mesothelioma were identified in the National Cancer Database (NCDB) from 2004 to 2103. Patients who underwent surgical resection were matched by propensity score (age, sex, race, income, location, hospital type, T stage, chemotherapy, radiation therapy, Charlson-Deyo score) with patients who did not receive surgery. Overall survival was compared using a Cox proportional hazard regression model.

**Results:** Out of 20,992 patients with mesothelioma queried from the NCDB, we identified 878 patients with clinical stage I or II intrapleural mesothelioma with either sarcomatoid (524) or biphasic (354) histology. In the sarcomatoid mesothelioma group, 114 patients who underwent surgical resection were matched with 114 patients who had no surgical procedure with overall median survival (mOS) of 5.5 months. In this group, those who underwent surgical resection had improved survival compared to those who did not have surgery (median survival, 7.56 months vs 4.21 months, respectively; log-rank  $P < .001$ ; hazard ratio 0.52; 95% CI 0.29 to 0.69). In biphasic mesothelioma group, median overall survival was 11.89 months. The surgery group had improved survival compared to the no surgery group (mOS 15.8 months vs 8.8 months, respectively; log-rank  $P < .001$ ; hazard ratio 0.55; 95% CI 0.42 to 0.72).

**Conclusions:** Surgical resection is associated with improved survival in early stage mesothelioma patients with either biphasic or sarcomatoid histology compared with those who did not have surgery. These findings suggest surgical resection may play a role in the management of early stage mesothelioma with aggressive histology in selected patients.



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Floridian Ballroom B-C

### Differences and Quality Indicators in Low- and High-Performing STS General Thoracic Surgery Database Participants

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<sup>1</sup>Duke University Medical Center, Durham, NC, <sup>2</sup>Duke Clinical Research Institute, Durham, NC,

<sup>3</sup>University of California, San Diego

**COMMERCIAL RELATIONSHIPS** T. D'Amico: Consultant/Advisory Board, Scanlan; M. A. Daneshmand: Speakers Bureau/Honoraria, Maquet; S. Vemulapalli: Research Grant, Abbott Vascular

**Purpose:** STS star ratings, based on a composite score of mortality and major morbidity, are used for public reporting of performance among STS National Database participants. We hypothesized that comparison of patient comorbidities, practice patterns, and outcomes in low-performing and high-performing centers would reveal areas for focused quality improvement across all centers.

**Methods:** The STS General Thoracic Surgery Database was queried for elective lobectomy operations performed January 1, 2012, through December 31, 2014. Low-performing centers (LPC) and high-performing centers (HPC) were defined as those outside the 80% Bayesian credible intervals as previously described. Differences in baseline patient characteristics and postoperative outcomes were compared between LPC and HPC. Participants were then divided into four groups of combined morbidity (low/high) and mortality (low/high) for comparison. Major morbidity included pneumonia, acute respiratory distress syndrome, bronchopleural fistula, pulmonary embolus, initial ventilator support >48 hours, reintubation, tracheostomy, myocardial infarction, unexpected return to OR, and new central neurological event.

**Results:** There were 7990 patients treated at 19 LPC, 180 average-performing centers, and 32 HPC. At baseline, although patients treated at LPC were more likely to be younger, a higher proportion was male and had coronary artery disease and/or cerebrovascular disease, compared to HPC patients ( $P < .05$ ). More patients had VATS lobectomy at HPC than LPC (70.8% vs 53.0%,  $P < .0001$ ). Major morbidity and mortality were more frequent at LPC (all events  $P < .005$ ). A higher proportion of patients at LPC had two or more major morbidity events compared to those at HPC (6.0% vs 1.3%,  $P < .001$ ). Among high morbidity centers, patients treated at those with low mortality had fewer overall complications and fewer multiple-morbidity postoperative events than centers with high mortality (1.5% vs 2.9%,  $P = .0034$ ). More patients in LPC were treated at teaching institutions. Although median case volume was significantly higher in HPC, there was notable overlap in IQR between groups.

**Conclusions:** Surgical volume does not seem to explain increased morbidity and mortality in LPC. Patients treated at HPC may be screened more effectively preoperatively and are more likely to undergo thoracoscopic lobectomy. In addition, LPC are more likely to be teaching institutions. Additional study is necessary to determine causation.

Table 1. Baseline patient characteristics and postoperative events at LPC and HPC.

Effects		19 low-performing participants for composite N=2906	32 high-performing participants for composite N=5084	P-Value
Age (years)	Median (IQR)	67.0 (60.0, 74.0)	69.0 (61.0, 75.0)	<.0001
Male gender		1,374 (47.3%)	2,255 (44.4%)	0.0115
Coronary Artery Disease		749 (25.8%)	1,060 (20.8%)	<.0001
Cerebrovascular Disease		262 (9.0%)	344 (6.8%)	0.0006
Center Volume (mean number of cases/year)	Median (IQR)	58.3 (49.3, 124.3)	70.3 (47.0, 92.3)	0.0066
Teaching Status of Center		1,521 (52.3%)	2,205 (43.4%)	<.0001
VATs		1,541 (53.0%)	3,599 (70.8%)	<.0001
Major Morbidity		462 (15.9%)	260 (5.1%)	<.0001
Major Morbidity including Central Neurologic Event		465 (16.0%)	269 (5.3%)	<.0001
Unexpected Reoperation		172 (5.9%)	113 (2.2%)	<.0001
Pneumonia		252 (8.7%)	105 (2.1%)	<.0001
Bronchopleural Fistula		23 (0.8%)	8 (0.2%)	<.0001
ARDS		24 (0.8%)	17 (0.3%)	0.0031
Ventilator Support > 48 hours		21 (0.7%)	13 (0.3%)	0.0020
Reintubation		188 (6.5%)	72 (1.4%)	<.0001
Tracheostomy		51 (1.8%)	29 (0.6%)	<.0001
Myocardial Infarction		17 (0.6%)	6 (0.1%)	0.0002
Total number of major complications including Central Neurologic Event	No complication	2,441 (84.0%)	4,815 (94.7%)	<.0001
	One complication	290 (10.0%)	200 (3.9%)	.
	Two complications	94 (3.2%)	33 (0.6%)	.
	Three or more complications	81 (2.8%)	36 (0.7%)	.
Operative Mortality		81 (2.8%)	23 (0.5%)	<.0001

1:00 PM – 3:00 PM

Room 316

**General Thoracic: Mediastinal/Pulmonary***Moderators: Usman Ahmad, Cleveland, OH, and Christopher R. Morse, Boston, MA*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.

1:00 PM

**Short-Term Outcomes of Tracheal Resection in the STS General Thoracic Surgery Database****B. P. Stanifer<sup>1</sup>, A. C. Andrei<sup>2</sup>, S. Meyerson<sup>2</sup>, D. D. Odel<sup>1</sup>, A. Bharat<sup>2</sup>, M. Liu<sup>1</sup>, M. M. DeCamp<sup>1</sup>**<sup>1</sup>Northwestern Memorial Hospital, Chicago, IL, <sup>2</sup>Northwestern University, Chicago, IL**COMMERCIAL RELATIONSHIPS** A. C. Andrei: Consultant/Advisory Board, AtriCure; M. M. DeCamp: Consultant/Advisory Board, Boston Scientific, Holaira, Intuitive Surgical

**Purpose:** Tracheal resection remains uncommon, and most of the literature consists of single-center studies. The goals of our study were to perform a contemporary, multicenter analysis of tracheal resection outcomes, identify independent predictors of morbidity and mortality, and evaluate the relationship between volume and outcome using the STS National Database.

**Methods:** The STS General Thoracic Surgery Database was queried for all patients who had a tracheal resection for benign or malignant disease by any approach from 2002 to 2016. There were 107 centers that reported on 1617 cases in the study period. We created a multivariable logistic regression model with stepwise selection to identify variables related to the combined outcome of mortality or major morbidity (M+M). The chi-square test was used to compare outcomes by average yearly volume in relationship to the combined M+M endpoint.

**Results:** The cervical approach was used 75% of the time, and benign disease was the indication in 75% of cases. Overall 30-day mortality was 1% (Figure). The 30-day readmission rate was 6.5%. There was no difference in mortality rate between cervical or thoracic approaches (1% vs 2%,  $P = .77$ ) or between benign or malignant indications (1% vs 2%  $P = .10$ ). Benign indications led to a longer length of stay when compared to malignant indications (10.9 days vs 8.9 days,  $P = .014$ ). Independent factors that predict morbidity or mortality include the thoracic approach, diabetes, and functional status (Table). Nine centers accounted for 50% of the volume. Centers were divided into those averaging less than four resections per year and those performing four or more per year. The <4 group had a combined M+M of 27%, while those  $\geq 4$  had a combined M+M of 17%,  $P < .0001$ .

**Conclusions:** STS National Database participants perform tracheal resection for benign or malignant disease with low early morbidity and mortality. Higher operative volume ( $\geq 4$  resections/year) is associated with improved outcome. Longer follow-up is needed to confirm airway stability and absence of reoperation.

Figure: Outcomes by Indication and Approach

Characteristics	Cervical (N=1295)	Thoracic (N=309)	p value	Benign (N=1209)	Malignant (N=408)	p value
Status 30 Days After Surgery, No. (%)			0.77			0.10
• Alive	1147 (91%)	275 (90%)		1062 (90%)	373 (93%)	
• Dead	15 (1%)	5 (2%)		14 (1%)	6 (2%)	
• Unknown	96 (8%)	25 (8%)		100 (9%)	21 (5%)	
Length of Stay (Mean SD)	10.3 ± 14.1	10.6 ± 12.8	0.80	10.9 ± 15.1	8.9 ± 8.7	0.014
Select Major Morbidity Criteria						
Pneumonia	31 (8%)	22 (17%)	0.003	34 (9%)	19 (14%)	0.07
ARDS	4 (1%)	5 (4%)	0.028	5 (1%)	4 (3%)	0.18
Pneumothorax	4 (2%)	4 (4%)	0.26	2 (1%)	6 (7%)	0.002
PE	1 (0%)	2 (2%)	0.09	1 (0%)	2 (2%)	0.10
Reintubation	47 (14%)	16 (15%)	0.70	54 (16%)	10 (9%)	0.05
Tracheostomy	41 (11%)	5 (4%)	0.026	43 (11%)	4 (3%)	0.006
Arrhythmia	30 (8%)	22 (17%)	0.002	29 (7%)	23 (18%)	<.001
DVT	5 (1%)	8 (6%)	0.002	8 (2%)	5 (4%)	0.26
Empyema	0 (0%)	2 (2%)	0.013	0 (0%)	2 (2%)	0.014
Recurrent Nerve Injury	12 (3%)	5 (4%)	0.61	7 (2%)	10 (8%)	0.001
Anastomotic Complication	3 (1%)	3 (2%)	0.14	1 (0%)	5 (4%)	<.001
Wound Infection	60 (16%)	15 (12%)	0.28	67 (18%)	9 (7%)	0.004

Table: Multivariate Logistic Regression Model for Morbidity or Mortality

Variable	Odds Ratio	OR 95% CI		p-value
Zubrod 2+ Yes vs. No	2.44	1.61	3.69	<.0001
Approach Thoracic vs. Cervical	1.65	1.12	2.43	0.011
Diabetes Yes vs. No	1.54	1.04	2.26	0.030
CAD Yes vs. No	1.52	0.95	2.41	0.081
ASA 3+ Yes vs. No	1.50	0.95	2.38	0.083
Obesity Yes vs. No	1.33	0.94	1.87	0.11
Last Creatinine Level	0.81	0.63	1.04	0.11
Pulmonary Hypertension Yes vs. No	2.87	0.75	10.99	0.12
Gender Male vs. Female	1.29	0.92	1.82	0.14
Indication Malignant vs. Benign	1.19	0.78	1.80	0.42

1:15 PM

Room 316

### Comparison of Neoadjuvant Chemotherapy Followed by Surgery to Surgery Alone for Advanced Thymic Malignancies: A Propensity Score-Matching Analysis Based on a Multicenter Database

S. Park<sup>1</sup>, K. Hyun<sup>1</sup>, Y. Hwang<sup>1</sup>, H. Lee<sup>1</sup>, I. Park<sup>1</sup>, Y. T. Kim<sup>1</sup>, S. S. Hwang<sup>2</sup>, G. Lee<sup>3</sup>, S. Choi<sup>3</sup>, H. Kim<sup>3</sup>, Y. Kim<sup>3</sup>, D. Kim<sup>3</sup>, S. Park<sup>3</sup>, J. H. Cho<sup>4</sup>, H. Kim<sup>4</sup>, Y. Y. Choi<sup>4</sup>, J. Kim<sup>4</sup>, J. Zo<sup>4</sup>, Y. M. Shim<sup>4</sup>, G. Byun<sup>5</sup>, C. Lee<sup>5</sup>, J. Lee<sup>5</sup>, D. Kim<sup>5</sup>, H. C. Paik<sup>5</sup>, K. Y. Chung<sup>5</sup>, C. Kang<sup>1</sup>

<sup>1</sup>Seoul National University Hospital, South Korea, <sup>2</sup>Ulsan University Hospital, South Korea,

<sup>3</sup>Asan Medical Center, Seoul, South Korea, <sup>4</sup>Samsung Medical Center, Seoul, South Korea, <sup>5</sup>Yonsei University College of Medicine, Seoul, South Korea

**Purpose:** Theoretical advantages of neoadjuvant chemotherapy before surgery include the possibility of tumor downstaging and an increase of the complete resection rate. However, whether neoadjuvant chemotherapy in thymic malignancies induces oncological benefit remains unclear. Therefore, we compared postoperative oncological outcomes of neoadjuvant chemotherapy followed by surgery with those of surgery alone.

**Methods:** Based on a multicenter database, a total of 1486 patients with thymic malignancies between 2000 and 2013 were included in the final study cohort. 110 (7.4%) underwent surgical resection following neoadjuvant chemotherapy (NC group) and 1376 patients (92.6%) underwent surgery alone (SA group). Median follow-up duration was 52.3 months. Postoperative outcomes were compared between two groups. A propensity score-matched analysis was performed for preoperative and intraoperative variables: centers, age, sex, comorbidities, smoking status, presence of preoperative symptoms, performance status, clinical tumor size, clinical Masaoka-Koga stage, histologic diagnosis, extent of surgery, and concomitant procedure.

**Results:** In the matched dataset, we obtained well-balanced patient characteristics (Figure). There were no significant differences in postoperative mortality (NC group vs SA group; 0% vs 0%;  $P =$  not calculated), postoperative complication rate (NC group vs SA group; 25.5% vs 23.6%;  $P = .883$ ), and length of hospital stay (NC group vs SA group; 12 days  $\pm$  13 days vs 14 days  $\pm$  20 days;  $P = .308$ ) between two groups. However, the NC group showed a significantly higher transfusion rate (NC group vs SA group; 42.7% vs 23.6%;  $P = .003$ ) and longer operation time (NC group vs SA group; 290 minutes  $\pm$  136 minutes vs 229 minutes  $\pm$  112 minutes;  $P < .001$ ) than those of the SA group. Pathological complete resection rate (NC group vs SA group; 64.5% vs 73.6%;  $P = .482$ ) and tumor size (NC group vs SA group; 7.3 cm  $\pm$  3.7 cm vs 7.7 cm  $\pm$  3.5 cm;  $P = .482$ ) were similar between two groups. Five-year overall survival rates were 77.9% and 76.7% (NC group vs SA group;  $P = .401$ ). Three-year recurrence-free survival rates were 62.9% and 67.5% (NC group vs SA group;  $P = .107$ ). A significant downstaging of tumor was not found in NC group compared to SA group ( $P = .239$ ). In subgroup analysis according to the stages, complete resection rates were not significantly different between the two groups (clinical Masaoka-Koga stage III,  $P = .092$ ; clinical Masaoka-Koga stage IV,  $P = .86$ ).

**Conclusions:** Neoadjuvant chemotherapy is not likely to be associated with an increase of resectability and tumor downstaging related to long-term survival. Therefore, the role of neoadjuvant chemotherapy should be refined in randomized controlled trials.

Patients characteristics after propensity score matching			
	Surgery alone (N=110)	Neoadjuvant chemotherapy and surgery (N=110)	standardized mean difference
<b>Hospital</b>			0.14
A	17 (15.5%)	12 (10.9%)	
B	31 (28.2%)	22 (20.0%)	
C	18 (16.4%)	36 (32.7%)	
D	44 (40.0%)	40 (36.4%)	
Age (year)	51 ± 12	50 ± 13	-0.13
Sex (male)	66 (60.0%)	64 (58.2%)	0.04
Diabetes mellitus (yes)	7 (6.4%)	8 (7.3%)	0.03
Hypertension (yes)	15 (13.6%)	18 (16.4)	0.07
Smoking history (yes)	39 (35.5%)	37 (33.6%)	-0.04
Preoperative symptom (yes)	61 (55.5%)	56 (50.9%)	-0.09
<b>Performance status (ECOG)</b>			0.12
0	95 (86.4%)	97 (79.1%)	
1	13 (11.8%)	21 (19.1%)	
2	1 (0.9%)	2 (1.8%)	
4	1 (0.9%)	0 (0.0%)	
Clinical tumor size (centimeter)	6.6 ± 2.9	6.9 ± 2.6	0.12
<b>Clinical Masaoka-Koga stage</b>			-0.03
1	1 (0.9%)	3 (2.7%)	
2	8 (7.3%)	5 (4.5%)	
3	36 (32.7%)	38 (34.5%)	
4	65 (59.1%)	64 (58.2%)	
Concomitant procedure (yes)	97 (88.2%)	98 (89.1%)	0.03
<b>Extent of surgery</b>			-0.07
Thymectomy	10 (9.1%)	12 (10.9%)	
Partial thymectomy	8 (7.3%)	9 (8.2%)	
Total thymectomy	92 (83.6%)	89 (80.9%)	
<b>Diagnosis</b>			0.04
Thymoma	64 (58.2%)	55 (50.0%)	
Thymic carcinoma	35 (31.8%)	48 (43.6%)	
Neuroendocrine differentiation	5 (4.5%)	3 (2.7%)	
Others	6 (5.5%)	4 (3.6%)	

1:30 PM

Room 316

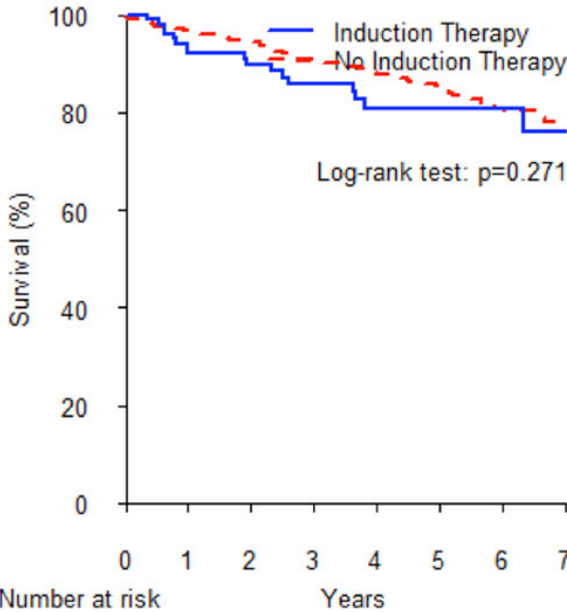
**Induction Therapy Does Not Improve Survival in Patients With Large Thymomas***D. Z. Liou<sup>1</sup>, N. S. Lui<sup>2</sup>, D. Ramakrishnan<sup>1</sup>, J. B. Shrager<sup>1</sup>, L. M. Backbus<sup>1</sup>, M. F. Berry<sup>1</sup>*<sup>1</sup>Stanford University, CA, <sup>2</sup>Stanford University Medical Center, Palo Alto, CA**COMMERCIAL RELATIONSHIPS** J. B. Shrager: Research Grant, Varian; Consultant/Advisory Board, Carefusion, Intuitive Medical Systems

**Purpose:** Tumor size of 8 cm or greater is a risk factor for recurrence after thymoma resection, but the role of induction therapy for large thymomas is not well defined. This study tested the hypothesis that induction therapy for thymomas 8 cm and larger improves survival.

**Methods:** The use of induction therapy for patients treated with surgical resection for Masaoka stage I-III thymomas in the National Cancer Database between 2006 and 2013 was evaluated using logistic regression. For patients with tumors  $\geq 8$  cm, the impact of induction therapy on overall survival was assessed using Kaplan-Meier analysis and Cox proportional hazards methods.

**Results:** Of the 1849 patients who met inclusion criteria, 582 (31.5%) had tumors  $\geq 8$  cm. Five-year survival was worse in patients with tumors  $\geq 8$  cm compared to smaller tumors (84.6% [95% CI 81.2%-88.1%] vs 89.4% [95% CI 87.2%-91.7%],  $P = .003$ ). Induction therapy was used in 166 patients (9.0%) overall and was more likely in patients with tumors  $\geq 8$  cm (adjusted odds ratio [AOR] 3.26,  $P < .001$ ). Chemotherapy was used in 162 patients (8.8%), chemoradiation in 21 patients (1.1%), and radiation alone in four patients (0.2%). Induction therapy was not associated with improved survival in the subset of patients with tumors  $\geq 8$  cm in either univariate (80.9% [95% CI 72.6%-90.1%] vs 85.4% [95% CI 81.8%-89.3%],  $P = .27$ , Figure) or multivariable analysis (hazard ratio [HR] 1.34,  $P = .30$ ). Increasing age (HR 1.55/decade,  $P < .001$ ) and Masaoka stage III (HR 1.88,  $P = .01$ ) were associated with worse survival in patients with tumors  $\geq 8$  cm (Table).

**Conclusions:** Survival after thymoma resection is worse for tumors 8 cm or larger compared to smaller tumors and is not improved by induction therapy. Size alone should not be a criteria for using induction therapy prior to thymoma resection.



Induction Therapy	102	89	77	62	45	27	19	12
No Induction Therapy	480	437	390	305	248	187	136	91

	Hazard Ratio (95% CI)	p-value
Age (per decade)	1.55 (1.32-1.83)	<0.001
Female	1.30 (0.86-1.95)	0.20
Masaoka Stage IIB (vs. Stage I-IIA)	0.93 (0.49-1.76)	0.80
Masaoka Stage III (vs. Stage I-IIA)	1.88 (1.16-3.05)	0.01
Charlson comorbidity index 1 (vs. 0)	1.02 (0.60-1.73)	0.90
Charlson comorbidity index ≥2 (vs. 0)	1.65 (0.65-4.17)	0.30
Induction therapy	1.34 (0.79-2.25)	0.30

1:45 PM

Room 316

**Accumulated Frailty Characteristics Predict Postoperative Respiratory Failure in Patients With Severe Tracheobronchomalacia Undergoing Tracheobronchoplasty***D. H. Buitrago<sup>1</sup>, D. E. Alape<sup>1</sup>, J. L. Wilson<sup>1</sup>, M. Parikh<sup>1</sup>, A. Majid<sup>2</sup>, D. H. Kim<sup>1</sup>,**S. P. Gangadharan<sup>2</sup>**<sup>1</sup>Beth Israel Deaconess Medical Center, Boston, <sup>2</sup>Harvard Medical School, Boston, MA*

**Purpose:** Pulmonary complications are the leading cause of morbidity in patients undergoing tracheobronchoplasty for severe tracheobronchomalacia. The concept of frailty as a measure of reduced physiologic reserve to tolerate acute stressors has not been examined in this population. We investigated the association between frailty and risk of pulmonary complications following tracheobronchoplasty.

**Methods:** A retrospective cohort study was conducted in 161 consecutive patients (median age 58 years, 64% women) who underwent tracheobronchoplasty in 2002 to 2016 at Beth Israel Deaconess Medical Center. A frailty index (FI) was calculated via the deficit-accumulation approach using 26 preoperative variables measured in multiple organ systems. The main outcome was any pulmonary complication (including respiratory failure, pneumonia, recurrent symptomatic pleural effusion and/or pneumothorax requiring chest tube drainage and/or pleurodesis, and airway abscess with mesh erosion) within 30 days of tracheobronchoplasty. Logistic regression was used to examine the association of frailty with pulmonary complications.

**Results:** The median FI was 0.25 (interquartile range: 0.15–0.33), and 26% of patients were considered severely frail (FI >0.33). Pulmonary complications occurred in 49 patients (30.4%), including 23 patients with respiratory failure (16.8%) and 25 patients with pneumonia (15.5%). After adjusting for age, sex, and race, each 0.1-point increase in FI was associated with higher risk of pulmonary complications (odds ratio [OR] 12.4; 95% confidence interval [CI]: 7.0–19.14), respiratory failure (OR 8.7; 95% CI: 3.4–14.9), and pneumonia (OR 9.7; 95% CI: 3.8–17). Patients with severe frailty were more likely than those with mild-to-moderate frailty to develop pulmonary complications (73.8% vs 15.1%; OR 14.4; 95% CI: 5.8–35.7), respiratory failure (47.6% vs 5.8%; OR 16.6; 95% CI: 5.5–49.8), and pneumonia (40.5% vs 6.7%; OR 6.9; 95% CI: 2.5–18.5). These associations were somewhat attenuated, yet remained statistically significant, when intraoperative crystalloid volume and preoperative forced expiratory volume in 1 second were additionally adjusted for.

**Conclusions:** Frailty is a strong predictor of pulmonary complications after tracheobronchoplasty, independently of preoperative pulmonary function. Preoperative identification of frailty may guide informed decision making and perioperative care in patients considering this effective, though arduous, procedure. Future studies are warranted to confirm our findings and translate them into clinical recommendations.

	Mild-to-Moderate Frail	Severely Frail	
Characteristic	OR (95%CI)	OR (95%CI)	P value
Any postoperative pulmonary complication (n=49)			
Incident cases, No (%)	18 (15.1)	31 (73.8)	
Multivariable <sup>a</sup>	1 [Reference]	14.4 (5.8-35.7)	<.0001
Multivariable + Crystalloid <sup>b</sup>	1 [Reference]	16.1 (5.2-49.9)	<.0001
Multivariable + Crystalloid + FEV <sub>1</sub> <sup>c</sup>	1 [Reference]	11.6 (3.5-38.7)	<.0001
Respiratory failure (n=27)			
Incident cases, No (%)	7 (5.8)	20 (47.6)	
Multivariable <sup>a</sup>	1 [Reference]	16.6 (5.5-49.8)	<.0001
Multivariable + Crystalloid <sup>b</sup>	1 [Reference]	13.1 (3.3-50.5)	<.001
Multivariable + Crystalloid + FEV <sub>1</sub> <sup>c</sup>	1 [Reference]	5.9 (1.4-25.2)	.016
Pneumonia (n=25)			
Incident cases, No (%)	8 (6.7)	17 (40.5)	
Multivariable <sup>a</sup>	1 [Reference]	6.9 (2.5-18.5)	<.001
Multivariable + Crystalloid <sup>b</sup>	1 [Reference]	5.7 (1.83-18)	.002
Multivariable + Crystalloid + FEV <sub>1</sub> <sup>c</sup>	1 [Reference]	3.3 (0.9-11.6)	.053

Abbreviations: FEV<sub>1</sub>, forced expiratory volume in one second.

<sup>a</sup> Multivariable analyses were adjusted by age (continuous), gender (female vs male), and white race (yes vs no).

<sup>b</sup> Multivariable analyses were additionally adjusted by intraoperative crystalloid (normalized by weight in Kg).

<sup>c</sup> Multivariable analyses were additionally adjusted by preoperative FEV<sub>1</sub>.

2:00 PM

Room 316

**Left Cardiac Sympathetic Denervation for Management of Long QT Syndrome: Single-Center 7-Year Experience***A. C. Antonopoulos, D. Patrini, S. A. Mitsos, M. M. Scarci, M. P. Hayward, R. George, D. R. Lawrence, N. T. Panagiotopoulos**University College London Hospitals NHS Foundation Trust, United Kingdom***COMMERCIAL RELATIONSHIPS** M. M. Scarci: Consultant/Advisory Board, Surgical Dynamics; Speakers Bureau/Honoraria, Medtronic

**Purpose:** Left cardiac sympathetic denervation (LCSD) has been shown to have an antiarrhythmic and antifibrillatory effect. We report the outcomes of a single-center experience using left video-assisted thoracoscopic cardiac sympathetic denervation as an adjunctive therapeutic technique in adult patients with long QT syndrome refractory to medical management.

**Methods:** A retrospective clinical review of all patients who underwent left cardiac sympathetic denervation by means of video-assisted thoracoscopic surgery (VATS) at our center was performed. From September 2009 to May 2016, six patients (four female, two male, mean age 30.5 years, range 20–47 years) underwent VATS LCSD for congenital long QT syndrome at our institution. All patients underwent sympathectomy and partial stellate gangliectomy via 2.5-mm port incisions. No drain was placed following the procedure.

**Results:** Two patients (one male, one female) had implantable cardioverter defibrillator implantations prior to their procedures. All six patients had uneventful recovery and no postoperative complications, such as Horner's syndrome, pneumothorax, or bleeding. The mean postoperative length of stay was 2.2 days  $\pm$  0.7 days. In a median follow-up period of 14 months, one female patient developed torsades de pointes. Out of all six patients being symptomatic preoperatively, the annual cardiac event rate decreased from 2.1 to 0.35 events per year.

**Conclusions:** LCSD is a safe and effective procedure for patients with long QT syndrome, providing no major postoperative complications and reduced hospital length of stay. LCSD serves as a critical adjunct to existing medical therapies representing a promising therapeutic option for all patients with life-threatening refractory arrhythmias on maximal medical therapy.

2:15 PM

Room 316

**Nerve-Sparing Surgery in Advanced Stage Thymomas***V. Aprile<sup>1</sup>, P. P. Bertoglio<sup>2</sup>, S. S. Korasidis<sup>1</sup>, D. D. Bacchin<sup>3</sup>, M. Lucchi<sup>1</sup>, A. A. Mussi<sup>1</sup>**<sup>1</sup>University of Pisa, Italy, <sup>2</sup>Sacro Cuore Don Calabria Research Hospital Cancer Care Centre, Verona, Italy, <sup>3</sup>AOU, Pisa, Italy*

**Purpose:** Phrenic nerve infiltration is described in up to 33% of locally advanced thymomas; en bloc resection causes diaphragmatic loss of function, with a detrimental effect on respiration. We report the short- and long-term outcomes of a nerve-sparing technique in a group of selected patients operated on for invasive thymoma.

**Methods:** In the period from 1990 to 2015, we performed the “nerve-sparing” technique, with the intention to treat, in all patients with stage III and IV thymomas without preoperative evidence of phrenic nerve paralysis but with intraoperative macroscopic evidence of phrenic nerve involvement. After surgery, all patients underwent adjuvant radiotherapy (45-60 Gy) with or without chemotherapy. Both thymic carcinoma and neuroendocrine tumors were excluded from the study. Short- and long-term outcomes, as well as pattern of recurrences, were then retrospectively analyzed.

**Results:** Among 140 patients with stage III and IV thymoma who were operated on in the study period, 19 women and 18 men received a nerve-sparing resection. Mean age was 52 years (range, 26-83 years). Myasthenia gravis was associated in 25 cases. B1 and B2 histologies were reported in 10 and nine patients, respectively. In 12 patients, phrenic paralysis was observed postoperatively, which completely recovered in four of them. Recurrence occurred in 10 patients (seven stage IVA, three stage III) after a median period of 35 months (range, 7-93 months) requiring additional therapies. Six patients died (two of systemic metastases, one of chemotherapy toxicity, and three of other causes). Overall survival (OS) and disease-free survival were 262.4 and 228.8 months, respectively; OS was not significantly different when we compared subgroups of patients who experienced recurrence (281 months vs 104 months,  $P = .126$ ) or with stage IV disease (273 months vs 109 months,  $P = .200$ ).

**Conclusions:** “Nerve-sparing” surgery for thymoma is feasible, and whenever associated to postoperative radiotherapy, it may warrant acceptable outcomes besides a preservation of diaphragmatic function. According to these results, we propose this technique always for higher-risk patients and in selected patients with a low operative risk.

2:30 PM

**Robotic Thymectomy: How I Do It***Inderpal S. Sarkaria, New York, NY***COMMERCIAL RELATIONSHIPS** I. S. Sarkaria: Speakers Bureau/Honoraria, Intuitive Surgical

2:45 PM

**Surgery for Myasthenia Gravis***Joshua R. Sonett, New York, NY***COMMERCIAL RELATIONSHIPS** J. R. Sonett: Speakers Bureau/Honoraria, Covidien

1:00 PM – 5:30 PM

Rooms 301–302

 **Patient Safety Symposium: Biases and Errors—Why We Do What We Do**

Cognitive biases have been implicated as a cause of errors in diagnosis and treatment. Thus, physicians who become familiar with common cognitive biases should be able to better recognize biases in their clinical practice. In spite of research evidence and clinical guidelines, there are variances in surgical diagnosis and treatment (eg, blood transfusion practices and antibiotic usage). The aim of this symposium is to better understand the ways by which cognitive biases and heuristics (general rules of thumb) impact how we practice cardiothoracic surgery and how we identify and learn from errors (eg, root cause analysis).

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Discuss cognitive biases and heuristics in health care delivery
- Recognize how these biases impact medical decision making
- Conduct more effective error analysis, such as root cause analysis
- Demonstrate how to communicate with others regarding variances in medical judgment and practice

**Moderators:** *W. Chance Conner, San Antonio, TX, and Michael S. Kent, Boston, MA*

**COMMERCIAL RELATIONSHIPS** M. S. Kent: Other, Intuitive Surgical, Received travel funds for case observation

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are patient care and procedural skills, interpersonal and communication skills, and practice-based learning and improvement. These physician competencies will be addressed through a series of lectures, panel discussions, and demonstrations on the impact of cognitive biases and heuristics on the quality of patient care.*

1:00 PM

**Introduction**

*W. Chance Conner, San Antonio, TX, and Michael S. Kent, Boston, MA*

**COMMERCIAL RELATIONSHIPS** M. S. Kent: Other, Intuitive Surgical, Received travel funds for case observation

1:30 PM

**Surgical Practice and Evidence-Based Medicine: Why the Incongruity?**

*Kevin W. Lobdell, Charlotte, NC*

**COMMERCIAL RELATIONSHIPS** K. W. Lobdell: Consultant/Advisory Board, Medtronic

2:10 PM

**How Do We Make the Diagnosis? Biases and Heuristics in Medicine**

*Geoffrey Norman, Hamilton, Canada*

2:50 PM

**Panel Discussion/Q&A**

3:10 PM

**Break**

3:40 PM

**Cognition in the Wild (of the Operating Room)**

*David Woods, Columbus, OH*

4:20 PM

**Break Root Cause Analysis: Is There a Right Way?**

*Juan A. Sanchez, Baltimore, MD*

5:00 PM

**Panel Discussion/Q&A**

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3:00 PM – 3:30 PM

**BREAK—Visit Exhibits and Scientific Posters**



3:30 PM – 4:30 PM

Rooms 220–221

**Cardiothoracic Surgical Education***Moderators: David D. Odell, Chicago, IL, and Rishindra M. Reddy, Ann Arbor, MI***COMMERCIAL RELATIONSHIPS** R. M. Reddy: Research Grant, GlaxoSmithKline; Consultant/Advisory Board, Medtronic; Speakers Bureau/Honoraria, GlaxoSmithKline, WiseOnCall

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are professionalism and interpersonal and communication skills. These physician competencies will be addressed through a series of lectures and a brief question-and-answer session after each topic.*

3:30 PM

**Lessons Learned From a Multicenter Prospective Randomized Study of Skill Acquisition in Cardiovascular Surgery Using a Low-Fidelity Simulation Platform**
**J. R. Spratt<sup>1</sup>, M. E. Brunsbold<sup>1</sup>, D. Joyce<sup>2</sup>, T. C. Nguyen<sup>3</sup>, M. B. Antonoff<sup>4</sup>, G. N. Loor<sup>5</sup>**

<sup>1</sup>University of Minnesota, Minneapolis, <sup>2</sup>Mayo Clinic, Rochester, MN, <sup>3</sup>Memorial Hermann–Texas Medical Center, Houston, <sup>4</sup>The University of Texas MD Anderson Cancer Center, Houston, <sup>5</sup>Texas Heart Institute/Baylor College of Medicine, Houston

**COMMERCIAL RELATIONSHIPS** G. Loor: Ownership Interest, Synaptic Design; Research Grant, Transmedics; T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott

**Purpose:** Simulation is a valuable avenue for skill acquisition and refinement in cardiovascular (CV) surgery. Most simulation experiences are static, expensive, and not designed for repetitive practice. We developed and evaluated a home deliberate practice curriculum of aortic and coronary anastomoses using a low-fidelity cardiovascular simulator.

**Methods:** We organized a multicenter prospective randomized study of surgical trainees who were oriented to a low-fidelity cardiac simulator and the 8-week curriculum of independent practice of aortic and coronary anastomosis that was developed through consensus by the study mentors (Figure). “Treatment” trainees received a simulator and the curriculum. Control trainees received only their usual operative experience. The groups then crossed over; all were studied for 16 weeks total. Video skill assessments were captured at 0, 8, and 16 weeks, and all were scored by one blinded investigator (M.B.) using the Joint Council on Thoracic Surgery Education (JCTSE) Assessment tool.

**Results:** A total of 32 trainees from four institutions were invited to the study and randomized (18 CV, five general, five abdominal transplant, four vascular). Of these, only 12 trainees (38%) completed the curriculum and (six treatment, six control) submitted the requisite three sets of videos, indicating complete technical data collection. When accounting for the planned crossover, there was a total of 12 treatment intervals and 12 control intervals for analysis, generating a total of 72 assessment videos. Although considerable variability was observed between participants, no significant differences were detected in assessment scores on the simulator before and after the 8-week curriculum, nor before or after the control period in the overall or postgraduate year-stratified populations.

**Conclusions:** Provision of a practice curriculum and simulator for repeated deliberate practice is feasible but was not widely embraced by trainees. Considerable variability existed among participants who completed the study, but overall, the curriculum alone was insufficient to improve simulator JCTSE scores in comparison to those not undergoing the curriculum.

#### DELIBERATE PRACTICE CURRICULUM

##### Week 1 –

1 hour – mentor session – reviewing needle angles and large and small-vessel anastomosis, description of JCTSE assessment tool

Day 1. one large vessel anastomosis (backwall only, please film representative 60s video segment)

Day 2. one LAD anastomosis (50% only, please film representative 60s video segment)

Day 3. one complete large vessel anastomosis

##### Week 2

Day 1. one complete LAD anastomosis

Day 2. one complete large vessel anastomosis

Day 3. one complete LAD anastomosis

##### Week 3

Day 1. one complete large vessel anastomosis

Day 2. one OM anastomosis (50% only)

Day 3. one complete OM anastomosis

##### Week 4

1 hour – mentor session – brief recap of large and small vessel anastomosis, review of study logistics

Day 1. one complete LAD anastomosis (Please film as above)

Day 2. one complete OM anastomosis

Day 3. one large vessel anastomosis (Please film as above)

##### Week 5

Day 1. one PDA anastomosis (50% only)

Day 2. one complete PDA anastomosis

Day 3. one complete large vessel anastomosis

##### Week 6

Day 1. one complete LAD anastomosis

Day 2. one complete LAD anastomosis

Day 3. one complete large vessel anastomosis

##### Week 7

Day 1. one complete OM anastomosis

Day 2. one complete large vessel anastomosis

Day 3. one large vessel anastomosis

##### Week 8

Day 1. one complete OM anastomosis

Day 2. one complete LAD anastomosis (Please film as above)

Day 3. one complete large vessel anastomosis (Please film as above)

3:42 PM

Rooms 220–221

### The Current State of Mentorship in Cardiothoracic Surgery Training: Results of the TSDA/TSRA In-Training Exam Survey

E. H. Stephens<sup>1</sup>, A. B. Goldstone<sup>2</sup>, A. G. Fiedler<sup>3</sup>, P. N. Vardas<sup>4</sup>, G. S. Pattakos<sup>5</sup>, X. Lou<sup>6</sup>, P. Chen<sup>7</sup>, V. Tchantchaleishvili<sup>8</sup>

<sup>1</sup>Columbia University Medical Center, New York, NY, <sup>2</sup>University of Pennsylvania, Philadelphia, <sup>3</sup>Massachusetts General Hospital and Harvard Medical School, Boston, <sup>4</sup>Indiana University School of Medicine, Indianapolis, <sup>5</sup>Texas Heart Institute/Baylor College of Medicine, Houston, <sup>6</sup>Emory University, Atlanta, GA, <sup>7</sup>Baylor College of Medicine, Houston, TX, <sup>8</sup>Mayo Clinic, Rochester, MN

**Purpose:** While the importance of mentorship in training the next generation of cardiothoracic surgeons is widely recognized, the current state of mentoring during training, including attributes valued, characteristics of mentors chosen, their impact on residents' careers, and areas in which mentorship is frequently lacking, has not been assessed.

**Methods:** Trainee responses to questions in the 2017 In-Training Examination regarding various aspects of mentorship, including key characteristics sought in mentors, impact of mentorship on specific aspects of training, and areas in which residents lacked mentorship, were analyzed. Response rate was 78% (288 of 370). Mentor-related (clinical vs research concentration, program-assigned vs self-identified, career stage) and trainee-related characteristics (residency stage, training pathway, specialty interest, gender) were assessed. Significance was set at  $P < .05$ .

**Results:** Characteristics that residents sought and found lacking are shown in the Table. 84% had mentors, who had a high impact on specialty choice (80%). 49% had program-assigned mentors, 53% found them as productive and 12% had more consistent/frequent meetings than personally selected mentors, with 20% reporting less ideal personality/gender match compared to personally selected mentors. Among residents with mentors, 36% lacked mentorship in work-life balance, 23% in job assistance, and 22% in career advice. Mentorship differences were evident between program type, seniority, and gender (Table). Junior residents more often viewed mentors as role models, while mentors chosen by senior residents were more impactful in technical training, job counseling, and societal involvement. Women valued mentors as role models and assisting in networking more than males. Men reported their mentors were more impactful in teaching technical skills and clinical ability than women. 91% agreed mentorship is critical to success, and 68% reported that the mentor characteristics they sought changed during training.

**Conclusions:** Residents believed mentorship is critical to success. Mentorship depended on program type and gender, and changed during training. Program-assigned mentors were productive, but can suffer in personality/gender match compared to personally selected mentors. A significant proportion of residents with mentors lack assistance in work-life balance, obtaining a job, and career advice.

## Characteristics Sought and Found Lacking by Residents in Mentors

Characteristics Sought**	% respondents	Characteristics lacking	% respondents <sup>^</sup>
Counseling career path	97	Work-life balance	36
Clinical advice	96	Involvement in research	31
Assistance in interviews	95	Assistance obtaining job	23
Networking	93	Career advice	22
Encouragement	92	Technical training	14
Technical training	91	Advice re additional training	12
Clinical management	85	<sup>^</sup> % of respondents with mentors	
Involvement in leadership	84		
Research advice	84		
Role model	83		
Didactic knowledge	82		
Support during difficult personal times	82		
Inclusion in research	80		

\*\*these characteristics were deemed extremely or moderately important

## Variability Between Groups in Mentorship Qualities and Effectiveness

	Junior	Senior	p-value	Tradtl	i6	p-value	Male	Female	p-value
Importance of mentor as role model*	90	82	<b>0.042</b>	79	91	<b>0.02</b>	93	100	0.087
Importance of mentor in advice regarding research*	83	94	0.133	77	92	<b>0.003</b>	84	90	0.621
Importance of mentor in networking*	98	92	0.353	92	95	0.183	91	100	<b>0.033</b>
Importance of mentor in interviews*	98	94	0.56	98	92	<b>0.049</b>	93	100	0.087
Mentor effective in technical training**	76	92	<b>0.004</b>	94	82	<b>0.004</b>	91	83	0.076
Mentor effective in clinical management**	71	81	0.269	86	72	<b>0.021</b>	67	83	<b>0.047</b>
Mentor effective in didactic knowledge**	76	83	0.495	87	76	<b>0.044</b>	85	70	<b>0.044</b>
Mentor effective in clinical advice**	88	88	0.489	87	91	0.155	91	81	<b>0.046</b>
Mentor effective as role model**	71	72	0.819	72	72	0.93	75	60	0.077
Mentor effective advice research**	84	72	0.311	69	82	0.051	76	67	0.271
Mentor impactful in clinical ability/knowledge**	67	83	0.092	87	73	<b>0.024</b>	83	70	<b>0.030</b>
Mentor impactful in technical ability**	67	84	<b>0.025</b>	86	75	<b>0.033</b>	82	72	<b>0.039</b>
Mentor impactful for job counseling**	67	78	<b>0.018</b>	83	73	0.123	78	70	0.078
Mentor impactful for involvement in societies**	13	41	<b>0.039</b>	55	59	0.613	57	49	0.122
Mentor impactful in academic/private career choice**	71	57	0.501	58	69	0.062	63	51	0.249
Resident lack technical training	25	11	<b>0.020</b>	11	17	0.129	12	19	0.134
Mentorship critical to success as CT surgeon	98	91	0.552	88	99	<b>0.004</b>	94	86	0.139

\*these characteristics were deemed extremely or moderately important

\*\*percentage of residents who perceived their mentor as "extremely or moderately" effective/impactful in these areas

<sup>^</sup>groups statistically significantly different on post-hoc testing ( $p < 0.05$ )

3:54 PM

Rooms 220–221

**Role of Social Media in Mentorship: A Comparative Analysis of Cardiothoracic Surgery and Other Surgical Specialties***J. Luc<sup>1</sup>, N. L. Stamp<sup>2</sup>, M. B. Antonoff<sup>3</sup>**<sup>1</sup>University of Alberta, Edmonton, Canada, <sup>2</sup>Fiona Stanley Hospital, Murdoch, Australia, <sup>3</sup>The University of Texas MD Anderson Cancer Center, Houston*

**Purpose:** There is a lack of same-sex mentors for women in surgery, which is more pronounced in cardiothoracic (CT) surgery where women represent fewer than 5% of practicing CT surgeons. With the widespread use of social media, its role in enhancing mentorship for individuals lacking access to same-sex mentors remains unknown.

**Methods:** A 35-item survey investigating trainee and physician social media use was designed using online survey software and distributed via social media and email. Responses were analyzed using descriptive statistics.

**Results:** 156 respondents who completed the survey reported careers in surgery, among whom 27 (17.3%) were in CT surgery and 129 (82.7%) were in other surgical specialties. Compared to women in other surgical specialties, women in CT surgery were more likely to report the field to be dominated by the opposite sex (100% vs 64%,  $P < .001$ ). Despite expressing the value of same-sex mentorship in their career more than other surgical specialties ( $P = .044$ ), respondents in CT surgery were more likely to lack exposure to same-sex mentors at their own institution ( $P = .028$ ) (Figure). CT surgery respondents more frequently engaged with mentors of the same sex by viewing mentor social media sites ( $P = .041$ ), discussing topics regarding surviving a career in the field ( $P = .049$ ) and scholarship opportunities ( $P < .001$ ) (Table). CT surgery respondents reported a trend toward a greater likelihood of using social media to build a network of same-sex mentorship compared to other surgical specialties ( $P = .077$ ).

**Conclusions:** Social media serves as a valuable tool to enhance the networking and mentorship of surgeons, particularly for women in CT surgery who may lack exposure to same-sex mentors at their own institution. Longitudinal studies surrounding the effectiveness of mentorship by social media are warranted.

## Mentorship Needs and Behaviors for Respondents in Surgical Specialties

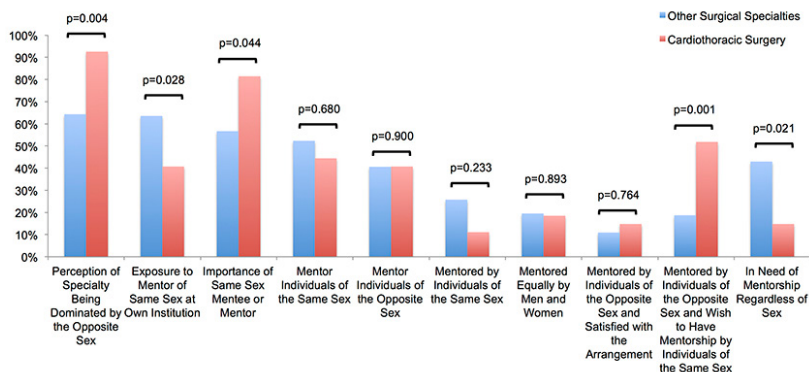


Table: Social Media Usage Characteristics of Respondents in Surgical Specialties

	Other Surgical Specialties, n = 129	Cardiothoracic Surgery, n = 27	P-Value
<b>Uses of Social Media</b>			
To Connect with Friends and Family	96%	89%	0.121
To Promote My Professional Interests	37%	48%	0.290
To Reach Patients / Educate the Public	15%	30%	0.063
To Learn About My Field of Interest	57%	67%	0.372
To Network With People In My Specialty / Field of Interest	56%	81%	0.013
<b>Important Aspects to See on Mentee/Mentor Social Media Site</b>			
Research	72%	88%	0.082
Family Life	63%	69%	0.555
Daily Activities	74%	77%	0.748
Scholarship	52%	92%	<0.001
Other	8%	4%	0.452

4:06 PM

Rooms 220–221

**Systematic Development, Implementation, and Evaluation of an Annual Hands-on Educational Program for Minimally Invasive Cardiac Surgery***E. O. Ebulomo, M. M. Lazarus, T. E. MacGillivray, C. S. Green McClennon, K. F. Stein, B. A. Peace, M. K. Ramchandani**Houston Methodist Hospital, TX*

**Purpose:** Over the last decade, cardiac surgery has undergone a paradigm shift toward minimally invasive cardiac surgery (MICS) for interventions including valve repair, coronary revascularization, ablation of atrial fibrillation, aortic pathology, and heart failure. Post-residency education for practicing surgeons in these minimally invasive techniques is important to improve patient care and clinical outcomes.

**Methods:** Following the six-step approach for curriculum development in medical education, we conducted a historical needs assessment to validate the intended focus areas for this annual hands-on educational conference. Cardiac surgeons collaborated with content experts to tailor the training agenda and educational strategies to suit learners' needs. Data collection tools were developed based on the Kirkpatrick Four-Level Training Evaluation Model to capture quantitative and qualitative data about learners' reaction, learning, and skill acquisition. Pre- and post-training data points were captured through questionnaires for didactic lectures and hands-on skills stations. We gauged program implementation fidelity using interviews and debrief sessions.

**Results:** Through an online survey, 84% (27/33) of respondents validated the importance of hands-on workshops to bridge the knowledge and skill gap in MICS. Respondents suggested the following as the most useful topics to address: thoracic endovascular aortic repair, MICS coronary artery bypass grafting, aortic valve replacement, mitral valve replacement (MVR), and robotic MVR. These were featured in the educational conference. Pre- and post-survey data (n=36) showed a statistically significant increase in attendees' confidence in their ability to meet the learning objectives ( $P < .05$ ). 92% (33/36) rated their ability to distinguish between open cardiac surgical techniques and minimal access cardiac surgical techniques as "excellent." 97% (35/36) also rated the hands-on skill stations as "good" or "excellent" (average=4.7 on a scale of 1=poor, 5=excellent). Hands-on stations were evaluated and earned positive remarks. For instance, average preparedness level to conduct specific tasks for robotic MVR improved before and after this rotation (Pre: 3–4, Post: 7 on a validated scale from 1=not at all prepared to 10=very prepared).

**Conclusions:** Educating current and future cardiac surgeons in MICS is vital to ensure that they have the knowledge and skills to deliver optimal patient care. Systematically developing, implementing, and evaluating this conference allows for data-driven decisions to improve the program and adapt its contents, format, and delivery for greatest skill acquisition.

ROBOTIC MVR PRE- AND POST-RATING OF SKILL LEVEL BY LEARNERS<sup>1</sup> (N=34)

LEARNER'S LEVEL OF PREPAREDNESS FOR:	Average rating (Pre)	Average rating (Post)
CAMERA MOVEMENT	4.7	7.1
DEVICE MOVEMENT	4.3	7.3
TRANSFERRING	4.4	7.2
CUTTING	4.2	7.1
SUTURING	4.1	7.1
KNOT TYING	4.0	6.9
MITRAL VALVE ANNULOPLASTY	3.5	6.7
ITA DISSECTION	3.6	6.4

<sup>1</sup>Valdis, Matthew, "Evaluation of Robotic Cardiac Surgery Simulation Training" (2015). *Electronic Thesis and Dissertation Repository*. Paper 2910.

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Rooms 220–221

**Development and Initial Validation of a Cervical Esophagogastric Anastomosis Simulator***M. Orringer<sup>1</sup>, D. R. Hennigar<sup>2</sup>, J. Lin<sup>1</sup>, D. M. Rooney<sup>1</sup>**<sup>1</sup>University of Michigan, Ann Arbor, <sup>2</sup>DRH Consulting, Ann Arbor, MI***COMMERCIAL RELATIONSHIPS** D. R. Hennigar: Employment, NuStep; Consultant/Advisory Board, Silicone Casting Manufacturers

**Purpose:** Cervical esophagogastric anastomosis (CEGA) vs intrathoracic reduces the risk of post-esophagectomy mediastinitis. However, the average reported 12%-14% CEGA leak rate is frustratingly high and is, in part, technically related and theoretically reducible with simulator practice of the well-established steps of the procedure. The development and preliminary testing of such a simulator is described.

**Methods:** A portable, low cost, scale reproduction of the CEGA operative site was engineered around a commercially available 19x11x6 cm plastic box. Insertable single-use silastic “esophageal” and “gastric tip” castings permitted construction of a side-to-side stapled CEGA guided by step-by-step illustrations and a video. Eight thoracic surgery faculty who regularly perform CEGA rated the simulator with paper surveys across two primary domains: 1) degree of realism (perceived fidelity-18 items), and 2) ability to perform five key technical tasks, using a 5-point rating scale for each item. Validity evidence was evaluated using a many-facet Rasch model.

**Results:** Participants observed averages (OA) across the four domains relevant to the simulator’s fidelity ranged from 4.6 (Realism of Materials) to 4.9 (Value). Lowest ratings were associated with Realism of suturing (OA=4.4). This, combined with higher variability associated with Ability to perform the interrupted outer layer of the anterior closure (item outfit mean square=2.15), seemed to identify an area for improvement. In spite of this, the Global OA=3.25 out of 4.0, indicating that overall, the faculty believed that the new simulator could be used in CEGA training, but could be improved slightly, particularly with regard to the wall thickness of the esophageal casting.

**Conclusions:** A functional CEGA simulator has been developed. Further educational research directions include multi-institutional simulator application in resident training (learning the technical steps), as well as testing (demonstrated proficiency before performing the procedure in patients), and determining if improved patient outcomes (ie, lower anastomotic leak rates) follow simulator experience.

3:30 PM – 5:30 PM

Floridian Ballroom A

**Adult Cardiac: Aorta II***Moderators: Jebangir J. Appoo, Calgary, Canada, and Edward P. Chen, Atlanta, GA*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures, a debate, and a brief question-and-answer session after each topic.*

3:30 PM

### **Early Clinical Outcomes of Hybrid Aortic Arch and Frozen Elephant Trunk Reconstruction With the Thoraflex Hybrid Graft: A Multicenter Experience From the Canadian Thoracic Aortic Collaborative**

**M. Chu<sup>1</sup>**, **L. A. Dubois<sup>2</sup>**, **K. L. Losenno<sup>3</sup>**, **P. M. Jones<sup>1</sup>**, **M. Ouzounian<sup>3</sup>**, **R. Whitlock<sup>4</sup>**, **F. Dagenais<sup>5</sup>**, **M. Boodhwani<sup>6</sup>**, **G. N. Bhatnagar<sup>3</sup>**, **A. A. Poostizadeh<sup>7</sup>**, **Z. I. Pozeg<sup>8</sup>**, **M. C. Moon<sup>9</sup>**, **B. Kiaii<sup>1</sup>**, **M. D. Peterson<sup>10</sup>**

<sup>1</sup>Western University, London Health Sciences Centre, Canada, <sup>2</sup>Western University, London, Canada, <sup>3</sup>University of Toronto, Canada, <sup>4</sup>Population Health Research Institute, Hamilton, Canada, <sup>5</sup>Institut Universitaire de Cardiologie et Pneumologie de Québec, Canada, <sup>6</sup>University of Ottawa Heart Institute, Canada, <sup>7</sup>KGH, Kelowna, Canada, <sup>8</sup>St Boniface Hospital, University of Manitoba, Winnipeg, Canada, <sup>9</sup>University of Alberta, Edmonton, Canada, <sup>10</sup>St Michael's Hospital, Toronto, Canada

**COMMERCIAL RELATIONSHIPS** G. Bhatnagar: Consultant/Advisory Board, LivaNova; Speakers Bureau/Honoraria, LivaNova; M. Chu: Speakers Bureau/Honoraria, Abbott Vascular, LivaNova, Medtronic, Symetis; B. Kiaii: Consultant/Advisory Board, Johnson & Johnson; Speakers Bureau/Honoraria, Johnson & Johnson, LivaNova, Medtronic, Symetis; M. D. Peterson: Consultant/Advisory Board, LivaNova; R. Whitlock: Consultant/Advisory Board, Armetheon, AtriCure, Boehringer Ingelheim, Daiichi Sando; Speakers Bureau/Honoraria, Boehringer Ingelheim

**REGULATORY DISCLOSURE** This presentation describes the off-label use of the Thoraflex hybrid graft, which is a novel, four-branched aortic arch graft with attached stent graft distally to allow for single setting arch replacement and stent grafting of the descending aorta with separate head vessel reimplantation (and a side limb for earlier lower body perfusion). Recently, the Thoraflex hybrid graft achieved CE mark and Health Canada approval. We describe the initial Canadian experience with this graft in treating patients with complex aortic arch aneurysms and dissections. The US clinical IDE trial began August 2016 with the hope for trial completion and FDA approval by 2019.

**Purpose:** Hybrid aortic arch surgery has evolved to include several technical variations, with most including an off-label use of a conventional thoracic endograft. We describe the early clinical outcomes of the Thoraflex hybrid graft specifically designed for the treatment of distal aortic arch and proximal descending thoracic aortic disease.

**Methods:** Between January 2014 and April 2017, 40 consecutive patients (66 years  $\pm$  14 years, 45% female) underwent hybrid aortic arch and frozen elephant trunk (FET) repair with the multibranched Thoraflex hybrid graft at nine Canadian centers. Surgical indications included distal arch/proximal descending aortic aneurysm in 98% (n=39), acute dissection in 10% (n=4), chronic dissection in 43% (n=17), and acute aortic rupture in one patient. Relevant patient characteristics included hypertension 80% (n=32), chronic obstructive pulmonary disease 21% (n=8), reoperation 28% (n=11), and non-elective surgery 30% (n=12). Concomitant procedures were performed in 65% (n=26). Antegrade cerebral perfusion and moderate hypothermia (24.3°C  $\pm$  1.8°C) were employed in all cases.

**Results:** All 40 device implants were successful. The 30-day/in-hospital mortality was 5% (n=2). Two patients (5%) suffered strokes, and one patient (3%) had a transient neurological deficit. Two patients (5%) experienced transient spinal cord ischemia, and there were no instances of permanent paraplegia. Other major complications included mechanical ventilation >48 hours (n=6; 15%), reoperation for bleeding (n=1; 3%), myocardial infarction (n=1; 3%), renal failure requiring temporary dialysis (n=1; 3%), sepsis (n=3; 8%), and recurrent laryngeal nerve palsy (n=2; 5%). Median ICU and hospital lengths of stay were 2 and 10 days, respectively. Computed tomography demonstrated a well-deployed FET graft in all patients with no signs of pseudoaneurysm, graft kinking, or proximal type 1 endoleaks. Mean follow-up was 378 days  $\pm$  310 days, and late complications included type A aortic dissection in one patient, type B dissection in two patients, and further distal endografting in two patients. Survival at 30 days, 1 year, and 2 years was 96%, 96%, and 96%, respectively.

**Conclusions:** Hybrid aortic arch and FET repair with the Thoraflex hybrid graft appears to be associated with good clinical outcomes, despite being early in the learning curve with this graft. Further investigation with this device is warranted to establish its role within the variations of hybrid arch repair.

3:45 PM

Floridian Ballroom A

**Salvage Coronary Artery Bypass Predicts Increased Mortality During Aortic Root Surgery***W. B. Keeling, B. G. Leshnower, C. W. Stouffer, J. Binongo, E. P. Chen**Emory University, Atlanta, GA***COMMERCIAL RELATIONSHIPS** B. G. Leshnower: Speakers Bureau/Honoraria, Medtronic; C. W. Stouffer: Consultant/Advisory Board, Edwards Lifesciences

**Purpose:** Aortic root replacement (ROOT) is an established therapy for aortic root pathology, yet the consequences of adding coronary artery bypass grafting (CABG) to ROOT is unknown. This study investigated the indications for performing CABG during ROOT and its impact on clinical outcomes.

**Methods:** A retrospective review from 2004 to 2016 of patients undergoing non-emergent ROOT surgery was performed. Cohorts were established based on the presence or absence of needing additional CABG during ROOT (CABG-R), and outcomes were compared. A propensity score-matched analysis of outcomes for CABG-R patients and ROOT patients was then conducted and resulted in 139 matched pairs.

**Results:** 820 patients were identified (671 ROOT [71.8%], 149 CABG-R [18.2%]). Indications for CABG-R included coronary artery disease (CAD, n=76, 51.7%), complex anatomy preventing primary coronary reimplantation (ANATOMY, n=46, 31.3%), and ventricular failure following isolated ROOT (EMERGENT, n=25, 17%). Overall mean age for the entire cohort was 53.4 years  $\pm$  15.2 years, and 30-day mortality was 5.0%. Prior to matching, CABG-R patients had an increased rate of preoperative renal insufficiency, redo surgery, and severe lung disease ( $P < .0001$ ) compared to ROOT patients. In the matched patients, operative mortality was higher in CABG-R patients (14.39%) compared with isolated ROOT (5.76%) ( $P = .02$ ). No difference in permanent stroke rate occurred with the addition of CABG to ROOT (2.16% vs 0.72%,  $P = .31$ ). Mortality rates in CABG-R patients differed depending on CABG indications and were highest in EMERGENT patients (28.0%) when compared to CAD (6.6%) or ANATOMY patients (21.7%) ( $P = .01$ ). Outcomes for propensity-matched patients are shown in the Table.

**Conclusions:** Performance of CABG during ROOT significantly increases postoperative morbidity or mortality; however, operative outcomes differ by the specific clinical indication for CABG. CABG-R for CAD was associated with similar outcomes as ROOT, whereas unplanned CABG in ANATOMY or EMERGENT had far worse outcomes, underscoring the importance of successful coronary reimplantation.

Variable	Total (N=278)	Root (n=139)	CABG-R (n=139)	OR *(95% CI)	p-value
30 day mortality, n (%)	28 (10.1%)	8 (5.8%)	20 (14.4%)	2.8 (1.2, 6.5)	0.02
Stroke, n (%)	4 (1.4%)	1 (0.7%)	3 (2.2%)	3.0 (0.3, 29.6)	0.31
Myocardial infarction, n (%)	14 (5.0%)	3 (2.2%)	11 (7.9%)	3.9 (1.1, 14.3)	0.03
MACE, n (%)	41 (14.8%)	10 (7.2%)	31 (22.3%)	3.7 (1.7, 7.9)	0.0004
Septicemia, n (%)	6 (2.2%)	4 (2.9%)	2 (1.4%)	0.5 (0.1, 2.7)	0.41
Renal Failure, n (%)	21 (7.6%)	7 (5.0%)	14 (10.1%)	2.1 (0.8, 5.4)	0.11
New Dialysis, n (%)	11 (4.0%)	4 (2.9%)	7 (5.0%)	1.8 (0.5, 6.3)	0.36
Prolonged ventilation, n (%)	93 (33.5%)	40 (28.8%)	53 (38.1%)	1.5 (0.9, 2.5)	0.10
Re-Exploration for Hemorrhage, n (%)	19 (6.8%)	6 (4.3%)	13 (9.4%)	2.3 (0.8, 6.2)	0.10

4:00 PM

Floridian Ballroom A

### Clinical Value of Computational Fluid Dynamics in the Management of Aortic Pathologies: Looking Beyond the Experimental Application

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**COMMERCIAL RELATIONSHIPS** M. Ricci: Consultant/Advisory Board, Maquet

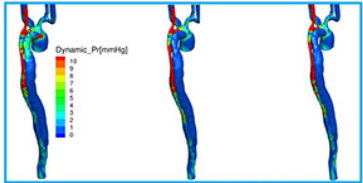
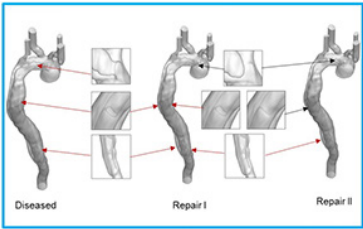
**Purpose:** Computational fluid dynamics (CFD) provides numerical analysis to solve flow physics. This technology has found vast application in the study of aortic diseases as a noninvasive method to analyze the characteristics of blood flow. Nonetheless, the use of CFD has found very limited translational correlation with its potential clinical applications.

**Methods:** In a review of 74 consecutive patients surgically treated for acute type A aortic dissection in an 8-year period, we identified 62 patients (83.7%) with distal aortic involvement (DeBakey type I). All surviving patients were followed with serial radiologic imaging to monitor for aortic degeneration. We used CFD to analyze aortic wall stress distribution with the objective of determining the clinical implications of our findings that could directly impact the treatment strategy for aortic dissections.

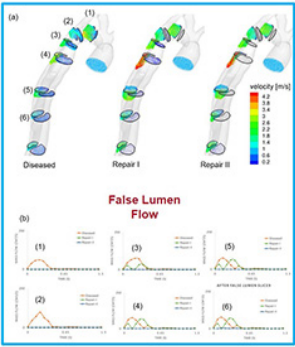
**Results:** At a mean follow-up of 40 months, one patient (1.8%) required reoperation for total arch replacement and four patients (7.5%) required distal thoracic aortic replacement, indicating that the disease of the distal aorta is subject to a higher rate of progression compared to the aortic arch. CFD assessment of aortic wall stress distribution in an idealized model of aorta demonstrated that the regional characteristics of aortic wall stress distribution explain the lower rate of aneurysmal degeneration observed in the arch. Furthermore, we analyzed the hemodynamic stress in the thoracic aorta of one of the patients with residual thoracic dissection after type A repair who had required surgical intervention for later aneurysmal degeneration, showing that the dissection determined a significant increase of hemodynamic stress. We simulated different repair scenarios and assessed their hemodynamic effects to identify the best therapeutic option that would have lowered aortic wall stress preventing aneurysmal degeneration (Figure).

**Conclusions:** CFD hemodynamic stress assessment provides relevant clinical applications identifying patients with type B dissections at higher risk of later degeneration. Simulations of different therapeutic options allow selection of the best treatment strategy. The real-world application of CFD to clinical practice opens new frontiers in the management and treatment of aortic diseases.





Pressure Distribution



Mass-flux Distribution in the false lumen



4:15 PM

Floridian Ballroom A

**Residual Tears in the Arch Vessel Is a Potential Risk Factor for Major Adverse Aortic Events After Acute DeBakey Type I Aortic Dissection Repair***W. Heo<sup>1</sup>, S. Song<sup>1</sup>, K. Lee<sup>1</sup>, T. Kim<sup>1</sup>, M. Baek<sup>1</sup>, K. Yoo<sup>1</sup>, B. Cho<sup>2</sup>**<sup>1</sup>Yonsei University, Gangnam Severance Hospital, Seoul, South Korea, <sup>2</sup>Korea Heart Foundation, Seoul, South Korea*

**Purpose:** Tear-oriented surgery is considered a standard treatment for acute DeBakey type I aortic dissection (AIAD). However, it seems to be insufficient for the long-term fate of residual thoracoabdominal aorta focusing on aortic growth and major adverse aortic events (MAAEs).

**Methods:** A total of 274 patients underwent surgical repair for AIAD between 2009 and 2016. Of those, 105 patients with both pre-discharge and follow-up computed tomographic scans were enrolled in this study. The surgical extent was determined by the location of primary entry tears (ascending, 1-partial, 2-partial, or total arch replacement [TAR]). We measured aortic diameters (pulmonary artery bifurcation [PAB], the maximum diameter of the descending thoracic aorta [maxDTA], and celiac axis), and compared MAAEs (defined as aorta growth rate >5 mm/year or maxDTA >55 mm) according to the surgical extent.

**Results:** All patients underwent tear-oriented surgery. Twenty-nine patients (27.6%) underwent TAR, and 76 (72.4%) underwent non-TAR. In the non-TAR group, patients with or without residual tears in the arch vessels were classified as complete (non-TAR-CAR, n=52) or incomplete arch repair (non-TAR-IAR, n=24) (Figure 1A). There were significant differences in the aorta growth rate: TAR vs non-TAR (PAB:  $-0.7\% \pm 19.4\%$  vs  $11.5\% \pm 20.0\%$ ,  $P = .006$ , max DTA:  $1.8\% \pm 16.0\%$  vs  $12.7\% \pm 19.7\%$ ,  $P = .009$ ) and non-TAR-CAR vs non-TAR-IAR (PAB:  $6.2\% \pm 17.4\%$  vs  $23.0\% \pm 20.7\%$ ,  $P < .001$ , maxDTA:  $6.4\% \pm 14.8\%$  vs  $26.2\% \pm 22.5\%$ ,  $P < .001$ ) (Table). Freedom from MAAEs at 5 years was significantly higher in the non-TAR-CAR group than in the non-TAR-IAR group (71.2% and 23.2%, log-rank  $P = .032$ ). However, there was no difference between the TAR and non-TAR groups in freedom from MAAE. There also were no differences between the TAR and non-TAR-CAR groups in aorta growth and freedom from MAAE (Figure 1B).

**Conclusions:** Classic “tear-oriented surgery” seems to be insufficient for long-term aortic outcomes if there is a residual tear in the arch vessels. Complete arch repair without residual tears in the arch vessels leads to favorable aorta remodeling at residual descending thoracic aorta and prevents MAAE after AIAD repair.

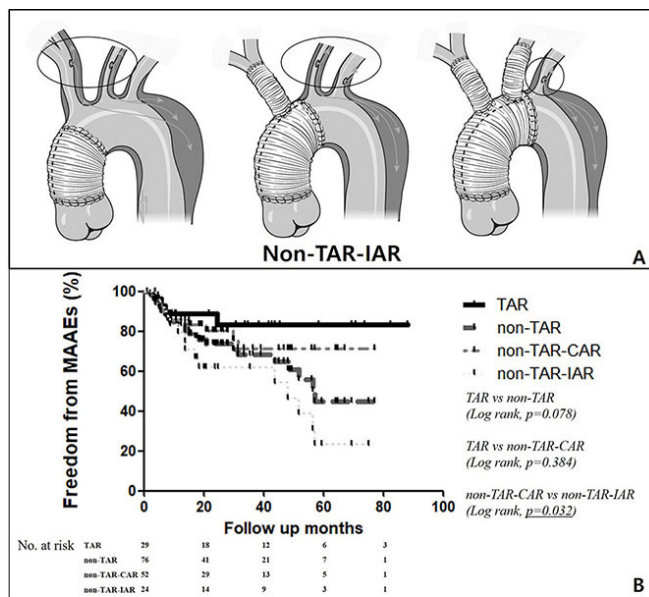


Fig 1. (A) Illustration of non-TAR-IAR. This image shows residual tear in the arch branches (circles) which is potential risk factor of unfavorable aorta remodeling. (B) Kaplan-Meier curves of freedom from MAAs

Table 1. Comparison of CAR and IAR group.

	CAR group (n=52)	IAR group (n=24)	P value
	Mean $\pm$ SD or No.(%)	Mean $\pm$ SD or No.(%)	
Sex			0.382
Male	21 (40.4%)	13 (54.2%)	
Female	31 (59.6%)	11 (45.8%)	
Age (years)	61.2 $\pm$ 12.3	57.8 $\pm$ 11.0	0.252
CT follow duration (months)	25.6 $\pm$ 19.7	29.2 $\pm$ 21.6	0.478
Growth rate (%) of aorta diameter			
Level of PAB	6.2 $\pm$ 17.4	23.0 $\pm$ 20.7	<0.001
True lumen	30.2 $\pm$ 48.7	19.4 $\pm$ 44.8	0.361
False lumen	-16.7 $\pm$ 58.3	32.8 $\pm$ 56.3	0.001
Level of CA	9.6 $\pm$ 24.3	8.7 $\pm$ 10.3	0.831
True lumen	16.2 $\pm$ 38.6	6.4 $\pm$ 32.6	0.286
False lumen	0.0 $\pm$ 47.2	12.1 $\pm$ 39.1	0.284
MaxDTA	6.4 $\pm$ 14.8	26.2 $\pm$ 22.5	<0.001
Annual growth			0.009
< 5mm	41 (78.8%)	11 (45.8%)	
$\geq$ 5mm	11 (21.2%)	13 (54.2%)	
MaxDTA			<0.001
< 55mm	52 (100.0%)	17 (70.8%)	
$\geq$ 55mm	0 (0.0%)	7 (29.2%)	

CAR;complete arch repair, IAR;incomplete arch repair, SD;standard deviation, PAB;pulmonary artery bifurcation, CA;celiac axis, MaxDTA;maximal diameter of descending thoracic aorta

4:30 PM

Floridian Ballroom A

**DEBATE: 55-Year-Old Patient Presenting With Acute Type A Aortic Dissection With Hemiplegia***Aggressive Immediate Intervention:* Thomas G. Gleason, Pittsburgh, PA*Expectant Management and Delayed Intervention:* Anthony L. Estrera, Houston, TX**COMMERCIAL RELATIONSHIPS** T. G. Gleason: Research Grant, Medtronic; Nonremunerative Position of Influence, Medtronic, Steering and Screening Committee; A. L. Estrera: Consultant/Advisory Board, W. L. Gore & Assoc

5:00 PM

**The Role of Multilayer Flow Modulator Stents in the Endovascular Treatment of Aortic Dissection: A Single-Center Experience***V. Costache<sup>1</sup>, D. M. Dorobantu<sup>2</sup>, A. D. Costache<sup>3</sup>, C. M. Goia<sup>3</sup>, O. I. Stiru<sup>2</sup>, R. A. White<sup>4</sup>**<sup>1</sup>Polisano European Hospital, Sibiu, Romania, <sup>2</sup>Institute for Cardiovascular Diseases CC Iliescu, Bucharest, Romania, <sup>3</sup>Lucian Blaga University, Sibiu, Romania, <sup>4</sup>MemorialCare Heart & Vascular Institute, Long Beach, CA***COMMERCIAL RELATIONSHIPS** R. A. White: Research Grant, Medtronic; Consultant/Advisory Board, Cardiatis, Intact Vascular; Speakers Bureau/Honoraria, Endologix, Medtronic; Other Research Support, Medtronic**REGULATORY DISCLOSURE** This presentation describes the use of the Cardiatis multilayer flow modulator graft, which is not FDA approved.**Purpose:** Recent reports showed promising results with endovascular treatment of chronic symptomatic type B aortic dissection using new-generation multilayer flow modulator grafts (MFM). We present our single-center experience and results with this technique.**Methods:** Patients with complex type A or B dissections were selected for MFM repair as per device indications of use and were followed prospectively between April 2013 and April 2017. High-resolution computed tomography was performed before and after the procedure and at follow-up on site visits. Follow-up was done through clinic visits or by phone, collecting data on survival and adverse effects.**Results:** A total of 12 consecutive patients (mean age 53 years) with aortic dissection were treated with an MFM endoprosthesis in our institution. Indications included type B dissection (n=8), residual type B after type A surgical correction (n=3), and acute type A after surgical correction requiring intervention for malperfusion (n=1). There were three complications: one case of reactive pericardial effusion, one minor stroke without sequelae unrelated to the procedure (spontaneous dissection in a Marfan patient), and one distal aortic and bilateral iliac thrombosis due to femoral access complication, which required urgent surgical revascularization. There were two early reinterventions in the same patient with no deaths, resulting in a reintervention-free survival of 92% at 3 years, on a mean follow-up of 471 days (maximum of 1157 days). Initial procedural success was 100% with no branch occlusions during follow-up. A significant reduction in false lumen at 1 year by computed tomography imaging was obtained ( $P = .01$ ).**Conclusions:** MFM endovascular grafts are a safe option in the treatment of complex aortic dissections, with no mortality and good procedural success. Further studies and longer follow-up are needed to establish the role of MFM devices in the management of aortic dissection.

5:15 PM

Floridian Ballroom A

## Axillary vs Femoral Cannulation in Acute Type A Aortic Dissection: An International Consortium Report

O. A. Preventza<sup>1</sup>, D. Tian<sup>2</sup>, T. D. Yan<sup>3</sup>, S. A. LeMaire<sup>1</sup>, J. S. Coselli<sup>1</sup>

<sup>1</sup>Baylor College of Medicine, Houston, TX, <sup>2</sup>International Aortic Arch Surgery Study Group, Macquarie Park, Australia, <sup>3</sup>Royal Prince Alfred Hospital, Sydney, Australia

**COMMERCIAL RELATIONSHIPS** J. S. Coselli: Ownership Interest, Vascutek; Research Grant, Bolton Medical, Medtronic, Vascutek, W. L. Gore & Assoc; Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc; S. A. LeMaire: Research Grant, Baxter Healthcare, CytoSorbents, W. L. Gore & Assoc; Consultant/Advisory Board, Vascutek; O. A. Preventza: Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc

**Purpose:** Debate still exists regarding cannulation strategies for patients who are undergoing emergent repair of acute type A aortic dissection. We compared early outcomes in patients who underwent perfusion through the two most popular cannulation sites: the femoral artery and the axillary artery.

**Methods:** We identified 1872 patients enrolled in an international aortic arch repair registry who underwent emergent hemiarch (n=1034) or total arch replacement with or without elephant trunk (n=838) for acute type A aortic dissection with either axillary or femoral cannulation between 2000 and 2015. The registry included patients from 37 institutions in 12 countries. Multivariable logistic regression analysis and propensity scoring based on baseline and operative characteristics, year of operation, and geographical distribution was performed.

**Results:** Overall, 1161 patients received axillary cannulation, and 711 patients received femoral cannulation. The incidence of permanent neurological deficit (PND) was significantly higher for the femoral cannulation cohort than in the axillary group (13.7% vs 8.4%,  $P < .001$ ). Mortality was 14.4% and 15.0% for the axillary and femoral group, respectively ( $P = .7$ ). Following propensity score matching of 340 patient-pairs, comparable outcomes for mortality ( $P = .6$ ) and PND ( $P = .4$ ) were seen. In separate subgroup analyses for hemiarch and total arch repairs, mortality and PND rates were similar after axillary and femoral cannulation. Multivariable logistic regression identified increasing age (odds ratio 1.028/year, [95% confidence interval 1.017-1.039],  $P < .001$ ), concomitant coronary artery bypass grafting (1.73 [1.148-2.606],  $P = .009$ ), and increasing cardiopulmonary bypass time (1.011/minute [1.008-1.014],  $P < .001$ ) as predictors of mortality. PND was associated with increasing age (1.023/year [1.01-1.036],  $P < .001$ ) and cardiopulmonary bypass time (1.002/year [1.001-1.004],  $P = .008$ ).

**Conclusions:** In a propensity-matched, international cohort of patients undergoing emergent repair of acute type A aortic dissection, axillary artery and femoral artery cannulation yielded similar early clinical outcomes, regardless of the extent of arch replacement. Both cannulation strategies remain acceptable in these cases.

3:30 PM – 5:30 PM

Floridian Ballroom D

**Adult Cardiac: Aortic Valve/Novel Technologies***Moderators: Ibrahim Sultan, Pittsburgh, PA, and Wilson Y. Szeto, Philadelphia, PA***COMMERCIAL RELATIONSHIPS** W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures, a debate, and a brief question-and-answer session after each topic.*

3:30 PM

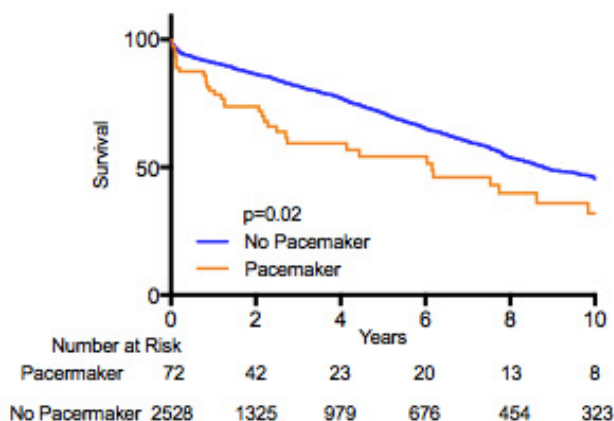
**Need for Permanent Pacemaker After Aortic Valve Replacement Reduces Long-Term Survival: Implications for Transcatheter Aortic Valve Replacement***J. H. Mebaffey, R. B. Hawkins, E. J. Charles, J. A. Kern, N. R. Teman, I. L. Kron, L. T. Yarboro, G. Ailawadi**University of Virginia Health System, Charlottesville***COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic

**Purpose:** Permanent pacemaker (PPM) has been touted as an inconsequential complication following transcatheter aortic valve replacement (TAVR). As TAVR moves to lower-risk patients, the long-term implications remain poorly understood. To investigate the impact of PPM, we evaluated the long-term outcomes of pacemaker in patients undergoing surgical aortic valve replacement (SAVR).

**Methods:** A total of 2,600 consecutive patients undergoing SAVR over the past 15 years were reviewed using an institutional STS National Database. Patients with endocarditis were excluded. Social Security death records were queried through the Department of Health and Human Services to determine long-term survival. Patients requiring PPM within 30 days of surgery were compared to those not requiring pacemaker. Kaplan-Meier survival analysis assessed the impact of PPM placement on long-term survival. Subsequently, Cox proportional hazards modeling was utilized to assess risk-adjusted survival by PPM status.

**Results:** A total of 72 patients (2.7%) required PPM placement postoperatively. Patients who required PPM had higher preoperative risks, including higher STS predicted risk of mortality (5.6% vs 4.7%,  $P = .009$ ), prior stroke (16.7% vs 6.8%,  $P = .001$ ), and prior cardiac surgery (23.6% vs 13.2%,  $P = .011$ ). Moreover, patients requiring PPM had more postoperative complications, including atrial fibrillation (43.1% vs 27.0%,  $P = .003$ ), prolonged ventilation (16.7% vs 5.7%,  $P < .0001$ ), and renal failure (12.5% vs 4.6%,  $P = .002$ ). These led to greater resource utilization, including longer ICU (154 hours vs 77 hours,  $P < .0001$ ) and hospital (12 days vs 8 days,  $P < .0001$ ) lengths of stay and higher inflation-adjusted cost (\$81,000 vs \$47,000,  $P < .0001$ ). By Kaplan-Meier, patients requiring PPM had significantly worse long-term survival ( $P = .02$ , Figure). Importantly, PPM placement remained highly associated with mortality even after risk adjustment with STS predicted risk (HR 1.48,  $P = .02$ ).

**Conclusions:** The need for PPM following aortic valve replacement independently reduces long-term survival. The rate of PPM after SAVR remains very low, but dramatically increases resource utilization. As TAVR expands into low-risk patients, impact of PPM placement on long-term survival warrants close monitoring.



3:45 PM

Floridian Ballroom D

## Transcatheter Aortic Valve Replacement After Previous Mitral Valve Repair or Replacement Surgery: Results From the STS/ACC Transcatheter Valve Therapy Registry

D. G. Cervantes<sup>1</sup>, J. J. Kelly<sup>1</sup>, S. Vemulapalli<sup>2</sup>, P. Manandhar<sup>3</sup>, J. Forcillo<sup>4</sup>, M. J. Mack<sup>4</sup>, D. R. Holmes<sup>5</sup>, D. Cohen<sup>6</sup>, A. J. Kirtane<sup>7</sup>, S. K. Kodali<sup>8</sup>, M. B. Leon<sup>8</sup>, V. C. Babaliaros<sup>1</sup>, S. C. Malaisrie<sup>9</sup>, S. R. Kapadia<sup>10</sup>, M. Reardon<sup>11</sup>, T. G. Gleason<sup>12</sup>, E. Holper<sup>5</sup>, J. E. Bavaria<sup>13</sup>, H. C. Herrmann<sup>13</sup>, W. Y. Szeto<sup>13</sup>, J. D. Carroll<sup>14</sup>, V. H. Thourani<sup>1</sup>

<sup>1</sup>Emory University, Atlanta, GA, <sup>2</sup>Duke Clinical Research Institute, Durham, NC, <sup>3</sup>Duke University, Durham, NC, <sup>4</sup>The Heart Hospital Baylor Plano, TX, <sup>5</sup>Mayo Clinic, Rochester, MN, <sup>6</sup>Saint Luke's Mid America Heart Institute, Kansas City, MO, <sup>7</sup>Columbia University, New York, NY, <sup>8</sup>Columbia University College of Physicians and Surgeons, New York, NY, <sup>9</sup>Northwestern Medicine, Chicago, IL, <sup>10</sup>Cleveland Clinic, OH, <sup>11</sup>Houston Methodist Hospital, TX, <sup>12</sup>University of Pittsburgh, PA, <sup>13</sup>University of Pennsylvania, Philadelphia, <sup>14</sup>University of Colorado Denver, Aurora

**COMMERCIAL RELATIONSHIPS** V. C. Babaliaros: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Abbott, Edwards Lifesciences; J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; J. D. Carroll: Research Grant, Abbott, Edwards Lifesciences, Medtronic; D. Cohen: Research Grant, Boston Scientific, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic; T. G. Gleason: Research Grant, Medtronic; Nonremunerative Position of Influence, Medtronic; H. C. Herrmann: Ownership Interest, Microinterventional Devices; Research Grant, Abbott, Bayer, Boston Scientific, Cardiokinex, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; Consultant/Advisory Board, Edwards Lifesciences, Microinterventional Devices; Other, Massachusetts Medical Society, Deputy Editor, Journal Watch; S. R. Kapadia: Ownership Interest, Navigate; A. J. Kirtane: Research Grant, Abbott, Abiomed, Boston Scientific, CathWorks, CSI, Medtronic, Philips, ReCor Medical, Spectranetics; S. K. Kodali: Consultant/Advisory Board, Claret Medical, Edwards Lifesciences, Meril Lifesciences, Thubrikar Aortic Valve, Inc; M. J. Mack: Research Grant, Abbott, Edwards Lifesciences, Medtronic; S. C. Malaisrie: Research Grant, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Edwards Lifesciences; M. J. Reardon: Consultant/Advisory Board, Medtronic; W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices; V. H. Thourani: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc; S. Vemulapalli: Research Grant, Abbott

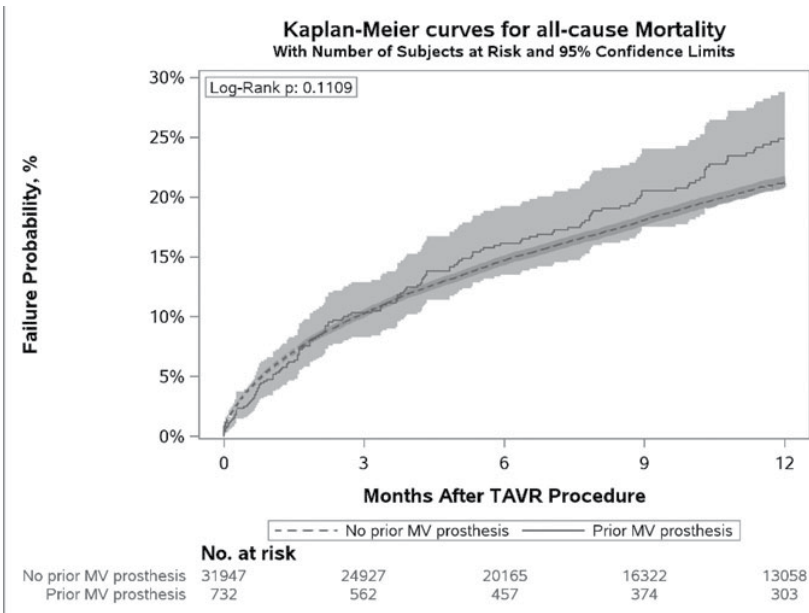
**Purpose:** Due to perceived technical challenges and anatomical factors, patients with previous surgical mitral valve repair or replacement (SMVR) have been excluded from most transcatheter aortic valve replacement (TAVR) trials. The purpose of this study was to evaluate 30-day and 1-year outcomes in TAVR patients with or without a prior SMVR.

**Methods:** In a retrospective review of the STS/ACC Transcatheter Valve Therapy (TVT) Registry, we compared outcomes of TAVR patients with previous SMVR (n=732) to those without previous SMVR (n=31,947) between November 2011 and September 2015 at 396 US sites. The primary outcomes (CMS-linked 1-year mortality) and secondary outcomes (30-day mortality and periprocedural outcomes as defined by VARC-2 criteria) were compared between groups. Moreover, a composite outcome (new pacemaker, stroke, bleeding, vascular complications, and acute kidney injury) was analyzed between groups. Logistic regression model was created for adjustment using 31 variables.

**Results:** Patients with SMVR were younger (81.0 years vs 84.0 years,  $P < .001$ ), more likely female (58.6% vs 48.6%,  $P < .001$ ), and higher risk for SAVR (median STS PROM 8.6% vs 6.8%,  $P < .001$ ). There was no difference in unadjusted 30-day (4.6% vs 5.5%,  $P = .29$ ) or 1-year (20.0% vs 17.5%,  $P = .09$ ) mortality following TAVR in those with vs without SMVR. There also was no difference between groups in the rates of postoperative myocardial infarction, stroke, valve reintervention, new dialysis, or readmission (Table). After adjustment,

there was higher mortality in patients with prior SMVR at 1 year (adjusted HR 1.18,  $P = .04$ , Figure), with separation in the curve around month 4. Post-procedure moderate/severe paravalvular regurgitation (PVR) at discharge was not higher in those with prior SMVR (5.8% vs 4.9%,  $P = .34$ ). In subgroup analysis, TAVR in those with prior bioprosthetic MVR revealed no difference in 30-day or 1-year mortality ( $P = .58$ ) when compared to controls matched by STS-PROM.

**Conclusions:** Patients undergoing TAVR have excellent short-term outcomes despite the presence of prior SMVR. However, there is a slightly higher rate of 1-year mortality. Surprisingly, there is no increase in early PVR in those with prior SMVR. Prior SMVR should not preclude TAVR in selected extreme, high, or intermediate-risk patients.



Outcome	30 days			p-value
	Overall (N=32679)	TAVR with prior SMVR (N=31947)	TAVR without prior SMVR (N=732)	
Death- no. (%)	1805 (5.5)	1771 (5.5)	34 (4.6)	0.29
Myocardial infarction- no. (%)	214 (0.65)	210 (0.66)	4 (0.55)	0.34
Stroke- no. (%)	777 (2.4)	762 (2.4)	15 (2.1)	0.43
Reintervention- no. (%)	158 (0.48)	154 (0.48)	4 (0.55)	0.47
New dialysis- no. (%)	555 (1.8)	543 (1.8)	12 (1.7)	0.77
Readmission- no. (%)	4805 (14.7)	4697 (14.7)	108 (14.8)	0.62
Readmission due to HF- no. (%)	1214 (3.7)	1186 (3.7)	28 (3.8)	0.83

4:00 PM

Floridian Ballroom D

**Evolving Trends in Aortic Valve Replacement: A Statewide Experience**

**K. M. Kim**<sup>1</sup>, **F. L. Shannon**<sup>2</sup>, **G. Paone**<sup>3</sup>, **S. C. Lall**<sup>4</sup>, **S. N. Batra**<sup>5</sup>, **T. Boeve**<sup>6</sup>, **A. Delucia**<sup>7</sup>,  
**H. J. Patel**<sup>8</sup>, **P. F. Theurer**<sup>8</sup>, **G. Deeb**<sup>1</sup>, **R. L. Prager**<sup>8</sup>

<sup>1</sup>University of Michigan, Ann Arbor; <sup>2</sup>Beaumont Cardiovascular Surgery, Royal Oak, MI; <sup>3</sup>Henry Ford Hospital, Detroit, MI; <sup>4</sup>Munson Medical Center, Traverse City, MI; <sup>5</sup>St John Hospital, Detroit, MI; <sup>6</sup>Spectrum Health, Grand Rapids, MI; <sup>7</sup>Bronson Methodist Hospital, Kalamazoo, MI; <sup>8</sup>University of Michigan Health System, Ann Arbor

**COMMERCIAL RELATIONSHIPS** G. M. Deeb: Research Grant, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Terumo; H. J. Patel: Consultant/Advisory Board, Terumo, W. L. Gore & Assoc; F. L. Shannon: Speakers Bureau/Honoraria, Edwards Lifesciences, Abbott; Consultant/Advisory Board, Boston Scientific, Medtronic

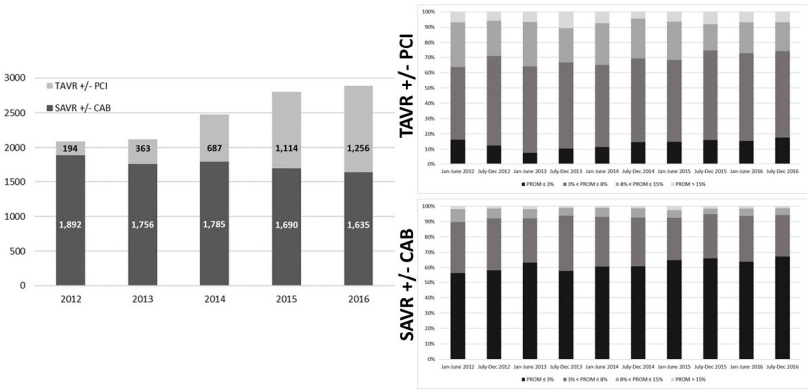
**Purpose:** Transcatheter aortic valve replacement (TAVR) is an alternative to surgical aortic valve replacement (SAVR) for the treatment of aortic valve disease in patients who are at intermediate, high, and extreme risk for mortality from SAVR. We examined recent trends in aortic valve replacement (AVR) in the state of Michigan.

**Methods:** The Michigan Society of Thoracic and Cardiovascular Surgeons Quality Collaborative database was queried to determine the number of SAVR with or without coronary artery bypass grafting (SAVR ± CAB) and TAVR with or without percutaneous coronary intervention (TAVR ± PCI) cases performed from January 2012 to December 2016. The STS Short-Term Risk Calculator was used to calculate predicted risk of mortality (PROM) for patients in both groups. Patients were divided into low (PROM ≤3%), intermediate (3% < PROM ≤8%), high (8% < PROM ≤15%), and extreme (PROM >15%) risk groups.

**Results:** From 2012 to 2016, 8758 SAVR ± CAB and 3614 TAVR ± PCI cases were performed. During this period, total annual AVR volume increased by 38.6% (from 2086 to 2891), with a 13.6% decrease in the number of SAVR ± CAB cases (from 1892 to 1635) and a 547% increase in the number of TAVR ± PCI cases (from 194 to 1256) (Figure). Patients at low or intermediate risk for mortality (PROM ≤8%) comprised >90% of patients who underwent SAVR ± CAB. In the TAVR ± PCI group, the proportion of patients with PROM ≤8% increased over time and most recently comprised >70% of patients.

**Conclusions:** The marked increase in AVR volume is due to a new group of lower-risk patients undergoing TAVR, rather than a decline in patients undergoing SAVR. Analysis of this group and other factors (eg, number of TAVR sites, FDA approval dates, changing guidelines) is needed to further explain these trends.

Aortic Valve Replacement Volume in Michigan and  
Patients Proportioned by STS Predicted Risk of Mortality



4:15 PM

Floridian Ballroom D

### Sutureless Aortic Valves in Elderly Patients With Aortic Stenosis and Intermediate Risk Profile: Early and Long-Term Outcomes

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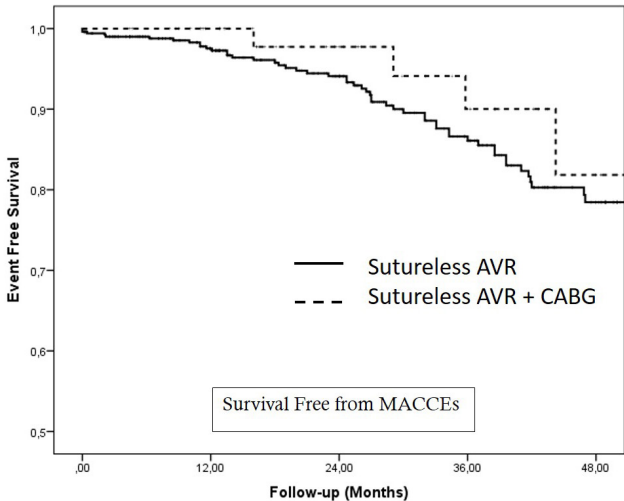
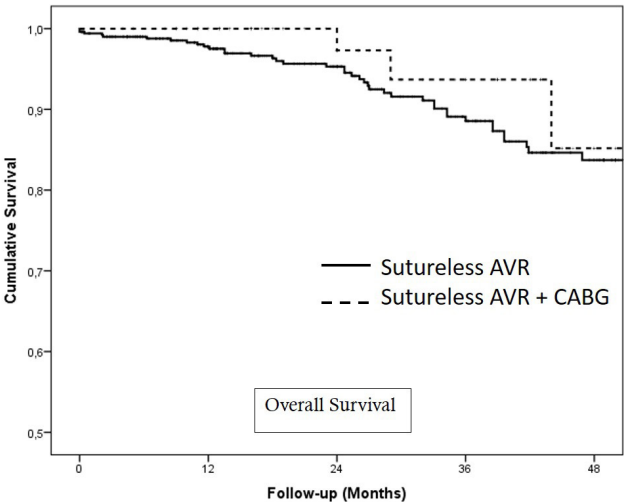
**COMMERCIAL RELATIONSHIPS** T. J. Fischlein: Consultant/Advisory Board, BioStable, LivaNova; T. A. Folliquet: Research Grant, LivaNova; S. Pfeiffer: Consultant/Advisory Board, LivaNova; A. Repossini: Consultant/Advisory Board, LivaNova; G. Santarpino: Consultant/Advisory Board, Sorin

**Purpose:** Sutureless valves have become an alternative to standard bioprostheses, allowing surgeons to significantly reduce cross-clamping and extracorporeal circulation time with a potential positive impact on major postoperative complications. The aim of this European multicenter study was to evaluate the safety and efficacy of sutureless aortic bioprostheses in patients with aortic stenosis and intermediate risk profiles.

**Methods:** Among 1134 consecutive patients with aortic stenosis undergoing aortic valve replacement (AVR) with sutureless aortic valves in high-volume European centers, we investigated early and mid-term outcomes of 518 elderly patients with intermediate risk profiles. The study population had a mean age of 79 years  $\pm$  5.8 years, with 51% of patients  $\geq$ 80 years old, and mean STS score of 6.1%  $\pm$  2% (STS range 4%-8%). Outcome variables were selected and analyzed according to VARC 1-2 criteria. Primary study endpoints were 30-day mortality and freedom from all-cause death at follow-up. The secondary endpoint was survival freedom from major adverse cardiac and cerebrovascular events (MACCEs; all-cause death, stroke/transient ischemic attack [TIA], bleeding, myocardial infarction, aortic regurgitation grade II, endocarditis, reintervention, and pacemaker implant).

**Results:** Sutureless valve implant was successfully performed in 508 patients with a procedural success rate of 98.1%. Minithoracotomy or ministernotomy were performed in 46.7% of cases, while 14.3% of patients underwent concomitant myocardial revascularization (CABG). There was no operative mortality, while hospital mortality was 1.9%, significantly lower than predicted STS mortality (6.1%). Major postoperative complications included revision for bleeding (4.4%), prolonged intubation >48 hours (0.7%), acute renal failure (2.7%), stroke/TIA (2.1%), vascular complication (0.2%), pacemaker implant (5.6%), and aortic regurgitation >grade II (1.35%). Postoperative peak and mean gradient were respectively 19.3 mm Hg  $\pm$  9.7 mm Hg and 11.2 mm Hg  $\pm$  6.6 mm Hg. At 48 months follow-up, Kaplan-Meier overall survival and freedom from MACCEs were respectively 83.7% (95% CI: 81.1%-86.3%) and 78.4% (95% CI: 75.5%-81.4%) (Figure). In patients who underwent AVR and concomitant CABG, there were no significant differences from the isolated AVR patients in terms of hospital mortality (2.7%) and overall survival and freedom from MACCEs at follow-up, respectively: 85.2% (95% CI: 76.2%-94.2%) and 81.8% (95% CI: 72.5%-91.1%).

**Conclusions:** The use of sutureless aortic valves in elderly patients with intermediate risk profiles provided excellent early and late outcomes with remarkable safety profiles. In particular, hospital mortality was significantly lower than predicted, underlying the needing to upgrade preoperative risk assessment score of surgical AVR when sutureless aortic valve are used.



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Floridian Ballroom D

**Transcaval Transcatheter Aortic Valve Replacement for the Treatment of Subaortic Stenosis***J. J. Kelly, J. Forcillo, V. C. Babaliaros, S. Lerakis, F. E. Corrigan, V. H. Thourani**Emory University, Atlanta, GA*

**COMMERCIAL RELATIONSHIPS** V. C. Babaliaros: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Edwards Lifesciences; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

**REGULATORY DISCLOSURE** This presentation describes the off-label use of an Amplatzer Duct Occluder, which was deployed in the abdominal aorta to close the aorto-caval fistula following transcaval TAVR.

**Purpose:** In patients with anatomy that precludes transfemoral transcatheter aortic valve replacement (TAVR), appropriate alternative access must be selected. This video demonstrates transcaval TAVR for the treatment of subaortic stenosis in a patient with narrow femoral arteries that prohibited the transfemoral approach.

**Methods:** A 34-year-old female with history of Down syndrome, atrioventricular canal repair, mechanical mitral valve replacement, and subaortic stenosis with mean gradient of 65 mm Hg was referred for transcaval TAVR by the heart team. Preoperative imaging identified a location suitable for aorto-caval fistula creation. After obtaining access via the Seldinger technique, an electrified guidewire was advanced from the inferior vena cava to a snare in the abdominal aorta. This was exchanged for an extra-stiff guidewire, over which the valve sheath was advanced across the fistula. TAVR was performed. Following TAVR, a nitinol duct occluder was used to close the aorto-caval fistula.

**Results:** A 23-mm valve was successfully implanted in the aortic position. There was no paravalvular leak and no interference with the existing mechanical mitral valve. The mean gradient across the aortic valve measured 15 mm Hg. When closing the aorto-caval fistula, a 9-mm balloon was inflated to better seat the nitinol duct occluder. No extravasation of contrast was seen on final angiography. The patient was discharged on postoperative day 1. Echocardiography at 30-day follow-up demonstrated continued resolution of the subaortic stenosis with excellent valve function. At 1 year, the patient had no complaints, and the valve continued to function well.

**Conclusions:** TAVR is effective for treating subaortic stenosis, and the transcaval approach is a viable alternative for patients unable to undergo transfemoral TAVR. This case highlights the importance of preoperative planning with the heart team to develop an optimal treatment strategy for each patient.

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Floridian Ballroom D

### Geometric Changes in the Aortic Root Complex With Annular Stabilization Techniques in Type I Bicuspid Aortic Valve Repair: Valve-Sparing Root Reimplantation vs Subcommissural Annuloplasty/External Subannular Aortic Ring

H. A. Ko<sup>1</sup>, J. E. Bavaria<sup>1</sup>, R. N. Shah<sup>1</sup>, L. F. Al Ghofaily<sup>1</sup>, C. Komlo<sup>1</sup>, J. G. Augoustides<sup>1</sup>, M. A. Siki<sup>1</sup>, N. Desai<sup>1</sup>, A. Habberthuer<sup>2</sup>, R. C. Milewski<sup>1</sup>, M. Freas<sup>1</sup>, W. Y. Szeto<sup>1</sup>, P. Vallabhajosyula<sup>1</sup>

<sup>1</sup>University of Pennsylvania, Philadelphia, <sup>2</sup>Hospital of the University of Pennsylvania, Philadelphia

**COMMERCIAL RELATIONSHIPS** J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; W. Y. Szeto: Research Grant, Edwards Lifesciences, Medtronic, Terumo; Consultant/Advisory Board, Medtronic, Microinterventional Devices

**Purpose:** Valve-sparing root reimplantation (VSRR) offers a three-dimensional (3-D) reorientation of the aortic root compared to other techniques, such as subcommissural annuloplasty (SCA) and external subannular aortic ring (ESAR), which only enable planar (2-D) annular reduction. We compared functional outcomes of 3-D vs 2-D techniques on aortic root complex in the context of type I BAV repair.

**Methods:** From 2003 to 2017, of 139 patients undergoing type I BAV repair, 79 patients had annular stabilization via ESAR/SCA, and 60 patients underwent VSRR. Intraoperative transesophageal echocardiography performed before and after procedure were retrospectively analyzed by three operators independently for 11 parameters in the functional aortic root complex (Figure): sinotubular junction, sinus of Valsalva diameter, left ventricular (LV) outflow tract, aortic annulus, cusp billowing depth, effective height, coaptation zone, degree of eccentricity of AI (AI angle), sinus height, ascending aorta diameter, and vena contracta. Paired and unpaired t-test analysis was performed for intra- and intergroup analysis.

**Results:** Preoperatively, VSRR patients had larger root dimensions, annulus, but lower degree of AI eccentricity and smaller LV end diastolic diameter (Table). In-hospital/30-day mortality, stroke, reoperation for bleeding, and pacemaker rates were zero in the entire cohort. Postoperative freedom from AI >1+ was 100%. Within each group, significant reduction in annulus (25 mm ± 2.4 mm ESAR/SCA; 22 mm ± 3.3 mm VSRR), LV outflow tract (26 mm ± 3.4 mm ESAR/SCA; 23 mm ± 3.3 mm VSRR), degree of AI (0.2 ± 0.5 ESAR/SCA; 0.3 ± 0.6 VSRR), vena contracta (1.6 mm ± 0.9 mm ESAR/SCA; 1.9 mm ± 0.9 mm VSRR) were achieved postoperatively (Table). Greater annular and LVOT reduction were achieved with VSRR ( $P < .05$ ). Furthermore, VSRR patients had improved transvalvular gradients, AI angle, and coaptation zone.

**Conclusions:** VSRR provides improved annular reduction and coaptation compared to ESAR/SCA. The added technical ability with VSRR to reorient the repaired BAV into a neoroot may enable superior reconstruction of the aortic root complex. Further echocardiographic follow-up may enable refinement in annular stabilization techniques in BAV repair.

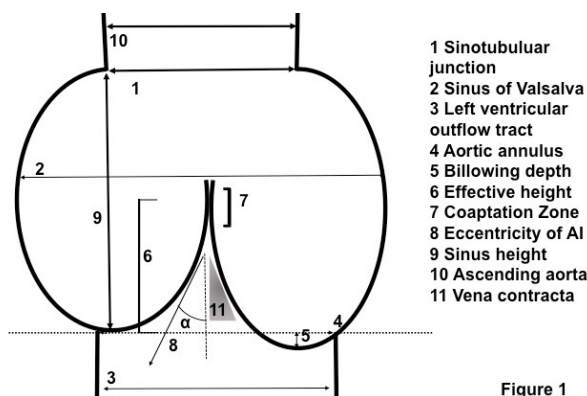


Figure 1

Preoperative Parameters	Subcommissural Annuloplasty + External Subannular Aortic Ring (n=79)	Valve Sparing Root Reimplantation (n=60)	P value
Ejection fraction (%)	55 ± 6.4	51 ± 8	0.002
Left ventricular end diastolic diameter (mm)	55 ± 8.5	55 ± 1.3	0.9
Left ventricular end systolic diameter (mm)	55 ± 8.5	39 ± 9	0.6
Annulus (mm)	29 ± 3.5	30 ± 3.8	0.07
Sinus of ValSalva (mm)	37 ± 4.3	45 ± 6	<0.0001
Sinotubular junction (mm)	33.6 ± 5.2	39.3 ± 7.0	<0.0001
Ascending aorta (mm)	40 ± 7.4	40.3 ± 7.1	0.6
Sinus height (mm)	23 ± 3.8	27 ± 7.1	0.01
AI grade	3.5 ± 1.0	1.7 ± 1.4	<0.0001
AI angle α	42 ± 29	34.2 ± 27	0.4
Vena Contracta (mm)	4.7 ± 1.9	5.1 ± 1.7	0.9
Peak gradient (mmHg)	10 ± 5.7	7.2 ± 3.9	0.01
Mean gradient (mmHg)	5 ± 3	3.5 ± 2.0	0.02
Left ventricular outflow diameter (mm)	29 ± 3.8	28 ± 5.2	0.6
Postoperative Parameters			
Ejection fraction (%)	55 ± 7.8	56 ± 8	0.4
Left ventricular end diastolic diameter (mm)	47 ± 7.0	49 ± 8.3	0.4
Left ventricular end systolic diameter (mm)	47.0 ± 7.0	32 ± 8.6	0.6
Annulus (mm)	25 ± 2.4	22 ± 3.3	<0.0001
Sinus of ValSalva (mm)	33 ± 4.5	33 ± 3	0.3
Sinotubular junction (mm)	30 ± 4.2	28 ± 3.3	0.02
Ascending aorta (mm)	31 ± 4.5	29 ± 4.1	0.06
Sinus height (mm)	23 ± 3.2	25 ± 4.0	0.0001
AI grade	0.2 ± 0.5	0.3 ± 0.6	0.3
AI angle α	11 ± 20	0.3 ± 0.6	0.06
Vena Contracta (mm)	1.6 ± 0.9	1.9 ± 0.9	0.2
Peak gradient (mmHg)	20 ± 10	10.6 ± 5	<0.0001
Mean gradient (mmHg)	9.5 ± 4.7	4.4 ± 2.2	<0.0001
Left ventricular outflow tract diameter (mm)	26 ± 3.4	23 ± 3.3	0.0006

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Floridian Ballroom D

**DEBATE:** Severe Symptomatic Aortic Insufficiency in a 50-Year-Old Patient With Non-Aneurysmal Bicuspid Aortic Valve

*Isolated Valve Repair:* Munir Boodhwani, Ottawa, Canada

*Mechanical Aortic Valve Replacement:* Ibrahim Sultan, Pittsburgh, PA

*Bioprosthetic Aortic Valve Replacement:* Michael J. Reardon, Houston, TX

**REGULATORY DISCLOSURE** This presentation describes the off-label use of the SimpliciT band as an annuloplasty device for aortic valve repair. This device has been used for mitral and tricuspid valve repair.



3:30 PM – 5:30 PM

Room 315

**Advanced Therapies for End-Stage Cardiopulmonary Disease**

The successful use of durable mechanical circulatory support (MCS) requires careful patient selection, infrastructure with specialized knowledge, and an institutional commitment. This course is an interactive and didactic session presented by leading authorities on practice recommendations regarding patient selection, infrastructure building, and surgical techniques in the field of durable MCS. Clinical practice guidelines from major societies and regulatory agencies will be covered, along with results of recent large-scale clinical trials. There will be ample time for audience questions on this complex and rapidly evolving field.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the impact of preoperative variables on durable ventricular assist device (VAD) outcomes, including the use of temporary MCS, vasoconstrictors, mechanical ventilation, and evidence of end organ injury
- Explain the roles of various MCS team members, including VAD coordinators, data collection personnel, occupational and physical therapists, social workers, clinical psychologists, financial specialists, heart failure cardiologists, and surgeons
- Discuss the essentials of maintaining and documenting competence of each of these individuals with respect to MCS, including the certification requirements of various regulatory agencies
- Explain the economics of MCS programs, including potential revenue streams and estimated operational costs
- Recognize the various surgical techniques employed in the MOMENTUM 3 clinical trial with an emphasis on measures that were associated with improved quality

**Moderators:** Jonathan W. Haft, Ann Arbor, MI, and Bryan A. Whitson, Columbus, OH

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*The physician competencies addressed in this session are patient care and procedural skills, medical knowledge, and practice-based learning and improvement. These physician competencies will be addressed through a series of lectures meant to enhance the understanding of patient selection, new technologies and devices, and necessary infrastructure for a successful durable ventricular assist device program.*

3:30 PM

**Introduction**

3:35 PM

**DEBATE: A Robust Shock/Temporary MCS System Can Successfully Augment a Growing VAD Program**

**Pro:** Pavan Atluri, Philadelphia, PA

**Con:** Ashish Shah, Nashville, TN

3:55 PM

**Discussion**

4:05 PM

**VAD Team Roles and Responsibilities***Simon Maltais, Rochester, MN*

4:20 PM

**VAD Economics***Michael A. Acker, Philadelphia, PA*

4:35 PM

**VAD Compliance and Certification***Michael F. McGrath, Norfolk, VA*

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**How to Grow a VAD Program***Scott C. Silvestry, St Louis, MO***COMMERCIAL RELATIONSHIPS** S. C. Silvestry: Consultant/Advisory Board, Abbott, Medtronic; Other, Medtronic, Proctor

5:05 PM

**MOMENTUM 3: Surgical Techniques in HeartMate 3 That Can Impact Quality***Chris T. Salerno, Carmel, IN***COMMERCIAL RELATIONSHIPS** C. T. Salerno: Consultant/Advisory Board, HeartWare, Abbott; Nonremunerative Position of Influence, St Jude, Co-Chair Surgical Sub-Committee, MOMENTUM 3 Trial; Member Publication and Presentation Committee, MOMENTUM 3 Trial

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**Discussion**

3:30 PM – 5:30 PM

Room 305

**Congenital: Pediatric Congenital III***Moderators: S. Adil Husain, San Antonio, TX, and Kirk R. Kanter, Atlanta, GA*

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Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

3:30 PM

**Beating Heart Root Harvesting for En Bloc Rotation of the Conotruncus***T. Sologashvili<sup>1</sup>, M. Beghetti<sup>1</sup>, Y. Aggoun<sup>1</sup>, R. Pretre<sup>2</sup>, **P. Myers<sup>1</sup>****<sup>1</sup>Geneva University Hospitals, Switzerland, <sup>2</sup>CHUV, Lausanne, Switzerland***COMMERCIAL RELATIONSHIPS** P. O. Myers: Consultant/Advisory Board, Admedus; Speakers Bureau/Honoraria, Admedus

**Purpose:** En bloc rotation of the conotruncus is an alternative to Nikaidoh and Rastelli repairs for transposition, ventricular septal defect (VSD), and pulmonary stenosis, recycling the dysplastic pulmonary valve in the pulmonary position and the better aortic valve in the systemic position. We describe our technique of partial beating heart conotruncus harvesting in this procedure.

**Methods:** A 6-year-old, 18-kg child was referred for surgical repair of double outlet right ventricle with D-transposed great arteries, valvular and subvalvular pulmonary stenosis (pulmonary annulus of 6 mm), and a small secundum atrial septal defect. The patient was referred for surgery. As the pulmonary valve appeared usable in the pulmonary position, a double root translocation was planned.

**Results:** The coronary arteries were extensively dissected free. On a beating heart, the aortic root was separated from the infundibulum, anteriorly and sideways up to the conal septum. The incision was directed, still on the beating heart, towards the pulmonary valve and the pulmonary-mitral continuity. The aorta was cross-clamped and the heart arrested with cold blood cardioplegia. Both great vessels were transected and the coronary buttons were harvested. Separation of the mitral and pulmonary valves along their common annulus was performed very cautiously. The aortic root was sutured to the mitral annulus, a pericardial patch was used to close the VSD, and the pulmonary root was sutured to the infundibulum. The coronary arteries were reimplanted in the aortic root, and the aorta and pulmonary artery were reanastomosed after a LeCompte maneuver. Echocardiography showed a wide-open left ventricular outflow tract and good biventricular function. The postoperative course was uneventful.

**Conclusions:** Beating heart root harvesting is feasible and reduces the duration of coronary ischemia during this complex operation. We prefer to address the specific difficulty of separating the pulmonary and mitral valve on an arrested heart.

3:45 PM

Room 305

**Late Results of Half-Turned Truncal Switch Operation for Transposition of the Great Arteries With Left Ventricular Outflow Obstruction***H. Hongu, M. M. Yamagishi, T. D. Miyazaki, Y. Y. Maeda, S. Taniguchi, S. Fujita, H. Nakatsuji, H. Yaku**Kyoto Prefectural University of Medicine, Japan***COMMERCIAL RELATIONSHIPS** M. Yamagishi: Consultant/Advisory Board, W. L. Gore & Assoc

**Purpose:** Conventional procedures for transposition of the great arteries (TGA) with left ventricular outflow tract obstruction have various problems postoperatively, including obstruction of both ventricular outflow tracts or coronary insufficiency. We developed a novel surgical technique called the “half-turned truncal switch operation” to resolve such problems.

**Methods:** From May 2002 to present, 13 patients underwent this method. The median age and body weight were 1.1 years and 8.9 kg. Diagnosis was TGA with pulmonary stenosis and ventricular septal defect (VSD) in eight, TGA type double outlet right ventricle in four, and TGA with VSD and degenerative pulmonary valve after pulmonary arterial banding in one. The relationship of the great arteries was all anterior-posterior. The coronary artery was Yacoub type A in 12 and type D in one. Four patients had small right ventricles. Pulmonary-aortic annular diameter ratio ranged from 0.43 to 1.00. In the right ventricular outflow tract reconstruction, the autologous pulmonary valve annulus was spared in six patients and patch augmentation was performed on seven.

**Results:** The median cross-clamp time was 199 minutes. The median follow-up period was 5.0 years (range, 0.9 to 14.9 years). There was no early mortality. Only one patient was lost after 11 months due to heart failure. Eleven patients are NYHA I. No patients showed coronary insufficiency. There was no significant pressure gradient at either outflow tract. Aortic regurgitation (AR) was mild in 11 patients, and one patient with aortic bicuspid valve had moderate AR. Reoperation was performed in three patients. Two (ages at operation were 1.0 and 0.4 years) underwent mitral valve plasty (MVP) for moderate-severe mitral regurgitation due to tethering and pacemaker implantation for complete atrioventricular block. One patient (age at operation was 0.9 years) underwent MVP only. The risk factor for late death and reoperation was age under 1.0 year at the operation ( $P < .05$ ).

**Conclusions:** This technique has various advantages, such as keeping both ventricular outflow tracts wide and straight with growth potential and evitable coronary insufficiency. This method also can be indicated for patients with small right ventricles, remote and restrictive VSD, and bicuspid pulmonary valves. However, it is necessary to carefully examine surgical indications in infants.

4:00 PM

Room 305

**Senning With Aortic Translocation, Anatomic Repair for Congenitally Corrected Transposition With Ventricular Septal Defect, and Pulmonic Stenosis***V. K. Tam, E. A. Erez, V. A. Sebastian, L. M. Roten, H. Nikaidoh**Cook Children's Medical Center, Fort Worth, TX*

**Purpose:** Anatomic repair for congenitally corrected transposition with ventricular septal defect (VSD) and pulmonic stenosis has been accomplished with atrial switch and Rastelli. Aortic translocation offers a direct left ventricular outflow without an extra-anatomic right ventricle to pulmonary conduit, which may lead to lower likelihood of reoperation. We review our entire experience with Senning aortic translocation.

**Methods:** From 2006 to 2016, seven patients (age 14.7 months [range, 12-18 months], size 9.2 kg [range, 7.7-10.9 kg]) underwent Senning atrial switch with aortic translocation. Associated anomalies included situs inversus (one), dextrocardia (five), multiple muscular VSDs (two), abnormal or straddling tricuspid valve chords (five), and branch pulmonary artery stenosis (three). Four of seven had previous systemic arterial shunts. Cardiopulmonary bypass was 498 minutes and cardiac ischemic time was 332 minutes. Additional procedures included repair of branch pulmonary artery stenoses and closure of multiple muscular VSDs.

**Results:** There was no hospital mortality. Two patients had delayed sternal closure. One patient was supported with extracorporeal membrane oxygenation because of junctional tachycardia on postoperative day 5 after extubation on day 3. One patient had pacemaker placement for first-degree heart block. Median hospital length of stay was 32 days (range, 19-115 days). Length of follow-up is mean of 41.6 months (range, 5-118 months). All patients remain well with mild or no aortic regurgitation, without any repeat surgery.

**Conclusions:** Despite the technical complexity, patient outcomes have been satisfactory. We believe Senning with aortic translocation provides a superior anatomic repair in these complex defects. Longer-term follow-up is needed regarding late intervention.

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Room 305

**Long-Term Outcomes of Coarctation Repair via Left Thoracotomy***M. R. Gropler<sup>1</sup>, B. S. Marino<sup>2</sup>, M. R. Carr<sup>2</sup>, O. Eltayeb<sup>2</sup>, M. C. Monge<sup>2</sup>, C. L. Backer<sup>2</sup>**<sup>1</sup>Washington University in St Louis College of Medicine, MO, <sup>2</sup>Ann & Robert H. Lurie Children's Hospital of Chicago, IL***COMMERCIAL RELATIONSHIPS** C. L. Backer: Consultant/Advisory Board, W. L. Gore & Assoc.

**Purpose:** The optimal surgical approach for repair of coarctation of the aorta (CoA) specifically with concomitant arch hypoplasia remains controversial. A median sternotomy approach has been suggested to decrease recoarctation. This study aims to evaluate reintervention rates using primarily a strategy of resection with extended end-to-end anastomosis (REEEA) via left thoracotomy.

**Methods:** A retrospective analysis was performed for patients who underwent isolated CoA repair via REEEA between January 2000 and December 2015. Patients with complex congenital heart disease or Shone's complex were excluded. Transverse arch hypoplasia was defined as an echocardiographic z-score < -2 or documentation of arch hypoplasia in echocardiographic or medical/operative reports. Recoarctation was defined as the presence of upper-to-lower limb blood pressure (BP) gradient >20 mm Hg or catheterization peak gradient >20 mm Hg. Hypertension was defined as presence of antihypertensive medication use or BP >95th percentile based on age and height.

**Results:** A total of 263 patients with a median age at repair of 16 days (range, 1-3420 days) underwent CoA repair with REEEA during the study period. Surgical approach was by left thoracotomy in 228 (86.7%) with a mean cross-clamp time of 16.9 minutes ± 3.8 minutes. Partial cardiopulmonary bypass was utilized in 14 patients. There were no early deaths or reoperations (<30 days). Follow-up data were available for 186/263 patients (71%) with a median follow-up time of 5.4 years (range, 0.2-15.3 years), of whom 169 (91%) had a left thoracotomy. Transverse arch hypoplasia was identified in 97/186 patients (52%) with follow-up data. Recoarctation occurred in 18/186 (9.7%) with 13/18 patients having transverse arch hypoplasia and 17/18 patients undergoing left thoracotomy. However, only four (2%) required reintervention at the time of last follow-up (two balloon angioplasties and two reoperations). Of patients requiring reintervention, three of four (75%) had transverse arch hypoplasia. Hypertension was identified in 33/186 patients (18%).

**Conclusions:** Repair of CoA, even with associated transverse arch hypoplasia via REEEA through left thoracotomy, has a low mortality, low reintervention rate, and low incidence of hypertension.

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Room 305

**Extra-Anatomic Bypass for Complex Adult Coarctation With Distal Arch Aneurysm and Anomalous Left Subclavian Artery***E. N. Feins, A. S. Jassar, L. F. Tapias, E. M. Isselbacher, T. M. Sundt III**Massachusetts General Hospital, Boston*

**Purpose:** Repair of complex aortic coarctation in adults poses many challenges. Several surgical techniques have been developed to treat this condition. We present a case of extra-anatomic bypass from distal aortic arch to descending thoracic aorta passing anterior to the phrenic nerve to repair a complex coarctation in a 32-year-old.

**Methods:** Computed tomography (CT) imaging was used to assess arch anatomy. Echocardiography was performed to assess aortic valve function. We performed the surgery via median sternotomy with a left thoracotomy counter-incision, and ascending aortic and bicaval cannulation. The distal anastomosis was performed with antegrade cerebral perfusion after cooling to 18°C. The tube graft was passed anterior to the phrenic nerve. After dividing the arch distal to the left carotid artery, the proximal anastomosis was performed. Part of this was performed with complete circulatory arrest in order to spatulate the hypoplastic arch. The patient was deaired, rewarmed, weaned from bypass, and decannulated.

**Results:** By CT imaging, the patient was found to have a long-segment narrowing of the transverse arch (minimum diameter 14 mm) with a large bilobed aneurysm just distal to the coarctation (maximum diameter 44 mm). Peak gradient across his coarctation was 71 mm Hg (by echocardiography). He had an anomalous left subclavian artery, which arose from the inferoposterior descending thoracic aorta and gave rise to the left vertebral artery. The patient had a congenitally absent left internal carotid artery. He had a well-functioning bicuspid aortic valve with only mild ascending aortic dilation (39 mm). A 26-mm tube graft was used. Total visceral ischemia time was 64 minutes, of which 59 minutes were with antegrade cerebral perfusion. His blood pressure gradient completely resolved following surgery. He was extubated on postoperative day 1 and discharged to home on postoperative day 7.

**Conclusions:** Complex coarctation in adults represents a challenging surgical problem for which a variety of techniques have been developed. We successfully performed an extra-anatomic bypass from the distal arch to descending thoracic aorta by passing the graft anterior to the phrenic nerve. This approach provided good exposure and yielded an excellent result.

4:45 PM

Room 305

**Posterior Leaflet Augmentation for Mitral Valve Regurgitation in Children: A Standardized Approach**

G. Brancaccio, M. Chinali, M. Trezzi, C. D'Anna, C. Esposito, E. E. Cetrano, S. B. Albanese, G. Rinelli, A. Carotti

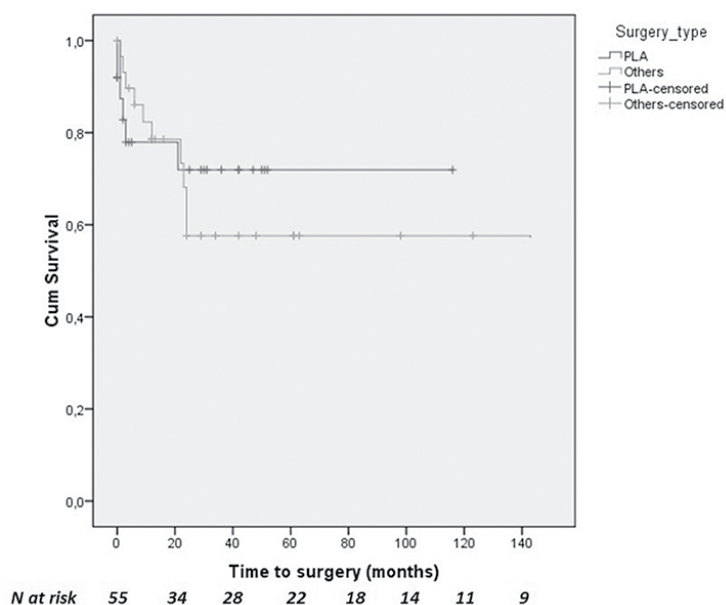
*Bambino Gesù Children's Hospital, Rome, Italy*

**Purpose:** Surgical treatment of mitral valve incompetence in pediatric patients is a challenge, and conservative approaches are preferred. Recently, posterior leaflet augmentation with untreated autologous pericardium (PLA) has proved promising. Herein, we report our experience with PLA in children and compare it to other more traditional surgical techniques (OTH).

**Methods:** Fifty-five pediatric patients with severe isolated mitral valve regurgitation, who underwent operations between January 2001 and March 2017, entered the study (55% female, median age 5.0 years  $\pm$  0.8 years). Of these, 25 underwent mitral repair with PLA and 30 with OTH (isolated cleft closure in 12, Alfieri procedure in 10, annuloplasty in five, and chordal resection in three). All patients underwent 2D-Echo evaluation before surgery and repeatedly after surgery, according to a pre-specified schedule (1 month postoperatively, and then every 6 months). Need for redo mitral surgery was the main study outcome. Follow-up time ranged from 1 to 143 months (median, 16 months  $\pm$  5 months).

**Results:** No differences in preoperative characteristics, including age, gender, mean weight, and echocardiographic parameters were observed between the two groups. No differences in mitral regurgitation grade or stenosis could be observed when comparing first post-surgical echocardiograms, suggesting similar short-term outcomes in both groups. However, during follow-up, differences could be observed in the incident endpoint. Reinterventions were slightly more frequent in the OTH group (37%), compared to the PLA group (24%; log rank  $P = .07$ ). However, mean time to intervention was significantly shorter in the PLA group compared to the OTH group (4 months vs 25 months), suggesting that PLA failure occurs earlier but less often as compared to OTH (Figure). Post-surgical transmitral gradient independently predicted outcome ( $P = .017$ ; HR 2.4/mm Hg; 95 CI % 1.2-5.1). ROC curve for reinterventions demonstrated that mitral stenosis had a high predictive power (AUC 0.89; SE 0.048) with a post-surgical transmitral mean gradient value of 4.5 mm Hg (Youden index = 0.44).

**Conclusions:** PLA is a suitable technique for pediatric mitral regurgitation with a low long-term rate of reintervention. However, although less common, occurrence of PLA failure is significantly faster as compared to OTH. Postoperative residual stenosis that may progress over time appears to be the strongest predictor of need for reintervention.



5:00 PM

Room 305

### Tetralogy of Fallot Repair in Developing Countries: Results From the International Quality Improvement Collaborative

N. F. Sandoval<sup>1</sup>, M. Carreño<sup>1</sup>, W. M. Novick<sup>2</sup>, R. Agarwal<sup>3</sup>, A. Ifrikbar<sup>4</sup>, R. Balachandran<sup>5</sup>, M. Ballestrini<sup>6</sup>, K. M. Cherian<sup>7</sup>, U. Crotti<sup>8</sup>, X. Du<sup>9</sup>, K. Gauthreau<sup>10</sup>, D. Giang<sup>11</sup>, R. Shastri<sup>12</sup>, K. J. Jenkins<sup>10</sup>

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**COMMERCIAL RELATIONSHIPS** K. J. Jenkins: Research Grant, NuMed; Other Research Support, Novartis

**Purpose:** Isolated reports from developing countries for surgical results in tetralogy of Fallot (TOF) are available. The International Quality Improvement Collaborative (IQIC) seeks to improve surgical results promoting reductions in infection and mortality in developing countries. We describe outcomes and risk factors for repair of TOF in developing countries from 2010 to 2014.

**Methods:** All cases of TOF in the IQIC database performed between 2010 and 2014 at 32 centers in 20 developing countries were included. Excluded from the analysis were TOF with any associated lesions. Patient characteristics, type of repair, and in-hospital outcomes were analyzed. A logistic regression analysis was performed to identify risk factors for in-hospital mortality after surgery for TOF, including initial primary repair, systemic to pulmonary artery shunt, and secondary complete repair.

**Results:** A total of 2164 patients were identified in the IQIC database. There were 1839 initial primary repair, 200 with initial systemic to pulmonary artery shunt and 125 underwent secondary repair following initial palliation. Overall mortality was 3.6% (78/2164), initial primary repair was 3.3% (60/1839), initial systemic to pulmonary artery shunt 8.0% (16/200), and secondary repair 1.6% (2/125);  $P = .003$ . Major infections occurred in 5.9% (128/2164) of the entire cohort, initial primary repair 5.8% (107/1839), systemic to pulmonary shunt 6.0% (12/200), and secondary repair 7.2% (9/125);  $P = .77$ . Risk factors for mortality following initial primary repair were oxygen saturation <90 and weight/body mass index for age below the 5th percentile ( $P < .001$ ). Over half, 54% (991/1839), underwent initial primary repair after 1 year of age. Older age at initial primary repair was not a risk factor for mortality ( $P = .21$ ).

**Conclusions:** In developing countries, TOF patients are often operated on primarily after 1 year of age. Unlike developed countries, older age is not a risk factor for mortality. Nutritional and hypoxemic status were associated with higher mortality and infections. This information fills a critical knowledge gap for surgery in developing countries.

Table 3. Surgical Outcomes, Overall and by Type of Repair

	Entire Cohort (n=2164)	Total Repair: Primary (n=1839)	Systemic-PA Shunt (n=200)	Total Repair: Secondary (n=125)	P Value
In-Hospital Death (n=1834, 198, 124)	78 (3.6%)	60 (3.3%)	16 (8.0%)	2 (1.6%)	0.003
Surgical Site Infection (n=1839, 199, 125)	42 (1.9%)	33 (1.8%)	5 (2.5%)	4 (3.2%)	0.35
Bacterial Sepsis (n=1839, 199, 125)	97 (4.5%)	82 (4.5%)	8 (4.0%)	7 (5.6%)	0.75
Any Major Infection (n=1839, 199, 125)	128 (5.9%)	107 (5.8%)	12 (6.0%)	9 (7.2%)	0.77
Median Ventilation Time (hr) (n=1759, 193, 122)	22 [12, 47]	23 [14, 47]	12 [4, 30]	20 [10, 44]	<0.001
Median ICU Stay (hr) (n=1814, 196, 123)	72 [48, 120]	72 [48, 120]	48 [24, 96]	96 [65, 144]	<0.001

Medians are shown with interquartile ranges

5:15 PM

Room 305

**Symptomatic Tetralogy of Fallot in the First 2 Months of Life: Comparison Between Repair vs Shunt****Y. M. Menaissy***Cairo University, Mohandesseen, Egypt*

**Purpose:** There were two strategies for management of symptomatic tetralogy of Fallot (TOF) in the first 2 months of life: either shunt followed by repair or one-stage repair. We conducted this study to compare the outcome of the two strategies and have a clear consensus for our future patients.

**Methods:** We retrospectively reviewed symptomatic TOF neonates and infants (age less than 60 days) between January 1, 2007, and January 1, 2017. Group A consisted of 173 patients who had primary repair, and the right ventricular outflow tract obstruction was managed with a transannular patch in 68.7% of cases (119/173 patients). Group B consisted of 132 patients who had a modified Blalock Taussig shunt size 3.5 from the right subclavian artery or the innominate artery to the right pulmonary artery through a median sternotomy approach. This was followed by TOF repair 243 days  $\pm$  87 days after the shunt.

**Results:** Hospital mortality within 30 days after operation was 4.04% in group A (seven out of 173) and 3.78% in group B (five out of 132). In group A, the mean age at repair was 36 days  $\pm$  18 days, and the mean weight was 3.7 kg  $\pm$  0.8 kg. In group B, the mean age at shunting was 31 days  $\pm$  19 days, and the mean weight was 3.4 kg  $\pm$  0.7 kg. One patient died after the shunt surgery, while four died after the TOF repair. In group A, the mean follow-up was 3.9 years  $\pm$  2.5 years (range, 4 months to 10 years). Late mortality after 30 days postoperatively outside the hospital was seven (4.2%) during the first year. In group B, the mean follow-up 3.7 years  $\pm$  2.4 years (range, 3 months to 10 years) and late mortality after 30 days was three (2.3%) during the first year.

**Conclusions:** Primary repair and shunting have similar morbidity and mortality in symptomatic tetralogy of Fallot cases in the first 2 months of life. Avoiding two surgeries is an added benefit and can be performed with similar mortality and good intermediate-term survival. Later repair for shunted cases required significantly less transannular patching.

3:30 PM – 5:30 PM

Room 316

**ESTS @ STS: Controversial Issues in General Thoracic Surgery—Perspectives From Europe and North America**

Level 1 evidence is often missing in thoracic surgical practice due to a lack of randomized controlled trials. Standard treatment, therefore, may vary between continents, and controversies in management persist. The aim of this session is to compare the current practice in four areas of general thoracic surgery between Europe and North America. The actual outcomes in these domains may not fit the ideal patient outcomes on each continent.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the adjuvant treatment for resected thymic malignancies
- Identify the potential of donation after cardiac death donors for lung transplantation
- Discuss the role of lung volume reduction surgery for emphysema in the modern era
- Describe the management of spontaneous esophageal perforations

**Moderators:** Janet P. Edwards, Calgary, Canada, and Kostas Papagiannopoulos, Leeds, United Kingdom

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in this session are medical knowledge and practice-based learning and improvement. These physician competencies will be addressed through a series of collaborative lectures by members of The Society of Thoracic Surgeons and the European Society of Thoracic Surgeons.*

**3:30 PM      Surgical Management of Pulmonary Metastases: The European Perspective**

*Tom Treasure, London, United Kingdom*

**3:40 PM      Surgical Management of Pulmonary Metastases: The North American Perspective**

*Mark W. Onaitis, La Jolla, CA*

**3:50 PM      Panel Discussion/Questions****4:00 PM      Management of Malignant Pleural Mesothelioma: The European Perspective**

*Isabelle Opitz, Zurich, Switzerland*

**4:10 PM      Management of Malignant Pleural Mesothelioma: The North American Perspective**

*David J. Sugarbaker, Houston, TX*

**4:20 PM      Panel Discussion/Questions****4:30 PM      Surgery in Small Cell Lung Cancer: The European Perspective**

*Clemens Aigner, Essen, Germany*

- 4:40 PM**      **Surgery in Small Cell Lung Cancer: The North American Perspective**  
*David Harpole, Durham, NC*
- 4:50 PM**      **Panel Discussion/Questions**
- 5:00 PM**      **Chest Wall Tumors From Diagnosis to Reconstruction: The European Perspective**  
*Kostas Papagiannopoulos, Leeds, United Kingdom*
- 5:10 PM**      **Chest Wall Tumors From Diagnosis to Reconstruction: The North American Perspective**  
*Stephen D. Cassivi, Rochester, MN*
- 5:20 PM**      **Panel Discussion/Questions**



3:30 PM – 5:30 PM

Floridian Ballroom B-C

**General Thoracic: Esophageal***Moderators: Farhood Farjab, Seattle, WA, and James D. Luketich, Pittsburgh, PA*

**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, Proctor and Gamble; Research Grant, Accuray; Other, Elsevier Patent from the University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

3:30 PM

**Complications After Esophagectomy Are Associated With Extremes of Body Mass Index: An STS National Database Study**

**B. A. Mitzman**<sup>1</sup>, P. H. Schipper<sup>2</sup>, M. A. Edwards<sup>3</sup>, S. Kim<sup>4</sup>, M. K. Ferguson<sup>1</sup>

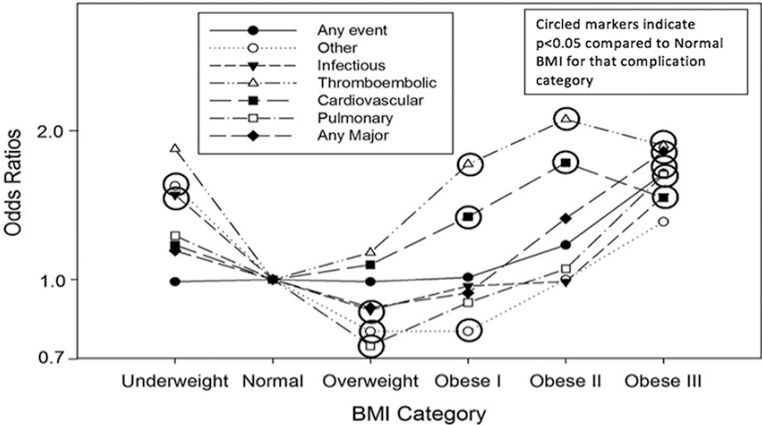
<sup>1</sup>The University of Chicago, IL, <sup>2</sup>Oregon Health & Science University, Portland, <sup>3</sup>St Louis University, MO, <sup>4</sup>Duke Clinical Research Institute, Durham, NC

**Purpose:** Body mass index (BMI) is not routinely taken into consideration for formal risk stratification prior to esophagectomy. Recent studies have shown that extremes of BMI are associated with adverse surgical outcomes. We assessed the relationship of BMI to outcomes after esophagectomy for esophageal cancer.

**Methods:** Patients in the STS General Thoracic Surgery Database who underwent elective esophagectomy for cancer from 2009 to 2016 were evaluated. Minimally invasive, hybrid, and open techniques for Ivor Lewis, three-hole, and transhiatal approaches were included. Complications were categorized based on the Esophagectomy Complications Consensus Group (ECCG) recommendations. Multivariate logistic regression was used to adjust for potential confounding variables.

**Results:** We evaluated 9389 patients (median age 64 years; 17.4% female) grouped by BMI: Underweight (<18.5 kg/m<sup>2</sup>; 2.7%); Normal (18.5 to 24.9 kg/m<sup>2</sup>; 30.9%); Overweight (25 to 29.9 kg/m<sup>2</sup>; 35.2%); Obese I (30 to 34.9 kg/m<sup>2</sup>; 18.4%); Obese II (35 to 39.9 kg/m<sup>2</sup>; 6.8%); and Obese III (>40 kg/m<sup>2</sup>; 3.2%). Most patients underwent open Ivor Lewis (33.4%), open transhiatal (23.4%), or minimally invasive Ivor Lewis (22.4%) approaches. The overall operative mortality rate was 3.4% and was unrelated to BMI. The frequency of complications by category ranged from 4% to 28%. On multivariate analysis, significant overall differences were identified among BMI categories for seven complication types (Table). Underweight and Obese III BMI categories were associated with somewhat of a significantly increased risk in most categories (Figure). In contrast, Overweight and Obese I BMI were associated with decreased risk for most categories, but were associated with increased risk for thromboembolic and cardiovascular events.

**Conclusions:** BMI is associated with postoperative complications after esophagectomy for cancer. Being underweight or severely obese is associated with an increased risk of complications, while overweight patients may benefit from a protective effect. Patients at the extremes of BMI may benefit from perioperative protective protocols for specific complications.



Outcome (overall P-value)	Underweight (<18.5 kg/m <sup>2</sup> )	Overweight (25-29.9 kg/m <sup>2</sup> )	Obese I (30-34.9 kg/m <sup>2</sup> )	Obese II (35-39.9 kg/m <sup>2</sup> )	Obese III (≥40 kg/m <sup>2</sup> )
Any Major Complication ( <b>&lt;0.0001</b> )	1.14 (0.84, 1.55) 0.4	<b>0.88 (0.77, 0.99)</b> 0.04	0.94 (0.81, 1.09) 0.43	<b>1.32 (1.07, 1.62)</b> 0.0095	<b>1.79 (1.35, 2.37)</b> <b>&lt;0.0001</b>
Any Pulmonary Complication ( <b>&lt;0.0001</b> )	1.22 (0.89, 1.69) 0.22	<b>0.74 (0.65, 0.85)</b> <b>&lt;0.0001</b>	0.90 (0.76, 1.06) 0.21	1.05 (0.83, 1.33) 0.67	<b>1.61 (1.19, 2.18)</b> 0.0021
Any Cardiovascular Complication ( <b>&lt;0.0001</b> )	1.17 (0.83, 1.66) 0.37	1.07 (0.93, 1.22) 0.33	<b>1.33 (1.13, 1.57)</b> 0.0005	<b>1.70 (1.36, 2.12)</b> <b>&lt;0.0001</b>	<b>1.45 (1.05, 1.99)</b> 0.024
Any Thromboembolic Complication ( <b>0.0013</b> )	1.81 (0.95, 3.45) 0.07	1.13 (0.83, 1.53) 0.44	<b>1.69 (1.22, 2.36)</b> 0.002	<b>2.07 (1.35, 3.19)</b> 0.0009	<b>1.84 (1.02, 3.35)</b> 0.045
Any Infectious Complication ( <b>0.011</b> )	<b>1.47 (1.08, 2.01)</b> <b>0.016</b>	0.87 (0.76, 1.00) 0.051	0.97 (0.83, 1.15) 0.75	0.99 (0.78, 1.25) 0.91	<b>1.46 (1.08, 1.97)</b> <b>0.015</b>
Any Other Complication ( <b>&lt;0.0001</b> )	<b>1.53 (1.13, 2.07)</b> <b>0.005</b>	<b>0.79 (0.69, 0.90)</b> <b>0.0003</b>	<b>0.79 (0.68, 0.93)</b> <b>0.0037</b>	1.00 (0.80, 1.24) 0.97	1.30 (0.97, 1.74) 0.078
Any Postoperative Event ( <b>0.035</b> )	0.99 (0.72, 1.35) 0.93	0.99 (0.88, 1.12) 0.91	1.01 (0.87, 1.17) 0.88	1.17 (0.95, 1.45) 0.14	<b>1.62 (1.19, 2.20)</b> <b>0.0022</b>

Values are adjusted odds ratio relative to Normal BMI patients (95% confidence interval) and p value. Statistically significant outcomes are in bold font.

3:45 PM

Floridian Ballroom B-C

### Detection of Tumor-Specific Mutations in Plasma DNA: A Potential Esophageal Adenocarcinoma Biomarker

M. R. Egyud<sup>1</sup>, J. B. Jackson<sup>2</sup>, E. R. Yamada<sup>1</sup>, A. Ståhlberg<sup>3</sup>, S. Filges<sup>3</sup>, P. M. Krzyzanowski<sup>4</sup>, G. Nielsen<sup>5</sup>, P. Sridhar<sup>6</sup>, A. Pennathur<sup>7</sup>, J. D. Luketich<sup>7</sup>, M. A. Tejani<sup>5</sup>, Z. Zhou<sup>5</sup>, V. R. Little<sup>4</sup>, L. Stein<sup>4</sup>, T. E. Godfrey<sup>6</sup>

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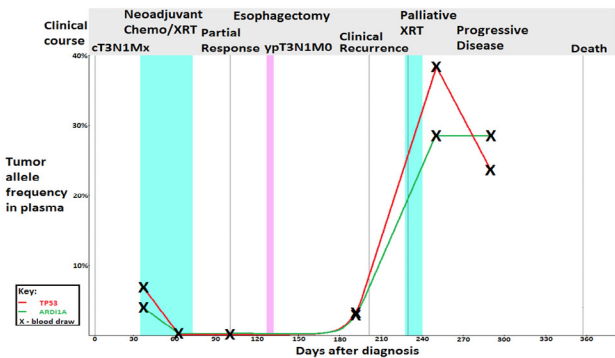
**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, Proctor and Gamble; Research Grant, Accuray; Other, Elsevier Patent from the University of Pittsburgh, *The Annals of Thoracic Surgery* Deputy Editor; A. Pennathur: Research Grant, Accuray; Consultant/Advisory Board, Baxter Healthcare; A. Ståhlberg: Ownership Interest: TATAA Biocenter, Boston University, Patent Pending

**Purpose:** There has recently been significant interest in detection of circulating, cell-free tumor DNA (ctDNA) for monitoring cancer response to treatment and recurrence. We sought to determine how ctDNA levels change with treatment of patients with esophageal adenocarcinoma (EAC), and to thus evaluate its potential as a biomarker in these patients.

**Methods:** Blood samples were obtained from patients with stage I-IV EAC. Longitudinal blood samples were collected from a subset of patients undergoing a combination of neoadjuvant therapy, surgery, and adjuvant chemotherapy. Clinical notes, imaging studies, and pathology reports were reviewed to determine disease course. Tumor DNA was sequenced using a targeted EAC panel to identify mutations. Customized assays were developed for each patient and used to generate sequencing libraries from cell-free DNA isolated from plasma. Mutations in plasma were identified and quantified, and associations with disease stage and response to therapy were explored.

**Results:** Seventy-five patients were recruited, and 47 were found to have targetable tumor mutations. Plasma from 38 patients has been analyzed: eight stage I, 10 stage II, 15 stage III, and five stage IV. Mutations were detected in 19 plasma samples, and detection rate increased with tumor stage (1/8 stage I, 6/10 stage II, 8/15 stage III, 4/5 stage IV). Total amount of detectable ctDNA also increased with tumor stage. Longitudinal plasma samples demonstrated correlation of ctDNA levels with response to therapy, recurrence, and disease progression (Figure). Increases in ctDNA levels preceded radiographic evidence of changes in tumor behavior.

**Conclusions:** ctDNA can be detected in plasma of EAC patients and correlates with disease burden. Changes in ctDNA levels correlate with response to therapy, recurrence, and progressive disease, and precede radiographic findings. ctDNA should be explored further as a possible biomarker in EAC.



**Figure 1: Clinical course of sample patient.** ctDNA levels initially decrease, correlating with partial response to neoadjuvant therapy noted on PET-CT. ctDNA levels subsequently rise after esophagectomy with R0 resection, prior to physical evidence of disease recurrence.

4:00 PM

Floridian Ballroom B-C

### Consequences of Refusing Surgery for Esophageal Cancer: A National Cancer Database Analysis

*M. Rabouma, M. K. Kamel, A. Nasar, B. E. Lee, S. W. Harrison, J. Port, N. K. Altorki, B. M. Stiles*

*Weill Cornell Medical College, New York, NY*

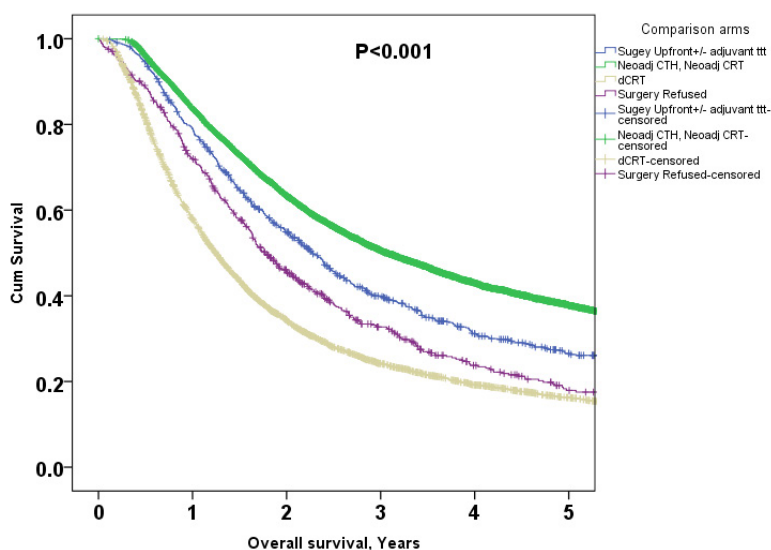
**COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest, Angiocrine Bioscience, Nanocyte; B. M. Stiles: Employment, Pfizer - Wife Employed by Pfizer; Consultant/Advisory Board, Merck

**Purpose:** Given the potential morbidity and decreased quality of life after esophagectomy, patients may instead pursue other treatment options. This is particularly true in the current era of shared decision-making. We therefore sought to determine predictors and outcomes of patients with esophageal cancer (EC) who refused esophagectomy.

**Methods:** The National Cancer Database (2004-2014) was queried for patients with EC, excluding those with  $\leq T1$  cancer, stage IV disease, multiple primary tumors, and cervical tumors. A unique field allows identification of patients recommended to have surgery, but who refused. Comparisons between groups were performed using ANOVA and Chi (X2) tests. Survival was compared using Kaplan-Meier curves. Logistic regression was performed to identify predictors of refusing surgery. A propensity score-matched (1:1, Caliper 0.01) analysis (including age, gender, race, comorbidities, location, histology, clinical T and N stages) was performed to compare OS in patients refusing surgery to those treated with neoadjuvant therapy and surgery.

**Results:** We identified 18,459 patients with EC meeting criteria, including 708 (3.8%) who were recommended but refused surgery (Table). The majority of these patients (93%) had Charlson/Deyo scores of 0/1. By multivariate analysis, older age (HR 1.06, CI 1.05-1.07), female gender (HR 1.37, CI 1.14-1.65), non-white race (HR 2.13, CI 1.68-2.71), and clinical stage I/II (HR 1.57, CI 1.35-1.84) predicted refusal of surgery. Patients refusing surgery were treated with definitive chemoradiation (n=292, 41%), sequential chemotherapy/radiation (n=256, 36%), radiation and/or chemo alone (n=58, 8.2%), or no treatment (n=102, 14%). Median survival was worse for patients who refused surgery compared to those undergoing surgery  $\pm$  adjuvant therapy or those treated with neoadjuvant therapy and surgery (Figure). Propensity matching was performed to compare patients refusing surgery to those treated with neoadjuvant therapy followed by surgery (n=525 each). Median survival was significantly better in the neoadjuvant group than in patients refusing surgery (32 vs 21 months,  $P < .001$ ).

**Conclusions:** Although patients may be reluctant to undergo esophagectomy for EC, refusal of surgery when offered comes at the expense of decreased survival. These data allow for a discussion of alternative outcomes with those patients in the context of shared decision making.



Data from 2004-2014 (n=18,459)	Surgery Upfront +/- Adjuvant ttt (n=907)	Neoadj Chemo, Neoadj CRT (n=10,683)	dCRT (n=6,161)	Surgery Refused (n=708); P value
<b>Age (n=18,459)</b>	63(55-70)	62(55-68)	67(59-75)	70(62.77); P<0.001
<b>Gender (n=18,459)</b>				
➢ Male	746(82.2)	9126(85.4)	4760(77.3)	522(73.7); P=0.008
➢ Female	161(17.8)	1557(14.6)	1401(22.7)	186(26.3%)
<b>Race (n=18,459)</b>				
➢ White	842(92.8)	9980(93.4)	5285(85.8)	592(83.6%); P<0.001
➢ Non-white	65(7.2)	703(6.6)	876(14.2)	116(16.4)
<b>Charlson/Deyo Score (n=18,459)</b>				
➢ CDCC=0/1	851(93.8)	10177(95.3)	5752(93.4)	658(92.9); P<0.001
➢ CDCC=2	56(6.2)	506(4.7)	409(6.6)	50(7.1)
<b>Histology (n=18,435)</b>				
➢ Adenocarcinoma	732(80.8)	8950(83.9)	3795(61.7)	484(68.5); P<0.001
➢ Squamous Cell Carcinoma	148(16.3)	1561(14.6)	2166(35.2)	203(28.7)
➢ Others	26(2.9)	159(1.5)	191(3.1)	20(2.8)
<b>Clinical stage (n=18,459)</b>				
➢ cStage I/II	504(55.6)	4747(44.4)	2490(40.4)	407(57.5); P=0.328
➢ cStage III	403(44.4)	5936(55.6)	3671(59.6)	301(42.5)
<b>Clinical T stage(n=18,459)</b>				
➢ T2	341(37.6)	2304(21.6)	1336(21.7)	214(30.2); P=0.355
➢ T3/4	566(62.4)	8379(78.4)	4825(78.5)	494(69.8)
<b>Clinical N stage(n=18,449)</b>				
➢ Nx, N0	460(50.8)	3736(35)	2215(36)	371(52.4); P=0.002
➢ N+	446(49.2)	6941(65)	3943(64)	337(47.6)

4:15 PM

Floridian Ballroom B-C

### Racial Disparity in Utilization of High-Volume Hospitals for Surgical Treatment of Esophageal Cancer Patients

S. S. Rehmani<sup>1</sup>, B. Liu<sup>2</sup>, A. M. Al-Ayoubi<sup>3</sup>, E. E. Lewis<sup>4</sup>, W. Raad<sup>5</sup>, R. M. Flores<sup>3</sup>, F. Bhora<sup>3</sup>, E. A. Tuioli<sup>2</sup>

<sup>1</sup>Mount Sinai St Luke's Hospital, New York, NY, <sup>2</sup>Icahn School of Medicine at Mount Sinai, New York, NY, <sup>3</sup>Mount Sinai Health System, New York, NY, <sup>4</sup>Mount Sinai West and St Luke's Hospitals, New York, NY, <sup>5</sup>Mount Sinai Health System, Icahn School of Medicine at Mount Sinai, New York, NY

**COMMERCIAL RELATIONSHIPS** F. Bhora: Ownership Interest, CSA Medical; Consultant/Advisory Board, Boston Scientific, CSA Medical, Ethicon, Veran Medical

**Purpose:** Utilization of high-volume (HV) hospitals for esophagectomy has been associated with improved perioperative outcomes and reduced mortality. We aimed to test the hypothesis that white/black racial disparities exist in HV hospital utilization and to identify predictors of surgical outcomes of esophageal cancer while adjusting for HV utilization patterns.

**Methods:** We queried electronic records in the New York Statewide Planning and Research Cooperative System (SPARCS) database (1995-2012) for esophageal cancer patients who underwent surgical resection exclusively. Only records for patients with self-reported white/black race and a valid New York State zip code were included (n=2895). Binomial logistic regression analysis was performed to identify factors associated with HV hospital (320 esophagectomies/year) utilization, and to determine predictors of complications and in-hospital mortality.

**Results:** Black patients (n=361, 12.5%) were significantly ( $P < .001$ ) different than their white counterparts in terms of proportion of women (39% vs 22%), Medicaid beneficiaries (24.9% vs 5.5%), and privately insured individuals (28% vs 47.2%). There was no significant difference in age and comorbidities between the two groups (Table). Overall, 55% patients utilized HV hospitals; however, 77% of blacks utilized a low-volume hospital and were significantly less likely to use a HV hospital (OR 0.18; 95% CI 0.14-0.24) even though most of them (74.5%) resided within 8.9 miles of one. Additionally, patients with Medicaid or no insurance and travel distances of >25.86 miles also were less likely to utilize a HV hospital (Table). Surgery performed at HV hospitals was associated with lower in-hospital mortality (OR 0.43; 95% CI 0.32-0.59). However, the adjusted odds of mortality remained higher for black patients (OR 2.34; 95% CI 1.65-3.30).

**Conclusions:** Black patients were less likely to undergo esophagectomy at an HV hospital and experienced higher mortality. Efforts should be made to understand factors influencing patients' decision-making process and improve referral practices to ensure optimal care is provided across all segments of the population irrespective of race or insurance status.

**Table: Multivariate Logistic Regression Analysis Assessing Prediction of HV Hospital Utilization and In-hospital Mortality in Patients Undergoing Esophagectomy**

Covariates	Whites (n = 2534)	Blacks (n = 361)	HV Hospital Utilization OR (95% CI)	In-hospital Mortality OR (95% CI)
<b>Distance to the Nearest HV Hospital (miles)</b>				
0 - 8.9 (Ref)	775 (30.6%)	269 (74.5%)	-	NA
> 8.9 - 25.86	913 (36.0%)	76 (21.1%)	0.83 (0.68 - 1.01)	
> 25.86	846 (33.4%)	16 (4.4%)	<b>0.43</b> (0.33 - 0.50)	
<b>Age (years)</b>	64 ± 11	63 ± 11	0.99 (0.98 - 1.00)	<b>1.05</b> (1.03 - 1.07)
<b>Sex</b>				
Male (Ref)	1979 (78.1%)	220 (60.9%)	-	-
Female	555 (21.9%)	141 (39.1%)	<b>1.28</b> (1.06 - 1.56)	1.12 (0.82 - 1.52)
<b>Race (Ref: White)</b>				
Black	-	-	<b>0.18</b> (0.13 - 0.24)	<b>2.34</b> (1.65 - 3.30)
<b>Charlson-Deyo Score</b>				
0 (Ref)	879 (34.7%)	108 (29.9%)	-	-
1 - 2	207 (8.2%)	37 (10.2%)	1.16 (0.85 - 1.59)	<b>1.89</b> (1.12 - 3.21)
>2	1448 (57.1%)	216 (59.8%)	0.86 (0.72 - 1.02)	<b>1.78</b> (1.27 - 2.49)
<b>Surgery Type</b>				
Total esophagectomy (Ref)	415 (16.4%)	74 (20.5%)	-	-
Partial esophagectomy	1184 (46.7%)	120 (33.2%)	<b>1.72</b> (1.37 - 2.16)	0.91 (0.63 - 1.33)
Other	935 (36.9%)	167 (46.3%)	0.84 (0.67 - 1.05)	0.73 (0.50 - 1.06)
<b>Insurance</b>				
Medicare (Ref)	1146 (45.2%)	150 (41.6%)	-	-
Medicaid	140 (5.5%)	90 (24.9%)	<b>0.62</b> (0.43 - 0.88)	1.24 (0.73 - 2.12)
Private insurance	1197 (47.2%)	101 (28.0%)	<b>1.29</b> (1.03 - 1.60)	<b>0.63</b> (0.42 - 0.94)
No insurance/Other	51 (2.0%)	20 (5.5%)	<b>0.41</b> (0.23 - 0.74)	<b>0.22</b> (0.05 - 0.93)
<b>Surgery Year</b>	-	-	1.07 (1.05 - 1.08)	<b>0.96</b> (0.93 - 0.99)
<b>Surgery at HV Hospital</b>				
No (Ref)	1015 (40.1%)	278 (77.0%)	NA	-
Yes	1519 (59.9%)	83 (23.0%)		<b>0.44</b> (0.32 - 0.59)

4:30 PM

Floridian Ballroom B-C

### Choice of Neoadjuvant Therapy for Locally Advanced Esophageal Cancer Should Be Targeted to Tumor Histology

B. M. Stiles, M. K. Kamel, M. Rabouma, B. E. Lee, S. W. Harrison, A. B. Nguyen, A. Nasar, J. Port, N. K. Altorki

Weill Cornell Medicine, New York, NY

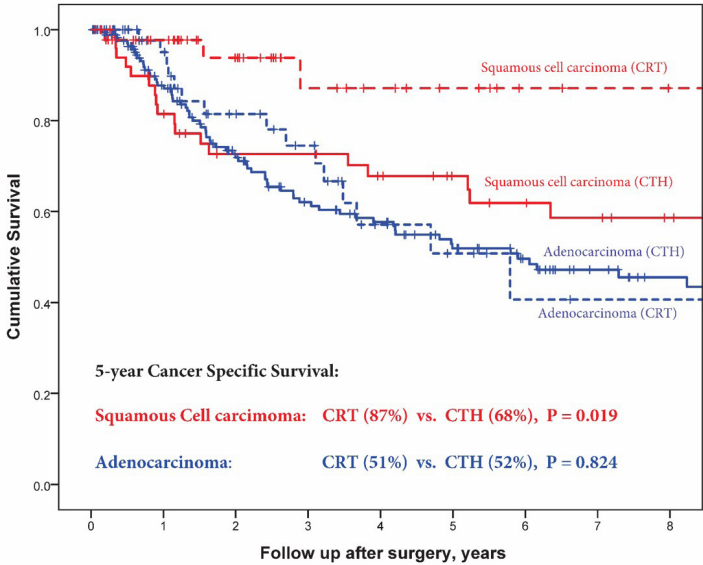
**COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest, Angiocrine Bioscience, Nanocyte; B. M. Stiles: Employment, Pfizer - Wife Employed by Pfizer; Consultant/Advisory Board, Merck

**Purpose:** Controversy exists over the optimal neoadjuvant therapy in patients with locally advanced esophageal cancer (EC). While most groups favor neoadjuvant chemoradiation (nCRT), some prefer preoperative chemotherapy (nCT) without radiation. The objective of this study was to compare outcomes in EC patients undergoing either regimen, followed by surgery.

**Methods:** We reviewed a prospectively collected database of EC patients undergoing esophagectomy following nCT or nCRT (1989-2016). Choice of therapy was at the discretion of the multidisciplinary team. Disease-free (DFS) and cancer-specific (CSS) survival were compared by KM (log-rank test). Independent predictors of CSS were estimated by Cox regression analysis.

**Results:** In the cohort, 338 patients were treated with nCRT (n=112) or nCT (n=226). Patients with squamous cell carcinoma (SCC) were more likely to receive nCRT (49% vs 26%,  $P < .001$ ). nCRT was associated with similar grade III/IV complications (34% vs 33%,  $P = .423$ ) but a trend toward higher mortality (5% vs 1%,  $P = .064$ ). Among adenocarcinoma (AC) patients (n=239), nCRT was associated with higher complete clinical response, negative lymph nodes, and complete pathologic response (Table). However, there was no difference for 5-year DFS or CSS. For patients with SCC (n=98), nCRT had higher rates of negative nodes and complete pathologic response than nCT (Table). For these patients, nCRT was associated with no statistical difference in 5-year DFS, but with improved 5-year CSS (Figure). On MVA for CSS, nCRT predicted improved survival for patients with SCC (HR 0.242, CI 0.071-0.830), but not for those with AC (Univariate HR 0.940, CI 0.544-1.623).

**Conclusions:** For AC patients undergoing surgery for EC, nCRT leads to increased local tumor response compared to nCT alone, but no difference in survival. For squamous carcinoma patients, nCRT appears to improve CSS compared to nCT. For patients with locally advanced EC, targeted neoadjuvant regimens should be used depending upon tumor histology.



	AC nCT (n=176)	AC nCRT (n=63)	SCC nCT (n=50)	SCC nCRT (n=48)
Complete clinical response	13 (7.4%)	11 (17.5%), $P < 0.001$	13 (26%)	15 (31.3%), $P = 0.205$
Pathologically negative lymph nodes	52 (29.5%)	33 (52.4%), $P = 0.001$	23 (46%)	31 (64.6%), $p = 0.064$
Complete pathologic response	9 (5%)	13 (21%), $P < 0.001$	6 (12%)	20 (42%), $P = 0.001$
5 year DFS	31%	28%, $p = 0.636$	40%	57%, $P = 0.595$
5 year CSS	52%	51%, $p = 0.824$	68%	87%, $P = 0.019$

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Floridian Ballroom B-C

## Does the Approach Matter? An Analysis of 9353 Patients in the National Cancer Database Comparing Survival and Outcomes of Robotic, Minimally Invasive, and Open Esophagectomies

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<sup>1</sup>Cedars-Sinai Medical Center, Los Angeles, CA, <sup>2</sup>Stanford University, CA

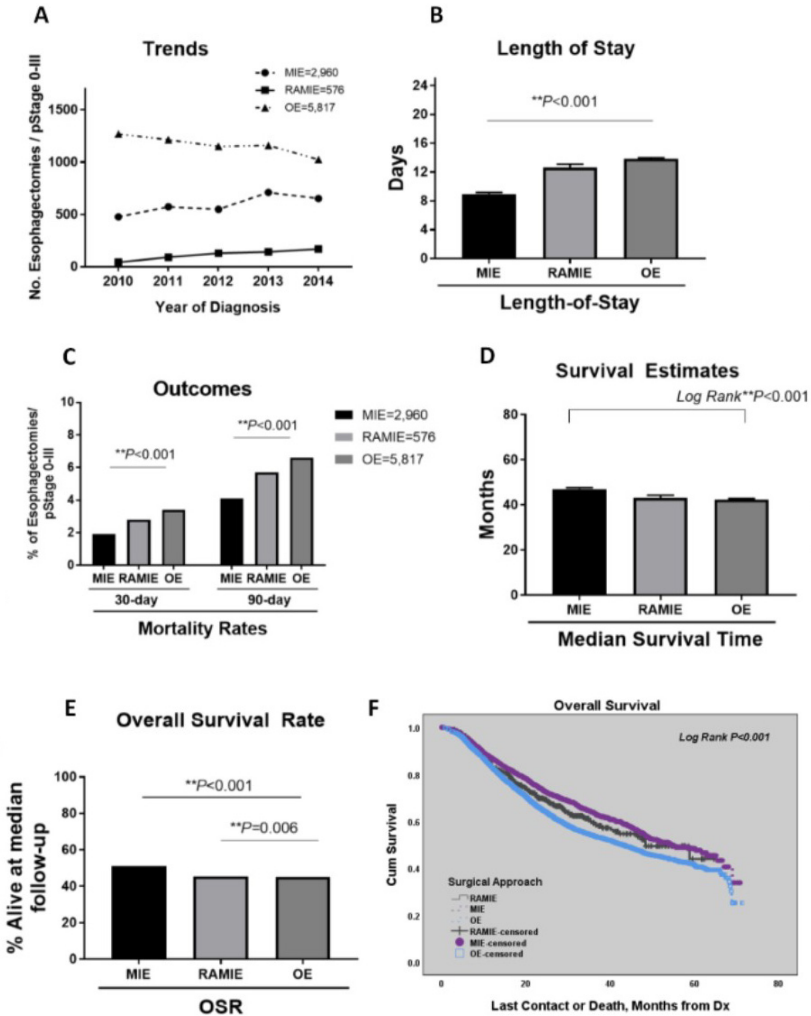
**COMMERCIAL RELATIONSHIPS** H. J. Soukiasian: Consultant/Advisory Board, Medtronic

**Purpose:** Minimally invasive approaches to esophageal cancer are an emerging modality; however, their role in long-term survival remains unclear. Our objective was to determine how surgical approach impacts overall survival and postoperative outcomes when comparing robotic-assisted minimally invasive esophagectomy (RAMIE), minimally invasive esophagectomy (MIE), and open esophagectomy (OE).

**Methods:** The National Cancer Database (NCDB) was queried for patients diagnosed with pathologic stage 0-III esophageal cancer from 2010 to 2014. Surgical approach groups were matched for clinicopathological variables. Primary outcome measures evaluated were length of stay (LOS), 30-day unplanned readmissions, mortality rates at 30 and 90 days, and overall survival rate (OSR). A multivariate logistic regression model was performed to identify factors associated with outcomes. Kaplan-Meier survival estimates and Cox proportional hazard modeling was used to evaluate overall survival, but not cancer-specific survival as this data is not available in the NCDB.

**Results:** Of 9353 patients that met criteria, 62.2% were OE, 31.6% MIE, and 6.2% RAMIE. From 2010 to 2014, an increasing adoption trend was seen in RAMIE and MIE (Figure 1A). Conversion rates were low in RAMIE (0.4%) and MIE (2.6%). MIE had significantly lower 30-day and 90-day mortality rates, 1.9% and 4.1%, respectively, compared to RAMIE (2.8% and 5.7%;  $P < .001$ ) and OE (3.4% and 6.6%;  $P < .001$ , Figure 1B). LOS was significantly shorter in MIE than RAMIE and OE (8.9 days vs 12.6 days and 13.8 days, respectively,  $P < .001$ , Figure 1C), and Unplanned 30-day readmission rates were lower in MIE (4.3%), and RAMIE (5.2%), compared to OE (6.5%) ( $P = .003$ ). MIE was associated with significantly higher survival than RAMIE (OSR: 51.1% vs 45.3%,  $P < .001$ ) and OE (OSR: 45.2%  $P < .006$ ) (Figure 1D-E). After matched analysis, overall median survival times were superior in minimally invasive approaches (MIE 54.21 vs RAMIE 48.33 and OE 42.97 months, log-rank  $P < .001$ ; Figure 1F).

**Conclusions:** RAMIE and MIE implementation are increasing in the U.S. MIE had significantly shorter LOS, reduced readmissions, 30 and 90-day mortality rates, and superior overall survival. The clinical significance of this should be interpreted cautiously until further studies evaluate disease-free survival.



5:00 PM

Floridian Ballroom B-C

**Volume-Outcome Relationship in Minimally Invasive Esophagectomy***H. V. Salfity, L. R. Timsina, D. P. Ceppa, T. J. Birdas**Indiana University School of Medicine, Indianapolis*

**Purpose:** Outcomes after open esophagectomy (OE) have been shown to depend on institution case volume. We aim to determine whether a similar relationship exists for minimally invasive esophagectomy (MIE).

**Methods:** Patients who had OE or MIE between 2010 and 2013 in the National Cancer Database were included. Robotic procedures were excluded. Outcomes included 30- and 90-day mortality, length of stay, hospital readmission, margin positivity, and number of lymph nodes harvested. These were analyzed both in the entire sample and a subset of OE and MIE patients who were matched with propensity score analysis using age, gender, tumor size, Charlson Comorbidity index, presence of induction therapy, and type of institution (academic vs community-based). Logistic and linear regression were used to adjust for possible cofounders.

**Results:** We identified 2371 patients in the MIE group and 6285 patients in the OE group. In multivariate analysis, higher case volume was an independent predictor for lower 30-day and 90-day mortality, shorter length of stay, and higher rate of negative-margin resection in OE ( $P < .001$  for all) but not MIE, and higher number of resected lymph nodes for both OE and MIE ( $P < .0001$ ). After propensity score matching of 1819 patients in each group, MIE had lower 30-day ( $P = .003$ ) and 90-day mortality ( $P < .05$ ) and higher number of resected nodes compared to OE ( $P < .0001$ ).

**Conclusions:** In this dataset, MIE postoperative outcomes were better than OE but, unlike OE, were not associated with hospital case volume. Volume-outcome relationships may be affected by surgical approach. Given the association between case volume and nodal harvest, the effect of case volume on long-term outcomes after MIE warrants further study.

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Floridian Ballroom B-C

## Outcomes of Octogenarians With Esophageal Cancer: An Analysis of the National Cancer Database

A. C. Salami<sup>1</sup>, A. E. Abbas<sup>2</sup>, R. V. Petrov<sup>2</sup>, C. T. Bakhos<sup>2</sup>

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**COMMERCIAL RELATIONSHIPS** A. E. Abbas: Speakers Bureau/Honoraria, Boston Scientific, Intuitive Surgical; R. V. Petrov: Speakers Bureau/Honoraria, Veran Medical

**Purpose:** The optimal treatment of esophageal cancer in octogenarians remains controversial. While the safety of esophagectomy has been demonstrated in elderly patients, surgery and multimodality therapy are still offered to a select group. Besides, the long-term outcomes of esophageal cancer treatment in octogenarians have not been thoroughly compared to younger patients.

**Methods:** We sought to compare the outcomes of esophageal cancer treatment between octogenarians (age  $\geq 80$ ) and non-octogenarians in the National Cancer Database between 2004 and 2014. The main outcome variables included early postoperative mortality and long-term survival. Multivariable logistic and Cox regression analyses were performed.

**Results:** A total of 107,921 patients were analyzed in this study (octogenarian – 16,388 [15.2%]). Compared to non-octogenarians, octogenarians were more likely to be female, of higher socioeconomic status, and had more Charlson comorbidities ( $P < .001$  for all). Octogenarians were significantly less likely to undergo esophagectomy (11.5% vs 33.3%;  $P < .001$ ) and trimodality therapy (2.0% vs 18.5%;  $P < .001$ ), a trend that persisted following stratification by tumor stage and Charlson comorbidities. Being octogenarian was not a predictor of 30- (OR: 0.77, CI: 0.59-1.00;  $P = .05$ ) and 90-day mortality (OR: 0.94, CI: 0.76-1.17;  $P = .588$ ) after esophagectomy, following multivariable adjustment. Regarding the long-term survival, being octogenarian was independently associated with worse outcomes in patients treated with esophagectomy alone (HR: 1.29, CI: 1.18-1.41;  $P < .001$ ), but there was no difference between the two groups after trimodality therapy (HR: 1.18, CI: 0.99-1.41;  $P = .062$ ).

**Conclusions:** Octogenarians are less likely to be offered treatment irrespective of tumor stage or comorbidities. This does not seem to be justified, as similar long-term survival is observed in patients who undergo combined chemoradiation and surgery, regardless of age. Octogenarians should be offered trimodality therapy whenever indicated to optimize outcomes.

4:30 PM – 5:30 PM

Room 304

**Quality Improvement***Moderator: Vinay Badhwar, Morgantown, WV*

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

Presenting authors are listed in **bold**.

*The physician competencies addressed in this session are patient care and procedural skills and medical knowledge. These physician competencies will be addressed through a series of individual lectures and a brief question-and-answer session after each topic.*

4:30 PM

**Development and Validation of a Risk Prediction Model for In-Hospital Stroke After Transcatheter Aortic Valve Replacement From the STS/ACC TVT Registry**

**V. H. Thourani<sup>1</sup>, J. J. Kelly<sup>1</sup>, S. O'Brien<sup>2</sup>, D. Cohen<sup>3</sup>, E. D. Peterson<sup>4</sup>, M. J. Mack<sup>5</sup>, D. M. Shabian<sup>6</sup>, F. L. Grover<sup>7</sup>, J. D. Carroll<sup>8</sup>, M. Brennan<sup>2</sup>, J. Forcillo<sup>1</sup>, S. V. Arnold<sup>9</sup>, S. Vemulapalli<sup>4</sup>, S. Fitzgerald<sup>8</sup>, D. R. Holmes<sup>9</sup>, J. E. Bavaria<sup>10</sup>, F. H. Edwards<sup>11</sup>**

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**COMMERCIAL RELATIONSHIPS** S. V. Arnold: Research Grant, National Heart, Lung, and Blood Institute; J. E. Bavaria: Research Grant, Abbott, Edwards Lifesciences, Medtronic, W. L. Gore & Assoc; J. D. Carroll: Research Grant, Abbott, Edwards Lifesciences, Medtronic; D. Cohen: Research Grant, Boston Scientific, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic; F. L. Grover: Consultant/Advisory Board, Somhalution; M. J. Mack: Research Grant, Abbott, Edwards Lifesciences, Medtronic; V. H. Thourani: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc; S. Vemulapalli: Research Grant, Abbott

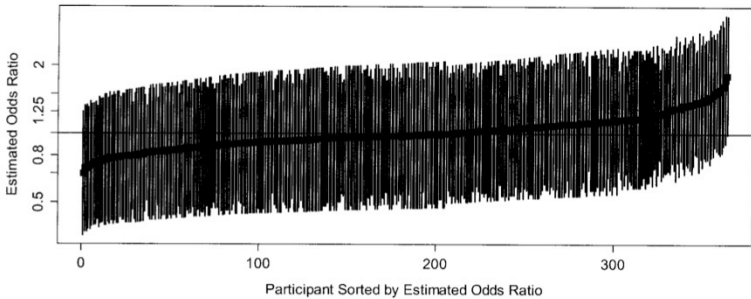
**Purpose:** New risk models are needed for the increasing number of patients undergoing transcatheter aortic valve replacement (TAVR), as existing models are based on surgical data. Our objective was to develop a risk model for in-hospital stroke following TAVR utilizing the national STS/ACC Transcatheter Valve Therapy (TVT) Registry to estimate site-specific stroke performance.

**Methods:** The study population included 34,391 patients discharged following TAVR from April 1, 2012, to March 31, 2015, in the TVT Registry. In-hospital stroke was the primary endpoint. Eighteen baseline covariates were identified by review of published risk models, expert opinion, and statistical analysis. The association between these covariates and in-hospital stroke was estimated by logistic regression. Calibration was performed using 75% training and 25% testing samples, and discrimination was evaluated by calculating the C statistic. A Bayesian hierarchical model was created to estimate risk-adjusted site-specific stroke performance.

**Results:** After excluding 123 patients (0.4%) with missing in-hospital outcome data, 34,268 records from 364 participating sites were used to develop the model. The median age was 83 years, 16,719 (48.8%) were female, and in-hospital stroke occurred in 714 (2.1%). Final

model covariates (odds ratio; 95% confidence interval) included prior stroke (1.56; 1.28-1.90), non-femoral access (1.49; 1.19-1.88), porcelain aorta (1.46; 1.12-1.89), prior transient ischemic attack (1.36; 1.04-1.77), unilateral carotid stenosis (1.31; 1.05-1.63), age per 5 years over 75 (1.13; 1.05-1.23), prior aortic procedure (0.77; 0.61-0.96), and body surface area per meter squared for males (0.52; 0.30-0.91). Calibration curves demonstrated agreement between observed and expected stroke rates. The optimism-adjusted C statistic was 0.596. Among the 364 participating sites, the median odds ratio for in-hospital stroke was 0.98 with an interquartile range of 0.91 to 1.1. Bayesian analysis showed no significant difference in the odds of in-hospital stroke across all centers (Figure).

**Conclusions:** A new risk model for in-hospital stroke following TAVR was developed using data from the STS/ACC TVT Registry and used to estimate site-specific stroke performance. This model can serve as a valuable resource for quality improvement, clinical decision-making, and patient counseling.



**Figure 1:** Risk-adjusted hospital-specific odds ratios for in-hospital stroke with 95% Bayesian credible intervals, which overlapped the null value (1.0) for all 364 participating sites.

4:45 PM

Room 304

### Socioeconomic “Distressed Communities Index” Predicts Risk-Adjusted Operative Mortality After Coronary Artery Bypass Grafting

E. J. Charles<sup>1</sup>, J. H. Mebaffey<sup>1</sup>, R. B. Hawkins<sup>2</sup>, C. E. Fonner<sup>3</sup>, L. T. Yarboro<sup>4</sup>, M. A. Quader<sup>5</sup>, J. T. Efird<sup>6</sup>, A. C. Kiser<sup>6</sup>, J. B. Rich<sup>3</sup>, A. M. Speir<sup>8</sup>, I. L. Kron<sup>5</sup>, M. C. Tracci<sup>1</sup>, G. Ailawadi<sup>1</sup>

<sup>1</sup>University of Virginia Health System, Charlottesville, <sup>2</sup>University of Virginia, Charlottesville, <sup>3</sup>Virginia Cardiac Services Quality Initiative, Virginia Beach, <sup>4</sup>University of Virginia Medical Center, Charlottesville, <sup>5</sup>Virginia Commonwealth University, Richmond, <sup>6</sup>East Carolina Heart Institute, Greenville, NC, <sup>8</sup>Cardiac, Vascular & Thoracic Surgery Associates, Falls Church, VA

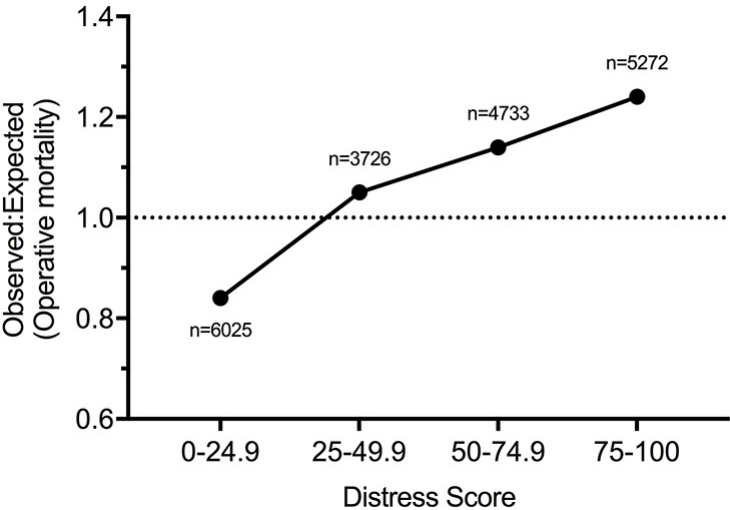
**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic; A. M. Speir: Consultant/Advisory Board, Medtronic

**Purpose:** Studies have correlated insurance status, a proxy for socioeconomic risk, with outcomes following cardiac surgery. However, insurance status does not account for all socioeconomic disparities. We hypothesized that the established Distressed Communities Index (DCI), a composite socioeconomic ranking by zip code, predicts operative mortality following coronary artery bypass grafting (CABG).

**Methods:** All patients who underwent isolated CABG (2010–2017) in a multistate STS database were analyzed. Developed by the Economic Innovation Group, the DCI accounts for unemployment, education level, poverty rate, median income, business growth, and housing vacancies, with scores ranging from 0 (no distress) to 100 (severe distress) and grouped by zip code. Patients were stratified by DCI quartiles (I: 0–24.9, II: 25–49.9, III: 50–74.9, IV: 75–100) and compared using one-way analysis of variance. Hierarchical logistic regression modeled the association between DCI and mortality with adjustments for year, hospital, STS predicted risk of mortality (PROM), and insurance status.

**Results:** A total of 19,756 CABG patients were included in the analysis, with a mean age of 64.5 years  $\pm$  10.3 years and PROM of 2.0%  $\pm$  3.5%. Higher DCI scores were associated with increasing PROM (I: 1.9%  $\pm$  3.3%, II: 2.0%  $\pm$  3.8%, III: 2.1%  $\pm$  3.5%, IV: 2.1%  $\pm$  3.5%,  $P < .0001$ ). The overall operative mortality was 2.2% ( $n=424$ ) and increased with each increasing DCI quartile (I: 1.6% [95], II: 2.1% [77], III: 2.4% [114], IV: 2.6% [138],  $P = .0009$ ). There was no association between DCI and total hospital cost or rate of major morbidity (both  $P > .05$ ). The observed-to-expected (O:E) ratio for mortality increased as level of socioeconomic distress increased (Figure). Importantly, after risk adjustment for year, hospital, PROM, and insurance status, the DCI remained highly predictive of mortality after CABG (OR 1.005, 1.001–1.009,  $P = .006$ , c-statistic=0.764, for each 1 point increase in DCI).

**Conclusions:** The Distressed Communities Index, an established metric for socioeconomic distress, independently predicts risk-adjusted operative mortality following CABG beyond insurance status. These findings highlight the impact of socioeconomic status on cardiac surgical outcomes and should be considered when building risk models, evaluating resource utilization, and comparing hospitals.



5:00 PM

Room 304

### Comparison of the Efficacy and Cost of Awake Thoracoscopy and Video-Assisted Thoracoscopic Surgery in Undiagnosed Pleural Effusion

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**COMMERCIAL RELATIONSHIPS** K. Czarnecka: Consultant/Advisory Board, Olympus; T. K. Waddell: Employment, XOR-Labs; Ownership Interest, XOR-Labs

**Purpose:** An estimated 25% of pleural effusions remain undiagnosed after repeated thoracentesis and/or closed pleural biopsy. There have been no studies to date comparing the efficacy, safety and cost of outpatient awake thoracoscopy (AT) to video-assisted thoracoscopic surgery (VATS) pleural biopsy in undiagnosed pleural effusions.

**Methods:** Thoracic surgery and hospital administrative databases were retrospectively reviewed to evaluate efficacy of AT performed in an endoscopy suite and VATS pleural biopsy performed in the operating room in patients with undiagnosed, exudative pleural effusions, managed at a tertiary thoracic surgery center in Canada, between January 2011 and October 2015. Test sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV) were calculated and compared. Procedure safety, hospital length of stay (LOS), and the need for additional pleural-based procedures were evaluated. Procedure-related direct and indirect costs were extracted from the hospital administrative database and adjusted for inflation.

**Results:** Between January 1, 2011, and October 31, 2015, 78 and 99 patients underwent AT and VATS, respectively. Sensitivity, specificity, NPV, and PPV were 85%, 100%, 100%, and 79% and 93%, 94%, 99%, and 76% for AT and VATS, respectively, with no statistically significant difference in the diagnostic test performance,  $P > .5$ . There was no difference in the rate of major (two [2.6%] AT vs four [4%] VATS,  $P = .694$ ) or minor (14 [17.9%] AT vs 16 [16.3%] VATS,  $P = .842$ ) complications, or the need for additional pleural-based procedures (20 [25.6%] AT vs 19 [19.2%] VATS,  $P = .362$ ). VATS procedures were associated with longer average hospital stay, 3.19 days (range, 2.6–3.8 days) vs 1.15 days (range, 0.44–1.87 days),  $P < .0001$ , and a higher procedure-related average cost (CAD \$7962; 95% CI \$7134–\$8790 vs CAD \$2815; 95% CI \$2010–\$3620,  $P < .001$ ).

**Conclusions:** AT and VATS have a similar diagnostic yield and safety profile in the assessment of undiagnosed exudative pleural effusions. AT is associated with shorter hospital stays and a lower average per-procedure cost. In the appropriate clinical setting, AT may be the diagnostic test of choice for evaluation of undiagnosed exudative effusions.

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Room 304

### Successful Strategies to Reduce 30-Day Readmission After Coronary Artery Bypass Graft Surgery

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**COMMERCIAL RELATIONSHIPS** J. R. Doty: Research Grant, Medtronic

**Purpose:** Reducing the number of preventable hospital readmissions after coronary artery bypass grafting (CABG) surgery has become a national priority. However, evidence about strategies associated with lower CABG readmission rates is limited. We sought to measure the effectiveness of the quality improvement strategies implemented at four adult cardiovascular surgery programs.

**Methods:** With our institution's data from the STS Adult Cardiac Surgery Database from 2014 to 2015, we conducted analyses to understand the readmission reasons, characteristics of the readmitted patients, and the timing and location from where patients were readmitted. A multidisciplinary team from all four programs reviewed the analyses' results, including surgeons, intensivists, physician assistants, nurses, cardiac rehabilitation therapists, and leadership from the Cardiovascular Clinical Program. The group developed and implemented the strategies listed in the Table with some variation in timing. Data from 2016 to Q1 2017 were used to evaluate the effectiveness of the interventions.


**Results:** A total of 1719 isolated CABG surgeries were analyzed. The overall 30-day readmission rate was 7.6%. The baseline (2014–2015) 30-day readmission rate was 8.9% (97/1090). In the post-intervention period, 2016–Q1 2017, only 34 out of 629 (5.4%) were readmitted (OR, 0.58; 95% CI, 0.37 – 0.88;  $P = .008$ ). The two hospitals that pioneered the readmission reduction efforts saw a 64% reduction in readmission (10.0% vs 3.6%;  $P < .001$ ). In contrast, the two hospitals that implemented readmission reduction strategies last saw a negligible 5% reduction in readmission (7.8% vs 7.4%;  $P = .835$ ). However, when we compare the pre-implementation data against 2017 data alone for these two late implementers, we observed a better improvement, although still insignificant due to the small sample size (7.8% vs 5.7%;  $P = .545$ ).

**Conclusions:** The 30-day readmission rate decreased 40% in the post-intervention period. This study suggests that a combination of effective care strategies delivered during the perioperative and post-discharge CABG surgery periods are effective for reducing 30-day readmissions. Further research should evaluate the cost effectiveness of these interventions.

Table 1. CABG readmission reduction multifactorial quality improvement strategies.

Care Period	Intervention
<b>Preoperative</b>	Use of risk scores to identify patients at increased risk for readmission (STS risk calculator, EuroSCORE, 5-meter walk test, and dysphagia screening)
<b>Operative</b>	<p>Early and more frequent follow-up for high readmission risk patients</p> <p>Discharge ready criteria for high risk patients:</p> <ul style="list-style-type: none"> <li>- Patient has a current weight &gt; 3 kg. above admission weight</li> <li>- Patient is not tolerating a regular diet</li> <li>- Patient is not moving their bowels</li> <li>- Patient is not at step 5 of Cardiac Rehab</li> <li>- Patient is on 4 lpm of O<sub>2</sub> or greater OR patient has increased oxygen needs</li> <li>- HCT &lt; 22</li> <li>- Patient does not have a stable heart rhythm with a rate &lt; 120</li> </ul> <p>Education:</p> <ul style="list-style-type: none"> <li>- Patients are encouraged to be seen in the office rather than the ER or their PCP</li> <li>- SNFs are encouraged to call the office first rather than the ER</li> <li>- ED physicians are encouraged to communicate with the surgeon to appropriately determine proper patient status for continued care and monitoring</li> </ul>
<b>Postoperative</b>	<p>Physician assistant assigned to monitor patients discharged to Skilled Nursing Facilities (frequent phone calls, visits when necessary)</p> <p>Surgeons are encouraged to see all patients within 7 days of discharge</p> <p>Readmissions are reviewed immediately after they occur and are reviewed in monthly quality improvement meeting</p>

6AM	
7AM	<div><div>6:30 AM – 9:30 AM Registration &amp; Breakfast</div><div>7:00 AM – 9:00 AM STS University</div></div>
8AM	
9AM	
10AM	<div>9:30 AM – 11:30 AM STS University (courses repeated)</div>
11AM	
12PM	
1PM	
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8PM	
9PM	

6:30 AM – 9:30 AM	Registration & Breakfast
7:00 AM – 9:00 AM	 STS University
9:30 AM – 11:30 AM	 STS University (courses repeated)

6:30 AM – 9:30 AM

Hall D Lobby, First Floor

**Registration & Breakfast**

7:00 AM – 9:00 AM and repeated 9:30 AM – 11:30 AM

Hall D, First Floor

**STS University**

Unless otherwise noted in this *Abstract Book* or by the speakers, speakers have no commercial relationships to disclose and will be presenting information only on devices, products, or drugs that are FDA approved for the purposes they are discussing.

*The physician competencies addressed in each STS University course are medical knowledge and practice-based learning and improvement. These physician competencies will be addressed through hands-on sessions to gain knowledge and practical application experience.*

**Course 1: Essentials of TAVR**

**Course Directors:** Basel Ramlawi, Winchester, VA, and George Zorn, Kansas City, KS

**Faculty:** William T. Brinkman, Plano, TX, Kevin L. Greason, Rochester, MN, Jefferson Lyons, Columbus, OH, S. Chris Malaisrie, Chicago, IL, Hersb S. Maniar, St Louis, MO, Himanshu J. Patel, Ann Arbor, MI, and Liam P. Ryan, Alexandria, VA

**COMMERCIAL RELATIONSHIPS** B. Ramlawi: Research Grant, LivaNova, Medtronic; Consultant/Advisory Board, AtriCure; S. C. Malaisrie: Research Grant, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Edwards Lifesciences; H. J. Patel: Consultant/Advisory Board, Terumo, W. L. Gore & Assoc

Proficiency in transcatheter aortic valve replacement (TAVR) requires the acquisition of multiple endovascular principles and techniques. This course will introduce attendees to balloon-expandable and self-expanding TAVR platforms, as well as the various sheaths, guidewires, and catheters relevant to TAVR. Basics of alternative TAVR access will be discussed, and all participants will gain operational knowledge of the various delivery systems.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the decision-making process for choosing a TAVR access point (transfemoral, direct aortic, subclavian artery, and transapical)
- State the salient differences in the deployment of balloon-expanded vs self-expanded devices
- Describe the various types of sheaths and guidewires used during the TAVR procedure and understand reasons for their use

**Course 2: TEVAR and Aortic Arch Debranching Procedures**

**Course Directors:** Ali Khojenezhad, Los Angeles, CA, and Ourania A. Preventza, Houston, TX

**Faculty:** Derek R. Brinster, New York, NY, Ankur Gupta, Long Beach, CA, Sepehr Naficy, New York, NY, and Rodney A. White, Long Beach, CA

**COMMERCIAL RELATIONSHIPS** A. Khojenezhad: Research Grant, AtriCure; Consultant/Advisory Board, AtriCure; O. Preventza: Consultant/Advisory Board, Medtronic, W. L. Gore & Assoc; R. A. White: Research Grant, Medtronic; Consultant/Advisory Board, Cardiatis, Intact Vascular; Speakers Bureau/Honoraria, Endologix, Medtronic; Other Research Support, Medtronic

This course will review basic catheter and wire skills for thoracic endovascular aortic repair (TEVAR). Participants will have hands-on experience with thoracic stent grafts and intravascular ultrasound (IVUS), as well as using vascular plugs from the brachial or femoral approach. Surgical techniques for zone 0-2 aortic arch debranching procedures will be discussed.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Identify the most common catheters and wires for TEVAR
- Describe the deployment of commercially available stent grafts
- Explain the use of IVUS and vascular plugs for subclavian artery occlusion
- Describe the surgical techniques used in aortic arch debranching

### Course 3: Mitral Valve Repair

**Course Directors:** Steven F. Bolling, Ann Arbor, MI, and Evelio Rodriguez, Nashville, TN

**Faculty:** W. Randolph Chitwood Jr, Greenville, NC, A. Marc Gillinov, Cleveland, OH, T. Sloane Guy, New York, NY, and Matthew A. Romano, Ann Arbor, MI

**COMMERCIAL RELATIONSHIPS** E. Rodriguez: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Abbott, Boston Scientific; Speakers Bureau/Honoraria, Abbott; A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure; T. S. Guy: Consultant/Advisory Board, Edwards Lifesciences, Verb Surgical

In this course, participants will be able to practice different mitral valve repair strategies for both anterior and posterior leaflet pathologies. These will include leaflet resection and non-resection techniques, commissural repair strategies, and different chordal approaches. In addition, different surgical therapies for secondary mitral regurgitation, including ring selection, leaflet extension techniques, and mitral valve replacement, will be reviewed.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe different leaflet resection and non-resection approaches, in addition to different chordal techniques required for successful mitral valve repair
- Identify advance repair techniques for both primary and secondary mitral regurgitation
- Demonstrate proper mitral valve replacement techniques

### Course 4: Valve-Sparing Aortic Root Replacement

**Course Directors:** Duke E. Cameron, Baltimore, MD, Edward P. Chen, Atlanta, GA, and Bo Yang, Ann Arbor, MI

**Faculty:** Jeffrey Brown, Baltimore, MD, Ruggero De Paulis, Rome, Italy, G. Michael Deeb, Ann Arbor, MI, Philip J. Hess Jr, Indianapolis, IN, Melissa Jones, Baltimore, MD, Bradley G. Leshnower, Atlanta, GA, and Luca A. Vricella, Baltimore, MD

**COMMERCIAL RELATIONSHIPS** R. De Paulis: Consultant/Advisory Board, Edwards Lifesciences; G. M. Deeb: Research Grant, Boston Scientific, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Medtronic, Terumo; B. G. Leshnower: Speakers Bureau/Honoraria, Medtronic

This course will provide interactive, hands-on instruction of the surgical techniques and critical steps necessary for performing a successful valve-sparing aortic root replacement (VSRR).

## Learning Objectives

Upon completion of this activity, participants should be able to:

- Describe the anatomy of the aortic root
- Summarize the technical steps necessary for a successful VSRR
- List different methods in choosing a graft size
- Discuss leaflet repair and annuloplasty methods

## Course 5: Aortic Root Enlargement Procedures and Aortic Valve Leaflet Reconstruction

**Course Directors:** *S. Adil Husain, San Antonio, TX, and Prashanth Vallabhajosyula, Philadelphia, PA*

**Faculty:** *Arminster Singh Jassar, Boston, MA, Alberto Pochettino, Rochester, MN, Edward Y. Sako, San Antonio, TX, and Ibrahim Sultan, Pittsburgh, PA*

This course will review two specialized subareas of technical expertise required to perform complex aortic root surgery. Participants will learn the anatomic approaches and surgical techniques employed in performing aortic root enlarging procedures, as well as aortic valve leaflet reconstructive techniques and the importance of providing annular stabilization in the context of a repaired aortic valve. Surgical strategies for root enlargement will include Nicks, Manouagian, and Ross Konno. Surgical techniques involving aortic valve leaflet reconstruction will include primary simple cusp plication techniques, patch augmentation technique, Gore-Tex free margin shortening technique, and orienting the repaired bicuspid aortic valve into its aortic neoroot.

## Learning Objectives

Upon completion of this activity, participants should be able to:

- Identify the anatomy and appropriate surgical landmarks in the left ventricular outflow tract and aortic valve apparatus
- Describe the incision sites and overall surgical techniques for a variety of root enlargement strategies
- Discuss surgical pitfalls associated with each strategy and mechanisms by which to delineate options based upon patient and anatomic substrate
- Describe how to set up and expose the aortic root for primary valve repair and identify the risk factors for repair failure based on the anatomy of the aortic valve
- Recall the different aortic annular stabilization techniques and recognize the impact of each technique on valve repair – subcommissural annuloplasty, external aortic ring, and root reimplantation
- Identify different bicuspid aortic valve types and explain the implications for valve repair and the choice of annular stabilization
- Demonstrate how to implant a type I bicuspid aortic valve in the context of its neoroot and explain what the different bicuspid subtypes mean for orienting the repaired valve when performing a root reimplantation

**Course 6: VATS Lobectomy**

**Course Directors:** Duy Khanh P. Ceppa, Indianapolis, IN, and Betty C. Tong, Durham, NC

**Faculty:** Mark F. Berry, Stanford, CA, Shanda H. Blackmon, Rochester, MN, William R. Burfeind, Bethlehem, PA, Todd L. Demmy, New Brunswick, NJ, Janet P. Edwards, Calgary, Canada, Jacob A. Klapper, Durham, NC, Jeremiah Martin, Portsmouth, OH, Jacob R. Moremen, Jackson, MS, Scott I. Reznik, Dallas, TX, and Paula A. Ugalde, Quebec, Canada

**COMMERCIAL RELATIONSHIPS** T. L. Demmy: Consultant/Advisory Board, Medtronic

This course will review the indications, patient selection, technical steps, and recent advances for performance of lobectomy using video-assisted thoracic surgery (VATS). Participants will be able to perform a VATS left upper lobectomy on porcine heart-lung blocks.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Describe the indications and steps to perform VATS
- Discuss potential pitfalls and strategies for intraoperative troubleshooting to successfully achieve minimally invasive lobectomy
- Identify instruments and other technologies available to perform minimally invasive lobectomy

**Course 7: Advanced Open Esophageal and Tracheal Procedures**

**Course Directors:** Sidbarta P. Gangadharan, Boston, MA, and Sandra L. Starnes, Cincinnati, OH

**Faculty:** Scott M. Atay, Los Angeles, CA, Andrew C. Chang, Ann Arbor, MI, Alberto de Hoyos, Dallas, TX, Robert E. Merritt, Columbus, OH, Karen M. Rieger, Indianapolis, IN, K. Robert Shen, Rochester, MN, and Jennifer L. Wilson, Boston, MA

This course will provide hands-on training for several esophageal anastomosis techniques, as well as airway anastomosis and repair. These advanced operative techniques are not frequently utilized in most general thoracic surgery practices, but competence in these techniques is important. Participants will be introduced to several techniques for airway and esophageal reconstruction with emphasis in the different technical aspects ("pearls") of the anastomosis from content experts.

**Learning Objectives**

Upon completion of this activity, participants should be able to:

- Identify and perform the appropriate esophageal anastomosis technique depending on anatomic or other considerations
- Perform airway anastomoses and recognize technical pitfalls associated with the various techniques
- Identify the key steps of tracheobronchoplasty

## Course 8: Chest Wall Resection, Reconstruction, and Pectus Surgery

**Course Directors:** Dawn E. Jaroszewski, Phoenix, AZ, Daniel L. Miller, Marietta, GA, and Mathew Thomas, Jacksonville, FL

**Faculty:** Staci Beamer, Phoenix, AZ

**COMMERCIAL RELATIONSHIPS** D. E. Jaroszewski: Consultant/Advisory Board, AtriCure, Zimmer Biomet; D. L. Miller: Research Grant, Medela; Consultant/Advisory Board, Ethicon; Speakers Bureau/Honoraria, Medtronic

In this hands-on course, participants will learn the various techniques for reconstruction of large chest wall defects after resection. Other highlights of the course include stabilization of rib and sternal fractures using the most current reconstruction systems and minimally invasive repair of adult pectus excavatum defects. At the end of this course, participants should be able to independently design and perform reconstruction of the chest wall for various indications.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Perform rigid and semi-rigid reconstruction of chest wall defects after resection, including the ribs and sternum
- Demonstrate how to stabilize single and multiple rib fractures using rib fixation devices
- Use sternal fixation devices to stabilize the sternum
- Perform minimally invasive repair of adult pectus excavatum defects

## ! Course 9: Minimally Invasive Aortic and Mitral Valve Surgery

**Course Directors:** Tom C. Nguyen, Houston, TX, and Vinod H. Thourani, Washington, DC

**Faculty:** Kuan-Ming Chiu, Taipei, Taiwan, Borut Gersak, Ljubljana, Slovenia, Mattia Glauber, Milan, Italy, Peter A. Knight, Rochester, NY, Eric J. Lebr, Seattle, WA, and Juan P. Umaña, Bogotá, Colombia

**COMMERCIAL RELATIONSHIPS** T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott; V. H. Thourani: Research Grant, Abbott, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott, Boston Scientific, Edwards Lifesciences, W. L. Gore & Assoc

Cardiothoracic surgeons face an increased demand to adopt minimally invasive valve techniques. Unfortunately, acquiring this skillset can be difficult in real-world practice. The objective of this course is to provide hands-on experience with the newest techniques in minimally invasive aortic and mitral valve surgery. Participants will work in alternating pairs at each station to learn critical exposure and cannulation techniques for minimally invasive aortic (right anterior thoracotomy and hemisternotomy) and mitral (lateral thoracotomy) surgery. Participants will then have an opportunity to perform aortic and mitral valve repair/replacement using simulators under both direct vision and via thoroscopic guidance. For aortic valve replacements, participants will gain exposure to sutureless and rapid-deployment technologies. At the conclusion of the course, a handout will be distributed with a list of key instruments for minimally invasive valve surgery and suggested steps for building a minimally invasive valve program.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Explain exposure (right anterior thoracotomy, hemisternotomy, and lateral thoracotomy), cannulation, and cardioprotection techniques for minimally invasive valve surgery

- Identify key operative steps for successful minimally invasive aortic and mitral valve surgery, including sutureless and rapid deployment technologies
- Describe the indications and contraindications for minimally invasive valve surgery

### ! Course 10: POEM Skills

**Course Directors:** *Ralph W. Aye, Seattle, WA, and Inderpal S. Sarkaria, Pittsburgh, PA*

**Faculty:** *Lara W. Schabehn, Pittsburgh, PA, and Jon O. Wee, Boston, MA*

**COMMERCIAL RELATIONSHIPS** I. S. Sarkaria: Speakers Bureau/Honoraria, Intuitive Surgical

This is a practical, hands-on course for learning peroral endoscopic myotomy (POEM) using an explant model. Participants will learn how to plan landmarks for the procedure, how to access the submucosal space and create a long submucosal tunnel extending through the gastroesophageal junction, how to perform myotomy, and how to close the mucosotomy. The standard tools and electrotherapy instruments for performing the procedure will be explored in detail.

### Learning Objectives

Upon completion of this activity, participants should be able to:

- Determine the proper landmarks for beginning and completing the procedure
- Create a submucosal tunnel
- Perform an endoscopic myotomy within the tunnel
- Close the mucosotomy

Adult Cardiac Posters

P1

**Risk Model for In-Hospital Mortality in Aortic Surgery for Ascending Aortic Aneurysm in the United States Using the STS National Database**

*M. Mori, K. Shioda, X. S. Wang, J. J. Yun, A. Mangi, U. M. Darr, A. O. Geirsson*

*Yale University, New Haven, CT*

**COMMERCIAL RELATIONSHIPS** A. Mangi: Consultant/Advisory Board, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Edwards Lifesciences, Medtronic

**Purpose:** A risk model for surgery for ascending aortic aneurysm incorporating pertinent and extensive surgical variables is needed. We aimed to develop a risk model for operative death following operations for ascending aortic aneurysm using the STS National Database.

**Methods:** From 2011 to 2016, 53,559 operations for ascending aortic aneurysm performed across 1045 centers in the United States were identified in the STS National Database. The cohort was stratified by surgical era (2011-2013 and 2014-2016) to compare unadjusted mortality across time. Logistic regression related baseline characteristics and comorbidities to in-hospital mortality. Ten-fold cross validation was performed to estimate sensitivity and specificity across various values of the discrimination threshold classifying cases that resulted in in-hospital mortality. The threshold was optimized based on the Yoden index. The final model was selected using stepwise selection and was fitted over the entire dataset.

**Results:** Of 53,559 operations, 116 cases missing mortality data were excluded. In-hospital mortality occurred in 1575 (3.0%). Early surgical era (2011-2013) had a higher unadjusted in-hospital mortality compared to that of late era (2014-2016) (3.4% vs 2.5%,  $P < .01$ ). 47,646 (89%) with complete data were included in the logistic regression model. After controlling for baseline demographics and comorbidity, 21 variables were significantly associated with in-hospital mortality (Table). Notably, cardiogenic shock (odds ratio [OR] 2.62, 95% confidence interval [CI] 1.82-3.72), dialysis (OR 3.16, 95% CI 2.28-4.30), active endocarditis (OR 1.89, 95% CI 1.44-2.46), emergent surgery (OR 7.16, 95% CI 5.56-9.15), concomitant coronary artery bypass grafting (OR 2.00, 95% CI 1.58-2.53), and mitral valve operation (OR 1.55, 95% CI 1.19-2.00) yielded higher odds ratios compared to other variables. Ten-fold cross validation yielded the receiver-operator characteristics curve, with a c-index of 0.80. Sensitivity and specificity that yielded the highest Yoden index was 74.0% and 72.0%, respectively.

**Conclusions:** Based on STS National Database data for operations for ascending aortic aneurysm conducted in the United States, a risk model for in-hospital mortality was developed with adequate discriminatory characteristics. Unadjusted in-hospital mortality decreased during the study period.

**Table: Select predictors for in-hospital mortality**

Variables	Odds Ratio	95%CI, lower limit	95%CI, Upper limit	P value
Age	1.04	1.03	1.04	<0.001
Gender (female)	1.34	1.14	1.56	<0.001
Hypertension	1.31	1.10	1.56	0.002
CHF	1.27	1.12	1.45	<0.001
Diabetes	1.24	1.05	1.45	0.009
Dialysis	3.16	2.28	4.30	<0.001
Cardiogenic shock	2.62	1.82	3.72	<0.001
EF ≥40% and < 55%	1.27	1.10	1.45	0.001
EF ≥30% and < 40%	1.30	1.04	1.63	0.021
EF <30%	1.23	0.92	1.61	0.153
Peripheral vascular disease	1.32	1.16	1.51	<0.001
Chronic lung disease	1.47	1.29	1.67	<0.001
Active endocarditis	1.89	1.44	2.46	<0.001
Immunosuppressed	1.36	1.05	1.75	0.017
1 <sup>st</sup> reoperation	1.87	1.50	2.34	<0.001
2 <sup>nd</sup> reoperation	2.20	1.55	3.09	<0.001
3 <sup>rd</sup> reoperation	4.41	2.75	6.90	<0.001
Concomitant CABG	2.00	1.58	2.53	<0.001
Concomitant MVR	1.55	1.19	2.00	0.001
Urgent status	1.67	1.46	1.91	<0.001
Emergent status	7.16	5.56	9.15	<0.001

## P2

**STS-PROM, Sarcopenia, and Frailty Markers Are Not Predictive of 1-Year Mortality After Transcatheter Aortic Valve Replacement**

J.J. Squiers<sup>1</sup>, K. R. Hebele<sup>2</sup>, H. Baumgarten<sup>2</sup>, B. D. Pollock<sup>3</sup>, J. Wooley<sup>1</sup>, M. Mack<sup>1</sup>, G. Filardo<sup>3</sup>, B. Lima<sup>4</sup>, J. M. DiMaio<sup>3</sup>

<sup>1</sup>The Heart Hospital Baylor Plano, TX, <sup>2</sup>Baylor Research Institute, The Heart Hospital Baylor Plano, TX, <sup>3</sup>Baylor Scott & White Health, Dallas, TX, <sup>4</sup>Baylor University Medical Center, Dallas, TX

**COMMERCIAL RELATIONSHIPS** G. Filardo: Research Grant, Gilead Lifesciences; M.J. Mack: Research Grant, Abbott Vascular, Edwards Lifesciences, Medtronic

**Purpose:** A validated model for 1-year transcatheter aortic valve replacement (TAVR) outcomes is not yet available. TAVR-specific risk models may benefit from the inclusion of frailty markers. Sarcopenia may represent an objective, easily obtainable frailty marker. We assessed the predictive ability of sarcopenia and frailty markers in addition to STS-PROM on 1-year mortality after TAVR.

**Methods:** We evaluated 470 patients who underwent TAVR at a single center. Sarcopenia was quantified by measuring the cross-sectional psoas muscle area (PMA) at the L3 level on pre-TAVR CT. Frailty was assessed using four markers (gait speed, handgrip strength, serum albumin, and Katz activities of daily living). The primary outcome was 1-year mortality. Performance of four models (see Figure 1A) predicting 1-year mortality in the study population was assessed and compared. For each model, area under the curve (AUC), Hosmer-Lemeshow statistics, and calibration plots were estimated and computed. *P* values and 95% confidence intervals were computed for each model estimate.

**Results:** At 1-year follow-up, mortality was observed in 63 patients (13%). STS-PROM alone was poorly predictive of 1-year mortality (AUC 0.52, 95% CI: 0.42-0.68). Most frailty markers and sarcopenia also were poorly predictive of 1-year mortality (see Figure 1A). Only the model that included sarcopenia and all four frailty makers (AUC 0.61, 95% CI: 0.53-0.68) had significantly improved predictive ability compared to STS-PROM alone (*P* = .05); however, this was due primarily to the inclusion of albumin in this model. Albumin was the only frailty marker significantly associated with increased risk for 1-year mortality (*P* = .03; see Figure 1B). PMA, as a surrogate for sarcopenia, was not significantly associated with increased risk for 1-year mortality.

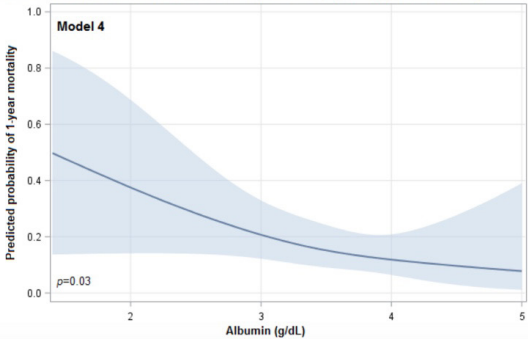
**Conclusions:** Commonly used pre-TAVR risk assessments, such as STS-PROM, frailty, and sarcopenia, are poorly predictive of 1-year mortality. A TAVR-specific risk model is necessary to accurately assess pre-TAVR risk of 1-year mortality. Albumin should be considered for inclusion during development of subsequent TAVR risk models.

**Figure 1.A. Model performances for potential risk factors of 1-year mortality in 470 patients undergoing TAVR.**

	<i>p</i> -value	Model AUC (95% CI)	<i>Hosmer-Lemeshow p</i> *
<b>Model 1: STS-PROM Only</b>	0.05	0.52 (0.42, 0.68)	0.65
<b>Model 2: STS-PROM + Sarcopenia</b>			
Total Psos Area	0.96	0.55 (0.47, 0.63)	0.66
<b>Model 3: STS-PROM + Frailty Markers</b>			
Katz ADL	0.43	0.58 (0.50, 0.66)	0.32
Albumin	0.03		
Grip Strength	0.24		
5m Walk Time	0.54		
<b>Model 4: STS-PROM + Frailty Markers + Sarcopenia</b>			
Katz ADL	0.43	0.61 (0.53, 0.68)	0.80
Albumin	0.03		
Grip Strength	0.13		
5m Walk Time	0.59		
Total Psos Area	0.53		

\*Higher Hosmer-Lemeshow p values represent increased goodness of fit.

**Figure 1.B. Association between albumin and probability of 1-year mortality**



P3

# Targeting the Hexosamine Biosynthetic Pathway in Chronic Myocardial Ischemia and Hyperglycemia

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<sup>1</sup>Brown University, Providence, RI, <sup>2</sup>Brown Medical School/Rhode Island Hospital, Providence

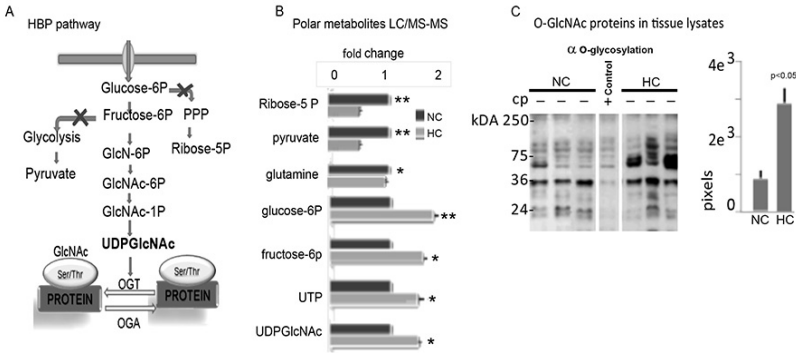
**COMMERCIAL RELATIONSHIPS** F. W. Sellke: Consultant/Advisory Board, Boehringer Ingelheim, Mallinckrodt, Stryker

**Purpose:** Metabolic syndrome (MetS) increases the risk of ischemia and coronary artery disease (CAD), but the underlying mechanism is poorly understood. Studies on cardiac collateral circulation in a MetS model with chronic ischemia may lead to better CAD treatment. We used metabolomics, transcriptomics, and proteomics analyses to identify potential therapeutic targets.

**Methods:** Yorkshire swine were fed either a high-cholesterol diet (HC, n=8) or a normal diet as a control (NC, n=8) for 4 weeks. An ameroid constrictor was placed on the left circumflex artery, and the diet continued for an additional 5 weeks. Cardiac tissue was tested for changes in physiological parameters (blood flow, mean arterial pressure [MAP]), identification of metabolite concentration (thin layer and affinity chromatography, LC/MS-MS), quantification of gene expression differences (qPCR) and different proteomics approaches were used (mass spectrometry, western blot). Finally, computational data analyses were used to identify HC and NC determinants of cardiac collateral integrity.

**Results:** Absolute blood flow in tissue from the high cholesterol group at rest was decreased in the HC vs NC (NC:  $0.516 \pm 0.204$ , HC:  $0.368 \pm 0.095$ ,  $P < .037$ ). MAP increased in the HC group vs NC (112 mm Hg vs 68 mm Hg, respectively). Activation of the hexosamine biosynthetic pathway (HBP) in the HC group was observed: the UDP-GlcNAc increased 1.82-fold in glucose-6-phosphate ( $P < .02$ ); fructose-6-phosphate increased 1.65-fold (n=6,  $P < .02$ ,  $\pm 0.12$ -fold change); UTP (n=6,  $P < .02$ ,  $1.42 \pm 0.16$ -fold change) and HBP final product UDP-GlcNAc increased as well (n=6,  $P < .02$ ,  $1.4 \pm 0.15$ -fold change) (Figure A, B). Activation of pan-expressed cardiac protein O-GlcNAcylation (3.54-fold higher in HC  $\pm 0.3$ ;  $P < .05$ , n=6). The competition with HBP for glucose-6-phosphate and fructose-6-phosphate glycolytic (pyruvate, n=4,  $P < .02$ ,  $0.41 \pm 0.08$ -fold change) and pentose phosphate pathways (ribose-5-phosphate, n=4,  $P < .01$ ,  $0.52 \pm 0.08$ -fold change) are downregulated in HC.

**Conclusions:** High cholesterol diet and chronically induced ischemia upregulates cardiac HBP. Subsequently, higher level of protein O-glycosylation is observed. The enzymes that regulate HBP and protein-specific O-glycosylation could be targeted to improve cardiac function in hypercholesterolemic patients.



P4

# **Bileaflet Repair vs Isolated Posterior Repair for Bileaflet Mitral Valve Prolapse**

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**COMMERCIAL RELATIONSHIPS** M. Y. Desai: Consultant/Advisory Board, Myokardia; A. M. Gillinov: Ownership Interest, Clear Catheter Systems; Research Grant, Abbott; Consultant/Advisory Board, Abbott, AtriCure, Clear Catheter Systems, CryoLife, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, AtriCure; L. G. Svensson: Ownership Interest, Cardiosolutions; Other, Posthorax Royalties

**Purpose:** Bileaflet mitral valve prolapse accounts for 30% of degenerative mitral valve disease, and surgical repair techniques are challenging, with continued debate on whether anterior repair is always necessary. This study seeks to evaluate long-term outcomes after bileaflet repair vs isolated posterior leaflet repair in patients with bileaflet mitral valve prolapse.

**Methods:** From January 1998 to January 2016, 1968 patients with bileaflet mitral valve prolapse underwent primary isolated mitral valve repair with either bileaflet (n=438, 22%) or isolated posterior leaflet repair (n=1530, 78%). Patients with anterior or centrally directed regurgitation jet were likely to undergo isolated posterior repair, and those with posterior directed regurgitation jet were likely to undergo bileaflet repair. Patients with bileaflet repair were older and more symptomatic than those with isolated posterior leaflet repair; thus, logistic regression analysis was used to generate propensity scores to identify 423 well-matched patient pairs for outcome comparisons. Repair durability was assessed by return of mitral regurgitation (MR).

**Results:** Overall 10-year survival after bileaflet repair was 95% vs 93% after isolated posterior repair ( $P = .8$ ); among matched patients, 10-year survival after bileaflet repair was 95% vs 90% after isolated posterior repair ( $P = .4$ ). Progression to severe MR after repair was uncommon—14% after bileaflet repair and 11% after isolated posterior repair by 10 years among matched patients ( $P = .5$ ); however, those undergoing bileaflet repair experienced slightly more very early postoperative return of severe MR ( $P = .0004$ ) (Figure).

**Conclusions:** Most bileaflet prolapse patients can be treated by isolated posterior repair rather than bileaflet repair, with long-term durability and survival similar to that of bileaflet repair. The data support use of posterior repair when jet direction is central or anterior, and bileaflet repair when it is posterior, subject to the surgeon's judgment.

### Progression of Severe Postoperative MR



P5

# **Impact of Sharing Adult Blood Type O Donor Hearts With Non-O Recipients: Survival Simulation by Blood Type Using the United Network for Organ Sharing Registry and Markov Modeling**

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**COMMERCIAL RELATIONSHIPS** P. Colombo: Research Grant, Abbott; Consultant/Advisory Board, Abbott; A. R. Garan: Research Grant, National Institutes of Health; Speakers Bureau/Honoraria, Abiomed

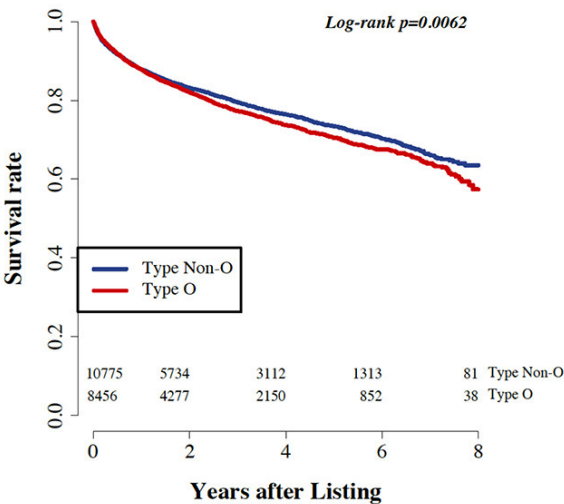
**Purpose:** Type O recipients wait longer than other blood types and frequently require bridging left ventricular assist devices (LVADs). The effect of this disparity has rarely been shown in a large contemporary registry. This study aims to clarify the outcome difference between O and non-O candidates and how allocation change affects survival using Markov simulation.

**Methods:** We reviewed the United Network for Organ Sharing (UNOS) registry for adults listed from 2008 to 2015. Cumulative incidences of death or transplant and overall survival after listing were compared between O and non-O candidates. Four-state Markov model (waiting without LVAD, waiting with LVAD, transplanted, and death) was created in O and non-O candidates to evaluate survival after listing, based on the transition probabilities calculated from the UNOS registry and previous publications. Sensitivity analysis was performed to see how donor O heart percentage in non-O recipients would affect survival difference between O and non-O candidates.

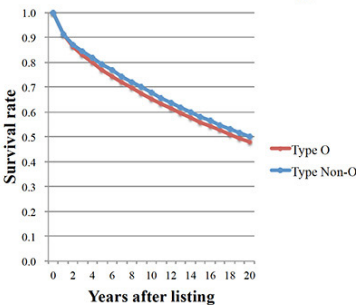
**Results:** We included 8456 candidates in O and 10,775 in non-O group. Although there was no significant survival difference between these groups for those who got transplanted, cumulative incidence of transplant was significantly lower in O candidates ( $P < .001$ ), with death after listing significantly higher in O candidates ( $P < .001$ ). During median follow-up of 2.1 years, 70.1% of non-O candidates were transplanted, compared to 54.9% of O candidates ( $P < .001$ ). Despite this disparity in transplant rate, among 7555 non-O recipients, 1442 (19.1%) received O hearts. Our simulated survival was quite similar to actual survival, and sensitivity analysis demonstrated that decreasing donor blood type O heart percentage in non-O recipients from the current 19% to 8% would provide similar simulated survival in O and non-O candidates after listing (Figures). If we make this percentage zero, indicating all O hearts only for O recipients, simulated survival becomes better in O candidates.

**Conclusions:** Under the current strategy, there are survival and transplant rate differences between O and non-O candidates. If we try to adjust this discrepancy, our survival simulation suggests donor blood type O heart percentage in non-O recipients should be lowered to 8% in a new strategy from the current 19%.

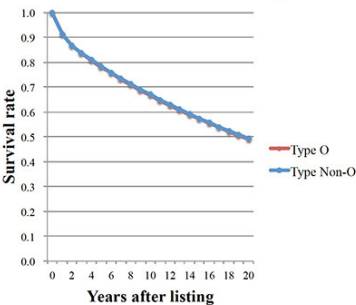
Survival in the UNOS registry (2008-2015)



Survival simulation - Current strategy



Survival simulation - New strategy



P6

## Development and Utility of a Preoperative Biomarker Panel to Improve Prediction of Readmission After Cardiac Surgery

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**COMMERCIAL RELATIONSHIPS** D. S. Likosky: Research Grant, Agency for Healthcare Research and Quality, National Institutes of Health; Consultant/Advisory Board, American Society of ExtraCorporeal Technology; K. W. Lobdell: Consultant/Advisory Board, Medtronic

**Purpose:** Improved preoperative prediction of 30-day readmission after cardiac surgery will assist clinical care teams in identifying high-risk patients prior to surgery. We constructed and tested the clinical utility of a preoperative biomarker panel to improve preoperative prediction of readmission prior to adult cardiac surgery over existing clinical models.

**Methods:** Preoperative samples of Cystatin C, IL10, IL6, Galectin-3, NTProBNP, and ST2 were measured in 1393 patients discharged alive after isolated coronary artery bypass grafting (CABG) surgery from eight medical centers in Northern New England. We developed a preoperative biomarker panel with fractional polynomials, a parametric approach to modeling continuous risk factors, using the preoperative measurements of all six biomarkers. We tested the biomarker panel against a preoperative clinical readmission model comparing the area under the receiver operating characteristic curves (ROC). We calculated cross-validated c-statistics in order to further guard against over-fitting and repeated our models using bootstrapping and multiple imputation for missing data.

**Results:** There were 150 patients (10.77%) readmitted within 30 days after CABG surgery. The Table provides the univariate associations between the preoperative biomarkers and 30-day readmission. The clinical model resulted in a ROC of 0.66 (95% CI: 0.62-0.70) (Figure). We constructed panels consisting of the preoperative biomarkers and produced 121 different panel candidates through combining similar timepoints and forms of biomarkers, absolute shrinkage and selection operator (LASSO) regression, random forest regression, and fractional polynomial regression. The top performing biomarker panel consisted of fractional polynomials resulting in a statistically significant ROC of 0.69 (bootstrapped 95% CI: 0.65-0.73; bootstrapped  $P < .0001$ ), modestly improving model discrimination (Figure). We confirmed these findings in a sensitivity analysis using multiple imputation also resulting in a statistically significant improvement in ROC of 0.69 (bootstrapped 95% CI: 0.64-0.73; bootstrapped  $P < .0001$ ).

**Conclusions:** We are the first to demonstrate a preoperative biomarker panel to improve prediction for 30-day readmission prior to patients undergoing isolated CABG surgery. Our findings suggest that preoperative biomarkers can improve detection of readmission risk and better equip clinical teams to manage high-risk patients during preoperative admission for CABG surgery.

Figure 1

ROC Comparison between Existing Clinical Model and Pre-operative Fractional Polynomial Biomarker Panel

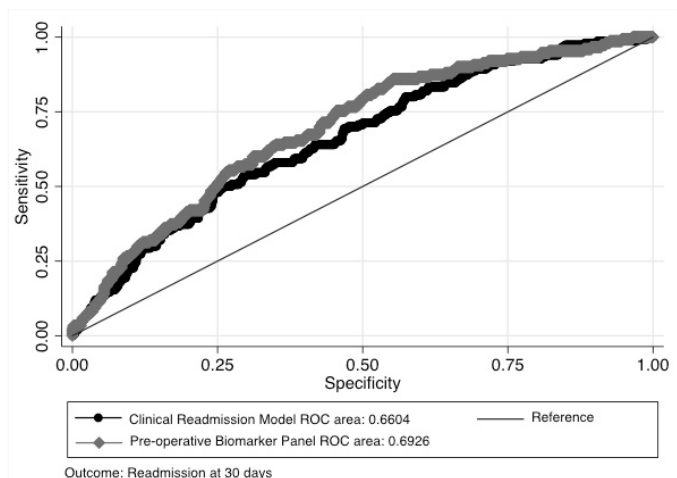


Table 1

Univariate Logistic Regressions for the Fractional Polynomial Forms of the Pre-operative Biomarkers and 30-day Readmission

Fractional Polynomial Forms <sup>a</sup> of the Biomarkers	OR	95%CI	P-value
Pre-operative Cystatin C	0.87	0.32-2.34	0.775
Pre-operative Cystatin C <sup>2</sup>	0.99	0.81-1.22	0.953
Pre-operative IL 10 <sup>0.5</sup>	1.56	0.08-29.12	0.766
Pre-operative IL 10	0.62	0.11-3.40	0.582
Pre-operative IL 6 <sup>-2</sup>	0.87	0.77-0.99	0.038
Pre-operative IL 6 <sup>2</sup>	1.00	0.99-1.00	0.154
Pre-operative Galectin 3 <sup>-2</sup>	15.75	0.30-826.60	0.172
Pre-operative Galectin 3 <sup>2</sup>	1.00	1.00-1.00	0.004
Pre-operative NT Pro BNP <sup>-2</sup>	0.77	0.62-0.97	0.025
Pre-operative NT Pro BNP <sup>-2</sup> (*ln(Pre-operative NT Pro BNP))	0.86	0.77-0.97	0.013
Pre-operative ST 2 <sup>2</sup>	1.00	0.99-1.01	0.432
Pre-operative ST 2 <sup>2</sup> (*ln(Pre-operative ST 2))	1.00	0.99-1.00	0.387

<sup>a</sup> Royston and Sauerbrei (2008) recommend choosing powers from among {-2, -1, -0.5, 0.5, 1, 2, 3}. By default, the fp command in STATA chooses powers from this set. The models presented here are the models with the lowest deviance.

\* Natural Log

P7

# **Surgical Repair of Anteroapical Left Ventricular Aneurysms Guided with Multislice Computed Tomography: Survival Determinants and Improvement of Heart Failure Symptoms**

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**COMMERCIAL RELATIONSHIPS** V. Falk: Research Grant, Boston Scientific, HeartWare; Speakers Bureau/Honoraria, Edwards Lifesciences, Abbott

**Purpose:** Surgical ventricular repair (SVR) is an established treatment option in patients with heart failure (HF) due to left ventricular (LV) aneurysms. In this study, we evaluated the postoperative improvement of HF symptoms and factors affecting survival after SVR using clinical criteria and morphological characteristics obtained with multislice computed tomography (MSCT).

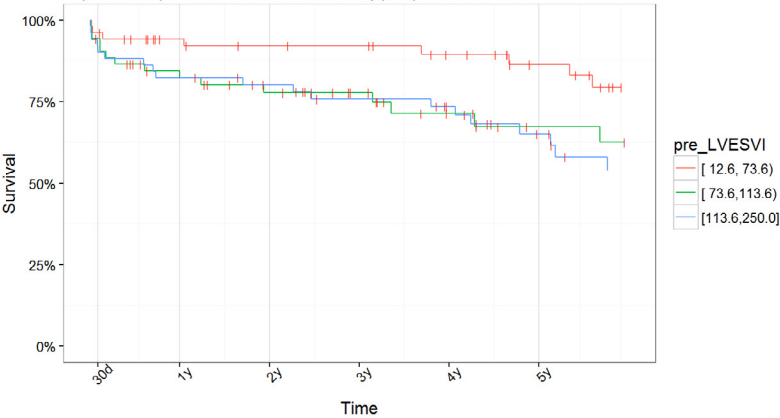
**Methods:** 205 patients (November 2005–January 2016, male:female=151:54, median age 63.4 years; mean NYHA class 3.03) with anteroapical LV aneurysm underwent SVR combined with coronary artery bypass grafting (77%), mitral valve repair/replacement (19%), and LV thrombectomy (19%). MSCT was performed in 160 patients before and 7 days after surgery. Endpoints in the survival analysis were death, implantation of LV assist device, and heart transplantation. Median follow-up time was 1528 days. MSCT characteristics for survival analysis were LV end diastolic and end systolic volume index (LVEDVI, LVESVI), LV ejection fraction (LVEF), and LV sphericity index (SI). NYHA class changes were analyzed in the survivor population.

**Results:** Thirty-day, 1-year, and 5-year survival was 92.6%, 82.7%, and 67.9%, respectively. After SVR, there was a significant reduction of LVEDVI from  $146.6 \text{ mL/m}^2 \pm 52.4 \text{ mL/m}^2$  to  $97.3 \text{ mL/m}^2 \pm 35.6 \text{ mL/m}^2$  ( $P < .001$ ) and LVESVI from  $100.0 \text{ mL/m}^2 \pm 49.6 \text{ mL/m}^2$  to  $59.2 \text{ mL/m}^2 \pm 33.4 \text{ mL/m}^2$ , ( $P < .001$ ) as well as an increase of LVEF from  $34.1\% \pm 12.1\%$  to  $43.1\% \pm 13.9\%$  ( $P < .001$ ). Multivariable proportional hazard regression modeling showed an effect on survival of preoperative and achieved postoperative LVESVI and no effect of preoperative diastolic SI. On average, a  $50 \text{ mL/m}^2$  increase of preoperative LVESVI was associated with a 35% increase of the hazard of death ( $P = .043$ ). Survival stratified by preoperative LVESVI resulted in following cutoff points:  $<74 \text{ mL/m}^2$ ,  $74\text{--}114 \text{ mL/m}^2$ , and  $>114 \text{ mL/m}^2$  (Figure). Also, achieved postoperative LVESVI was strongly predictive for all defined endpoints with following cutoff points:  $<58 \text{ mL/m}^2$ ,  $58\text{--}82 \text{ mL/m}^2$ , and  $>82 \text{ mL/m}^2$ . We demonstrated a strong reduction of NYHA class III–IV quota after surgery in survivors (95.1% preoperative and 20.5% in the follow-up).

**Conclusions:** Surgical repair of anteroapical LV aneurysms can be performed with good mid-term survival and significant improvement of HF severity due to LV volume reduction and functional improvement. MSCT delivers important predictive parameters for survival. Based on the MSCT assessment, we propose an algorithm for surgical planning in anterior LV aneurysms.

Survival stratified by pre LVESVI

Kaplan-Meier plot of time to death stratified by preoperative LVESVI



P8

# Early and Mid-Term Clinical and Hemodynamic Outcomes of Rapid Deployment Aortic Bioprostheses: Results From a National Registry

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**COMMERCIAL RELATIONSHIPS** A. D'Onofrio: Consultant/Advisory Board, Edwards Lifesciences; R. P. De Paulis: Consultant/Advisory Board, Edwards Lifesciences; D. Maselli: Consultant/Advisory Board, Edwards Lifesciences

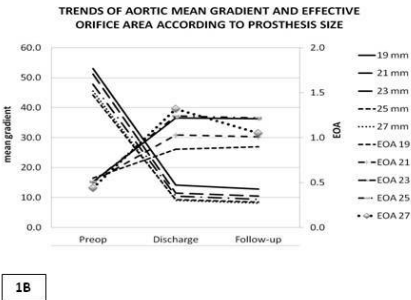
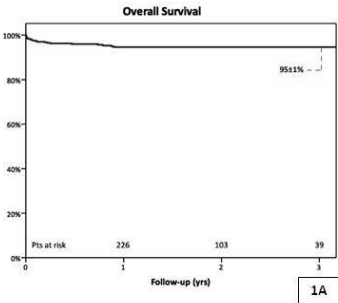
**REGULATORY DISCLOSURE** This presentation describes the off-label use of the Intuity device.

**Purpose:** Rapid deployment bioprostheses (RDB) have been recently introduced into clinical practice for the treatment of severe aortic valve stenosis. The aim of this retrospective multicenter study was to assess early and mid-term clinical and hemodynamic outcomes of patients undergoing RDB implantation.

**Methods:** Data from a national registry that includes patients who underwent isolated or combined aortic valve replacement with RDB in our country were analyzed. Data were collected at each study site and then anonymously sent to the coordinating center for storage and analysis. EuroSCORE definitions were used for preoperative variables, and updated VARC definitions were used for postoperative outcomes assessment. Univariate and multivariable analysis were performed to identify independent predictors of mortality. Follow-up was carried out with clinical and echocardiographic examinations at each study site and, if this was not possible, through telephone interviews. Kaplan-Meier method was used for survival analysis.

**Results:** A total of 546 patients (December 2012-May 2017) from 15 national centers were included in the registry. Mean age was 74.6 years  $\pm$  7.8 years. Mean logistic EuroSCORE II and STS-PROM score were 3.3%  $\pm$  3.2% and 2.5%  $\pm$  1.9%, respectively. There were 244 patients (44.7%) in NYHA class 3 and 4. Thirty-eight patients (7%) underwent previous cardiac operations. Intraoperative variables are depicted in the Table. Thirty-day overall mortality occurred in 13 (2.4%). Acute myocardial infarction, major stroke, and life-threatening bleeding occurred in five (0.9%), four (0.7%), and 28 (5.1%) patients, respectively. Permanent pacemaker implantation was needed in 32 patients (5.9%). Mild and moderate paravalvular leaks at discharge were found in 28 (5.1%) and 10 (1.8%) patients, respectively. Median follow-up time was 12 months (IQR: 4-20 months). Survival at 3 years was 95%  $\pm$  1% (Figure 1A). At follow-up, 518 patients (94.9%) were in NYHA class 1 and 2. Figure 1B shows hemodynamic outcomes. Diabetes and preoperative dialysis were independently associated with mortality.

**Conclusions:** Rapid deployment aortic bioprostheses provide good early and mid-term clinical and hemodynamic outcomes. These devices may be considered as a reasonable alternative to conventional bioprostheses, especially in minimally invasive and combined operations.



Variables	N (%)
Prosthesis size (mm)	
19	77 (14,1)
21	188 (34,4)
23	166 (30,4)
25	87 (15,9)
27	28 (5,1)
Surgical access	
Full sternotomy	358 (65,6)
Mini sternotomy	169 (31,0)
Mini thoracotomy	19 (3,5)
Combined procedures	
CABG	129 (23,6)
Ascending aorta replacement	7 (1,3)
Mitral procedures	14 (2,6)
Other procedures	35 (6,4)
Prosthesis displacement	17 (3,1)
Conversion to full sternotomy	6 (1,1)
Device success	527 (96,5)
Cardiopulmonary bypass time	105 ± 43 min
Isolated AVR	93 ± 36,1 min
Combined procedures	128 ± 46 min
Aortic cross clamping time	76,8 ± 37,6 min
Isolated AVR	66,5 ± 26,8 min
Combined procedures	94,2 ± 35,1 min

P9

# Valve-in-Valve Transcatheter vs Redo Surgical Aortic Valve Replacement

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**COMMERCIAL RELATIONSHIPS** V. C. Babaliaros: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Edwards Lifesciences; C. Devireddy: Consultant/Advisory Board, Medtronic; R. Guyton: Research Grant, Edwards Lifesciences, Medtronic; B. G. Leshnower, Speakers Bureau/Honoraria, Medtronic; V. H. Thourani: Research Grant, Abbott Vascular, Boston Scientific, Edwards Lifesciences; Consultant/Advisory Board, Abbott Vascular, Boston Scientific, Edwards Lifesciences; W. L. Gore & Assoc

**Purpose:** Valve-in-valve transcatheter aortic valve replacement (ViV-TAVR) is emerging as a less invasive alternative to redo surgical aortic valve replacement (redo-SAVR) for patients with a degenerated aortic bioprosthesis. Previous comparisons have been limited by small sample size. The objective of this study was to evaluate the early outcomes of ViV-TAVR and redo-SAVR.

**Methods:** A retrospective review of 196 patients with prior SAVR who underwent ViV-TAVR (n=101) or isolated redo-SAVR (n=95) from September 2007 to March 2017 at a single US academic institution was performed. Those with active endocarditis or previous TAVR were excluded. Patient demographics, operative characteristics, and clinical and echocardiographic outcomes were reviewed. The primary endpoint was a risk-adjusted composite that included operative mortality, readmission, new-onset atrial fibrillation, new permanent pacemaker, acute renal failure, new requirement for dialysis, stroke, vascular complication, and major or life-threatening bleeding. Routine statistical analyses were performed.

**Results:** ViV-TAVR patients were older (mean age 73.8 years  $\pm$  13.8 years vs 64.0 years  $\pm$  14.6 years,  $P < .01$ ) and had a higher mean STS Predicted Risk of Mortality (STS PROM) score (8.9% vs 6.7%,  $P < .01$ ). The composite outcome occurred in 18.8% (n=19) of ViV-TAVR and 37.9% (n=36) of redo-SAVR patients ( $P < .002$ ). Additional outcomes are presented in the Table. All-cause 30-day mortality was 1.0% (n=1) for ViV-TAVR and 3.2% (n=3) for redo-SAVR ( $P = .32$ ). The mean gradient was higher following ViV-TAVR (median: 17.3 mm Hg vs 11.7 mm Hg,  $P < .01$ ). There was no difference in coronary obstruction (ViV-TAVR: 1% [n=1] vs redo-SAVR: 0,  $P = .62$ ) or moderate/severe paravalvular leak (4% [n=4] vs 1.3% [n=1],  $P = .2$ ). The ViV-TAVR group had fewer postoperative strokes (0% vs 7.4% [n=7],  $P < .04$ ), less new-onset atrial fibrillation (3.0% [n=3] vs 23.2% [n=22],  $P < .01$ ), shorter median ICU stay (32.0 hours vs 108.1 hours,  $P < .01$ ) and reduced median length of hospital stay (3.7 days vs 9.0 days,  $P < .01$ ).

**Conclusions:** Compared with redo-SAVR, patients who underwent ViV-TAVR had no significant difference in early mortality, but demonstrated lower morbidity and improved resource utilization. ViV-TAVR is a viable, less invasive alternative to redo-SAVR in appropriate patients with a degenerated aortic bioprosthesis.

**Table 1:** Early Outcomes of ViV-TAVR and Redo-SAVR

Outcome	ViV-TAVR (n=101)	Redo-SAVR (n=95)	p-value
STS PROM score (%), mean (std)	8.9 (6.4)	6.7 (7.4)	<0.01
All-cause 30-day mortality, n (%)	1 (1.0%)	3 (3.2%)	0.32
Stroke, n (%)	0 (0.0%)	7 (7.4%)	0.04
Myocardial infarction, n (%)	0 (0.0%)	1 (1.1%)	0.41
New-onset atrial fibrillation, n (%)	3 (3.0%)	22 (23.2%)	<0.01
New permanent pacemaker, n (%)	3 (3.0%)	8 (8.4%)	0.1
Intra-op and post-op blood transfusions, mean (std)	0.7 (2.1)	4.9 (4.1)	<0.01
ICU stay (hrs), median (IQR)	32.0 (69.6)	108.1 (141.0)	<0.01
Post-op hospital stay (days), median (IQR)	3.7 (4.1)	9.0 (6.6)	<0.01
Mean gradient aortic valve (mmHg), median (IQR)	17.3 (9.0)	11.7 (7.2)	<0.01
Moderate/severe aortic paravalvular leak, (%)	4 (4%)	1 (1.3%)	0.2

P10

# **Transcatheter Aortic Valve Replacement: A Comparison of Outcomes via Transfemoral, Transcarotid, and Transcaval Valve Delivery**

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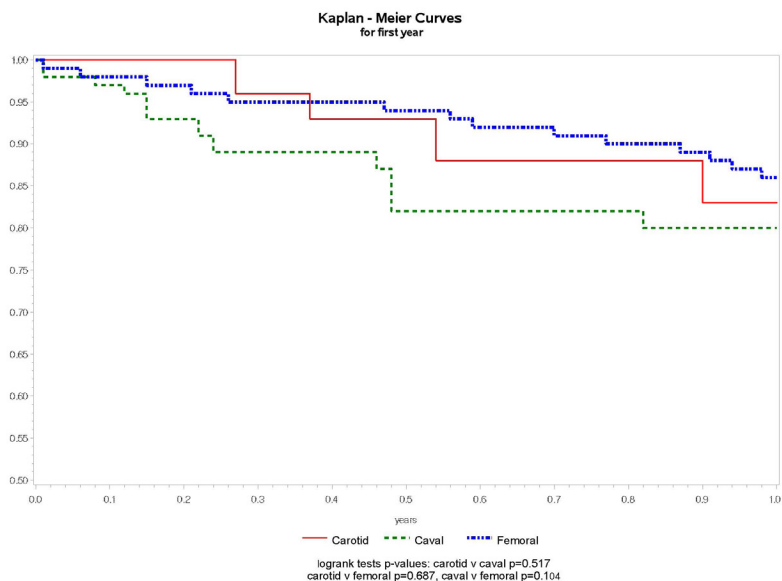
**COMMERCIAL RELATIONSHIPS** A. Greenbaum: Consultant/Advisory Board, Transmural Systems; Speakers Bureau/Honoraria, Edwards Lifesciences

**Purpose:** Outcomes for transcatheter aortic valve replacement (TAVR) using transaortic or transapical approaches are worse than those with transfemoral (TF) valve delivery. To avoid a transthoracic procedure, we have utilized transcarotid (TC) and transcaval (TCAV) approaches in patients unsuitable for TF. In this study, we review our recent experience with TF, TC, and TCAV approaches.

**Methods:** Between January 2015 and March 2017, 373 patients underwent TAVR via a TF approach at our institution. Thirty-two patients underwent TC TAVR, 25 via the right common carotid artery and seven via the left. All TC cases were done without shunting and without electroencephalography monitoring. In addition, TCAV delivery was used in 58 patients. Patient characteristics and outcomes were compared. In-hospital and 1-year survival were assessed.

**Results:** Preoperative demographics and postoperative outcomes were similar for all three groups with several exceptions (Table). TCAV patients had higher STS risk score than TF patients ( $8.0 \pm 5.2$  vs  $6.1 \pm 4.3$ ,  $P = .004$ ). Chronic obstructive pulmonary disease, cerebrovascular disease, and peripheral vascular disease were more common in both TC and TCAV patients than in TF patients. No patient undergoing TC access had a stroke. TCAV patients were transfused more often than TF patients (22.4% TCAV vs 6.4% TF,  $P = .006$ ). Median length of stay was 2 days for TF, 3 days for TC, and 4 days for TCAV (TF vs TC,  $P = .069$ ; TF vs TCAV,  $P = .001$ ). In-hospital and 30-day mortality, percent discharged home, and readmission at 30 days were all similar for the three groups. Unadjusted Kaplan-Meier survival at 1 year was 86% for TF, 83% for TC, and 80% for TCAV (TF vs TC,  $P = .687$ ; TF vs TCAV,  $P = .104$ ; TC vs TCAV,  $P = .517$ ).

**Conclusions:** Patients unsuitable for TF TAVR treated with TC or TCAV access had 30-day/in-hospital and 1-year survival similar to that of a contemporary cohort undergoing a TF approach. TAVR via alternative access that avoids surgical entry to the chest may offer intermediate-term outcomes equivalent to TF TAVR.



Variable	Transfemoral n=373	Transcarotid n=32	Transcaval n=58	p-value		
				TF v TC	TF v TCAV	TC v TCAV
Preoperative Characteristics						
STS Predicted Risk of Mortality	6.1 ± 4.3	6.9 ± 4.4	8.0 ± 5.2	0.281	<b>0.004</b>	0.337
Age, years (mean ± sd)	80.4 ± 9.2	79.0 ± 9.6	79.6 ± 9.6	0.323	0.449	0.798
Female Sex	168 (45.0)	16 (50.0)	32 (45.0)	0.589	0.650	0.638
BMI (mean ± sd)	29.2 ± 6.6	26.8 ± 6.9	25.6 ± 5.9	<b>0.028</b>	<b>0.001</b>	0.548
Hematocrit (mean ± sd)	35.8 ± 5.2	35.7 ± 6.7	34.5 ± 5.5	0.839	0.076	0.366
NYHA Class 3/4	334 (90.0)	26 (81.3)	54 (93.1)	0.123	0.632	0.157
COPD	102 (27.4)	20 (62.5)	25 (43.1)	<b>0.001</b>	<b>0.014</b>	0.078
Cerebrovascular Disease	79 (21.2)	13 (40.6)	25 (43.1)	<b>0.012</b>	<b>0.005</b>	0.802
Peripheral Vascular Disease	87 (23.3)	25 (78.1)	44 (75.9)	<b>0.001</b>	<b>0.001</b>	0.808
Renal Failure - Dialysis	14 (3.8)	2 (6.3)	3 (5.2)	0.368	0.714	1.000
Ejection Fraction (mean ± sd)	55.1 ± 13.9	56.2 ± 11.9	53.3 ± 15.5	0.825	0.741	0.686
Postoperative Outcomes						
In-hospital/30 day Mortality	8 (2.1)	0 (0.0)	2 (3.5)	1.000	0.631	0.537
RBC Transfusion	24 (6.4)	3 (9.4)	13 (22.4)	0.461	<b>0.006</b>	0.828
Stroke	9 (2.4)	0 (0.0)	1 (1.7)	1.000	1.000	1.000
Transient Ischemic Attack	0 (0.0)	0 (0.0)	0 (0.0)	1.000	1.000	1.000
Renal Failure	6 (1.6)	0 (0.0)	1 (1.7)	1.000	1.000	1.000
New Pacemaker	30 (8.0)	2 (6.3)	30 (8.0)	1.000	0.556	0.707
Length of Stay (median; range)	2 (0-43)	3 (2-20)	4 (1-15)	0.069	<b>0.001</b>	0.100
Discharge location home	320 (87.0)	25 (78.1)	50 (87.7)	0.164	0.873	0.233
Readmit 30 days	41 (11.2)	4 (14.3)	8 (14.8)	0.545	0.440	1.000

P11

### Frozen Elephant Trunk Reduced Stroke

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**Purpose:** Total aortic arch repair is challenging in older populations with multiple comorbidities. Neurologic deficits, such as stroke and paraplegia, particularly increase mortality and morbidity. We retrospectively analyzed our experience with aortic arch replacement using frozen elephant trunk vs conventional elephant trunk.

**Methods:** Between February 2007 and September 2016, 161 consecutive patients were involved in this study (frozen elephant trunk = 40, conventional elephant trunk = 121). The cases of chronic dissection were 60% in frozen elephant trunk and 22% in conventional elephant trunk ( $P < .001$ ). A propensity score-matching analysis was applied to adjust patients' baseline characteristics; 26 pairs were matched and analyzed.

**Results:** Stroke occurred in 0% of frozen elephant trunk patients and 22% of conventional elephant trunk patients,  $P = .0012$ . The propensity score-matching analysis revealed a lower stroke rate in frozen elephant trunk (0% vs 21% for frozen and conventional, respectively [ $P = .024$ ]). Paraplegia was significantly higher in frozen elephant trunk (13% vs 3.4%,  $P = .045$ ) overall; however, the difference between groups disappeared when compared with 26 matched pairs (10% vs 3.5%,  $P = .61$ ). Multivariate logistic regression analysis showed the frozen elephant trunk procedure was the only protective factor against stroke ( $P = .0005$ ). Freedom from aortic events was significantly lower in frozen elephant trunk patients overall in the 86-month follow-up period (log-rank 0.01); however, there was no significant difference when compared with matched pairs (log-rank 0.86).

**Conclusions:** Frozen elephant trunk reduced stroke rates both overall and in a propensity score-matched cohort. It also increased paraplegia rate, however, and should be applied with careful case selection.

P12

# Endoscopy in Aortic Valve Repair: A Helpful Tool?

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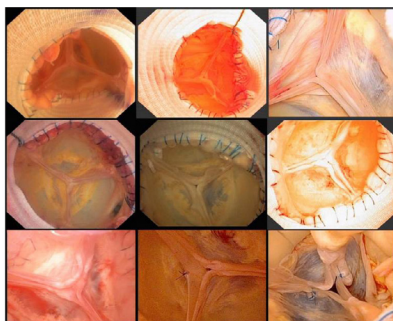
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**Purpose:** Aortic valve repair (AVR) is a technically challenging procedure. Usually, testing of the repaired valve is performed by transesophageal echocardiogram after weaning from cardiopulmonary bypass (CPB). We aimed to evaluate intraoperative and clinical outcomes of aortic valve repair patients in whom intraoperative aortic root endoscopy was applied.

**Methods:** The present study was a retrospective single-center study. An autoclavable videoscope was used to evaluate aortic valve geometry and competence in 66 cases (Figure). During endoscopy, crystalloid cardioplegia was administered to create an artificial blood pressure within the aortic root. Primary endpoints were: need for re-CPB after weaning from bypass and early postoperative aortic valve regurgitation. Secondary endpoints included: major adverse cardiac and cerebrovascular events, 30-day mortality, and freedom from aortic regurgitation during follow-up (follow-up was completed for all patients).

**Results:** A total of 66 consecutive patients who underwent aortic valve repair (including concomitant replacement of the ascending aorta) between September 2012 and March 2017 were evaluated. Patients' mean age was 53.5 years  $\pm$  4.5 years, and 74.2% were male. 73% of the patients were in NYHA functional class III/IV. The main underlying aortic valve pathology was aortic valve regurgitation in 83.3%, aortic valve stenosis in 9.1%, and a combination of both in 7.6% of the cases. A tricuspid or bicuspid aortic valve was observed in 48.5% and 43.9%, respectively, whereas 7.6% showed a functional unicuspid aortic valve. Intraoperative results revealed that according to intraoperative endoscopy, eight patients needed additional plication of the aortic valve before weaning from bypass. Thirty-day mortality was 3.0%, with one stroke within 30 days postoperatively. During follow-up (48 months  $\pm$  2.1 months), two patients required reoperation due to recurrent aortic valve regurgitation.

**Conclusions:** The present analysis showed that intraoperative aortic valve endoscopy is a helpful tool to evaluate the aortic valve after repair before weaning from bypass. This easy-to-use tool gives real-time information about the intraoperative result and might therefore provide additional guidance to achieve optimal results after aortic valve repair.



P13

# **Despite No Influence on Short-Term Mortality, Intensity of Glycemic Control Affects Long-Term Survival After Coronary Artery Bypass Grafting**

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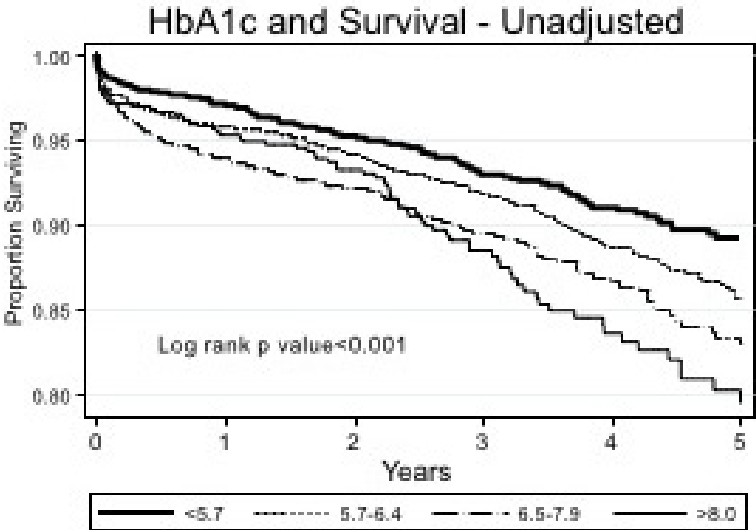
**COMMERCIAL RELATIONSHIPS** R. Quinn: Consultant/Advisory Board, CryoLife, LivaNova; M. P. Robich: Speakers Bureau/Honoraria, LivaNova

**Purpose:** A patient's HbA1c level, regardless of diabetic status, is a measure of glycemic control. Recent studies have found it to be an independent predictor of short-term mortality in patients undergoing coronary artery bypass grafting (CABG). In this study, we used HbA1c to assess to what extent differing levels are associated with long-term survival after CABG.

**Methods:** From a regional registry of consecutive cases, we identified a cohort of 6415 patients who underwent on-pump, isolated CABG from 2008 to 2015 who had a documented preoperative HbA1c level. We defined four HbA1c groups: <5.7 (n=1713); 5.7-6.4 (n=2505); 6.5-8.0 (n=1377); >8 (n=820). We then assessed their relationship to in-hospital outcomes and long-term survival. Outcome rates and hazard ratios (HR) were adjusted for patient and disease risk factors using multivariable logistic regression and Cox models.

**Results:** The study included 3740 patients (58%) who were not diagnosed as diabetic and 2674 diabetics. The majority of non-diabetics had HbA1c <6.5 (95%), and most diabetics had HbA1c ≥6.5 (76%). 52% (1933) of nondiabetics were prediabetic (5.7-6.4). Higher HbA1c values were associated with younger age, female gender, greater body mass index, more comorbid diseases, lower ejection fraction, more three-vessel coronary disease, and recent myocardial infarction (*P* trend for all < .05). After adjustment for patient risk, greater HbA1c values were not associated with higher rates of adverse in-hospital outcomes, including mortality, low output heart failure, cerebrovascular accident, return to OR for bleeding, or postoperative atrial fibrillation. Long-term survival was significantly worse as HbA1c increased (Figure). Compared to patients with a normal HbA1c <5.7, the adjusted HR was increased for each higher level: 5.7-6.4, adjHR=1.15 (95% CI 0.92-1.44, *P* = .229); 6.5-8.0, adjHR=1.41 (95% CI 1.10-1.81, *P* = .008); >8.0, adjHR=1.87 (95% CI 1.41-2.49, *P* < .001). Risk of death increased by 13% for every unit increase in HbA1c (adjHR=1.13, 95% CI 1.07-1.19, *P* < .001).

**Conclusions:** Glycemic control, as assessed by HbA1c, is predictive of long-term survival with higher levels associated with poorer prognosis. It remains to be determined if this risk can be modified by better glycemic control.



P14

# **Biological vs Mechanical Valve in Patients With Aortic Prosthesis-Patient Mismatch**

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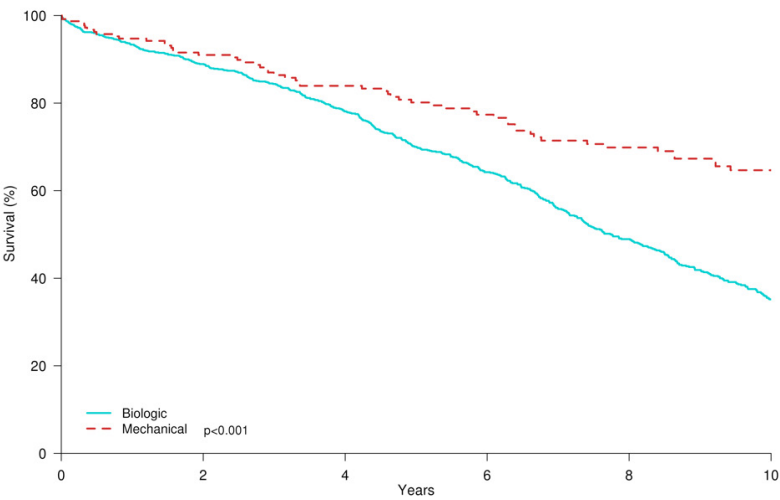
**COMMERCIAL RELATIONSHIPS** R. C. Daly: Ownership Interest, NeoChord

**Purpose:** The association between prosthesis type (biological vs mechanical) and prosthesis-patient mismatch (PPM), as well as the influence of prosthesis type on long-term survival in post-aortic valve replacement (AVR) patients with PPM, are unknown. We sought to evaluate the impact of prosthesis type on post-AVR PPM incidence, and whether prosthesis type affects survival in these patients.

**Methods:** From January 1993 to December 2016, a total of 4538 patients underwent isolated AVR at our institution. Medical records of 3345 (2280 biological and 1065 mechanical) consenting patients were retrospectively reviewed to determine the degree of post-AVR PPM. Severe PPM was defined as effective orifice area index (EOAI)  $<0.65 \text{ cm}^2/\text{m}^2$ , and moderate PPM was defined as EOAI of  $0.65\text{--}0.85 \text{ cm}^2/\text{m}^2$ . Overall median [IQR] follow-up was 9 [2.9, 16] years; 9.2 [3.2, 15.6] years for biological patients and 8 [1.7, 16.3] years for mechanical patients.

**Results:** Of the entire cohort, 42% of patients had moderate PPM (1411/3345 patients), while 3.7% (125/3345 patients) had severe PPM. The incidence of severe PPM was comparable between groups; 3.9% (88/2280) in biological vs 3.5% (37/1065) in mechanical patients,  $P = .67$ . However, the incidence of moderate PPM was significantly higher for patients in the biological cohort; 47% (1077/2280) vs 19.6% (209/1065),  $P < .001$ . Biological patients were older (76 years [70–81] vs 61 years [53–67],  $P < .001$ ), were more likely to be males (54% vs 44%,  $P = .005$ ), had a higher STS risk score (2.9 [1.9–4.7] vs 1.8 [1.2–2.9],  $P < .001$ ), and had a higher prevalence of coronary artery disease (37% vs 22%,  $P < .001$ ) and hypertension (74% vs 59%,  $P < .001$ ). Mechanical patients were more likely to have undergone previous cardiac surgery (33% vs 20%,  $P < .001$ ), including aortic valve surgery (21% vs 6%,  $P < .001$ ). As expected, overall survival was lower in bioprosthesis patients; 35% vs 65% at 10 years,  $P < .001$ . While univariable analysis suggested the use of a bioprosthesis to be associated with increased mortality (HR=2.12 [1.69, 2.65]), the effect was not significant in the multivariable model (HR=1.13 [0.85, 1.49]). Independent predictors of mortality in this analysis included older age, diabetes, chronic lung disease, renal failure, peripheral vascular disease, higher NYHA functional class, and a history of previous cardiac surgery.

**Conclusions:** In a contemporary clinical cohort of patients undergoing isolated AVR, severe PPM is uncommon regardless of the prosthesis type; however, moderate PPM is significantly more common in bioprosthesis patients. In patients with moderate or severe post-AVR PPM, the type of valve is not independently associated with mortality.



P15

# **Impact of Redo Sternotomy on Proximal Aortic Repair: Does Previous Aortic Repair Affect Outcomes?**

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**COMMERCIAL RELATIONSHIPS** A. L. Estrera: Consultant/Advisory Board, W. L. Gore & Assoc

**Purpose:** Proximal aortic repair (AoR) in the setting of previous sternotomy may be associated with higher risk than primary repair. Our objective was to determine if redo sternotomy increases risk of adverse outcomes following proximal aortic surgery.

**Methods:** We reviewed all proximal AoRs from 1991 to 2014. Outcomes were compared between first-time AoR (Group-1=1305) and redo AoRs, which were further classified into three categories: prior acute type A dissection (AAD) repair (Group-2=161); prior proximal aneurysm repair (Group-3=150); and previous cardiac/non-aortic sternotomy (Group-4=145). Data were analyzed by contingency tables and logistic regression.

**Results:** 456/1761 (25.9%) proximal AoRs had redo sternotomy. Aortic redos (Groups 2+3) had significantly more connective tissue disorders ( $P < .001$ ). On presentation, AAD was least common in aortic redos followed by cardiac redos (5% vs 28% vs 31%,  $P < .001$ ). At reoperation, 190 underwent ascending+hemiarch (26% Group-2, 47% Group-3, 53% Group-4), 140 total arch (58% Group-2, 17% Group-3, 15% Group-4), 113 elephant-trunk (47% Group-2, 15% Group-3, 10% Group-4), 159 AVR (35% Group-2, 45% Group-3, 25% Group-4), 100 aortic-root (32% Group-2, 23% Group-3, 10% Group-4). Except for pulmonary, redo sternotomy did not increase risk of postoperative complications (Table). Thirty-day mortality after redo sternotomy was 14% and was highest among cardiac redos (Table). On multivariable analysis, AAD on admission (17% vs 13%,  $P < .016$ ) significantly increased 30-day mortality-risk among redos. Over a median follow-up of 13 years, non-redos had significantly higher long-term survival (Figure 1a,  $P < .001$ ). Coronary artery disease (CAD) was a significant predictor of mortality ( $P < .001$ ). After adjustment for CAD, cardiac redos had highest long-term mortality risk (HR: 1.43,  $P < .004$ ). Previous AoR did not significantly add risk above redo sternotomy alone ( $P = .245$ ).

**Conclusions:** Redo sternotomy is associated with increased risk for short- and long-term mortality after proximal aortic repair. Despite need for extensive repair, previous proximal aortic (for aneurysm or AAD) repair did not add further risk above that attributable to redo sternotomy.

Figure 1a: Overall Survival After Proximal Aortic Repair by Redo Status

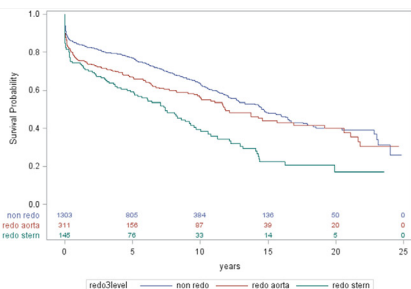
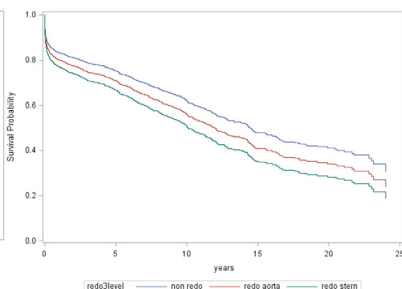


Figure 1b: Direct Adjusted Survival by Redo Status



### Perioperative Outcomes by Redo Status

Variable	Non-redo (Group 1; n=1305)	Redo: Prior AAD AoR (Group 2; n=161)	Redo: Prior Aneurysm AoR (Group 3; n=150)	Redo: Prior Cardiac (Group 4; n=145)	p-value
Stroke	77 (5.9%)	10 (6.2%)	6 (4.0%)	15 (10.3%)	0.123
Renal Failure	295 (22.6%)	41 (25.5%)	31 (20.7%)	40 (27.6%)	0.419
Pulmonary	323 (24.8%)	61 (37.9%)	34 (22.7%)	45 (31.0%)	0.002
Reop for bleeding	27 (2.1%)	3 (1.9%)	2 (1.3%)	5 (3.5%)	0.624
30-day death	119 (9%)	17 (11%)	21 (14%)	25 (17%)	0.008

P16

**Impact of Baseline Mitral Regurgitation on Postoperative Outcomes in Left Ventricular Assist Device Implantation as Destination Therapy Patients**

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**COMMERCIAL RELATIONSHIPS** D. Baran: Speakers Bureau/Honoraria, Maquet, Novartis, Otsuka; Consultant/Advisory Board, Maquet

**Purpose:** The present study aimed to investigate the impact of baseline mitral regurgitation (MR) on short- and long-term survival in patients who had left ventricular assist device (LVAD) as destination therapy at a single center.

**Methods:** Patients who underwent LVAD implantation as destination therapy at a single center were studied. Patients were classified into two groups based on baseline MR status: ( $\geq$  moderate MR,  $<$  moderate MR). Baseline clinical characteristics and post-LVAD implant adverse events were compared. Unadjusted mortality rates at 30 days, 1 year, and 2 years were analyzed. Cox proportional hazards model, Kaplan-Meier survival curves, and the log-rank test were used to identify the predictors of survival and calculate the differences in survival in both groups.

**Results:** Out of 91 patients studied, 62 (68%) had significant MR ( $\geq$  moderate MR) before LVAD implant.  $\geq$  moderate MR patients had a higher incidence of concomitant pulmonary disease (11% vs 0%,  $P = .001$ ) and  $\geq$  moderate tricuspid regurgitation (TR) (55% vs 23%,  $P = .004$ ) than  $<$  moderate MR patients. Other baseline clinical characteristics were similar in both groups. Post-LVAD adverse events did not differ between the two groups: overall complications ( $P = .489$ ); malfunction and thrombosis ( $P = .072$ ); major infection ( $P = .673$ ); and re-hospitalization ( $P = .267$ ). Mortality rates at 30 days, 1 year, and 2 years for both groups ( $\geq$  moderate MR vs  $<$  moderate MR) were (10% vs 0%;  $P = .028$ ), (37% vs 10%,  $P = .001$ ), and (48% vs 17%,  $P = .002$ ), respectively. On multivariable analysis, age, sex, major infection and  $\geq$  moderate MR at baseline were found to be independent predictors of overall all-cause mortality. Overall, survival was significantly lower in the  $\geq$  moderate MR group than the  $<$  moderate MR group (log-rank test:  $P = .029$ ).

**Conclusions:** A high incidence of significant MR exists in advanced heart failure patients undergoing LVAD implantation as destination therapy. Significant MR pre-implant is associated with worse post-implant survival at both short- and long-term follow-up.

P17

**The Impact of Preoperative Atrial Fibrillation on Patients Undergoing Surgical and Transcatheter Aortic Valve Replacement**

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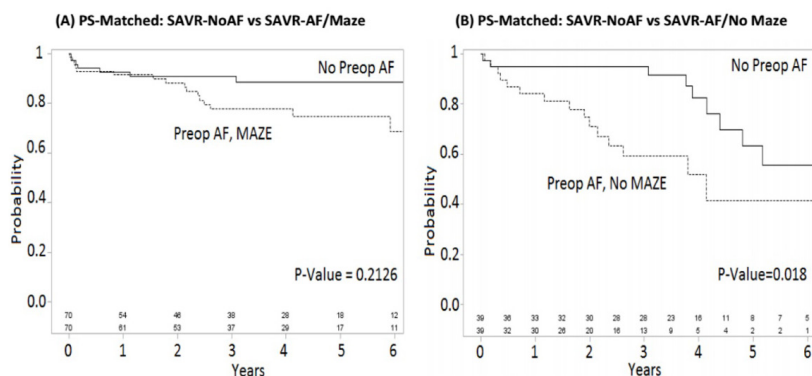
**COMMERCIAL RELATIONSHIPS** A. C. Andrei: Consultant/Advisory Board, AtriCure; J. L. Cox: Ownership Interest, Adagio Medical, AtriCure, ClearFlow, CorMatrix, Harpoon Medical, PAVmed, PotentiaMED; Consultant/Advisory Board, Adagio Medical, AtriCure, ClearFlow, CorMatrix, Harpoon Medical, PAVmed; C. J. Davidson: Research Grant, Edwards Lifesciences; S. C. Malaisrie: Research Grant, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Abbott, Edwards Lifesciences, Medtronic; P. M. McCarthy: Ownership Interest, Edwards Lifesciences; Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, Medtronic

**Purpose:** Preoperative atrial fibrillation (AF) is associated with increased mortality in cardiac surgery patients. Concomitant AF ablation during cardiac surgery has been associated with improved survival. We sought to evaluate the impact of AF and ablation in contemporaneous cohorts of patients undergoing surgical (SAVR) and transcatheter aortic valve replacement (TAVR).

**Methods:** Between June 2008 and June 2016, 756 consecutive patients underwent SAVR (n=154 [20%] with AF) or TAVR, 442 patients (n=203 [46%] with AF) at a single institution. Among the SAVR patients with AF, 96 (62%) received concomitant surgical AF ablation (SAVR-AF/Maze), while one of the TAVR patients with AF received late catheter AF ablation. In pairwise propensity score (PS) analyses, we compared SAVR-noAF, SAVR-AF/Maze, and SAVR-AF/noMaze patients, and separately TAVR-noAF and TAVR-AF groups. Mean follow-up in the SAVR-noAF, SAVR-AF/Maze, and SAVR-AF/noMaze groups was 3.2 years  $\pm$  2.1 years, 3.6 years  $\pm$  2.2 years, and 2.6 years  $\pm$  1.9 years; in the TAVR-noAF and TAVR-AF patients, it was 1.4 years  $\pm$  1.3 years and 1.1 years  $\pm$  1.2 years, respectively.

**Results:** In unmatched comparisons of SAVR patients, there were no significant differences in 30-day mortality (Table). The SAVR-AF/Maze patients had higher overall survival compared to SAVR-AF/no Maze ( $P = .019$ ), but the ablation group had lower overall survival compared to SAVR-noAF ( $P < .001$ ). Freedom from AF at last follow-up was progressively lower across the spectrum (SAVR-noAF 95%, SAVR-AF/Maze 68%, SAVR-AF/no Maze 52%,  $P < .001$ ). In PS-matched analyses, there were no significant differences between SAVR-noAF and SAVR-AF/Maze in 30-day (3% vs 3%,  $P = 1.00$ ) and mid-term mortality (log-rank  $P = .21$ , Figure 1A). In comparisons of SAVR-noAF to SAVR-AF/noMaze patients, there was similar 30-day (3% vs 3%,  $P = 1.00$ ), but worse mid-term mortality (log-rank  $P = .018$ , Figure 1B). In the TAVR group, patients with AF had higher 30-day mortality (5% vs 1%,  $P = .05$ ) and overall mortality (log-rank  $P = .004$ ) than patients without AF.

**Conclusions:** Preexisting AF is associated with worse overall survival after SAVR and TAVR. After adjusting for bias, concomitant AF ablation in patients undergoing SAVR appears to confer improved midterm survival, comparable to that of patients without preoperative AF.



**Table 1 - Baseline Characteristics and Mortality Outcomes by Preoperative Atrial Fibrillation and Treatment in the Unmatched Groups**

Variable	SAVR-NoAF (N=602)	SAVR-AF/Maze (N=96)	SAVR-AF/No Maze (N=58)	P-value
Age	66.1 ± 14.2	73.4 ± 9.5	77.7 ± 11.9	<.001
Gender (female), No. (%)	238 40%	34 35%	21 36%	0.68
Ejection Fraction	59.4 ± 10.3	56.5 ± 10.2	54.7 ± 14.1	<.001
Left Atrial Size	3.8 ± 0.7	4.2 ± 0.8	4.3 ± 0.8	<.001
NYHA Class, No. (%)				<.001
. Class I	223 38%	17 18%	8 14%	
. Class II	194 33%	34 37%	9 16%	
. Class III	146 25%	34 37%	34 59%	
. Class IV	29 5%	8 9%	7 12%	
30-Day Mortality, No. (%)	11 2%	2 2%	2 3%	0.7
All-Cause Long-Term Mortality, No. (%)	64 11%	22 23%	26 45%	<.001

P18

# **Outcomes of Papillary Muscle Realignment at the Time of Septal Myectomy for Treatment of Hypertrophic Obstructive Cardiomyopathy**

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**COMMERCIAL RELATIONSHIPS** M. J. Chirpich: Consultant/Advisory Board, MyoKardia; S. B. Heitner: Research Grant, MyoKardia; Consultant/Advisory Board, MyoKardia

**Purpose:** Hypertrophic obstructive cardiomyopathy (HOCM) is commonly associated with mitral valve (MV) abnormalities. We report our experience with a novel MV procedure, papillary muscle realignment (PMR), which we have used in combination with septal myectomy for the treatment of left ventricular outflow tract (LVOT) obstruction and mitral regurgitation in HOCM patients.

**Methods:** Our practice has evolved to perform PMR at the time of septal myectomy for HOCM patients who have MV leaflet elongation or papillary muscle displacement contributing to systolic anterior motion (SAM), mitral regurgitation (MR), and LVOT obstruction. This is usually accomplished with a single pledgeted suture attaching the papillary muscle heads together, which centralizes the mitral subvalvular apparatus within the left ventricular cavity away from the LVOT, thereby limiting SAM, MR, and LVOT obstruction. Patients undergoing combined septal myectomy and PMR at our institution over a 2-year period (June 2015-June 2017) were identified.

**Results:** Forty-four patients who underwent combined septal myectomy and PMR during the study period were identified. Demographic, pre-, and postoperative data were collected (Table). The patients were relatively young, with a mean age of 54 years, and were predominantly male. Severe symptoms were common with 64% of patients in NYHA Functional Class III or IV. The mean preoperative LVOT peak gradient was 138 mm Hg and was secondary to SAM-septal contact in all cases. Significant preoperative MR was common with 91% of patients presenting with moderate or severe MR. The mean length of stay was 6 days. There were no mortalities, and major complications were unusual. The mean LVOT peak gradient with pharmacologic stress (dobutamine infusion up to 40 mcg/kg/min) was reduced from 138 mm Hg preoperatively to 26 mm Hg postoperatively. Only one patient had significant residual SAM, and only three had moderate MR with pharmacologic stress following the combined procedure.

**Conclusions:** MV abnormalities commonly contribute to LVOT obstruction in HOCM. PMR is a simple, safe, and reproducible procedure that directly addresses the leaflet elongation and papillary muscle displacement commonly associated with HOCM. In combination with septal myectomy, PMR reliably eliminates SAM and MR and relieves LVOT obstruction in HOCM patients.

Demographics		LVOT Gradients	
N	44	Preop Peak Gradient (Mean, mm Hg)	138 (SD 49.4)
Age (Range)	18-78	Postop Peak Gradient (Mean, mm Hg)	26.6 (SD 13.9)
Mean Age	54	Change in Gradient Pre to Post (Mean, mm Hg)	111
Sex (male:female)	25:19	Preoperative Mitral Regurgitation	
NYHA		None	0
Class 1 (N,%)	3, 6.8%	Trace	0
Class 2 (N,%)	13, 29.6%	Mild	4
Class 3 (N,%)	23, 52.2%	Moderate	11
Class 4 (N,%)	5, 11.4%	Severe	29
Surgical Outcomes		Postoperative Mitral Regurgitation	
Mean LOS	6	None	2
Prolonged Mech Vent	1	Trace	22
Reintubation	1	Mild	17
Takeback for Bleeding	1	Moderate	3
Heart Block	2	Severe	0
VSD	0		
CVA	1		
Mortality	0		

P19

# **Reversibility of Pulmonary Vascular Remodeling and Prognostic Role in Outcome After Restrictive Mitral Annuloplasty in Patients With Preexisting Pulmonary Hypertension**

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**Purpose:** Pulmonary hypertension (PH) is known to have prognostic importance for heart failure patients, while its reversibility after restrictive mitral annuloplasty (RMA) is not well established. We assessed pulmonary hemodynamic changes over time following RMA and the impact of preoperative pulmonary vascular remodeling on late outcome in patients with preexisting PH.

**Methods:** We examined clinical outcomes of 64 patients (mean age 63 years  $\pm$  11 years) who underwent scheduled RMA for medically refractory functional mitral regurgitation secondary to advanced cardiomyopathy (ejection fraction  $\leq$ 40%) with preexisting secondary PH (mean pulmonary artery pressure [PAP]  $\geq$ 25 mm Hg). All underwent pre- and postoperative (1 month) cardiac catheterization to evaluate left ventricular function, pulmonary capillary wedge pressure (PCWP), mean PAP, pulmonary vascular resistance (PVR), systemic vascular resistance (SVR), and transpulmonary gradient calculated as mean PAP minus PCWP. Serial echocardiography was performed to evaluate estimated systolic PAP over time after surgery. All were followed for  $\geq$ 1 year after surgery (mean 54 months  $\pm$  27 months).

**Results:** After RMA, mean PAP was decreased, though remained abnormal ( $\geq$ 25 mm Hg) in 33 patients (51.6%, Table). PVR was modestly decreased in relation to cardiac output increase, whereas transpulmonary gradient and PVR/SVR ratio did not change and remained abnormal ( $>$ 12 mm Hg and  $>$ 0.15, respectively) in 20 (31.3%) and 27 (41.5%) patients, respectively (Table). Doppler-derived systolic PAP decreased early after surgery and increased thereafter (baseline, 1 month, 1, and 2 years; 52 mm Hg  $\pm$  13 mm Hg, 38 mm Hg  $\pm$  11 mm Hg, 39 mm Hg  $\pm$  12 mm Hg, 42 mm Hg  $\pm$  12 mm Hg, respectively;  $P < .001$ ), despite significant mitral regurgitation improvement over time. During follow-up, there were 16 late mortalities and 13 unscheduled heart failure readmissions. After adjusting for all preoperative covariates, elevated transpulmonary gradient ( $>$ 12 mm Hg) was independently associated with composite adverse events (adjusted hazards ratio 3.9, 95% confidential interval 1.5-10,  $P = .006$ ). Patients with a preoperative transpulmonary gradient  $>$ 12 mm Hg had substantially lower 5-year survival (60%  $\pm$  12% vs 88%  $\pm$  5%,  $P = .052$ ) and freedom from adverse events (20%  $\pm$  11% vs 70%  $\pm$  7%,  $P = .003$ ; Figure).

**Conclusions:** Following RMA, the reversibility of PH and vascular disease secondary to long-standing chronic LV failure might be limited. For optimal long-term outcome, surgical intervention should be indicated before pulmonary vascular disease becomes irreversible for patients with functional mitral regurgitation and preexisting PH.

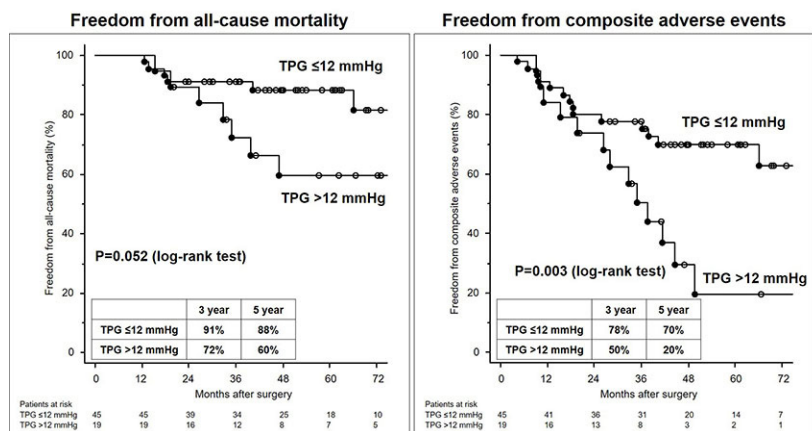


Table. Changes in LV function and pulmonary hemodynamic after RMA

Variables	Baseline	1 month	p value
Volume and function data			
	n=57	n=57	
LVESVI (ml/m <sup>2</sup> )	114±33	78±25	<0.001
LVEDVI (ml/m <sup>2</sup> )	149±36	114±29	<0.001
LVEF (%)	24±7	32±9	<0.001
Hemodynamic data			
	n=64	n=64	
LVEDP (mmHg)	22±6	14±6	<0.001
PCWP (mmHg)	24±7	15±6	<0.001
Mean PAP (mmHg)	35±10	26±8	<0.001
Right atrial pressure(mmHg)	8.6±4.0	8.3±3.2	0.628
Cardiac output (L/min)	4.1±0.8	4.5±1.1	<0.001
Trans-pulmonary gradient (mmHg)	11±5	11±5	0.530
PVR (dynes sec cm <sup>-5</sup> )	226±120	199±99	0.011
SVR (dynes sec cm <sup>-5</sup> )	1491±284	1360±371	0.006
PVR/SVR ratio	0.16±0.09	0.15±0.07	0.349

P20

**Bioprosthetic Valve Fracture to Facilitate Valve-in-Valve Transcatheter Aortic Valve Replacement in Small Surgical Bioprostheses: Early Hemodynamic and Echocardiographic Results**

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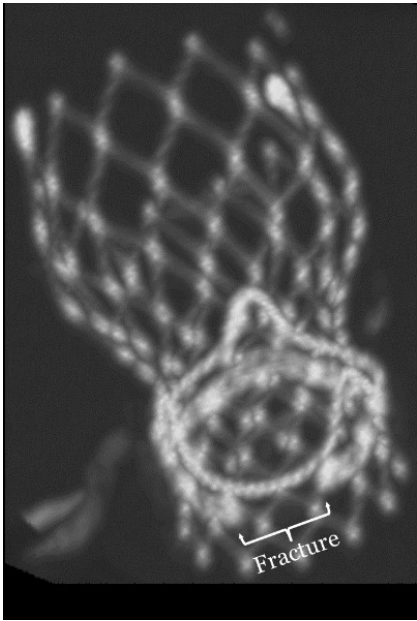
**COMMERCIAL RELATIONSHIPS** K. B. Allen: Research Grant, Abbott, Edwards Lifesciences, Medtronic, Zimmer Biomet; Consultant/Advisory Board, Zimmer Biomet; Speakers Bureau/Honoraria, Edwards Lifesciences; T. M. Beaver: Research Grant, Edwards Lifesciences; A. K. Chhatrivala: Other, Abbott Vascular, Edwards Lifesciences, Medtronic, Travel Reimbursement; D. J. Cohen: Research Grant, Boston Scientific, Edwards Lifesciences, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Edwards Lifesciences; P. Loyalka: Other, Abbott, Proctor for Amplatzer Devices; T. C. Nguyen: Consultant/Advisory Board, Edwards Lifesciences; Speakers Bureau/Honoraria, St. Jude Medical/Abbott; J. D. Rovin: Speakers Bureau/Honoraria, Abbott, Medtronic; B. K. Whisenant: Consultant/Advisory Board, Boston Scientific, Edwards Lifesciences, Johnson & Johnson; Speakers Bureau/Honoraria, Edwards Lifesciences

**Purpose:** Valve-in-valve transcatheter aortic valve replacement (VIV-TAVR) in small surgical bioprostheses often results in suboptimal hemodynamics and reduced 1-year survival. We evaluated the early hemodynamic and echocardiographic results of bioprosthetic valve fracture (BVF) using a high-pressure balloon inflation to facilitate VIV-TAVR.

**Methods:** From March 2016 through June 2017, BVF was performed in 30 consecutive patients undergoing VIV-TAVR at 10 US centers. Hemodynamic parameters and valve effective orifice area (EOA) at baseline, immediately after VIV-TAVR, and after BVF were analyzed, along with 1-month echocardiographic follow-up.

**Results:** Procedural success was 100% using both balloon-expandable (n=13) or self-expanding (n=17) transcatheter valves (Figure). Baseline prosthetic valve gradient was 42.8 mm Hg  $\pm$  14.4 mm Hg. BVF reduced the mean transvalvular gradient following VIV-TAVR from 20.4 mm Hg  $\pm$  8.1 mm Hg to 8.3 mm Hg  $\pm$  4.9 mm Hg ( $P < .001$ ) and increased the valve EOA from 1.1 cm<sup>2</sup>  $\pm$  0.7 cm<sup>2</sup> to 1.8 cm<sup>2</sup>  $\pm$  0.7 cm<sup>2</sup> ( $P < .001$ ). There were no aortic root disruptions or coronary occlusions, no new permanent pacemaker implants, and 30-day survival was 100%. Complications included one non-disabling stroke on postoperative day 2 and one patient with new moderate mitral regurgitation managed medically. Final paravalvular aortic insufficiency was either none (n=28) or trivial (n=2). In 10 patients who underwent VIV-TAVR followed by BVF, transthoracic echocardiograms at 1 month demonstrated normal leaflet function and a mean Doppler gradient of 12.1 mm Hg  $\pm$  5.1 mm Hg. In three patients who underwent BVF first, followed by VIV-TAVR, the mean valve gradient at 1 month was 21.3 mm Hg  $\pm$  4.9 mm Hg.

**Conclusions:** BVF to facilitate VIV-TAVR in small surgical valves results in reduced residual gradients, increased EOA, and encouraging short-term echocardiographic findings. Valve gradients were higher when BVF was done prior to, rather than following, VIV-TAVR. Continued evaluation of BVF safety and its effect on outcomes following VIV-TAVR is warranted.



P21

**Propensity Score-Matched Analysis of Coronary Artery Bypass Grafting versus Second Generation Drug-Eluting Stents for Triple-Vessel Disease***K. Nishigawa, A. A. Shimizu, T. N. Uchimuro, S. Takanashi**Sakakibara Heart Institute, Tokyo, Japan*

**Purpose:** Few previous studies have compared coronary artery bypass grafting (CABG) to percutaneous coronary intervention (PCI) with second generation drug-eluting stents (DES) for multivessel disease. This study aimed to compare the outcomes of CABG to that of PCI with second generation DES in patients with triple-vessel disease (TVD).

**Methods:** Between February 2010 and December 2015, 607 patients underwent primary isolated CABG and 264 patients underwent PCI with second generation DES (everolimus-, biolimus-, or zotarolimus-eluting stents) for TVD. Patients with acute myocardial infarction within the previous 2 weeks or previous coronary revascularization were excluded. Of these, we compared the CABG group to the second generation DES group in a propensity score matching analysis. Study endpoints were all-cause death, target vessel revascularization, and major adverse cardiac and cerebrovascular events (MACCE).

**Results:** As a result of propensity score matching, 238 pairs of patients were successfully matched (C-statistic, 0.762). The mean number of distal anastomoses in the CABG group was 4.7, and the mean number of implanted stents in the second generation DES group was 2.8. The 30-day mortality was similar between the groups (0.8% [2/238] vs 0.4% [1/238];  $P = .564$ ). The median follow-up period was 3.6 years (interquartile range, 2.1 to 5.3 years). Although freedom from all-cause death at 3 years was similar between the groups ( $93.2\% \pm 1.7\%$  vs  $93.5\% \pm 1.7\%$ ; log-rank,  $P = .909$ ), both freedom from target vessel revascularization ( $91.3\% \pm 1.9\%$  vs  $86.5\% \pm 2.3\%$ ; log-rank,  $P = .020$ ) and freedom from MACCE ( $82.8\% \pm 2.6\%$  vs  $67.2\% \pm 3.2\%$ ; log-rank,  $P < .001$ ) at 3 years were significantly higher in the CABG group than in the second generation DES group.

**Conclusions:** In this retrospective observational study, CABG was found to be superior to PCI with second generation DES for patients with TVD in terms of target vessel revascularization and MACCE.

## P22

### Impact of Frailty on Outcomes in Acute Type A Aortic Dissection

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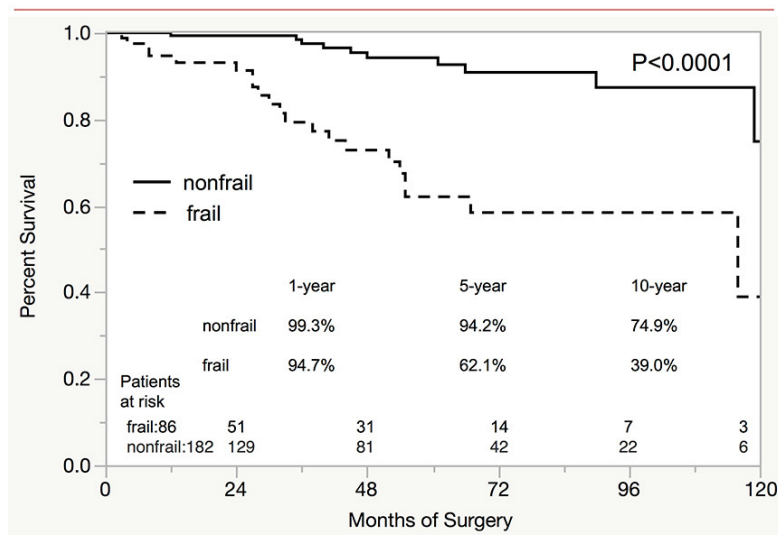
**Purpose:** Although frailty has been examined as a predictor of morbidity and mortality, its effect on acute type A aortic dissection outcomes has not been studied. The objective of the present study was to evaluate the role of frailty in predicting postoperative morbidity and mortality in patients undergoing operation.

**Methods:** A retrospective analysis of a prospectively maintained database was performed for all patients undergoing aortic operations at a single institution from May 2004 to March 2017. 312 patients were treated surgically. Frailty was evaluated using an index consisting of age >70 years, body mass index < 18.5 kg/m<sup>2</sup>, serum creatinine >1.2 mg/dl, anemia, history of stroke, hypoalbuminemia, and the psoas muscle area index. One point was given for each criterion met to determine a frailty score of 0 to 7. Frailty was defined as a score of ≥3. Risk models for hospital mortality and long-term survival were calculated using multivariable regression modeling.

**Results:** Of the 312 patients, 106 (34.1%) were defined as frail (frailty score ≥3). Thirty-six (34.0%) in the frail group and 11 (5.4%) in the non-frail group were octogenarians. In-hospital mortality of the frail vs non-frail patients were 10.4% and 8.3%, no difference respectively (P = .54). There was no statistical difference of the incidences of postoperative major morbidities, such as prolonged mechanical ventilation, new onset dialysis, and stroke between the two groups. Five-year survival rates in the frail and non-frail groups were 62.1% and 94.2%, significantly worse for the frail vs non-frail patients respectively (P < .0001). In the multivariable model, a frailty score of ≥3 and male gender were associated with late mortality.

**Conclusions:** Frailty, as defined using a seven-component frailty index, can serve as an independent predictor of late mortality risk in patients undergoing operation in acute type A aortic dissection. These frailty markers, all of which are easily assessed preoperatively, could provide valuable information for patient counseling and risk stratification before operation.

# Actuarial survival



## Independent predictors of late mortality among all patients

	Univariable			Multivariable		
	HR	95%CI	p value	HR	95%CI	P value
Frailty score $\geq 3$	5.1	2.5-10.9	0.005	5.3	2.2-13.6	0.0003
Gender:Male	2.2	1.1-4.7	0.03	3.2	1.5-7.2	0.003

P23

# **Cost Effectiveness of Self-Expandable Transcatheter Aortic Valve Replacement vs Surgery for Aortic Stenosis in the Intermediate Surgical Risk Population**

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**COMMERCIAL RELATIONSHIPS** H. C. Wijeyesundera: Research Grant, Edwards Lifesciences, Medtronic

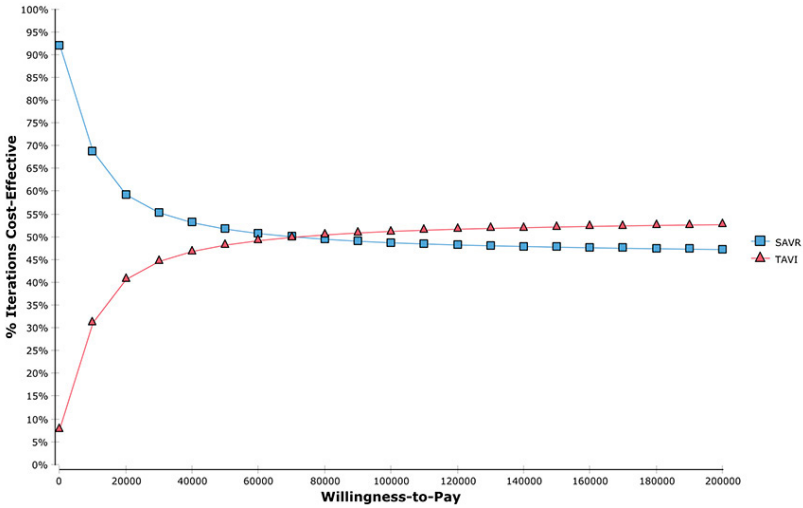
**Purpose:** The recently published Surgical Replacement and Transcatheter Aortic Valve Implantation (SURTAVI) Trial showed that self-expandable transcatheter aortic valve replacement (TAVR) was non-inferior to surgical aortic valve replacement (SAVR). However, the cost effectiveness of self-expandable TAVI vs SAVR in the intermediate surgical risk population (STS-PROM: 4%-8%) remains unknown.

**Methods:** A cost-utility analysis from the Canadian health care system payer's perspective was undertaken comparing self-expandable TAVI (transfemoral or transthoracic) to SAVR. A fully probabilistic Markov model over the lifetime time horizon was constructed to estimate differences in costs (2016 Canadian dollars [CAD]) and effectiveness (as quality-adjusted life-years [QALYs]), discounted at 1.5% per annum. Incremental cost effectiveness ratios (ICERs) were calculated. Efficacy inputs were obtained from SURTAVI and costs were primarily obtained from the Canadian Institute of Health Information. A probabilistic sensitivity analysis (PSA) and one-way deterministic sensitivity analyses (DSA) were conducted around cost and efficacy point estimates to address uncertainty.

**Results:** In the base case analysis, with discounting, the total lifetime cost in the TAVI and SAVR arms were \$38,941 ± \$5013 and \$25,907 ± \$8194 respectively, while total effectiveness was 6.14 QALYs ± 1.61 QALYs and 5.95 QALYs ± 1.62 QALYs, respectively. This yielded an incremental cost of \$13,035 and incremental effectiveness of 0.19 QALYs when TAVI was compared to SAVR. The ICER was, therefore, \$68,607/QALY. In the PSA, 51.4% and 54.3% of ICERs were below willingness-to-pay thresholds of \$50,000 and \$100,000 respectively (Figure). In a series of one-way DSAs, costs varied by ± 50%, and the ICER was largely influenced by the cost of the TAVI valve (range: \$11,173-\$127,446/QALY) and the total hospital length of stay for TAVI (\$54,952-\$83,667/QALY) and SAVR (\$44,963-\$93,655). When the cost of TAVI valve system was priced at \$18,346 (base case \$22,000 CAD), TAVI was found to be cost effective at a WTP threshold of \$50,000/QALY.

**Conclusions:** TAVI was found to be cost effective at a WTP threshold of \$100,000/QALY. If the cost of the TAVI valve system was lowered to \$18,000, TAVI would be cost effective at a WTP threshold of \$50,000/QALY. There remains much uncertainty surrounding the base-case ICER, reflecting the non-inferiority nature of the data.

CE Acceptability Curve



P24

# **Off-Pump Coronary Artery Bypass in Octogenarians: Results of a Statewide, Matched Comparison**

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**COMMERCIAL RELATIONSHIPS** J. V. Conte: Research Grant, Medtronic; Consultant/Advisory Board, Medtronic; B. S. Taylor: Nonremunerative Position of Influence, Medtronic

**Purpose:** An off-pump approach to coronary artery bypass grafting (OPCAB) surgery may have advantages in the elderly. Although proven safe, it remains unclear whether OPCAB provides a short-term survival benefit in octogenarians. We sought to compare outcomes using propensity matching between OPCAB and conventional surgery in a statewide database.

**Methods:** We identified all octogenarians (≥80 years) who underwent isolated coronary artery bypass grafting (CABG) at 10 different centers in the state of Maryland from July 2011 to June 2016. We separated patients into two groups: OPCAB and on-pump coronary artery bypass (ONCAB). Patients were then assigned propensity scores using a semi-parsimonious logistic regression model with 36 variables and matched 1:1 by the nearest-neighbor principle. Standardized STS Adult Cardiac Surgery Database definitions were used for this study. Completeness of revascularization was assessed as the ratio of number of distal grafts completed to number of diseased coronaries (≥50% stenosis).

**Results:** In total, 926 octogenarians had isolated CABG (8.2% of all CABG): 798 (86%) underwent ONCAB and 128 (14%) underwent OPCAB. Propensity matching yielded 128 well-matched pairs (all absolute standardized difference of means <17%). Operative mortality was similar for propensity-matched groups (OPCAB 5.5% vs ONCAB 3.1%,  $P = .36$ ). Incidence of postoperative renal failure, prolonged ventilation, stroke, median ICU length of stay, prolonged hospital length of stay, ICU readmission, hospital readmission, and discharge location also were similar between groups. Further analysis revealed OPCAB patients had a lower revascularization ratio (0.92 vs 1.15,  $P < .01$ ), but shorter operative time (158 minutes vs 194 minutes,  $P < .01$ ), more frequent use of the left internal mammary artery (97% vs 89%,  $P = .01$ ), decreased transfusion rates (42% vs 90%,  $P < .01$ ), and higher nadir intraoperative hematocrit (27% vs 22%,  $P < .01$ ).

**Conclusions:** In comparing CABG outcomes among octogenarians across the state of Maryland, OPCAB and ONCAB had similar mortality and morbidity. However, OPCAB was associated with an inferior completeness of revascularization. Thus, our results demonstrate no significant benefit of OPCAB over ONCAB in octogenarians, at least in the short-term.

P25

# **Safety and Rhythm Control Efficacy of En Bloc Isolation of the Left Pulmonary Veins and Appendage in Port Access Thoracoscopic Surgery for Standalone Atrial Fibrillation**

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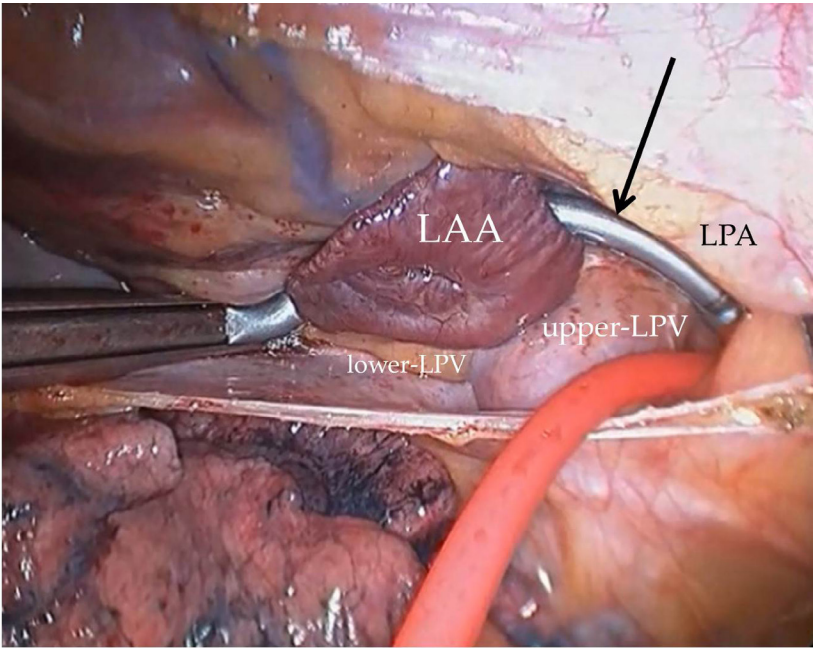
**COMMERCIAL RELATIONSHIPS** T. Ohtsuka: Consultant/Advisory Board, AtriCure; Speakers Bureau/Honoraria, AtriCure, Century Medical

**Purpose:** To evaluate safety and rhythm control efficacy of en bloc left pulmonary veins and appendage isolation technique developed in port access thoracoscopic surgery for standalone atrial fibrillation.

**Methods:** Our previous off-pump port access thoracoscopic procedure (bilateral pulmonary vein and superior vena cava isolations and a box lesion using bipolar radiofrequency epicardial ablation devices [clamp and pen] and appendage amputation) developed into a new version in which the left pulmonary veins and appendage were isolated together by placing the clamp isolator alongside the medial base of the appendage (Figure). The procedural safety was evaluated by reviewing the surgical records. The 1-year rhythm control results from Holter electrocardiography were compared with the corresponding data from the previous method routinely conducted between October 2008 and May 2014.

**Results:** Starting in May 2014, the new technique was applied to 238 consecutive patients and successfully performed in all but 23 (10%): 17 had the left atrium greater than 55 mm, five had small appendages over which the clamp slipped, and one patient could not tolerate the technique; they instead received the previous technique. The mean operating time was 81 minutes  $\pm$  9 minutes. None died or suffered procedure-related complications, including appendage damage or ischemic events. The new-technique group statistically matched the previous-technique group (324 patients), except the new technique treated more patients who had experienced catheter ablations (Table). At 1-year follow-up for sinus rhythm maintenance, there was no statistic difference between two groups in paroxysmal (94% vs 92%,  $P = .12$ ) and persistent (80% vs 77%,  $P = .10$ ) cases, but the new technique was better in long-standing cases (71% vs 64%,  $P = .04$ ).

**Conclusions:** In port access thoracoscopic surgery for standalone atrial fibrillation, en bloc isolation of the left pulmonary veins and appendage is achievable in most cases; it is safe and may provide better rhythm control efficacy in long-standing atrial fibrillation than isolating the left pulmonary vein alone.



Thoracoscopic view of en bloc LPVs and LAA Isolation:  
LAA = left atrial appendage; LPV, A = left pulmonary vein, artery; ↓ = Clamp Isolator

PATIENTS CHARACTERISTICS  
(En bloc vs previous Technique)

	En bloc technique (2014.05 - 2017.05)	Previous technique (- 2014.05)	p value
Patients, No. (Men, %)	238 (55)	324 (52)	.33
Age, mean (SD), [range] y	67 (9), [24-86]	68 (8), [38-84]	.21
Clinical data about atrial fibrillation			
Left atrial size on UCG, mean (SD), mm	47 (5)	46 (6)	.10
Duration, mean (SD), [range] y	4.8 (1.2) [0-19]	4.5 (1.5) [0-20]	.29
Previous Catheter Ablation, No. (%)	30 (13)	27 (8)	.04
Type			
Paroxysmal	87 (37)	130 (40)	.21
Persistent	53 (22)	77 (24)	.22
Long-standing	98 (41)	117 (36)	.10

P26

### Wall Stress of Early Remodeled Pulmonary Autograft

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**COMMERCIAL RELATIONSHIPS** L. Ge: Ownership Interest, Revalve Med; F. P. Mongeon: Research Grant, Bracco, Siemens; E. E. Tseng: Ownership Interest, Revalve Med; Research Grant, National Institutes of Health, Veterans Administration, Canadian Health Institutes; Other, *Journal of Heart Valve Disease* Editor-in-Chief

**Purpose:** The Ross procedure is particularly appealing for children and young adults who need aortic valve replacement due to excellent survival and ability to grow. However, autograft remodeling can lead to aneurysmal formation, and the biomechanics of dilatation is unknown. This study investigated patient-specific stress distributions on autografts at 1 year postoperatively.

**Methods:** Patients who underwent the Ross procedure (n=15) were consented for the study. Intraoperative pulmonary root tissues were collected for research when available. Cine magnetic resonance imaging was performed at 1 year postoperatively, and lumen geometry of autografts and aorta were reconstructed based on MRI images. Material properties and wall thickness of autografts and aorta measured from biaxial stretching were incorporated when available and averaged material property and thickness were used for remaining. The multiplicative approach was used to account for pre-stress from in vivo imaging.

**Results:** At systemic systole, peak stresses along the circumferential direction were 1172 kPa  $\pm$  387 kPa, 1364 kPa  $\pm$  546 kPa, 1075 kPa  $\pm$  414 kPa, and 370 kPa  $\pm$  186 kPa at the ascending aorta, sinotubular junction, sinuses, and annulus, respectively (Figure). Along the longitudinal direction, peak stresses were 790 kPa  $\pm$  688 kPa, 741 kPa  $\pm$  277 kPa, 708 kPa  $\pm$  257 kPa, and 536 kPa  $\pm$  252 kPa at the ascending aorta, sinotubular junction, sinuses, and annulus, respectively. Mean autograft diameter was 35.8 mm  $\pm$  1.7 mm, 37.9 mm  $\pm$  3.2 mm, and 35.3 mm  $\pm$  2.25 mm at the sinotubular junction, sinuses, and annulus, respectively.

**Conclusions:** Peak circumferential stresses were mainly located at the sinotubular junction, which may be prone to autograft dilatation. Using patient-specific simulations, risk of autograft dilatation may be predicted in the future after incorporating behavior from longer-term follow-up Ross patients.

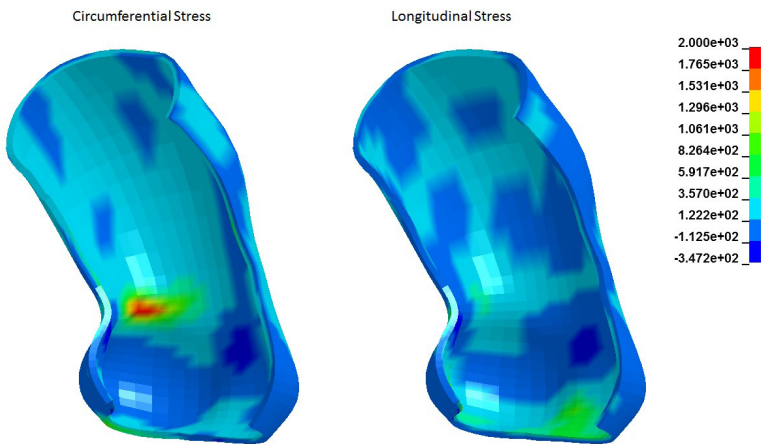


Figure 1. Typical stress distribution along the circumferential and longitudinal direction of ascending aorta and pulmonary autograft.

P27

# **Are Internal Mammary Artery Grafts Beneficial in Emergent Coronary Artery Bypass Surgery? An STS National Database Analysis**

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*University of Louisville, KY*

**Purpose:** Often, only saphenous vein grafts (SVGs) are used in emergent coronary artery bypass grafting (CABG) to provide quicker myocardial revascularization, despite its lower long-term patency relative to internal mammary artery (IMA) grafts. We examined differences between IMA and non-IMA graft recipients in emergent CABGs and its impact on in-hospital outcomes.

**Methods:** Retrospective review of the STS National Database was done to identify patients age  $\geq 18$  years undergoing primary emergent isolated CABG between 2013 and 2016. Emergent salvage, non-left anterior descending disease, subclavian stenosis, and revascularization with other arterial grafts were excluded. The study population was divided in two groups: IMA and non-IMA. Demographics, preoperative, and intraoperative factors were analyzed to assess differences between the groups. Univariate statistical methods; non-parametric test (Kruskal-Wallis) and chi-square estimates were used to analyze the data using SAS 9.4 statistical software at 95% confidence level.

**Results:** There were 18,280 emergent CABG patients during the study period, of whom 16,281 had IMA used and 1999 had only vein grafts. The IMA group was younger, more likely to be male, and had lower creatinine and higher ejection fraction compared to the non-IMA group. Table 1A describes the differences between the study groups. To account for differences in demographics and preoperative risk factors between the non-IMA and IMA groups, a propensity matching was performed with a ratio of 1:2. The propensity matching resulted in a well-matched cohort (Table 1B). After propensity matching, the in-hospital and 30-day mortality was significantly higher in the non-IMA group (15% vs 7%,  $P < .0001$ ). The non-IMA groups also had higher rates of bleeding (5% vs 3%,  $P < .01$ ), renal failure (10% vs 6%,  $P < .0001$ ), and prolonged ventilation (44% vs 30%,  $P < .0001$ ) (Table 2).

**Conclusions:** IMA grafts in primary isolated emergent CABGs are associated with significantly lower rates of in-hospital mortality. There may be clinical benefit in using IMA grafts, rather than SVGs only, for emergent CABGs, despite the time required for harvest.

Table 1A. Demographic and Clinical Factors between IMA and non-IMA groups (Unmatched)			
Variable	IMA group (16281)	No-IMA group (1999)	p-value
Age	64.3+/-11.0	66.6+/-12.0	<0.0001
Gender (male)	73% (11812)	60% (1196)	<0.0001
Body Mass Index	29.4+/-5.8	29.0+/-6.2	<0.0001
Hypertension	81% (13158)	81% (1622)	0.7
Diabetes	38% (6117)	36% (725)	0.2
Creatinine	1.15+/-1.0	1.29+/-1.2	<0.0001
Chronic Lung Disease>= moderate	6% (947)	9% (157)	0.0004
Cardiogenic Shock	12% (1900)	21% (421)	<0.0001
Pre-operative IABP	51% (8348)	56% (1122)	<0.0001
Ejection fraction	45.9+/-14.2	43.2+/-15.9	<0.0001
Cross clamp time	65.1+/-27.9	56.2+/-29.1	<0.0001

Table 1B. Demographic and Clinical Factors between IMA and non-IMA group (Propensity matched)			
Variable	IMA group (3466)	No-IMA group (1737)	p-value
Age	66.7+/-10.8	66.7+/-10.8	0.4
Gender (male)	58% (2024)	59% (1025)	0.6
Body Mass Index	29.1+/-5.9	29.1+/-6.1	0.7
Hypertension	83% (2884)	82% (1416)	0.1
Diabetes	37% (1289)	37% (637)	0.7
Creatinine	1.0 (0.8-1.2)	1.0 (0.8-1.2)	0.01
Chronic Lung Disease>= moderate	9% (306)	9% (154)	0.9
Cardiogenic Shock	18% (639)	19% (329)	0.6
Pre-operative IABP	45% (1549)	44% (769)	0.7
Ejection fraction	45.4+/-14.4	43.3+/-15.9	<0.0001
Cross clamp time	63.7+/-27.6	60.3+/-28.8	<0.0001

**Table 2**

Variable	IMA group	Non-IMA group	p-value
ICU hours	69 (42-120)	86 (48-168)	<0.0001
Post-op Blood use	53% (1822)	65% (1125)	<0.0001
POLOS	7 (5-10)	7 (5-12)	0.0001
Mortality-discharge	7% (258)	15% (251)	<0.0001
Reoperation	3% (108)	5% (79)	0.01
Bleeding			
Stroke	3% (119)	3% (54)	0.5
Prolonged Vent	30% (1054)	44% (767)	<0.0001
Renal Failure	6% (193)	10% (173)	<0.0001
Renal Failure dialysis	4% (132)	7% (121)	<0.0001
Discharge Location			
Home	67% (2156)	61% (905)	<0.0001

P28

# **Episode Payments of Transcatheter Aortic Valve Replacement vs Surgical Aortic Valve Replacement and Relationship to Case Volume**

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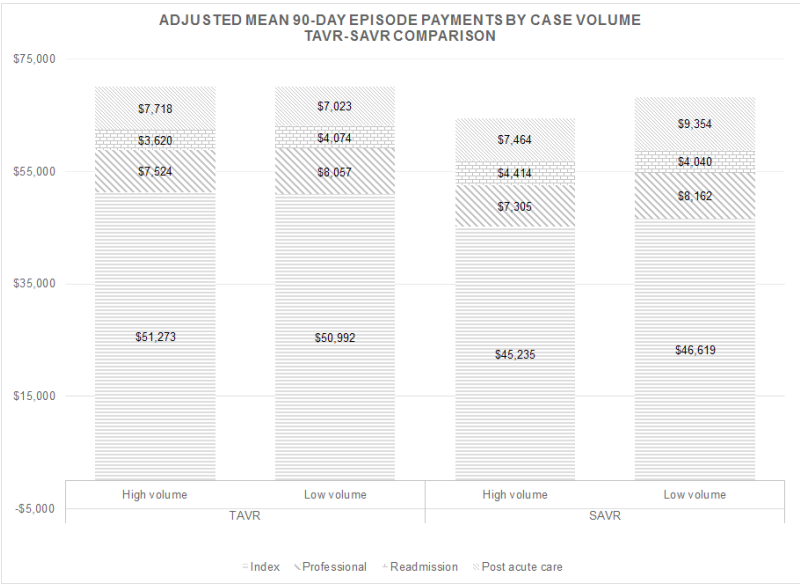
**COMMERCIAL RELATIONSHIPS** J. M. Dupree: Ownership Interest, Lipocine; Research Grant, BCBSM; D. S. Likosky: Research Grant, Agency for Healthcare Research and Quality, National Institutes of Health; Consultant/Advisory Board, American Society of ExtraCorporeal Technology; H. J. Patel: Consultant/Advisory Board, Terumo, W. L. Gore & Assoc; F. L. Shannon: Consultant/Advisory Board, Boston Scientific, Medtronic; Speakers Bureau/Honoraria, Abbott, Edwards Lifesciences; J. D. Syrjamaki: Research Grant, BCBSM

**Purpose:** Transcatheter aortic valve replacement (TAVR) has increased in volume nationwide as an alternative to surgical aortic valve replacement (SAVR). Because most work to date has focused on clinical outcomes, less is known concerning differences in episode payments—data that will be key to the value proposition for payers.

**Methods:** We evaluated 5220 Blue Cross Blue Shield of Michigan PPO and Medicare fee-for-service beneficiaries undergoing TAVR (15 hospitals, n=1180) or SAVR (33 hospitals, n=4040) in Michigan between 2012 and 2016. Data from two statewide quality collaboratives focusing on cardiothoracic surgery and payments (index, professional, readmission, post-acute care) were linked. Total and component payments between TAVR and SAVR were risk-adjusted using a two-step regression model (adjusting for case mix and payments 6 months prior to index procedure). Centers were divided into terciles of procedural volume separately for TAVR and SAVR, and payments were compared between lowest and highest terciles.

**Results:** Ninety-day episode payments ( $\pm$  standard deviation) were higher for TAVR than SAVR (\$70,764  $\pm$  \$23,443 vs \$66,622  $\pm$  \$27,301,  $P < .0001$ ), while mean hospital length of stay (LOS) was shorter for TAVR (6.7 days  $\pm$  6.0 days vs 10.2 days  $\pm$  7.5 days,  $P < .0001$ ). Index payments were \$5546 higher for TAVR ( $P < .0001$ ), while readmission payments were \$1086 lower ( $P = .006$ ), and professional and post-acute care payments were similar between TAVR and SAVR (Table). For SAVR, high-volume hospitals had significantly lower episode payments (difference: 4.3%, \$2783;  $P = .02$ ) and shorter index LOS (10.1 days  $\pm$  7.5 days vs 11.0 days  $\pm$  7.8 days,  $P = .01$ ) than low-volume centers. In contrast, we identified no significant volume-outcome relationships for TAVR (Figure).

**Conclusions:** Episode payments were higher for TAVR, despite significantly shorter LOS. Center case volume was not a large driver of payments among TAVR centers, while significant volume relationships existed for SAVR centers, favoring high-volume centers. These data will be increasingly important for payers and hospitals as they address value-based reimbursement.



**Table. Adjusted Mean 90-day Episode Payments by Valve Replacement Procedure Type**

Measure	Procedure Type		P-Value
	SAVR (n=4,040)	TAVR (n=1,180)	
<b>Index</b>			
Mean	\$45,859	\$51,405	<b>&lt; 0.0001</b>
SD	\$16,116	\$10,332	
<b>Professional</b>			
Mean	\$7,537	\$7,495	0.736
SD	\$3,085	\$4,035	
<b>Readmission</b>			
Mean	\$4,634	\$3,548	0.0055
SD	\$14,503	\$10,894	
<b>Post-Acute Care</b>			
Mean	\$8,014	\$7,497	0.1116
SD	\$9,792	\$9,900	
<b>90-day Episode</b>			
Mean	\$66,622	\$70,764	<b>&lt; 0.0001</b>
SD	\$27,301	\$23,443	
<b>Index Length of Stay (days)</b>			
Mean	10.24	6.68	<b>&lt; 0.0001</b>
SD	7.45	5.99	

*Note: Blue Cross/Shield of Michigan Payments are price-standardized to Medicare rates.*

P29

# **Characterization of Permanent Pacemaker Implantation Following Rapid Deployment Aortic Valve Replacement**

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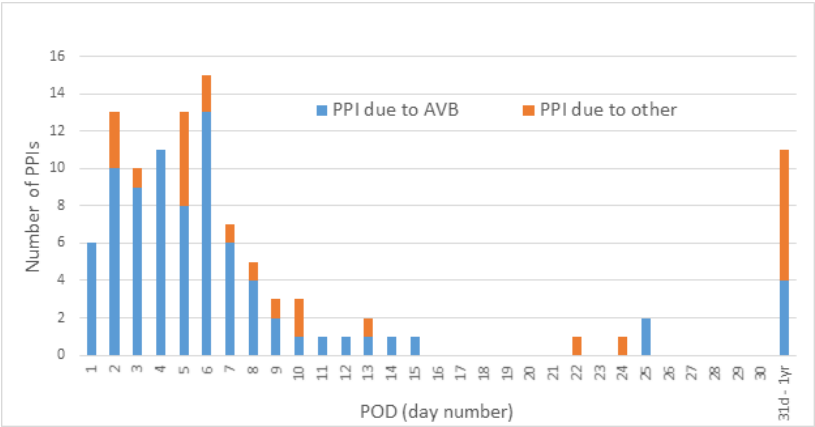
**COMMERCIAL RELATIONSHIPS** G. R. Barnhart: Consultant/Advisory Board, Edwards Lifesciences; W. R. Chitwood Jr: Consultant/Advisory Board, Edwards Lifesciences, NeoChord; Other, Scanlan; E. A. Grossi: Consultant/Advisory Board, Edwards Lifesciences, Medtronic; Speakers Bureau/Honoraria, Medtronic; Other, Edwards Lifesciences; H. J. Patel: Consultant/Advisory Board, Terumo, W. L. Gore & Assoc; F. N. Slachman: Speakers Bureau/Honoraria, CorMatrix; Edwards Lifesciences, Intuitive, Medtronic

**Purpose:** Expandable, rapid deployment aortic valves may interfere with the cardiac conduction system, which can lead to permanent pacemaker implantation (PPI). We sought to characterize short- and long-term PPI following rapid deployment aortic valve replacement (RDAVR) and investigate associated factors.

**Methods:** We analyzed 708 patients from 29 centers in the FDA investigational device trial undergoing RDAVR ± CABG without preexisting pacemakers. Intrinsic conduction status was recorded at baseline, and PPI incidence was evaluated at multiple time points through 1 year. PPI indications were categorized based on expert review of patient PPI source documents. Multivariate analysis was conducted to identify conditions and patient characteristics associated with PPI.

**Results:** Following RDAVR ± CABG, the PPI incidence through 30 days (PPI30) was 13.6%, with 10.9% due to atrioventricular block (AVB). In the 423/708 patients (59.7%) without baseline conduction abnormalities, the PPI30 incidence was 8.0%, with 5.0% for AVB. For PPIs inserted pre-discharge, the median time to PPI was 5 days; 22% were placed within 48 hours of aortic replacement. Independent predictors of PPI30 were baseline right bundle branch block (RBBB; odds ratio 7.35,  $P < .0001$ ), female (2.62,  $P = .004$ ), larger valve size (1.20,  $P = .016$ ), and AVB (1.80,  $P = .062$ ). Subset analysis revealed a greater than 2-fold difference in PPI30 among the largest enrolling centers. At 1 year, PPI incidence for all cause was 15.1% (107/708) and PPI for AVB was 11.4% (81/708).

**Conclusions:** Preexisting conduction defect had the greatest risk of PPI after RDAVR; significant center-level effect also was associated with PPI. This effect may reflect differences in practice patterns (drug management or timing to PPI). These findings provide deeper understanding of PPI after RDAVR and help guide clinical practice and patient management.



P30

# Acute Kidney Injury in Acute Type B Aortic Dissection: Incidence, Risk Factors, and Outcomes Over 20 Years

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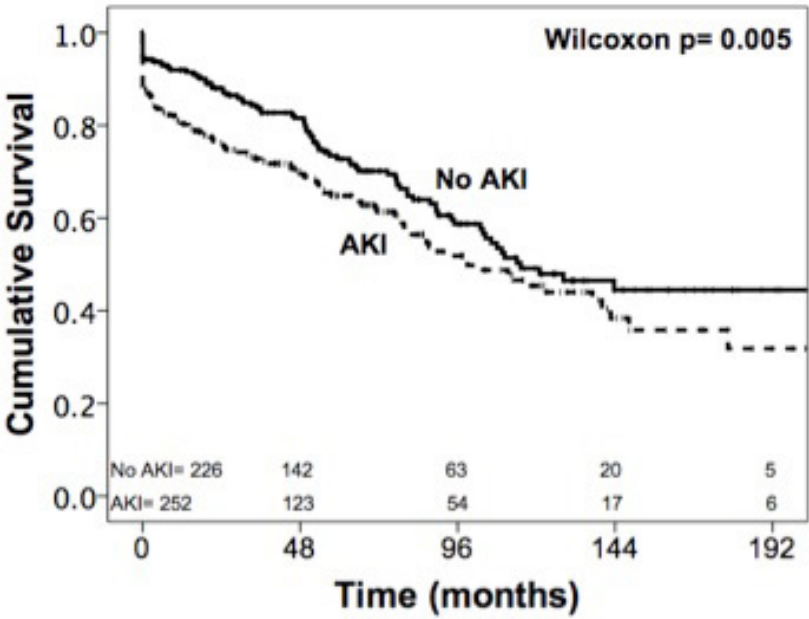
**COMMERCIAL RELATIONSHIPS** G. M. Deeb: Research Grant, Boston Scientific, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Medtronic, Terumo; H. J. Patel: Consultant/Advisory Board, Terumo, W. L. Gore & Assoc; D. M. Williams: Consultant/Advisory Board, Boston Scientific, W. L. Gore & Assoc

**Purpose:** Potential mechanisms contributing to acute kidney injury (AKI) after acute type B aortic dissection (ABAD) include renal malperfusion or underlying renal dysfunction from comorbidities. Despite its potential for adverse outcomes, AKI in ABAD is poorly characterized. We describe the incidence, risk factors, and early and late impact of AKI after ABAD.

**Methods:** 478 patients without prior dialysis requirement (mean age 62.1 years, 60.5% male) presented with ABAD (1995-2016). Comorbidities frequently seen included hypertension (79.1%), coronary artery disease (20.1%), peripheral vascular disease (5.0%), stroke (6.3%), diabetes (8.6%), and chronic kidney disease (CKD, 8.6%). Renal malperfusion was identified by catheterization with manometric measurements in 87 (18.2%). AKI was assessed by the KDIGO criteria.

**Results:** AKI was seen in 251 patients (52.7%; stage 1 = 130, stage 2 = 71, stage 3 = 51), and was associated with increased median hospital stay (11 days vs 7 days no AKI,  $P = .008$ ). Independent predictors of AKI included hypertension (OR 1.7), CKD (OR 4.0), and visceral (OR 2.1), renal (OR 3.46), or limb malperfusion (OR 2.2, all  $P < .05$ ). Early mortality was seen in 44 patients (9.2%) and was associated with AKI ( $P = .013$ ). Fifteen-year survival was 37.7% and independently predicted by age (OR 1.0), chronic obstructive pulmonary disease (OR 2.1), CKD (OR 3.3), and stages II (OR 1.9) and III AKI (OR 1.7, all  $P < .05$ , Figure). Fifteen-year freedom from aortic rupture, aortic redissection, or need for aortic reintervention was 30.1%. Independent predictors of late aortic events included hyperlipidemia (OR 1.5), diabetes (OR 0.4), and connective tissue disease (OR 2.2, all  $P < .03$ ), but not AKI ( $P = .57$ ).

**Conclusions:** AKI is common following ABAD and increases early mortality and hospital stay, as well as diminishes late survival. This impact on survival appears to occur independently of late aortic events and suggests the importance of other factors deserving of future study.



P31

# **Redo Surgical Aortic Valve Replacement vs TAV/SAV for Failed Surgical Aortic Prosthetic Valves**

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*<sup>1</sup>University of Michigan Health System, Ann Arbor, <sup>2</sup>University of Michigan, Ann Arbor*

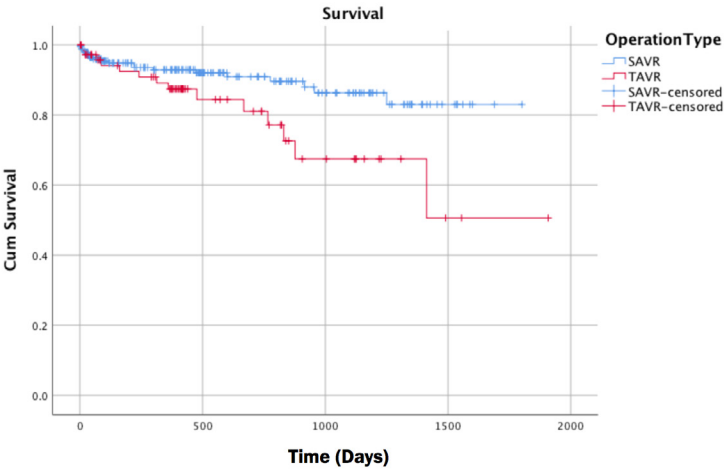
**COMMERCIAL RELATIONSHIPS** S. J. Chetcuti: Research Grant, Abbott, Edwards Lifesciences, W. L. Gore & Assoc, Medtronic; Consultant/Advisory Board, Medtronic; G. M. Deeb: Research Grant, Medtronic; Consultant/Advisory Board, Edwards Lifesciences, Terumo

**Purpose:** The Food and Drug Administration has approved transcatheter aortic valve-in-surgical aortic valve (TAV/SAV) in higher-risk redo aortic valve replacement (AVR) patients due to suboptimal results for redo surgical AVR (SAVR). TAV/SAV has been creeping into the lower-risk redo population. No randomized trial for exists for this topic; therefore, we compared TAV/SAV and redo SAVR to determine the appropriate use for the redo population.

**Methods:** We reviewed two contemporary cohorts of patients at one institution with failed prosthetic aortic valves between July 2011 and March 2016. Active endocarditis patients were excluded. There were 241 patients who underwent redo SAVR and 75 patients who received a TAV/SAV. Patients were compared using t-test for continuous variables and chi-squared test for categorical variables. Medium-term survival was estimated using a Kaplan-Meier curve.

**Results:** TAV/SAV patients were significantly older ( $P < .001$ ) and sicker (STS PROM,  $P < .001$ ). However, despite the greater trauma burden in the redo SAVR group, both redo SAVR and TAV/SAV patients had similar rates of 30-day mortality and stroke ( $P = .729$  and  $P = .449$ , respectively). The average follow-up time for postoperative echocardiography was 1.3 years. Kaplan-Meier curve shows superior medium-term survival in the redo SAVR population. Compared to TAV/SAV, the SAVR patients had significantly larger post-procedure aortic valve areas ( $P < .001$ ), significantly lower peak gradients ( $P < .001$ ), mean valvular gradient ( $P = .002$ ), and incidences of permanent pacemaker ( $P < .001$ ).

**Conclusions:** Redo SAVR in the lower-risk patient population has equivalent rates with TAV/SAV for 30-day mortality and stroke and excellent medium-term survival. Post-procedure hemodynamics were outstanding in redo SAVR. Excellent results for redo SAVR in the lower-risk patients is evidence for a randomized trial.



	Redo SAVR ( <u>n=241</u> )	Valve-in-valve TAVR (n=75)	P-value
Age (years)	59.2	70.4	< .001
Male (%)	172 (71%)	49 (65%)	.319
STS PROM	3.5	7.2	< .001
Length of stay (days)	10	4.4	< .001
Stroke	2.9%	1.4%	.449
30-day Mortality	2.5%	2.7%	.729
30-day Readmission	14%	8%	.19
Aortic Valve Area (cm <sup>2</sup> )	2.12	1.72	< .001
Mean Gradient	9.77	13.26	< .001
Peak Gradient	18.24	25.23	< .001
Patient Prosthesis Mismatch	23%	48%	< .001

P32

# **Novel Pulmonary-Systemic Pressure Ratio Correlates With Morbidity in Cardiac Valve Surgery More Than Pulmonary Arterial Pressure Alone**

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*<sup>1</sup>University of Virginia, Charlottesville, <sup>2</sup>University of Virginia Health System, Charlottesville, <sup>3</sup>University of Virginia Medical Center, Charlottesville*

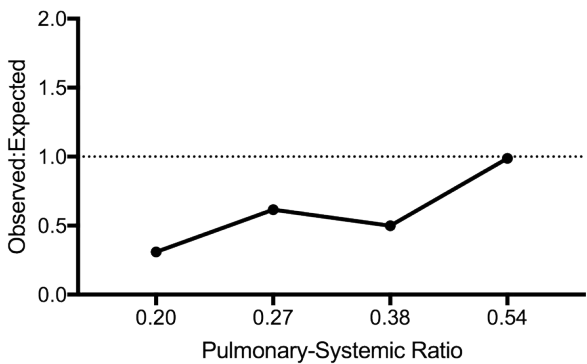
**COMMERCIAL RELATIONSHIPS** G. Ailawadi: Consultant/Advisory Board, Abbott, Cephea, Edwards Lifesciences, Medtronic

**Purpose:** Pulmonary hypertension portends worse outcomes in cardiac valve surgery; however, pulmonary pressures alone do not account for ventricular interdependence. We therefore used the novel pulmonary-systemic ratio (PSR) to better characterize cardiac function. We hypothesized that patients with a higher PSR undergoing valve surgery would have worse outcomes.

**Methods:** Patients undergoing valve surgery with or without coronary artery bypass grafting and with an STS predicted risk of morbidity or mortality (PROMM) score available were extracted from an institutional database (2004–2016). Clinical data were paired with right heart catheterization values obtained from a clinical data repository. The PSR was calculated as (mean pulmonary arterial pressure/mean systemic arterial pressure), and patients stratified by PSR quartile. Logistic regression modeling assessed the association between PSR and mean pulmonary artery pressure (mPAP) on morbidity and mortality after adjusting for PROMM and year.

**Results:** A total of 314 consecutive patients underwent valve surgery with a preoperative right heart catheterization. The median PSR was 0.33 (IQR 0.23–0.65), while the median mPAP was 29 mm Hg (21–30 mm Hg). With each increasing quartile of PSR, PROM (2.9%, 3.6%, 5.5%, 5.7%,  $P < .0001$ ) and PROMM (18.1%, 24.6%, 29.0%, 31.1%,  $P < .0001$ ) increased. Patients with the highest PSR also had the greatest combined morbidity and mortality (6.4%, 16.5%, 16.7%, 35.4%,  $P < .0001$ ). The observed to expected mortality for the entire cohort was 0.61. Overall mortality was 2.5%, compared to the STS PROM of 4.1%, and all deaths were in the highest PSR quartile. High PSR also was associated with longer duration in the intensive care unit ( $P < .0001$ ) and hospital ( $P < .0001$ ). Risk-adjusted morbidity or mortality was significantly greater in patients with a higher PSR (OR=23.88,  $P = .008$ , Wald 7.1) and was a much stronger predictor than increasing mPAP (OR=1.035,  $P = .011$ , Wald 6.5).

**Conclusions:** The pulmonary-systemic ratio independently predicts risk-adjusted morbidity and mortality in patients undergoing valve surgery and provided better predictive power compared to pulmonary artery pressure alone. By capturing ventricular interdependence, this metric may better characterize the overall risks associated with valve surgery.



**Figure:** The Pulmonary-Systemic Ratio (PSR) increases with the ratio of observed to expected STS Predicted Risk of Morbidity or Mortality, and an increasing PSR was a stronger predictor of risk-adjusted morbidity or mortality than increasing mean pulmonary arterial pressure.

P33

# **Clinical and Echocardiographic Outcomes in Aortic Valve Replacement for Mixed Aortic Valve Disease**

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**COMMERCIAL RELATIONSHIPS** L. Lozonschi: Ownership Interest, Abbott; Consultant/Advisory Board, Abbott

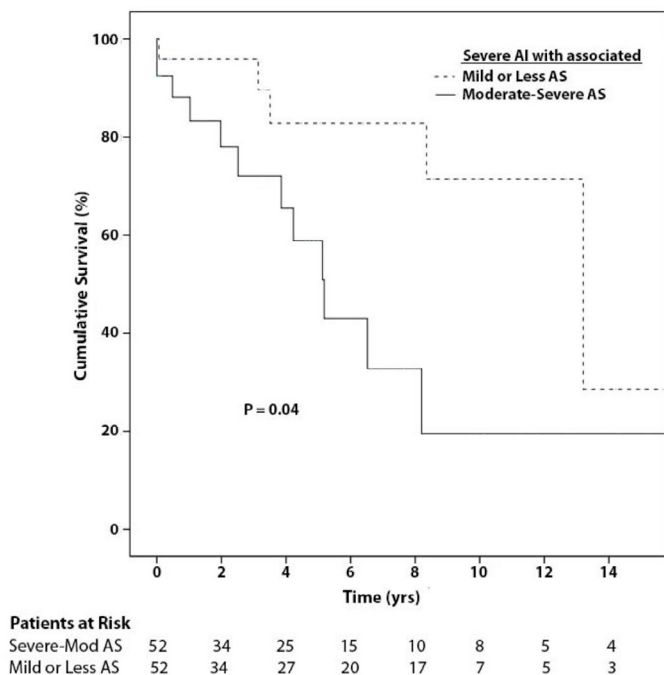
**Purpose:** Mixed aortic valve (AV) disease is associated with a poorer natural history compared with isolated stenotic or regurgitant lesions. However, the clinical and echocardiographic outcomes for aortic valve replacement (AVR) in mixed AV disease is less understood. This study aims to compare outcomes in mixed vs single AV lesions.

**Methods:** Retrospective review of AVRs (n=1011) from 2000 to 2016. AVR may occur with coronary bypass (n=857) or limited ascending aortic replacement (n=90). The severe or moderate predominant aortic stenosis (AS) group was stratified into group 1 (n=660) with concomitant aortic insufficiency (AI) that was mild or less and group 2 (n=197) with accompanying moderate or greater AI. Severe to moderate predominant AI group was stratified using the same schema for AS into groups 3 (n=143) and 4 (n=53). Echo follow-up was 3.0 years + 3.5 years and 4.3 years + 4.6 years, and survival follow-up was 4.0 years + 3.7 years and 5.2 years + 4.6 years, respectively, for AS and AI groups. Propensity matching for comorbidities was performed.

**Results:** For the predominant AS group (n=857) preoperatively, group 2 had a larger preoperative left ventricular (LV) end diastolic ( $52.2 \pm 9.5$  vs  $48.2 \pm 7.3$ ,  $P < .001$ ) and end systolic diameters ( $35.5 \pm 9.5$  vs  $31.6 \pm 8.2$ ,  $P < .001$ ), as well as a higher grade of right ventricular (RV) dysfunction ( $P = .02$ ) and lower LV ejection fraction ( $56.7\% \pm 13.5\%$  vs  $59.56\%$ ,  $P = .01$ ). No differences in LV dimensions or LV or RV function was evident at follow-up. Following propensity matching for age, operation, and comorbidities, there was no difference in mid-term survival. For the predominant AI group (n=196), after similar propensity matching, survival was lower for group 4 compared to group 3 (Figure). There were no differences in LV dimensions or LV or RV function preoperatively or on follow-up. Mean preop and follow-up AV gradients were: Group 1:  $45.7$  mm Hg  $\pm$   $15.9$  mm Hg vs  $17.2$  mm Hg  $\pm$   $16.5$  mm Hg; Group 2:  $46.9$  mm Hg  $\pm$   $17.7$  mm Hg vs  $16.0$  mm Hg  $\pm$   $7.9$  mm Hg; Group 3:  $14.3$  mm Hg  $\pm$   $9.9$  mm Hg vs  $18.2$  mm Hg  $\pm$   $11.1$  mm Hg, Group 4:  $39.0$  mm Hg  $\pm$   $20.4$  mm Hg vs  $16.6$  mm Hg  $\pm$   $6.9$  mm Hg. No differences in coronary bypass or aortic replacement were present.

**Conclusions:** AVR outcomes in mixed disease differ according to pathology. Predominant AS associated with higher AI grades had larger LV dimensions and greater RV dysfunction preoperatively. These differences resolve after AVR with equivalent survival. However, predominant AI with more severe AS had reduced survival despite AVR.

Figure 1



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**Aortic Valve-Sparing Root Replacement (David Procedure): Comparison Between Straight Tube Graft (David I) and Valsalva Graft**

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<sup>1</sup>Hanover Medical School, Germany, <sup>2</sup>S. Orsola-Malpighi Hospital, Bologna, Italy, <sup>3</sup>Clinic for Cardiothoracic, Transplantation and Vascular Surgery, Hanover, Germany

**COMMERCIAL RELATIONSHIPS** M. L. Shrestha: Consultant/Advisory Board, Vascutek; Speakers Bureau/Honoraria, Vascutek

**Purpose:** Since its introduction in 1992, multiple variations of the aortic valve-sparing David procedure technique have been described. Here, we present a comparison between the straight tube graft (David I) and the Valsalva prosthesis in patients who underwent isolated David procedure.

**Methods:** Between March 2002 and October 2015, 229 patients underwent the David procedure at two European centers. Patients received either straight tube graft (David-I, group A, n=103, 74% male) or Valsalva graft (group B, n=126, 87% male). Mean age was 47 years  $\pm$  17 years in group A and 48 years  $\pm$  17 years in group B ( $P = ns$ ). Type A dissection was present in 7% (n=7) of group A and 7% (n=9) of group B ( $P = ns$ ). Marfan syndrome was present in 30% (n=31, group A) and 23% (n=29, group B,  $P = ns$ ). Bicuspid valve was present in 9% (n=9, group A) and 13% (n=17, group B,  $P = ns$ ).

**Results:** Mean cardiopulmonary bypass times for groups A and B were 159 minutes  $\pm$  36 minutes and 152 minutes  $\pm$  30 minutes, respectively ( $P = ns$ ). Mean cross-clamp times were 112 minutes  $\pm$  21 minutes in group A and 126 minutes  $\pm$  22 minutes in group B, respectively ( $P < .001$ ). Re-thoracotomy rates for bleeding were 3% (n=3, group A) and 6% (n=7, group B,  $P = ns$ ). The 30-day mortality rate was 1% (n=1) in group A and 2% (n=2,  $P = ns$ ) in group B. Mean follow-up time was 5.3 years  $\pm$  3.4 years in group A and 6.0 years  $\pm$  4.1 years in group B. During follow-up, the rates for aortic valve-related reoperation were 8% (n=8) in group A and 10% (n=12) in group B ( $P = ns$ ). Follow-up echocardiography was obtained for 61% (n=63) of patients in group A and 66% (n=83) of patients in group B, and showed aortic insufficiency  $\geq 2^\circ$  in 14% (n=9) of group A and 35% (n=29) of group B ( $P = .005$ ). No erosion due to supposed leaflet contact with straight graft was observed in group A.

**Conclusions:** Regardless of the underlying pathology, the valve-sparing David procedure has acceptable mid- and long-term results. Our results show that the David I procedure with straight tube graft is not inferior to those performed with a Valsalva prosthesis.

## Cardiothoracic Surgical Education

P35

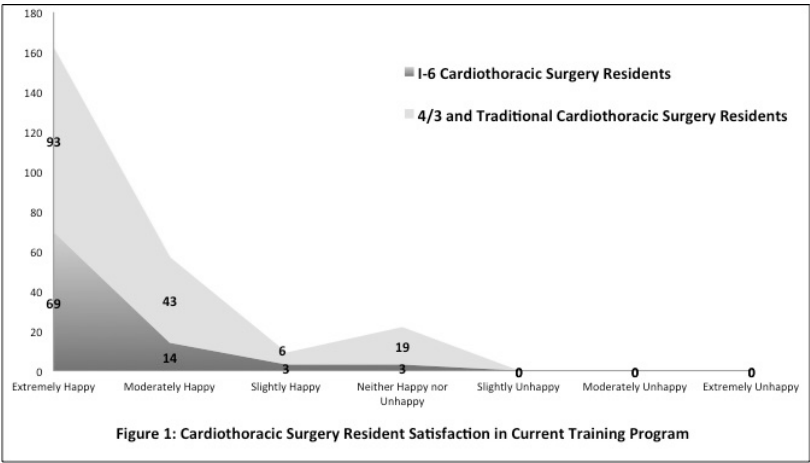
**Preferences in Pathway to Becoming a Cardiothoracic Surgeon: A Survey of Current Cardiothoracic Surgery Residents**T.A. Davis<sup>1</sup>, S. C. Yang<sup>2</sup><sup>1</sup>The Johns Hopkins Medical Institutions, Baltimore, MD, <sup>2</sup>The Johns Hopkins University School of Medicine, Baltimore, MD

**Purpose:** With the relatively recent introduction of integrated 6-year (I-6) cardiothoracic surgery (CTS) residency programs, limited data exist on resident preference and perception. We aimed to expose resident preference in the route to CTS and determine the dropout rate in individuals who applied to I-6 programs but did not match.

**Methods:** An online IRB-approved survey was sent to current residents with active email addresses (n=409), provided by the Thoracic Surgery Directors Association, to evaluate preferences and pathway to CTS. Descriptive analysis, including proportions and frequencies, was performed on quantitative data. Main Residency Match Data from 2008 to 2016 was collected from the National Resident Matching Program (NRMP).

**Results:** Of 250 respondents, 89 (36%) were in I-6 programs, while 161 (64%) were in 4/3 and traditional pathways. Including those currently enrolled, 112 (45%) applied for at least one I-6 program, while only 10 of the remaining 138 CTS residents had contemplated applying. From written comments of those 138 residents, the most common reasons against applying for I-6 programs were: 1) uncertainty of I-6 training/belief that general surgery offered more well-rounded training; 2) uncommitted to CTS as a medical student; and 3) general thoracic surgery interest. Interestingly, most I-6 residents (96%) were set on a cardiac career (adult or congenital), while a larger proportion (36%) of 4/3 and traditional residents were interested in general thoracic. According to the NRMP, 147 individuals applied to I-6 programs from 2008 to 2011 and were unmatched. Only 20 (14%) of those individuals, from our results, ended up in a CTS residency program. The Figure displays trainee satisfaction.

**Conclusions:** Only a small percentage of applicants that did not match to an I-6 program from 2008 to 2011 have ended up in CTS residency. As I-6 programs continue to develop and improve, the concerns brought about by current CTS residents must be addressed to attract the next generation of surgeons.



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# **Where Do We Begin: Building Blocks to Establish a Cardiothoracic Surgery Interest Group**

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**Purpose:** With the impending shortage of cardiothoracic surgeons, much focus has been on increasing trainee interest, particularly at the medical student level. We aimed to determine the impact of intervening participation in events hosted by our cardiothoracic surgery interest group (CTSIG) on medical student perception and attitudes regarding surgery, and especially CT surgery.

**Methods:** An IRB-approved survey was administered at two different timepoints to the current member list of our 2015-2016 CTSIG, once at the beginning of the academic year (pre) and once at the end (post). This was repeated for the 2016-2017 academic year. A set CTSIG event schedule was developed before each academic year with current CT surgery educators and included events every 1-2 months. Total CTSIG membership over the 2-year period was 101 students. Descriptive analysis, including proportions and frequencies, was performed on quantitative data.

**Results:** Of 73 pre-clinical students completing both pre-/post-surveys, 62% (45) were male. Post-surveys demonstrated increased interest in surgery and CT surgery as a career, which was significantly greater than those reporting no change ( $P < .01$  for both). Common factors mentioned as deterrents for a CT surgery career included lifestyle, length of training, and personality/culture associated with CT surgery. Events hosted by the CTSIG most frequently reported as increasing interest included lunches with CT surgery faculty (89%), a "Leadership in Surgery" event (58%), and an "Intro to CT Surgery and Q/A Session" hosted by a CT surgeon (51%). In ranking 10 items in order of importance best reflecting choice of CT surgery as a career, Personal Satisfaction and Intellectual Challenge were most commonly the top choices. Prestige was least important. Students reported increased attraction to CT surgery because of newfound knowledge on the "complexity" of procedures, "variety" of patients, and technological innovation.

**Conclusions:** Establishing a CTSIG that includes preset events with exposure to CT surgery via shadowing and interaction with faculty in a relaxed setting has the ability to increase pre-clinical interest in CT surgery. More emphasis on advocacy is needed to clear up misconceptions about a career in CT surgery.

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# Resident Perspective of a Novel Simulation Curriculum in Cardiac Surgery

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**Purpose:** Simulation-based training allows cardiac surgery trainees to learn operative techniques and management of crisis scenarios in a low-risk environment. The purpose of this study is to report the resident perspective of a novel simulation-based cardiac surgery curriculum.

**Methods:** Four cardiothoracic trainees were enrolled into an immersive cardiac surgery simulation program. Residents were assigned to either a 2-week or a 4-week curriculum. Residents reported their prior cardiac surgery experience. In addition to didactic sessions, low- and high-fidelity simulators were used to simulate venous and arterial cannulation, institution and weaning of cardiopulmonary bypass (CPB), as well as operative procedures including coronary artery bypass grafting, aortic valve replacement, and ascending aortic replacement. Over time, high- and low-frequency intraoperative events were introduced. At the conclusion of the program, residents completed a post-curriculum survey and were asked to comment on the program.

**Results:** Residents in the 4-week course spent 144 hours in the simulation curriculum: 15.5 hours in didactic sessions, 8 hours in the cadaver lab, and 120.5 hours in simulation. Residents in the 2-week course spent 65 hours in the curriculum: 5 hours in didactic session and 60 hours in simulation. The Table describes the pre-simulation and simulation experience for each group. Collectively, the residents viewed the program as a worthwhile endeavor. At the conclusion of the program, residents in both groups felt comfortable establishing and weaning from cardiopulmonary bypass (CPB) and managing the CPB circuit during high- and low-frequency events. Three of the four residents reported a perceived increase in operative autonomy after participating in the curriculum. Residents agreed faculty involvement in the simulation sessions greatly enhanced subsequent participation in the operating room. Together, residents believe the program is best positioned at the beginning of training with no preference for duration of the curriculum.

**Conclusions:** Residents endorse the overall benefit of the program and recommend continuation of the curriculum for future trainees. Simulation at the beginning of cardiac training results in earlier technical opportunities in the operating room. Importantly, residents state that the strength of the program is predicated upon the involvement of cardiac surgery faculty.

Table 1 - Average individual operative experience for each simulation group

	2-week course (n=2)		4-week course (n=2)	
	Pre-curriculum Experience	Curriculum experience	Pre-curriculum Experience	Curriculum experience
Aortic Cannulation	5	12	0	35
Distal coronary anastomosis	5	15	0	30
Proximal coronary anastomosis	7	16	2	25
Aortic valve replacement	0	2	0	4
AIAD Management	0	0	0	4
Air Embolism Management	0	4	0	8
Perfusionist	1	2	0	1

\*AIAD - Acute Intraoperative Aortic Dissection

P38

# **Tobacco Education in Adolescents: The Role of the Thoracic Surgeon**

**K. D. Mortman**

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**COMMERCIAL RELATIONSHIPS** K. D. Mortman: Consultant/Advisory Board, Bard/Davol, Ethicon, Medtronic; Speakers Bureau/Honoraria, Bard/Davol, Myriad Genetics

**Purpose:** The 2015 National Youth Tobacco Survey reports 4.7 million students use tobacco. From 2011 to 2015, there has been no decline in overall tobacco use in middle and high school students. The study's aim is to measure the impact of a novel, surgeon-led program on students' knowledge of the tobacco-lung cancer relationship.

**Methods:** From 2015 to 2017, 247 high school students from 20 local schools attended a monthly half-day Students Attending Thoracic Surgery (StATS) program at our university hospital. The highlight of the program is the opportunity for students to view a live, thoracoscopic lung cancer resection and have the ability to ask questions during the procedure. There is a thoracic surgeon-led discussion prior to and following the operation. Students completed a 10-question survey on tobacco and lung cancer facts at the start and again at the completion of the program. The primary endpoint was change in the students' knowledge base.

**Results:** All 247 students (mean age 16 years; grades 9-12; 84% female) completed the entire StATS program and survey (Figure). The students that attend the program are typically part of an advanced biology or health science class in the Washington, DC, metro area (16 DC and four suburban Maryland schools). Only one student (0.4%) reported current cigarette use, but 10 students (4.0%, mean age 16.4) reported prior use of cigarettes. Use of other forms of tobacco or nicotine delivery devices (such as hookah or electronic cigarettes) were not recorded. The mean number of correct pretest responses was 5.00/10 (range 1-9; standard deviation 1.67). The mean number of correct posttest responses was 8.55/10 (range 2-10; standard deviation 1.38). The mean difference between pre- and posttest scores is 3.54 (95% confidence interval 3.3-3.8;  $P < .0001$ ).

**Conclusions:** Attending the half-day StATS program led to a significant increase in high school students' knowledge of the tobacco-lung cancer relationship. Further longitudinal studies are needed to determine if this knowledge is retained and if these students continue to refrain from smoking.

## Students Attending Thoracic Surgery (StATS)

Taking part in this research study is completely voluntary. You have the right to refuse to take part and you may withdraw at any time. By proceeding with the survey, you are consenting to participate.

This survey is anonymous. Please do not write your name on it.

Date \_\_\_\_\_

Age \_\_\_\_\_ Gender: M / F

School \_\_\_\_\_ Grade \_\_\_\_\_

Do you currently smoke cigarettes? Y / N If so, for how long? \_\_\_\_\_ years

Have you ever smoked cigarettes? Y / N

### Questions

### Pre-test

### Post-test

- What is the leading cause of cancer death in the U.S.?
  - a. Breast cancer
  - b. Colon cancer
  - c. Prostate cancer
  - d. Lung cancer
- How many people are DIAGNOSED with lung cancer in the U.S. each year?
  - a. 2,000
  - b. 12,000
  - c. 120,000
  - d. 210,000
- How many people DIE from lung cancer in the U.S. each year?
  - a. 1600
  - b. 16,000
  - c. 160,000
  - d. 1,600,000
- What is the primary risk factor in the development of lung cancer?
  - a. asbestos
  - b. radiation
  - c. air pollution
  - d. tobacco use
- Approximately which percentage of lung cancer patients have never smoked?
  - a. 1%
  - b. 10%
  - c. 50%
  - d. 85%
- What percentage of high school students currently smoke cigarettes?
  - a. 1%
  - b. 9%
  - c. 35%
  - d. 55%
- How many carcinogens (cancer-causing substances) are in cigarettes & the smoke they produce?
  - a. 7
  - b. 20
  - c. 41
  - d. 70
- What is the most common presenting symptom of a patient with an early stage (stage I) lung cancer?
  - a. shortness of breath
  - b. cough
  - c. chest pain
  - d. no symptoms
- What is the most common organ for lung cancer to spread to (metastasize)?
  - a. brain
  - b. liver
  - c. bones
  - d. lung
- In addition to lung cancer, smoking can also cause:
  - a. heart disease
  - b. blindness
  - c. infertility
  - d. all of the above.

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# **Risks and Rewards for the Expanding Role of Physician Extenders in Cardiothoracic Surgery: A National Survey**

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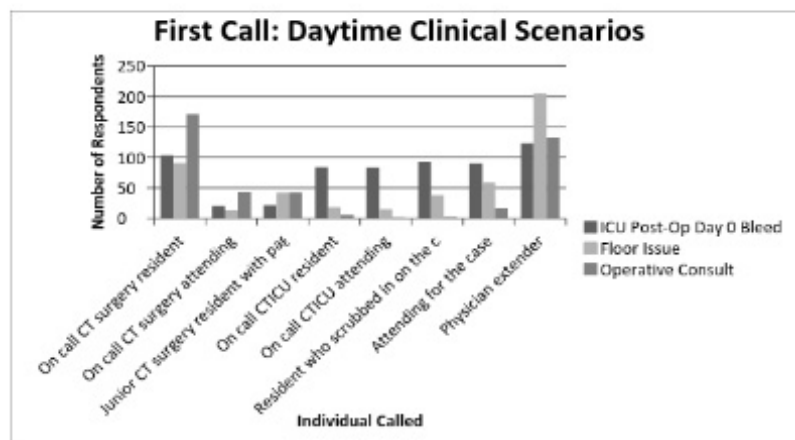
**Purpose:** Changes in health care have led to increasing utilization of physician extenders (PE), but their role on the cardiothoracic surgery (CTS) team remains undefined. This study aimed to analyze the extent of CTS PE utilization, their role within the hierarchy of clinical care, and the impact of PEs on CTS training.

**Methods:** CTS residents' responses to the 2017 Thoracic Surgery Residents Association (TSRA)/Thoracic Surgery Directors Association (TSDA) In-Service Training Examination (ITE) survey regarding utilization of PEs in various clinical settings, their role in specific clinical scenarios, and perception of PE contribution to the residents' educational environment were analyzed. Clinical practice of PEs in relationship to resident seniority and training pathway was assessed. Statistical analysis of categorical variables was performed in SPSS using Fisher's exact test and Pearson chi-square and statistical significance set at  $P < .05$ .

**Results:** Response rate was 82.1%. The median number of employed PEs was 16-20 ( $n=54$ ), while the median for PEs in the operating room, floor, and ICU was three, three, and two, respectively. 87.5% of respondents had a "very positive" ( $n=133$ ; 47.7%) or "positive" ( $n=112$ ; 40.1%) impression of PEs overall. There was a trend toward increased resident involvement for postoperative bleeding and operative consults, and increased PE involvement for floor issues. 72.5% of residents had not missed a surgical opportunity due to PEs, while 9.6% missed an opportunity due to a PE despite being at an appropriate level of training, 44% of those were I-6 residents, and 48.1% were junior residents (Graph 1). There were no significant differences in PEs' operative role based on resident seniority.

**Conclusions:** While the overall impression of PEs among CTS residents is favorable, they may also be an occasional impediment to residents' operative training. There is further opportunity to optimize and standardize their role within programs, improving clinical outcomes and enhancing the CTS educational experience.

Graph 1



Graph 2



P40

# **Recruiting the Best and Brightest Medical Students into Cardiothoracic Surgery: A 5-Year Follow-Up**

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**Purpose:** To determine whether early exposure to cardiothoracic (CT) surgery increases the number of potential CT surgeons. Starting in 2010, an early introduction, which included an 8-week summer internship, didactics, and shadowing, was started for medical students.

**Methods:** We contacted the American Association for Thoracic Surgery (AATS), which provided us with its list of matches and results from surveys of the AATS Summer Intern scholars from 2007 to 2012. We similarly compared our results relative to matching for our interns who completed our Ohio State University Summer Scholars program. We looked at how many interns in both programs matched to surgical or medical specialties.

**Results:** AATS Summer Interns matched for 106 surgery positions and 115 medical specialties as depicted in the Table. A total of sixteen Summer Scholars from our program have matched, with seven having gone into surgical fields: five into CT surgery, one into general surgery, and one into urology. Eight have matched into medical fields. In the AATS pool, five were still in medical school, one quit, and one died, leaving 214 matches.

**Conclusions:** Early exposure works to attract more medical students into surgery and into cardiothoracic surgery in particular. It takes organization and teamwork for our associates, mid-level providers, fellows, and surgeons to provide this experience for our Summer Scholars, but relative to the matches, the investment seems worthy.

Table 1. Matches for AATS Summer Interns Program

SURGERY	NUMBER	MEDICINE	NUMBER	OTHER	NUMBER
CARDIOTHORACIC					
GENERAL SURGERY	34	INTERNAL MEDICINE	23	UNABLE TO LOCATE STILL IN MEDICAL SCHOOL	16
ORTHOTRAUMATOLOGY	7	PEDIATRICS	17		5
UROLOGY	7	EMERGENCY MEDICINE	7	PHARMACOLOGY	1
ENT	7	FAMILY MEDICINE	6	DENTISTRY	1
OB-GYN	6	SPORTS MEDICINE	1	DECEASED	1
PLASTIC SURGERY	4	CARDIOLOGY	7	QUIT	1
OPHTHALMOLOGY	3	ONCOLOGY	5	PERFUSIONIST	1
NEUROSURGERY	2	DERMATOLOGY	2	OTHER	1
TRANSPLANTATION	2	PSYCHIATRY	2		
		EPIDEMIOLOGY	1		
		NEUROLOGY	1		
		RADIOLOGY	8		
		ANESTHESIA	6		
		PATHOLOGY	2		
	106		88		27

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### Cardiac Surgery in Africa: How Do Outcome Measures Fare?

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**Purpose:** Evaluating patient outcomes is imperative to quality improvement in cardiac surgery. We review the last 20 years of literature surrounding such care in Africa to elucidate whether programs are monitoring and publishing mortality, morbidity, and health-related quality of life (HQRL) measures.

**Methods:** A systematic search of the literature was performed. PubMed, Embase, and African Index Medicus were queried using cardiac surgery MeSH and Emtree terms, relevant anatomic and procedural terms, and geographical terms related to Africa. Articles pertaining exclusively to percutaneous, vascular, or thoracic procedures were excluded. Title screening and data abstraction were performed in duplicate. Items for abstraction included: perioperative mortality, major and minor morbidities as defined by the National Surgical Quality Improvement Program, and HQRL measures, such as economic strains, functional status (eg, NYHA classes), and social burden.

**Results:** The search returned 4884 articles, and 209 met inclusion criteria. Less than half of patients received inpatient follow-up (45.9%) or outpatient follow-up (40.7%). Mortality outcomes were reported in 62.7% of studies. Morbidity was reported in 45.5% of studies, though the detail varied greatly. Major morbidities were reported in 36.8% of studies, of which reoperation for any reason (55.8%), permanent stroke (11.7%), and renal failure (11.7%) were most common. Minor morbidities were reported in 27.8% of studies. Most commonly reported factors included prolonged length of stay (36%), surgical site infections (32.8%), and wound dehiscence (10.4%). HQRL measures were reported in 4.8% of studies.

**Conclusions:** Future collaboration must include monitoring basic quality measures. Reporting such data is contingent upon the maintenance of high quality health records, as well as a standardized approach to defining morbidities and including HQRLs. The extent to which contextual factors limit the ability to report such findings also should be studied.

## Congenital Heart Surgery

P42

### Graft Replacement and In-Situ Reconstruction of Kommerell Diverticulum and Aberrant Subclavian Artery in Adults

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**Purpose:** The aim of this study is to evaluate the early and long-term outcomes of graft replacement and in-situ reconstruction of Kommerell diverticulum and aberrant subclavian artery.

**Methods:** Between October 1999 and March 2017, 16 patients who had Kommerell diverticulum underwent open repair. Mean age was 68.2 years  $\pm$  13.2 years, and 11 patients were men. Mean follow-up was 7.7 years  $\pm$  4.7 years. Four patients were symptomatic, and 10 patients had right aortic arch. Two patients underwent open surgery for ruptured aneurysm. Indications for surgery were dilatation of Kommerell aneurysm (n=8), non-dissecting aneurysm with Kommerell diverticulum (n=6), acute type A aortic dissection (n=1), and acute complicated type B aortic dissection (n=1).

**Results:** Ten patients underwent replacement of the descending aorta and in-situ reconstruction (n=9) or ligation (n=1) of the aberrant subclavian artery through the right (n=7) or left (n=3) thoracotomy. Five patients underwent arch replacement and in-situ reconstruction (n=5) of the aberrant subclavian artery through median sternotomy. One patient underwent total arch-descending aortic replacement and in-situ reconstruction of the aberrant left subclavian artery through right thoracotomy. Hospital mortality was found in one patient (6.3%) who underwent total arch replacement for ruptured aneurysm. Permanent neurological deficit did not occur, and transit neurological deficit was recognized in two patients (11.8%). Five-year and 10-year actual survival were 90.0%  $\pm$  9.5% and 80.0%  $\pm$  12.7%, respectively. There were two late deaths due to myocardial infarction and malignancy. In the follow-up period, there were no recurrence of symptoms or stenosis of the reconstructed subclavian arteries.

**Conclusions:** Early outcomes of graft replacement of Kommerell diverticulum and in-situ reconstruction of the aberrant subclavian artery were acceptable. Given the long-term symptomatic improvement and excellent patency rate of the reconstructed aberrant subclavian artery, in-situ surgical repair is a recommendable option.

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# **Maximizing Survival in Hypoplastic Left Heart Syndrome: Evolution of a Balanced Institutional Strategy**

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**Purpose:** Despite improved initial survival, long-term survival for infants with hypoplastic left heart syndrome (HLHS) is suboptimal and infrequently reported. We describe the evolution and outcomes of a comprehensive institutional approach for HLHS that is tailored to an individual patient's characteristics and that leverages all available strategies.

**Methods:** Retrospective review of our institutional database identified all patients with a diagnosis of HLHS (rather than Norwood procedural cohort) undergoing initial intervention between 2005 and 2016 under the same surgical leadership. Two periods were defined (Era1: 2005–2009 and Era2: 2010–2016), coinciding with three deliberate management changes: 1) preferential adoption of right ventricle-pulmonary artery conduit (RV-PAC); 2) increased use of hybrid procedure for high-risk neonates; 3) proactive utilization of heart transplantation (Tx). Clinical factors were compared among eras and procedures using the Fisher-exact or Kruskal-Wallis tests. Kaplan-Meier and Cox proportional hazards analyses examined time-related overall and Tx-free survival.

**Results:** Among 114 HLHS patients, 46 underwent RV-PAC, 45 underwent aortopulmonary shunt, and 23 underwent hybrid procedure. Thirteen patients underwent Tx. Median follow-up was 2.2 years (0–10 years). Less favorable anatomic subgroups (mitral atresia/aortic atresia and mitral stenosis/aortic atresia) predominated in Era2 (Table). Significantly higher rates of RV-PAC (22%–55%;  $P < .0001$ ), hybrid procedures (16%–23%;  $P < .0001$ ), and Tx (4%–17%,  $P = .03$ ) were detected during Era2. Overall 5-year survival improved over time. Moreover, survival changed significantly within different procedure types over time, with 5-year survival among RV-PAC recipients of 90% in Era2, despite the increase in higher-risk anatomic subgroups (Figure). Era-dependent survival benefit was seen with overall survival as end-point,  $P = .014$ , but not for Tx-free survival,  $P = .60$ . Multivariable risk factors associated with time-related death included Era1 ( $P = .009$ ) and the hybrid procedure ( $P = .04$ ).

**Conclusions:** Adoption of a balanced approach to HLHS significantly improves long-term survival relative to existing benchmarks. Our data support the use of RV-PAC in lieu of aortopulmonary shunt, with excellent 5-year survival in the later era for RV-PAC cohort. Proactive transition to Tx pathway is an important strategy to optimize long-term survival.

Survival Stratified by Procedure Type for Era 2: 2010 - 2016

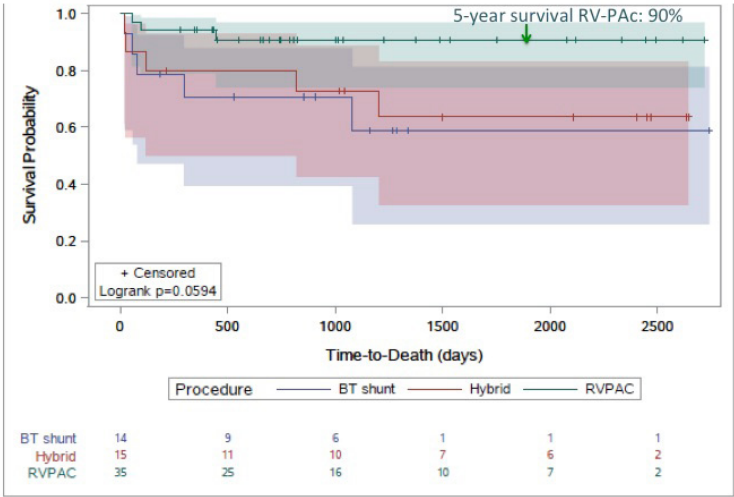


Table : Comparison of Clinical Factors and Outcomes By Initial Procedure

	BT Shunt (N=45)	RV-PAC (N=46)	Hybrid (N=23)	P-value
<b>Diagnosis</b>				
MA AA	10 (56)	21 (78)	1 (9)	0.0002
MA AS	0 (0)	2 (7)	1 (9)	
MS AA	4 (22)	2 (7)	8 (73)	
MS AS	4 (22)	2 (7)	1 (9)	
<b>Age (days), Mean (SD)</b>				
Stage 1 (N=112)	6.4 (3)	6.7 (3.8)	24 (48)	0.07
Stage 2 (N=78)	140 (45)	125 (63)	151 (74)	0.12
Fontan (N=35)	1147 (286)	1235 (316)	1501 (107)	0.08
Transplant (N=13)	1121 (1558)	904 (1425)	100 (57)	0.13
Reached Stage 2 N (%)	33 (73)	34 (74)	11 (48)	0.06
Reached Fontan N (%)	20 (44)	10 (22)	5 (22)	0.04
Transplanted N (%)	3 (7)	6 (13)	4 (17)	0.40

P44

# **Patients With a Systemic Right Ventricle Are at Higher Risk of Chylothorax After Cavopulmonary Connections**

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**COMMERCIAL RELATIONSHIPS** C. P. Brizard: Consultant/Advisory Board, Admedus; Y. A. d'Udekem: Consultant/Advisory Board, Actelion, MSD

**Purpose:** Chylothorax occurs in 1% to 9% of patients after pediatric cardiac surgery and is related to a higher morbidity and early mortality rate. It is suspected to be more frequent after single ventricle staged palliation procedures, but there are no focused long-term studies in patients with univentricular heart physiology.

**Methods:** The records of consecutive patients who underwent a bidirectional cavopulmonary shunt (BCPS) and a Fontan completion in our institution from January 2008 to December 2016 were reviewed. Patients who underwent previous or further cardiac procedures in other institutions were excluded. A total of 289 patients underwent 376 cavopulmonary connection (CC) procedures over 9 years (BCPS = 199, Fontan completion = 177). Eighty-three patients (22%) underwent both a BCPS and a Fontan completion during the period of study. Patients were classified according to whether they had a chylothorax (Group 1) or not (Group 2).

**Results:** BCPS and Fontan completion were performed at a median age of 3.6 months (3–6.1) and 4.8 years (4.5–5.6), respectively. The rate of chylothorax following a CC procedure was 19.7% (74/376): 15.6% (31/199) after BCPS and 24.3% (43/177) after Fontan completion. There were seven (2.4%) early deaths and 26 (9%) late deaths. Mean follow-up was 4.3 years  $\pm$  0.1 year. Hypoplastic left heart syndrome and systemic right ventricle were more frequent in Group 1 ( $P = .009$  and  $.003$ , respectively). Chylothorax also was associated with a higher rate of early reoperation ( $P < .001$ ), early and late failure of the CC ( $P = .005$  and  $.006$ , respectively) and a longer hospital stay ( $P < .001$ ). By multivariate analysis, having a systemic right ventricle was a predictor for the development of chylothorax (OR 2.49, 95% CI 1.4–4.7,  $P = .004$ ).

**Conclusions:** The incidence of chylothorax in patients undergoing the univentricular pathway is higher than previously suggested and is associated with increased morbidity at the time of surgery. Having a systemic right ventricle is a significant risk factor for developing a postoperative chylothorax after a cavopulmonary connection.

Table. Comparison of characteristics and outcomes in patients with chylothorax and without chylothorax after cavopulmonary connections

Patients characteristics	Group 1/ Chylothorax, n = 74	Group 2/ No chylothorax, n = 302	p value*
Male	42 (56.8 %)	184 (63.2 %)	0.511
Age (years)	3.5 +/- 0.4	2.7 +/- 0.2	0.098
<b>Anatomy</b>			
Hypoplastic left heart syndrome	36 (48.6 %)	96 (32.4 %)	<b>0.009</b>
Systemic right ventricle	48 (64.9 %)	138 (46 %)	<b>0.003</b>
<b>Previous chylothorax</b>	10 (13.5%)	27 (8.9 %)	0.237
At Stage 1	6 (8.1 %)	21 (6.9 %)	0.801
<b>Previous ECLS</b>	9 (12.2 %)	29 (9.6 %)	0.513
<b>BCPC</b>	31 (41.9 %)	168 (55.6 %)	0.034
Interval with Stage 1 (months)	5.2 +/- 0.7	7.3 +/- 0.7	0.963
Additional pulmonary forward flow	15 (20.3 %)	48 (15.9 %)	0.36
<b>Fontan completion</b>	43 (58.1 %)	134 (44.3 %)	0.034
Interval with BCPS (years)	4.7 +/- 0.3	4.4 +/- 0.1	0.486
<b>Postoperative ECLS</b>	5 (6.8 %)	11 (3.6 %)	0.234
<b>Early outcomes</b>			
Reoperation	20 (27 %)	16 (5.3 %)	<b>&lt; 0.001</b>
Revision of connection	11 (14.9 %)	5 (1.7 %)	<b>&lt; 0.001</b>
Failure/takedown	3 (4 %)	1 (< 0.5 %)	<b>0.005</b>
Death (≤ 30 days)	2 (2.7 %)	5 (1.7 %)	0.55
Intensive care stay (days)	7.2 +/- 1.8	3.1 +/- 0.3	<b>0.01</b>
Hospital stay (days)	32.3 +/- 2.9	14.8 +/- 0.8	<b>&lt; 0.001</b>
<b>Late outcomes</b>			
Reoperation	9 (12.2 %)	26 (8.6 %)	0.346
Failure/takedown	5 (6.8 %)	2 (< 0.5 %)	<b>0.006</b>
Death (> 30 days)	13 (17.6 %)	13 (4.3 %)	<b>&lt; 0.001</b>
<b>Follow-up (years)</b>	4.1 +/- 0.3	4.4 +/- 0.1	0.557

ECLS: extracorporeal life support; BCPS: bidirectional cavopulmonary shunt

\*p value from the Pearson chi-square test for categorical variables and the Mann-Whitney test for continuous variables (Group 1 vs Group 2)

P45

**Is a Decellularized Porcine Small Intestine Submucosa Patch Suitable for Aortic Arch Repair?**

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**Purpose:** Decellularized porcine small intestine submucosa (DPSIS) patch has been introduced for the surgical treatment of congenital heart defects, with implantations performed in both the systemic and pulmonary circulations. Because of recent reports of less than favorable medium- and long-term outcomes, we decided to review our experience with DPSIS patch implantation.

**Methods:** Between October 2011 and April 2016, a DPSIS patch was used for the surgical treatment of congenital heart defects in 191 patients, median age 8 months (range, 2 days-42 years). Among them, 51 patients (51/191=26.7%), median age 1.1 months (range, 5 days-14.5 years) and median weight 4.0 kg (range, 2.2-50.2 kg), who underwent either aortic arch reconstruction (45/51=88.2%) or aortic coarctation repair (6/51=11.8%) with DPSIS patch, were included in this study. All medical records were retrospectively reviewed, with primary endpoints being either reintervention (balloon dilatation/stent) or reoperations (DPSIS patch replacement) due to patch-related complications.

**Results:** In a median follow-up time of 1.5 years  $\pm$  1.1 years (range, 0.6-2.3 years), 11 out of 51 patients (21.6%) had either percutaneous interventional cardiology procedure (6/51=11.8%) or reoperation (5/51=9.8%) due to obstruction related to the DPSIS patch used for enlargement of the aortic arch/isthmus. In these patients, the median max velocity flow at Doppler interrogation across the aortic arch/isthmus was 4.0 m/sec  $\pm$  0.51 m/sec. Two patients required reoperation after unsuccessful interventional cardiology procedure. The mean interval between DPSIS patch implantation and reintervention, either percutaneous or surgical, was 7.4 months. In addition, two patients are waiting reoperation, raising the total number of patients requiring reinterventions to 13/51 (25.5%). There was no early and late death after primary DPSIS patch implantation and subsequent reintervention. The median max velocity flow at Doppler interrogation across the aortic arch/isthmus in patients who did not require reintervention was 1.7 m/sec  $\pm$  0.57 m/sec.

**Conclusions:** Unacceptably high incidence of reinterventions in patients who had aortic arch/coarctation repair with DPSIS patch forced us to utilize alternative materials for aortic arch/coarctation repair: decellularized glutaraldehyde preserved bovine pericardial matrix and homograft patch. Long-term follow-up will be required for meaningful comparison between the DPSIS patch and the alternative materials.

P46

# **Extracardiac vs Lateral Tunnel Fontan: A Meta-Analysis of Long-Term Results With Special Focus on Arrhythmias**

*W. Ben Ali, I. Boubout, P. N. Khairy, D. Bouchard, N. Poirier*

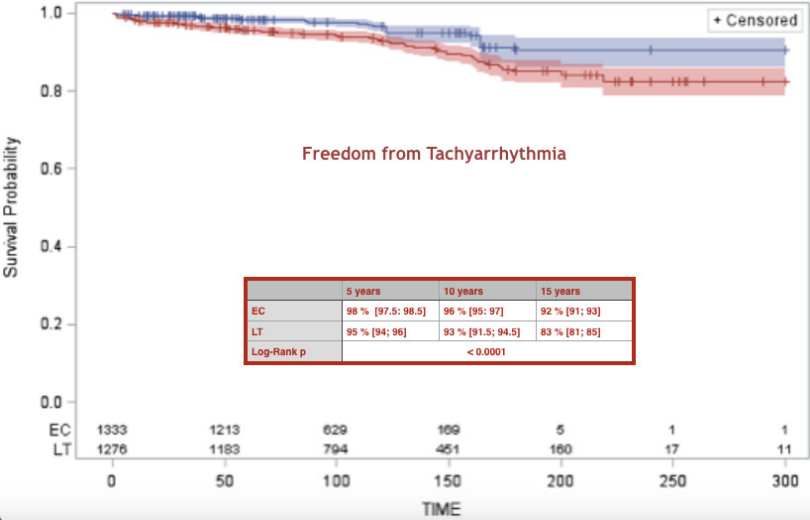
*Montreal Heart Institute, Canada*

**Purpose:** Comparative data on the incidence of supraventricular arrhythmias and sinus node dysfunction post-extracardiac conduit (EC) and post-lateral tunnel (LT) Fontans are controversial. The only available contemporary data are limited to small single-center series compromised by referral bias. We performed a meta-analysis to pool all available long-term results of Fontan procedures.

**Methods:** Keywords for PubMed and EMBASE search were: “Fontan,” “long-term results,” “cardiac replacement therapy,” and “arrhythmia,” limited to publications from 2000 until 2016 in humans. Inclusion criteria were studies reporting on long-term results of Fontan comparing EC and LT and completeness of follow-up of 90%. Kaplan-Meier curves in each of the selected studies were digitized. Time-to-event (TTE) data from different studies were stored together, and statistical methods for TTE data were employed to analyze outcomes.

**Results:** Twelve studies were selected with 3330 patients (1729 EC, 1601 LT). Studies were symmetrically distributed on a Funnel plot. Survival at 20 years was 93% (87, 99) and 89% (83, 95) respectively in the EC and LT groups (log-rank  $P = .007$ ). Freedom from tachyarrhythmia was significantly higher in the EC group (92% [91, 93] and 83% [81, 55] at 15 years; log-rank  $P < .0001$ ) whereas there was no significant difference between the two groups in term of bradyarrhythmia (log-rank  $P = .7$ ). Risk of thromboembolic events was 2.87% per year in the EC group vs 0.9% per year in the LT group (OR= 2.15 [0.95; 4.85];  $P = .07$ ). A meta-regression was performed including the following confounding variables: age, sex, ventricle morphology, heterotaxy, tricuspid atresia, and pre-Fontan collaterals. These variables did not influence survival nor freedom from tachyarrhythmia.

**Conclusions:** The long-term survival of Fontan population is excellent. EC confers long-term survival advantage over the LT without higher rate of reoperations. The incidence of arrhythmias increases with time since surgery. EC, even though more challenging for the electrophysiologist, preserves sinus node function and significantly reduces the incidence of long-term postoperative arrhythmias.



P47

# **A Novel Bio-Chemo-Mechanical Model of Tissue-Engineered Vascular Graft Development**

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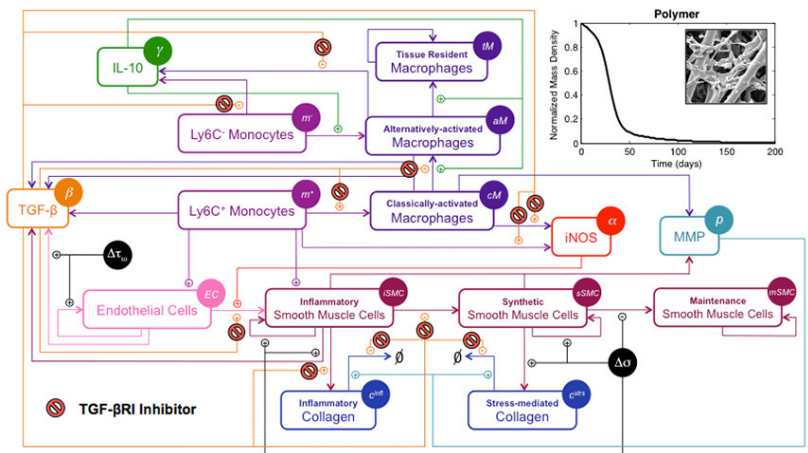
**COMMERCIAL RELATIONSHIPS** C. A. Best: Ownership Interest, Lyst Therapeutics; Consultant/Advisory Board, Lyst Therapeutics; C. K. Breuer: Research Grant, Gunze Ltd; Other Research Support, Gunze Ltd; T. Shinoka: Research Grant, Gunze Ltd

**Purpose:** The primary graft-related complication of biodegradable polymeric scaffolds for pediatric congenital heart surgery is stenosis, and these vascular conduits have yet to be optimized to yield a graft with growth potential and long-term patency. Mouse models and computational modeling can be used to predict pharmacological interventions and design modifications to improve graft performance.

**Methods:** Poly(glycol acid) scaffolds sealed with a 50:50 co-polymeric solution of poly( $\epsilon$ -caprolactone and l-lactide) and varying in key physical parameters that modulate the host immune response were implanted as inferior vena cava interposition grafts in C57BL/6 mice for 6 months. A subset of the mice was treated with TGF- $\beta$ R1 inhibitor SB431542 for 2 weeks following scaffold implantation. Graft patency was evaluated by serial ultrasound, and harvested grafts underwent biaxial mechanical testing, histology and immunohistochemistry, and FACS analysis. We concurrently developed a mechanistic model that extends a growth and remodeling computational framework by incorporating the complex interplay of mechanical and biochemical factors throughout neovessel development.

**Results:** Stenotic grafts are characterized by extensive monocyte/macrophage infiltration, luminal neotissue formation, and eventual occlusion and inward remodeling. We used our bio-chemo-mechanical model of neovessel formation to parametrically explore the in vivo development of graft stenosis as a function of key scaffold parameters and the immunomodulatory cytokine TGF- $\beta$ 1. Our model accurately predicts the biaxial mechanical behavior of grafts implanted in the murine venous circulation over a 6-month period, and captures the molecular and cellular profiles of pro- and anti-inflammatory cytokines, vascular cells, and classically/alternatively activated macrophages throughout neovessel evolution. We identify scaffold pore size as a key regulator of monocyte infiltration and determinant of stenosis. Furthermore, we show that treatment with a TGF- $\beta$ R1 inhibitor not only improves graft patency by blocking endothelial-to-mesenchymal transition and preventing the TGF- $\beta$ 1-induced classic activation of infiltrating monocytes, but also improves graft distensibility by significantly reducing the production of stiff, inflammatory collagen while still preserving vascular cell infiltration during the foreign body response.

**Conclusions:** A mechanistic model allows us to parametrically evaluate key scaffold parameters and simulate multiple pharmacological interventions delivered at different concentrations and over varying durations. This can help predict ideal clinical interventions and optimal scaffold designs for achieving favorable long-term outcomes, such as graft patency and distensibility, which can then be validated experimentally.



P48

# **Intra/Extracardiac vs Extracardiac Fontan Modifications: Comparison of Early Outcomes**

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**Purpose:** Intra/extracardiac Fontan modification has shown to have superior early and long-term freedom from arrhythmias compared to lateral tunnel modification. A direct comparison of intra/extracardiac (IE) to the extracardiac (EC) modification has so far not been done. This study aims to compare IE to EC Fontan, with respect to early outcomes.

**Methods:** We retrospectively evaluated 81 consecutive patients who underwent the Fontan operation at a single institution between January 2012 and December 2016. Patients were grouped according to the Fontan modification into intra/extracardiac (IE Group; n=43) or extracardiac (EC Group; n=38). Intergroup comparisons were made between the groups for preoperative, operative, and postoperative variables. Multivariable regression analysis was performed to determine independent predictors of increased duration of pleural effusion and hospital length of stay.

**Results:** The study group comprised of 81 patients (IE Group=43; EC Group=38). The groups were comparable with respect to preoperative variables. Preoperative, operative, and postoperative variables are detailed in the Table. The Fontan conduit was fenestrated in 100% of the IE Group but only 55% in the EC Group ( $P < .001$ ). Cardiopulmonary bypass times were shorter for the IE Group (mean  $\pm$  SD; IE Group, 80 minutes  $\pm$  22 minutes vs EC Group, 114 minutes  $\pm$  34 minutes;  $P < .001$ ). Only two patients needed aortic cross-clamping in the EC group. IE Group had significantly shorter duration of pleural effusion (median [IQR]; IE Group, 8 [6-10] days vs EC Group, 8 [7.25-19.5] days;  $P = .004$ ). IE Group also had significantly shorter hospital length of stay (median [IQR]; IE Group, 9 [7-12] days vs EC Group, 9 [9-21.8] days;  $P = .002$ ). Multivariable linear regression analysis revealed that IE Fontan modification was the only independent factor associated with reduced duration of pleural effusion (CI, 1.8-7.7;  $P = .001$ ) and hospital length of stay (CI, 1.6-10.8;  $P = .008$ ).

**Conclusions:** Intra/extracardiac Fontan modification is associated with reduced duration of postoperative pleural effusion and hospital length of stay compared to the extracardiac modification. Despite need for aortic cross-clamping, cardiopulmonary bypass times are shorter, and it is easier to fenestrate. Longer-term outcome studies are needed to determine the optimal Fontan modification.

Table 1

Preoperative characteristics compared between the study groups			
Variable	IE Group (n=43)	EC Group (n=38)	P value
Number Fenestrated	43(100%)	21(55%)	<0.001
Age at operation (Years)	2.9±2.2	2.8±1.1	0.72
Female Gender	16(37%)	15(39%)	0.84
Weight at operation (kg)	13.8±8.6	12.4±4.7	0.29
Known Syndrome	4 (9%)	10 (26%)	0.10
Chromosomal abnormalities	2 (4%)	4 (10%)	0.5
Non Cardiac Anomalies	1 (2%)	8(21%)	0.05
Preoperative Hemodynamics			
VEDP, mmHg	11±2.7	10±1.7	0.47
Mean PAP, mmHg	13±2.3	13±2.2	0.96
PVR, Woods U/m <sup>2</sup>	1.6±0.5	1.5±0.6	0.53
Greater than Moderate AVVR	2(4%)	1 (2%)	0.78
Operative Data			
Cardiopulmonary Bypass Time, minutes	80±22	113±34	<0.001
Aortic Cross-clamp times, minutes	35±12	66±41*	0.48
Post-operative outcomes compared between the study groups			
Duration of mechanical ventilation (hours)	12(9.1-28)	12(6.2-25.6)	0.55
ICU Length of Stay (days)	4(3-6)	4(2-7.8)	0.20
Pleural effusion, days	8(6-10)	8(7-19)	0.004
Hospital Length of Stay (days)	9(7-12)	9(9-21.8)	0.002
Early postoperative arrhythmias	15 (34%)	18 (47%)	0.25
Mortality	1 (2.3%)	1 (2.6%)	0.96

# n=2 for EC Group

Continuous data presented as mean ± SD or median (IQR), categorical data presented as numbers (proportions)

AVVR= Atrioventricular valve regurgitation

ICU = intensive care unit

PAP= Pulmonary Artery Pressure

PVR= Pulmonary Vascular Resistance

VEDP= Ventricular End Diastolic Pressure

P49

# **Surgical Repair of Pulmonary Atresia With a Ductus Arteriosus or Hemi-Truncus to One Lung and Major Aortopulmonary Collaterals to the Contralateral Lung**

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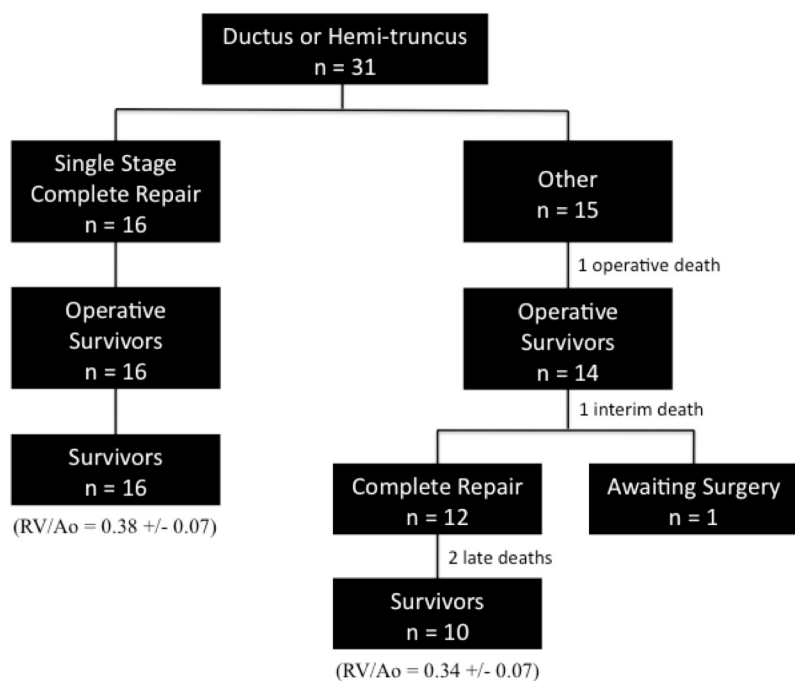
*Stanford University School of Medicine, CA*

**Purpose:** There are patients born with pulmonary atresia and a ductus arteriosus or hemi-truncus to one lung and major aortopulmonary collateral arteries (MAPCAs) to the contralateral lung. The purpose of this study was to review our surgical results for this relatively rare and unique subset of patients.

**Methods:** This was a retrospective review of 31 patients with ductus/hemi-truncus in association with pulmonary atresia with ventricular septal defect and MAPCAs. The median age at surgery was 3 months (range, 1-7 months), and the mean number of MAPCAs to the contralateral lung was  $3.1 \pm 1.3$  (range, 1-5). Twenty-eight of the 31 patients had a complete absence of central pulmonary arteries.

**Results:** Sixteen of the 31 patients underwent a single-stage complete repair, including unifocalization of the ductus/hemi-truncus and MAPCAs, closure of the ventricular septal defect, and insertion of a right ventricle to pulmonary artery conduit. The mean number of unifocalized MAPCAs was  $3.1 \pm 1.3$ . All 16 of these patients are alive, with a mean right ventricle to aortic pressure ratio of  $0.38 \pm 0.07$ . Fifteen patients underwent a staged approach, including unifocalization of the MAPCAs to a central shunt and control of the pulmonary blood flow to the ductus/hemi-truncus. The mean number of unifocalized MAPCAs was  $3.1 \pm 1.6$ . There was one operative death and one interim death. Twelve of the 13 survivors have undergone complete repair with a mean right ventricle to aortic pressure ratio of  $0.34 \pm 0.07$ . There were an additional two late deaths following complete repair in this cohort.

**Conclusions:** The data demonstrate that 28 of 31 patients with ductus/hemi-truncus and MAPCAs were able to achieve complete repair with relatively low pulmonary artery pressures. The decision to perform staged repair was associated with a significantly higher mortality compared to the single stage complete repair approach.



P50

# **Remote Ischemic Preconditioning Does Not Prevent White Matter Injury During Cardiac Surgery in Neonates**

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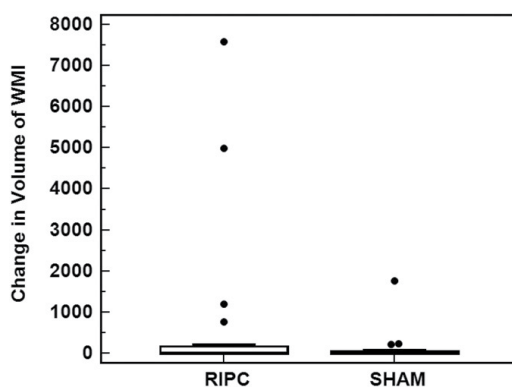
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**Purpose:** Remote ischemic preconditioning (RIPC) is a mechanism to protect tissues from injury during ischemia and reperfusion. Brief periods of ischemia are applied to tissues with ischemic tolerance, thus protecting vital organs more susceptible to ischemic damage, including the brain. We investigated the neuroprotective effects of RIPC in neonates undergoing cardiac surgery.

**Methods:** The primary outcome was severity of white matter injury (WMI), assessed by the change in volume of WMI (assessed by manual segmentation) from preoperative to postoperative brain MRI. After the preoperative MRI, subjects were randomized to RIPC or SHAM. RIPC was induced in advance of cardiopulmonary bypass (CPB) by four 5-minute cycles of blood pressure cuff inflation to produce ischemia of the lower extremity. For subjects randomized to SHAM, the cuff was positioned for the same time, but not inflated. Differences in WMI volume between treatment groups were evaluated using a two-sample T-test.

**Results:** The study included 67 subjects, with 33 randomized to RIPC and 34 randomized to SHAM. Preoperative and postoperative MRIs were available in 50 subjects to evaluate the change in WMI volume, including 26 of the 33 RIPC subjects (79%) and 24 of the 34 SHAM subjects (71%). There were no significant differences in baseline and operative characteristics, including brain total maturation score, for either the overall study group or the group with evaluable MRIs (Table). There was no significant difference in the proportion of subjects who experienced a perioperative increase in WMI volume between the two groups, 54% of RIPC subjects vs 50% of SHAM subjects,  $P = .786$ . RIPC subjects had a mean increase in WMI volume of 600 mL<sup>3</sup>, and SHAM subjects had a mean increase in WMI volume of 107 mL<sup>3</sup>,  $P = .178$  (Figure).

**Conclusions:** In this prospective, randomized, blinded clinical trial, there was no evidence that use of preoperative RIPC provides neuroprotection in neonates undergoing repair of congenital heart defects with CPB.



Variable		RIPC (n=33)	SHAM (n=34)	P-value
<u>Baseline Characteristics</u>				
Diagnosis Category	HLHS	12 (36.4%)	14 (41.2%)	0.952
	TGA	9 (27.3%)	9 (26.5%)	
	OTHER	12 (36.4%)	11 (2.4%)	
Genetic Anomaly	No	27 (81.8%)	24 (70.6%)	0.392
	Yes	6 (18.2%)	10 (29.4%)	
Total Maturation Score		10.0±1.0	10.3±1.1	0.304
<u>Operative Factors</u>				
Age at Surgery (days)		4.8±3.0	4.7±3.1	0.911
Weight at Surgery (kg)		3.4±0.5	3.3±0.6	0.516
Total Support Time (min)		117.8±41.4	105.8±41.6	0.240
CPB Time (min)		92.3±31.6	78.9±25.2	0.059
DHCA Time (min)		25.5±21.0 (n=22)	26.9±21.6 (n=23)	0.793
Duration of Cooling (min)		14.1±9.9	14.0±10.8	0.981
Lowest Nasopharyngeal Temperature (°C)		23.6±8.3	23.3±7.9	0.899
Hematocrit on CPB (%)		29.8±3.1	29.5±3.1	0.677
Days after Surgery for Postoperative MRI		6.5±2.8	7.2±3.3	0.443

P51

**Aortic Extension to Relieve Pulmonary Artery Compression Following Norwood Palliation***L. M. Wiggins<sup>1</sup>, J. D. Cleveland<sup>1</sup>, C. Baker<sup>1</sup>, V. A. Starnes<sup>1</sup>, W. J. Wells<sup>2</sup>, S. Kumar<sup>1</sup>**<sup>1</sup>University of Southern California, Los Angeles, <sup>2</sup>Children's Hospital Los Angeles, CA*

**Purpose:** Extrinsic compression of the pulmonary artery (PA) by the reconstructed neoaorta can adversely impact PA growth following the Norwood procedure. We have used aortic extension with an interposition graft coupled with pulmonary arterioplasty to adequately relieve PA stenosis following Norwood. We sought to evaluate intermediate-term outcomes of this approach.

**Methods:** We retrospectively reviewed the charts of 728 patients who underwent Glenn at our institution from 2001 to 2015. Of these patients, 15 underwent aortic extension with interposition grafts prior to Fontan completion. Patient characteristics, preoperative imaging, operative details, need for reintervention, and outcomes to Fontan were evaluated.

**Results:** All patients had undergone Norwood reconstruction as a neonate. Median age to diagnosis of PA stenosis was 5.4 (3.6–7) months, and there were 13 right pulmonary artery (RPA) and four left pulmonary artery stenoses. Of these, two underwent balloon angioplasty of the RPA with incomplete relief of stenosis. During surgery, PA plasty with homograft onlay patch was undertaken, and the ascending aorta was extended with polytetrafluoroethylene grafts ranging from 14 mm to 20 mm. Major morbidity included one patient with postoperative neurologic injury and one with abdominal complications requiring exploratory laparotomy. Two patients (15%) died. Median follow-up amongst survivors was 43 months. Ten patients reached Fontan circulation. No patients required reintervention on the PA during follow-up. No significant gradient has been recorded in the aortic graft; one patient underwent prophylactic upsizing of a 14-mm conduit to 20-mm conduit during Fontan. All patients have normal cardiac function and normal neoaortic valve function at follow-up.

**Conclusions:** Aortic extension with interposition grafting effectively relieves extrinsic compression and related PA stenosis following Norwood procedure. Aortic interposition is a durable approach in the intermediate term.

P52

# **Impact of Passive Peritoneal Drainage on Achieving Negative Fluid Balance and Decreasing Inflammatory Mediators: A Randomized Prospective Trial**

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**Purpose:** Neonates after cardiopulmonary bypass are exposed to increasing inflammatory mediator release and are at risk of developing fluid overload. The aim of this study was to evaluate the impact of passive peritoneal drainage on achieving negative fluid balance and its ability to dispose of inflammatory cytokines.

**Methods:** From September 2014 to November 2016, neonates at a single center undergoing STAT category 3, 4, and 5 operations were prospectively randomized to receive or not receive intraoperative prophylactic peritoneal drain. We analyzed variables for demographic, intraoperative, early postoperative, and discharge for those who underwent only passive peritoneal drainage and those without a drain, who served as the control group. Inflammatory and anti-inflammatory cytokines also were evaluated from serum and peritoneal fluid in the peritoneal drain group and only serum in the control group, at 24 and 72 hours postoperatively.

**Results:** Twenty-five neonates were randomized to the control group without a drain (n=12) and peritoneal drain group (n=13). The two groups did not differ significantly in gestational age, weight, preoperative maximum lactate, cardiopulmonary bypass, or cross-clamp time. Patients with peritoneal drain had significantly lower diuretic index<sup>1</sup> at 72 hours (2.83 vs 6.06,  $P = .02$ ) and tended to reach negative fluid balance earlier (34 hours vs 70 hours,  $P = .08$ ), Table. However, there was no significant difference between the two groups in postoperative ventilation index<sup>2</sup>, inotropic score<sup>3</sup>, peak lactate level, time to sternal closure, time to first extubation, length of stay, and mortality (Table). Consistently, all cytokines, TNF- $\alpha$ , IL-4, IL-6, IL-8, IL-10, and IFN- $\gamma$  were present at a higher level in peritoneal fluid at 24 and 72 hours compared to serum levels in the peritoneal drain group. However, when serum cytokine levels were compared between the peritoneal drain and control groups at 24 and 72 hours postoperatively, no significant difference was found.

**Conclusions:** Patients with passive peritoneal drain use less diuretic in early postoperative period and tend to reach negative fluid balance earlier. However, early clinical outcome measures do not differ significantly between the two groups. Passive peritoneal drainage does not decrease serum inflammatory cytokine levels at 24 and 72 hours postoperatively.

Table 1: Peritoneal drain and control group postoperative clinical variables

Variables	Control, no drain (n=12)	Peritoneal drain (n=13)	p-value
Diuretic index <sup>1</sup> , 72-hours	6.06 (4.64-10.13)	2.83 (1.14-4.65)	0.02
Time-to-negative-fluid-balance (hours)	70.00 (38.00-81.00)	34.00 (24.00-70.00)	0.08
Ventilation index <sup>2</sup> , 72-hours	13.77 (0.00-25.70)	21.00 (17.32-26.12)	0.28
Inotropic score <sup>3</sup> , 72-hours	5.73 (5.00-11.92)	10.00 (5.20-19.92)	0.19
Cardiopulmonary bypass (minutes)	218.50 (182.50-292.50)	271.00 (234.00-309.50)	0.15
Cross-clamp (minutes)	111.00 (74.75-140.75)	120.00 (92.50-179.00)	0.61
Length-of-stay (days)	44.00 (27.00-75.00)	42.00 (22.00-74.00)	0.73
Peak lactate, 72-hours	6.10 (3.70-9.90)	5.70 (4.55-6.95)	1.00
Mortality (n)	2	2	1.00
STAT (n)			
3	1	2	1.00
4	6	4	1.00
5	5	7	1.00

Results are presented as median with interquartile range when indicated.

<sup>1</sup>Diuretic index = furosemide (mg/Kg/24-hours) + bumetanide (mg/Kg/24-hours) X (40) + chlorothiazide (mg/Kg/24-hours) + spironolactone (mg/Kg/24-hours); <sup>2</sup>Ventilation index = respiratory rate X (peak inspiratory pressure – positive end expiratory pressure) X PaCO<sub>2</sub>/1000; <sup>3</sup>Inotropic score = dopamine (μg/Kg/minute) + dobutamine (μg/Kg/minute) + 100 X epinephrine (μg/Kg/minute) + 10 X milrinone (μg/Kg/minute) + 10,000 X vasopressin (μg/Kg/minute) + 100 X norepinephrine (μg/Kg/minute).

P53

# **Electroencephalogram Activity During Deep Hypothermia and Circulatory Arrest in Neonatal Swine and Humans: A Comparative Study**

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**COMMERCIAL RELATIONSHIPS** T. J. Kilbaugh: Research Grant, Ischemix, Mallinckrodt Pharmaceuticals, Neurovive

**Purpose:** Piglets are used to study neurological effects of deep hypothermic circulatory arrest (DHCA), but no studies have compared human and swine responses to DHCA. The importance of electroencephalogram (EEG) silence before circulatory arrest is not fully known in neonates. We compared the EEG response to DHCA in human neonates and piglets.

**Methods:** We recorded and compared output from two channel, left-right centroparietal, subdermal EEG in 10 neonatal human patients undergoing surgery involving DHCA and 10 neonatal piglets who were placed on cardiopulmonary bypass and underwent a high-fidelity, simulated procedure using DHCA. Using a definition of EEG suppression as  $<10 \mu V$  for  $>2.4$  seconds, mild burst suppression was defined as suppression for  $<30$  seconds, severe burst suppression as suppression for  $>30$  seconds, and EEG silence as suppression  $>3$  minutes by automated moving window analysis. Human patients were monitored with 16-channel array EEG for 48 hours postoperatively.

**Results:** All human and piglet subjects started at mild suppression following induction of general anesthesia. All progressed to severe suppression, with humans progressing at mean nasopharyngeal (NP) temperature  $24.1^{\circ}C \pm 1.3^{\circ}C$  and piglets at mean NP temperature  $28.1^{\circ}C \pm 1.9^{\circ}C$ . All piglets reached EEG silence prior to DHCA (mean NP temperature  $21.9^{\circ}C \pm 2.1^{\circ}C$ ), while only one human subject did immediately prior to DHCA at  $18.1^{\circ}C$ . All piglets emerged from EEG silence at mean NP temperature  $33.8^{\circ}C \pm 2.5^{\circ}C$  and emerged from severe suppression at mean NP temperature  $34.9^{\circ}C \pm 2.0^{\circ}C$ . All human subjects emerged from severe suppression at mean NP temperature  $23.6^{\circ}C \pm 1.6^{\circ}C$ . All piglets and humans remained at mild suppression at the end of their respective procedures. No human patient had any EEG or clinical evidence of seizure in postoperative monitoring, and all human patients had continuous, baseline EEG activity at 48 hours.

**Conclusions:** Our data suggest that current cooling strategies are not sufficient to eliminate all EEG activity prior to circulatory arrest in humans, but are sufficient in swine. This important difference between the swine and human response to DHCA should be considered when using this model.

P54

# **Methemoglobin as a Potential Marker of Inadequate Tissue Oxygenation Following Palliation for Complex Congenital Heart Disease**

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**Purpose:** Postoperative anemia and cyanosis following infant cardiac surgical palliation can result in inadequate tissue oxygenation, oxidizing hemoglobin (Hb) to methemoglobin (MetHb). We hypothesized that MetHb levels may serve as a marker for inadequate tissue oxygenation following palliation for congenital heart disease.

**Methods:** We analyzed data from a subgroup of infants prospectively enrolled in a red blood cell (RBC) transfusion trial (n=57). Six infants were excluded because they required inhaled nitric oxide. Daily MetHb (normal: 0%-1.0%) and evidence for inadequate tissue oxygenation (Hemoglobin [Hb], venous saturation [SVO<sub>2</sub>], arteriovenous oxygen difference [avO<sub>2</sub>diff] and lactate) were evaluated for 10 days postoperatively. Correlation and multivariate regression analysis determined the relationship between MetHb and measures of inadequate tissue oxygenation. Values were further evaluated 12 hours pre- and post-RBC transfusion.

**Results:** There were 51 infants (61% neonates), and the median age at the time of palliation was 12 days (range, 7-142 days). Correlation analysis of 234 MetHb levels demonstrated a significant inverse relationship between MetHb and Hb ( $P = .01$ ), as well as the SVO<sub>2</sub> ( $P < .001$ ). There was a direct relationship between MetHb and avO<sub>2</sub>diff ( $P < .001$ ), as well as lactate ( $P < .001$ ). Multivariate regression demonstrated a significant relationship between MetHb, lactate, and SVO<sub>2</sub>, and Hb values (Table). Following 38 RBC transfusions, Hb and SVO<sub>2</sub> levels increased significantly, while MetHb levels decreased significantly (Figure). In 91% (21/23) of RBC transfusions administered when MetHb levels were high ( $\geq 1.0\%$ ), the level subsequently decreased, compared to 53% (8/15) of transfusions with low MetHb levels ( $< 1.0\%$ ) ( $P = .015$ ).

**Conclusions:** Following infant palliation, MetHb levels correlated with other physiologic metrics for impaired oxygen delivery and were significantly decreased following the transfusion of RBCs particularly when levels were high. This suggests that MetHb levels may be considered during the postoperative care of infants following cardiac surgery.

Figure 1.

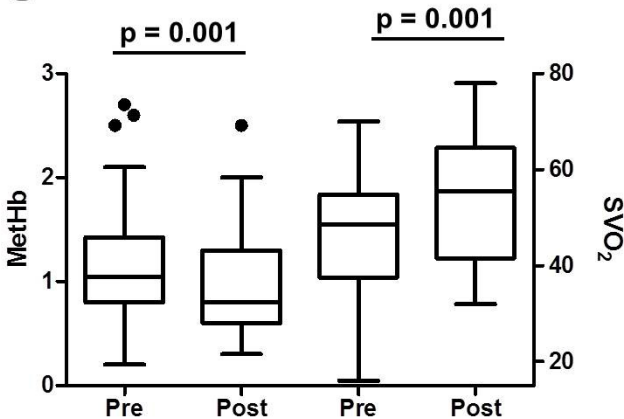


Figure 1. Methemoglobin (MetHb) and Venous Saturation (SVO<sub>2</sub>) 12 hours pre- and post- red blood cell transfusion

Table 1. Multiple Regression Analysis for Methemoglobin Levels

	Estimate	95% CI	p value
Hemoglobin	-0.033	-0.059, -0.007	0.013
SVO <sub>2</sub>	-0.006	-0.012, -0.001	0.023
avO <sub>2</sub> diff	0.032	-0.002, 0.066	0.063
Lactate	0.099	0.029, 0.168	0.006

Abbreviations: CI-Confidence Interval, SVO<sub>2</sub>-Venous Saturation, avO<sub>2</sub>diff-Ateriovenous oxygen difference

P55

# **Glial Fibrillary Acidic Protein Plasma Levels During Congenital Heart Disease Surgery Inversely Correlate With Vineland Adaptive Behavior Scales Communication Score**

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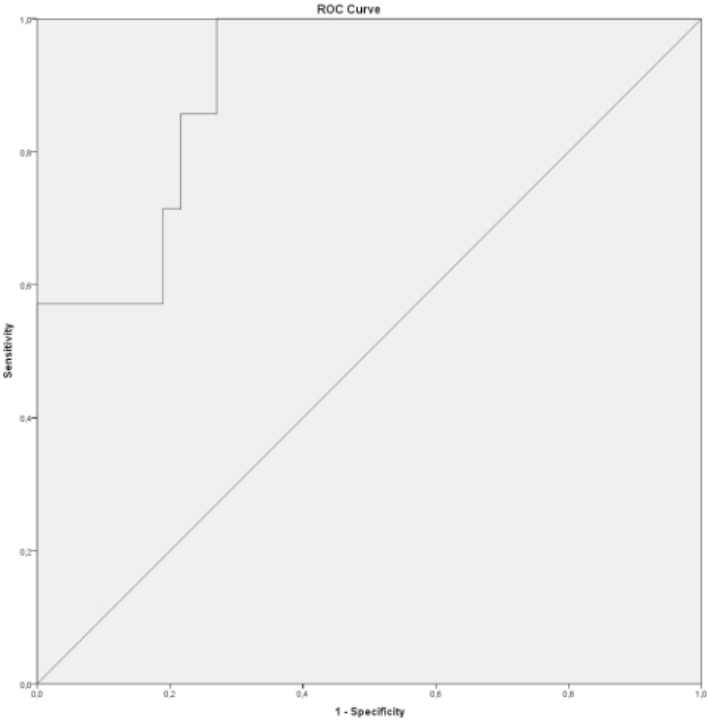
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**Purpose:** Neurocognitive deficits in congenital heart diseases (CHD) affect nearly 50% of children who undergo surgery for complex CHD. Newly acquired brain injuries affect 30% of patients postoperatively. We analyzed glial fibrillary acidic protein (GFAP) plasma levels during cardiopulmonary bypass to correlate the increase of GFAP with neurological outcomes.

**Methods:** This is a prospective, single-center, observational study in children undergoing cardiac surgery. We studied 46 children with CHD: six with univentricular physiology (UNIV); 16 with septal defects; and 24 with conal defects. GFAP was measured by ELISA at different cardiopulmonary bypass (CPB) stages. Vineland Adaptive Behavior Scales were administered to patients that were at least 18 months old. We recorded clinical and surgical parameters, applied multiple and logistic regressions to assess which parameters, along with GFAP, were independent predictors of Vineland scores (IQ).

**Results:** GFAP increased during CPB and peaked at the end of rewarming. Multiple regression analysis showed GFAP maximum-reached value and neurological comorbidity (prior to surgery) as significant independent predictors of Vineland communication domain IQ, corrected for cerebral saturation during CPB, age at Vineland, univentricular heart, minimum temperature reached during CPB, and occurrence of a period of neurological risk time interval during CPB. Age, CHD group, cyanosis before surgery, and other surgical independent factors also were tested with a stepwise-backward regression, but were not included in the model because they were not significant. A receiver operating characteristic curve was calculated to verify the power of the model to predict a communication IQ <70, and it was highly significant (Figure,  $P = .001$ , Area=0.9, 95% CI 0.8-1.0, SE=0.053).

**Conclusions:** Neurodevelopmental outcome in CHD seems to be the result of an underlying disruption of cognitive function network. Newly acquired brain injuries could be related to modifiable clinical risk factors, especially during surgery. We found that GFAP is a potential plasma marker of brain injury that correlates with the neurological outcome.



P56

# **Clinical Characteristics of Patients Requiring Prolonged Stays in the Intensive Care Unit Following Total Cavopulmonary Connection**

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**COMMERCIAL RELATIONSHIPS** A. Hager: Consultant/Advisory Board, Gilead, Johnson & Johnson, Merck; Nonremunerative Position of Influence, Actelion

**Purpose:** A prolonged stay in the intensive care unit (ICU) following total cavopulmonary connection (TCPC) is thought to be a premonitory sign of late morbidities and late Fontan failure. This study was performed to determine the morphological and preoperative characteristics of these patients and to evaluate the long-term outcomes following TCPC.

**Methods:** Among consecutive 483 patients who underwent a TCPC between May 1994 and December 2016, 54 patients required a prolonged stay in the ICU more than 14 days (median and IQR: 19 [16-28] days). Patients' main diagnosis, morphological characteristics, palliative procedures, pre- and postoperative systemic ventricular function and systemic atrioventricular valve (AVV) function, and hemodynamic and laboratory parameters were compared to the remaining 429 patients whose ICU stay was within 14 days (median and IQR: 6 [5-8] days). In-hospital morbidities, overall survival, and late morbidities following TCPC were also compared between the groups.

**Results:** Patients requiring prolonged ICU stay had a higher rate of dextrocardia ( $P = .008$ ), heterotaxy syndrome ( $P = .044$ ), anomalous systemic venous return ( $P = .007$ ), and systemic right ventricle ( $P = .048$ ). Genetic anomaly, extracardiac anomaly, palliative surgery, preoperative ventricular and AVV function did not influence the length of ICU stay. Preoperative hemoglobin level ( $16.8 \text{ g/dl} \pm 2.2 \text{ g/dl}$  vs  $16.2 \text{ g/dl} \pm 1.8 \text{ g/dl}$ ,  $P = .033$ ) and mean pulmonary artery pressure (mPAP,  $10.6 \text{ mm Hg} \pm 3.5 \text{ mm Hg}$  vs  $9.5 \text{ mm Hg} \pm 3.1 \text{ mm Hg}$ ,  $P = .012$ ) was higher in patients with prolonged ICU stay. Median age at bidirectional cavopulmonary shunt (0.5 years vs 0.5 years,  $P = .206$ ) and median age at TCPC (2.6 years vs 2.3 years,  $P = .139$ ) were not significantly different between the groups. With multivariable logistic regression analysis, high mPAP remained as a significant risk ( $P = .026$ ) for prolonged ICU stay. Patients with prolonged ICU stay had more frequently prolonged effusion ( $P < .001$ ), chylothorax ( $P < .001$ ), ascites ( $P < .001$ ), and secondary fenestration ( $P < .001$ ). Overall survival (82.1% vs 94.5% at 10 years,  $P = .001$ ), freedom from cardiac reoperation (81.4% vs 87.1% at 10 years,  $P = .008$ ), and freedom from catheter intervention (58.1% vs 77.1% at 10 years,  $P < .001$ ) was lower, and hemoglobin level ( $14.5 \text{ g/dl} \pm 1.5 \text{ g/dl}$  vs  $13.8 \text{ g/dl} \pm 2.4 \text{ g/dl}$ ,  $P = .008$ ) and the gamma-glutamyl transferase value ( $59.7 \pm 43.9$  vs  $47.4 \pm 33.8$ ,  $P = .043$ ) at final follow-up was higher in patients with prolonged ICU stay. ROC analysis with prolonged ICU stay demonstrated that mPAP of 10.5 mm Hg produced the maximum value of the Youden-Index.

**Conclusions:** A prolonged ICU stay was highly correlated with a worse outcome following TCPC. Among others, preoperative mPAP more than 10.5 mm Hg was identified as a risk factor. Hence, optimization of pulmonary circulation achieving low mPAP prior to TCPC might alternate the outcome following TCPC, especially in patients with anatomical risks.

P57

# **Quantitative Assessment of Vascular Ring in Children Using Multislice Computed Tomography Imaging**

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**Purpose:** The purpose of this study was to evaluate the severity of vascular ring from the perspective of tracheal compression using multislice computed tomography imaging.

**Methods:** Between April 2005 and January 2017, 262 children who underwent cardiovascular surgery with preoperative multislice enhanced computed tomography were retrospectively analyzed. Mean age was 0.7 years  $\pm$  1.4 years. We established two computed tomographic indices (passing interval index and percent tracheal stenosis) and determined the cutoff values of respiratory symptoms of vascular ring. Passing interval index was defined as the minimal interval of two structures that encircled the intrathoracic part of trachea (aorta, cervical branches, pulmonary artery, ligamentum arteriosus, and vertebra) standardized by height. Percent tracheal stenosis was defined as the narrowest tracheal area divided by the control tracheal area.

**Results:** Thirty-five children were diagnosed with vascular ring, and 10 of them had symptoms of severe tracheal compression (stridor in eight children and respiratory distress in two children). Mean passing interval index and percent tracheal stenosis were  $17.2 \pm 4.6$  and  $89.4 \pm 14.1$ , respectively. Children with symptoms had significantly lower values than children without symptoms (passing interval index:  $17.5 \pm 4.4$  vs  $10.3 \pm 2.6$ ,  $P < .001$ , and percent tracheal stenosis:  $91.1 \pm 10.7$  vs  $48.9 \pm 25.3$ ,  $P < .001$ ). The cutoff values of symptomatic tracheal compression were 12.7 in passing interval index (area under the curve 0.94) and 80.1 in percent tracheal stenosis (area under the curve 0.98). Assuming that children whose two values were below the cutoff value were classified into severe vascular ring, sensitivity and specificity were 90.0% and 98.0%, respectively.

**Conclusions:** We evaluated the severity of vascular ring using two indexes of passing interval index and percent tracheal stenosis assessed by multislice enhanced computed tomography. Both indexes had high diagnostic capability and might be useful for decision making.

P58

# **Perioperative Outcome of Stage 1 Norwood Palliation With Dual Arterial Cannulation**

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**Purpose:** Norwood reconstruction using direct cannulation of the innominate artery and descending aorta (dual arterial cannulation, DAC) can be performed under mild hypothermia and with uninterrupted full flow to the brain and viscera. We sought to report outcomes of this procedure with regard to survival, blood transfusion, and inotropic support.

**Methods:** Retrospective review of all patients with hypoplastic left heart syndrome (HLHS) who underwent Norwood stage 1 palliation at our institution by a single surgeon, since adoption of the DAC technique in 2009.

**Results:** Forty-two neonates with HLHS underwent Norwood operation with DAC. Thirty-eight survived to second stage operation (90%). Duration of cross-clamp and cardiopulmonary bypass (median, IQR) were 31 (23, 57) minutes and 110 (95, 146) minutes, respectively. All patients received washed red cells in the circuit prime. Twelve patients (28%) required no additional transfusion for hemostasis. Twenty-eight patients received platelets, of whom three also received cryoprecipitate and one received FFP. Six patients (14%) were treated with open chest. Duration of mechanical ventilation was 3 (1, 4) days. Duration of ICU stay was 9 (5, 19) days. The mean inotrope score (dopamine + milrinone x10 + epinephrine x100) was 6.74.

**Conclusions:** Stage 1 palliation for HLHS can be performed safely with DAC under mild hypothermia. Survival is similar to reported series from highly experienced centers. Inotrope score, blood transfusion, length of stay, and duration of ventilation compare favorably to national benchmarks.

P59

# **National Benchmarks for Proportions of Patients Receiving Blood Transfusions During Pediatric and Congenital Heart Surgery: An Analysis of the STS Congenital Heart Surgery Database**

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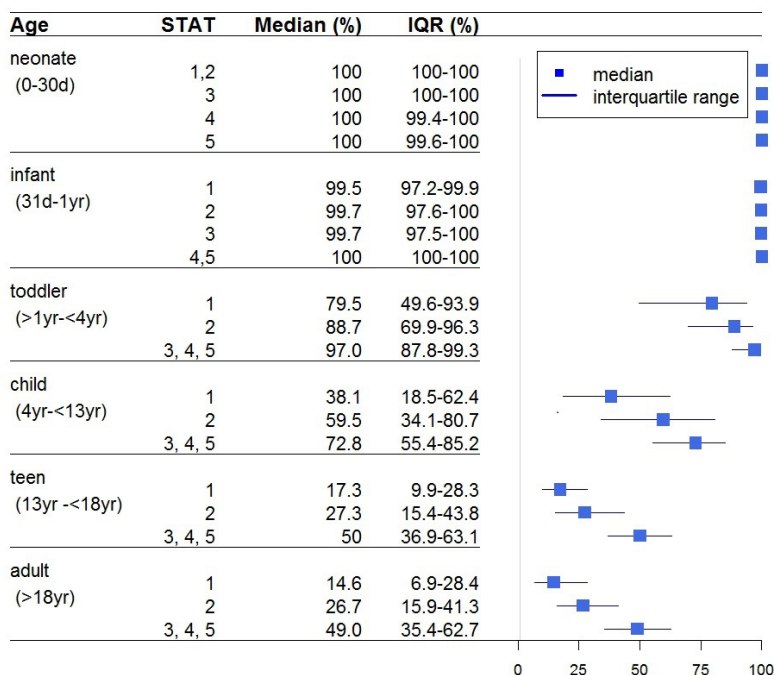
**COMMERCIAL RELATIONSHIPS** K. Hill: Research Grant, Gilead; Consultant/Advisory Board, Myokardia

**Purpose:** Nationwide variation in transfusion practices for pediatric and congenital heart surgery has not been assessed. Using the STS Congenital Heart Surgery Database (CHSD), we analyzed proportions of patients receiving blood transfusion during open heart surgery to determine national benchmarks and assess variability across centers.

**Methods:** Index cardiopulmonary bypass (CPB) operations reported in the CHSD (2014-2015) were potentially eligible for inclusion. Packed red blood cell (PRBC) transfusion was defined as intraoperative use of PRBC or CPB blood prime. Centers with >15% missing data for PRBC transfusion and operations missing information about PRBC transfusion were excluded. To generate robust estimates of center-level blood product usage despite excess sampling variability due to small volume centers, the distribution of center-level PRBC transfusion rates in various clinically relevant groups was estimated by fitting a two-level logistic model. PRBC transfusion was modeled by group with a fixed intercept and random center effect.

**Results:** The study population included 24,354 index CPB operations (81 centers). Center-level intraoperative PRBC transfusion rates stratified by age group and STAT mortality category are summarized in the Figure. For younger patients, and patients undergoing higher complexity operations, median center PRBC transfusion rates were at, or very close to, 100%, with narrow interquartile ranges (IQR) indicating relatively little center variability. Center PRBC transfusion rates diminished with increasing patient age, but with greater variability (wider IQRs) across centers. Intraoperative PRBC transfusion was uncommon (median center transfusion rates <30%) in older patients (teenagers and adults) undergoing lower complexity (STAT <3) operations. Plots and interpretations were similar when the models were rerun with patient age categories replaced with similar weight-based strata.

**Conclusions:** Most centers transfuse PRBCs routinely in higher-risk, younger, and smaller patients, with little variability across centers. For lower-risk operations in older and larger patients, centers are more likely to forgo intraoperative transfusions. This analysis provides national benchmarks for center-level PRBC transfusion rates during pediatric and congenital heart surgery.



P60

# **Selective Placement of Temporary Epicardial Pacing Leads and Determinants of Postoperative Use in Early Infancy After Cardiac Surgery**

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**COMMERCIAL RELATIONSHIPS** A. C. Polimenakos: Ownership Interest, Abbott, Boston Scientific

**Purpose:** Use of temporary epicardial pacing leads (TEP) remains a routine perioperative strategy in congenital heart surgery for diagnostic or therapeutic purposes. However, placement has been associated with perioperative complications. Selective use of TEP in neonates and infants undergoing cardiac intervention within the first 6 months of life and outcome analysis was undertaken.

**Methods:** From August 2014 to December 2016, 112 consecutive neonates and infants underwent cardiac intervention within the first 6 months of life. Patients with STS/EACTS Congenital Heart Surgery Complexity Categories (STAT) 1-5 were prospectively followed from the index cardiac operation until hospital discharge and included in the study. Patients on permanent pacemaker prior to the definitive cardiac intervention were excluded. Selective TEP placement was pursued only for specific intraoperative indications, including 1) anticipated diagnostic use, 2) sinus or atrioventricular (AV) nodal disturbance, or 3) attenuated hemodynamic performance present after weaning from cardiopulmonary bypass. Need for permanent pacemaker insertion, vasoactive-inotropic score, time-to-negative-balance, and determinants associated with the postoperative use of TEP were assessed.

**Results:** TEP was used in 11 patients (9.8%; Group A); none on STAT I and II patients, seven in STAT III (18%), three in STAT IV (14%), and two in STAT V (21%). It was used for diagnostic purposes in four patients, for therapeutic purposes in three patients, and for diagnostic and therapeutic purposes in two patients. It was not used in two patients (18%). In the 98 patients without TEP (Group B), one required treatment for perioperative rhythm disturbance amenable to pacing. Vasoactive-inotropic score, ICU length of stay, and time to negative balance was not statistically different between groups ( $P > .05$ ). None of the 112 patients required permanent pacemaker insertion during hospital stay. Intraoperative need for cardioversion, sustained sinus or AV nodal disturbance, severely reduced ventricular ejection fraction, and unresolving elevated serum lactate level at the time of operating room discharge were found to be predictors for the use of TEP.

**Conclusions:** Selective placement of epicardial pacing leads is justified during early infancy for congenital heart surgery. Nearly 20% of those selected for placement will not require it, and only 1% of those without TEP might need it. Specific intraoperative parameters can guide the need and judicious use of TEP early after cardiac surgery.

Critical Care

P61

**Addressing Diaphragm Dysfunction in Cardiac Surgery Patients: Successful Therapeutic Use With Current Technology and Future Prophylactic Use of Temporary Diaphragm Pacing Utilizing Intramuscular Electrodes**

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**COMMERCIAL RELATIONSHIPS** R. P. Onders: Ownership Interest, Synapse Biomedical; Research Grant, Synapse Biomedical; J. F. Sabik: Research Grant, Abbott; Consultant/Advisory Board, Medtronic

**REGULATORY DISCLOSURE** This presentation describes the off-label use of NeuRx for use in overcoming phrenic nerve injuries and diaphragm dysfunction after cardiac surgery.

**Purpose:** Between 1.6% and 60% of cardiac surgery patients experience phrenic nerve injury and diaphragm dysfunction (DD). Up to 5% require prolonged ventilator support. Invasive or noninvasive mechanical ventilation carries significant morbidity and potential mortality. We describe therapeutic intramuscular diaphragm pacing (DP) in 11 patients and a feasibility trial of prophylactic capability in four patients.

**Methods:** A retrospective review of compassionate off-label use of an FDA-approved device under IRB approval. In this group, an electrical stimulus was delivered to the diaphragm via laparoscopically placed intramuscular electrodes to facilitate diaphragm strengthening and subsequent weaning from mechanical ventilation. A second group prospectively received two temporary DP electrodes placed intramuscularly in each diaphragm at the motor point of where the phrenic nerve enters the muscle at the end of their primary cardiac procedure. Serial diaphragmatic electromyograms (EMGs) were obtained. Safety and efficacy parameters for pacing and implantation are reported.

**Results:** Eleven post-cardiac surgery patients with prolonged ventilator support from DD were implanted. Ages ranged from 57-81 years old (average 68 years). Mean duration of positive pressure ventilation prior to DP was 20 days. All patients were successfully weaned with DP (eight patients received invasive and three received noninvasive mechanical ventilation). The average survival is 32.6 months (1.67 to 76.8 months). There was one non-DP-related early death. Serial EMGs of the diaphragm measured through DP electrodes showed improved burst activity and was used to guide DP therapy. In the next phase, temporary DP electrodes were implanted in four patients who underwent median sternotomy. Subject ages ranged from 46-84 years (average 72 years). The temporary electrodes were successful in achieving ideal tidal volumes and exceeded ideal tidal volumes by 47%. Temporary electrodes successfully measured dEMG. There were no complications. There was complete intact removal of all electrodes at the bedside.

**Conclusions:** DP can be used successfully to treat DD from phrenic nerve injury. This trial also demonstrates safe placement, removal, and functionality of temporary DP electrodes. Routine use of temporary DP electrodes at cardiac surgery followed by early DP use may mitigate prolonged mechanical ventilation and the need for tracheostomy.

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# **The Role of an Artificial Pancreas in Glucose Management During Aortic Surgery**

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**COMMERCIAL RELATIONSHIPS** Y. Hoshino: Research Grant, Nikisso; K. Nawata: Other, Nipro

**Purpose:** The bedside-type artificial pancreas has been used for therapeutic purposes in the field of emergency/gastrointestinal surgery. However, there are few reports describing its use in cardiovascular surgery. We therefore examined the effectiveness and safety of the intraoperative use of an artificial pancreas (STG-55).

**Methods:** An STG-55 was used during cardiopulmonary bypass in aortic surgery in our hospital in the treatment of 16 patients between April and September 2016. Historical data from 52 patients who underwent aortic surgery in our hospital from June 2014 to June 2015 were used as a control. The blood glucose-related indices (mean blood glucose level, peak blood glucose level, coefficient of variation (CV) in glucose variability, percentages with glucose levels of <90 mg/dl) and insulin usage during cardiopulmonary bypass were compared and studied.

**Results:** The mean ages of the patients in the STG-55 and control groups were 46.6 years  $\pm$  18.0 years and 54.7 years  $\pm$  19.9 years, respectively ( $P = .1502$ ). The mean STG-55 usage time was 136.1 minutes  $\pm$  45.0 minutes. With regard to the mean blood glucose level, peak blood glucose level, and CV, significantly better glycemic control was achieved in the STG-55 group (STG-55 vs control: mean blood glucose level, 139.2 mg/dl  $\pm$  20.0 mg/dl vs 167.3 mg/dl  $\pm$  35.6 mg/dl [ $P = .0037$ ]; peak blood glucose level, 160.5 mg/dl  $\pm$  22.1 mg/dl vs 221.8 mg/dl  $\pm$  53.0 mg/dl [ $P < .0001$ ]; and CV, 0.10  $\pm$  0.05 vs 0.19  $\pm$  0.08 [ $P < .0001$ ]). The percentage of patients in the STG-55 group with blood glucose levels <90 mg/dl was 0.0%, while that in the control group was 15.4% ( $P = .183$ ). The insulin usage in the STG-55 group was 6.3 U  $\pm$  6.4 U, while that in the control group was 8.1 U  $\pm$  12.9 U ( $P = .5800$ ).

**Conclusions:** A bedside-type artificial pancreas (STG-55) was safely used in aortic surgery and achieved better glucose control compared to conventional management. It is necessary to investigate whether more stable glycemic control becomes possible when STG-55 is used not only in the operation, but also in the postoperative phase.

General Thoracic Surgery

P63

**Fast Tracking in Video-Assisted Lobectomy: A Prospective, Historically Controlled, Case-Matched Clinical Trial**

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**COMMERCIAL RELATIONSHIPS** M. A. Liberman: Research Grant, Boston Scientific, Cook Medical, Ethicon

**Purpose:** Fast-track surgery (FTS) pathways have been shown to diminish the rate of complications and length of stay in various surgical procedures. The objectives were to assess the feasibility of implementing a FTS pathway for video-assisted thoracoscopic surgical (VATS) lobectomy, evaluate associated postoperative outcomes, and compare FTS to case-matched controls.

**Methods:** This study consisted of a prospective clinical trial. Patients were prospectively enrolled between November 2015 and October 2016. Eligible patients included all patients who consented to undergo a VATS lobectomy at a single academic medical center. Strict adherence to the FTS pathway was attempted in all enrolled patients. The primary outcome was the number and severity of complications measured by the Comprehensive Complication Index. Secondary outcomes included length of stay, readmission, and recovery. Recovery of patients was measured using EQ-5D-3L, preoperatively and postoperatively at 1 week, 1 month, and 4 months. Prospectively enrolled patients were case-matched with historical controls.

**Results:** Ninety-eight patients (36 men and 62 women) in the FTS group were enrolled and matched to 98 historical controls (29 men and 69 women). Mean age was 65.1 years  $\pm$  9.3 years, mean body mass index was 26.9 kg/m<sup>2</sup>  $\pm$  5.9 kg/m<sup>2</sup>, and the median Charlson Comorbidity Index was 2 (IQR 2-3) in the FTS group, and 66.2 years  $\pm$  9.4 years, 27.4 kg/m<sup>2</sup>  $\pm$  5.6 kg/m<sup>2</sup>, and 3 (IQR 2-3) in the control group ( $P > .05$ ). Twenty-three patients (23.4%) experienced one or more postoperative complications in the FTS group, in comparison to 28 (28.6%) in the control group ( $P = .44$ ). The mean Comprehensive Complication Index Score was 7.4  $\pm$  16.7 in the FTS group compared to 8  $\pm$  14.3 in the control group ( $P = .79$ ). The median postoperative length of stay was 3 days in the FTS group and 5 days in the control group ( $P < .05$ ). Five patients in the FTS group and four patients in the control group were readmitted ( $P = .72$ ).

**Conclusions:** Following VATS lobectomy, implementation of a fast-track protocol is feasible. It is associated with a shorter length of hospitalization compared to historical controls, without increased complications or readmissions.

**Table 1. Length of stay of patients per group**

Length of stay (days)	Fast-Track group (n)	Control group (n)	p-value
1	5	0	0.02
2	21	2	0.0007
3	24	17	0.26
4	13	24	0.08
5	12	21	0.1
6	8	16	0.1
7	3	7	0.2
>7	11	11	0.98
<b>Overall</b>	<b>97*</b>	<b>98</b>	<b>0.0004</b>

\*One patient died in the Fast-Track Surgery group

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# **Patterns of Recurrence and Methods of Surveillance in Low- and Intermediate-Grade Neuroendocrine Tumors**

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**COMMERCIAL RELATIONSHIPS** B. E. Louie: Research Grant, Intuitive Surgical, Torax Medical; Consultant/Advisory Board, Torax Medical

**Purpose:** Surveillance of resected low (LG) and intermediate grade (IG) neuroendocrine tumors is undefined. Scheduled imaging based on non-small-cell lung cancer surveillance guidelines is usually chosen. Recently, this was challenged because of low recurrence rates and unclear efficacy. We reviewed recurrences from a multi-institutional cohort to define a surveillance strategy for these tumors.

**Methods:** We retrospectively reviewed 461 patients who underwent resection of LG or IG neuroendocrine tumors in nine international centers (Table). At a median follow-up of 42.5 months, 56 (12.2%) recurrences were identified. Charts were reviewed to determine the location, time to recurrence, and subsequent management. Imaging was obtained as part of planned surveillance, incidental if done for unrelated reasons or obtained for symptoms. Local recurrences were identified in the ipsilateral lobe/staple line, regional in the ipsilateral hemithorax and lymph nodes, and distant if outside the ipsilateral hemithorax. All sites employed 6-month planned imaging with at least yearly computed tomography (CT).

**Results:** There were 32 LG recurrences (8.5%) and 24 IG recurrences (28.2%). The LG recurrences were distant in 16 (50%), regional in seven (22%), and local in nine (28%). IG recurrences were distant in 15 (62%), regional in eight (33%), and local in one (4%). The liver was the site of distant spread in nine LG and 11 IG tumors. Nodal disease was present in six (22%) LG recurrences and 13 (54%) IG recurrences. The median time (months) to recurrence was 26 (IQR 8-50) for LG and 13 (IQR 6-45) for IG. Of 29 LG recurrences, 21 (72%) were detected on planned imaging, five (17%) on incidental imaging, and three (10%) imaging for symptoms. Of 21 IG recurrences, 19 (90%) were detected on planned imaging, two (9.5%) on incidental imaging, and none for symptoms. Surveillance data for six patients was not available. All but one recurrence was detected with CT imaging.

**Conclusions:** Recurrences were uncommon, but more likely in IG tumors. The majority in both LG and IG were distant and asymptomatic. The use of planned CT surveillance, including the liver, is an appropriate strategy for management of a resected neuroendocrine tumor.

Table 1: Cohort Demographics, Clinical and Recurrence data

	Low Grade Neuroendocrine tumor		Intermediate Grade Neuroendocrine tumor	
Total	n=376		n=85	
Female	254	67.7%	56	65.9%
Age (median)	59		60	
Central tumor	195	53.6%	42	50.0%
Node positive	40	12.9%	31	39.7%
Resection Margin				
R0 Resection	358	96.8%	70	83.3%
R1 Resection	12	3.2%	13	15.5%
R2 Resection	0	0	1	1.2
Type of resection				
Anatomic	267	70.5%	72	84.7%
Non-anatomic	112	29.6%	13	15.5%
Site of systemic recurrence				
Liver	9	56.3%	11	73.3%
Bone	3	18.8%	3	20.0%
Other	4	25.0%	1	6.7%
Treatment of recurrence				
Surgery	5	20.0%	3	12.5%
Chemotherapy	6	24.0%	7	29.2%
Chemotherapy + radiation	0	0	3	12.5%
Radiation	3	12.0%	3	12.5%
Biologic therapy	5	20.0%	6	25.0%
No therapy	6	24.0%	2	8.3%
Unknown	7	21.9%	0	0

P65

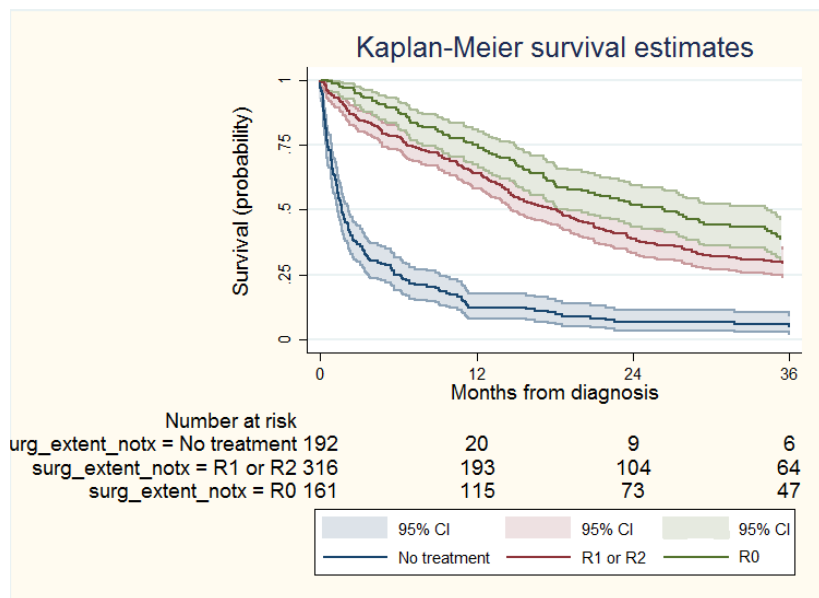
**Treatment Approaches and Outcomes for Primary Mediastinal Sarcoma****K. E. Engelhardt<sup>1</sup>, M. M. DeCamp<sup>1</sup>, A. M. Yang<sup>1</sup>, K. Y. Bilimoria<sup>1</sup>, D. D. Odell<sup>2</sup>**<sup>1</sup>Northwestern University, Chicago, IL, <sup>2</sup>Northwestern Memorial Hospital, Chicago, IL**COMMERCIAL RELATIONSHIPS** M. M. DeCamp: Consultant/Advisory Board, Boston Scientific, Holaira, Intuitive Surgical

**Purpose:** Primary mediastinal sarcomas are rare, impairing comprehensive investigation of treatment strategies and outcomes beyond single-institution studies. Our objective was to examine national treatment approaches and outcomes of surgery, radiation, and/or chemotherapy for mediastinal sarcomas.

**Methods:** We queried the National Cancer Database for all cases of mediastinal sarcoma diagnosed from 2004 to 2013 in the United States. Patient, tumor, and hospital-level characteristics were assessed. Survival was examined using the Kaplan-Meier method. Differences in survival were assessed using log-rank analysis and Cox proportional hazards regression.

**Results:** We identified 1116 patients for analysis. The mean age of diagnosis was 52 years (range, 0-90 years) with the majority of patients being male (58.4%). The most common histological subtype was hemangiosarcoma (27.1%). For those patients whose grade was known (n=577, 51.7%), the majority of tumors were poorly or undifferentiated (82.7%). Fewer than half of patients underwent surgery (48.4%), while 20.3% of patients had no treatment. Surgical patients were younger and less likely to have distant metastasis ( $P < .001$  for both). An R0 resection was accomplished in only 33.5% of patients undergoing surgical resection. Five-year survival was 43.6% for the entire cohort. Of those who underwent surgery (n=540, 48.4%), 5-year survival was significantly better for those who achieved an R0 resection as compared to those who did not (54.7% vs 35.7%;  $P = .002$ ). However, patients who had an incomplete resection had a 5-year survival of 35.7% compared to 12.2% for those who had no therapy ( $P < .001$ ; Figure). The patients who received a combination of surgical resection and radiation therapy had a 5-year survival of 41.9%.

**Conclusions:** The 5-year survival for primary mediastinal sarcoma is poor. Surgical resection can be successful and should be considered whenever possible.



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**Is Esophagectomy for Benign Conditions Benign?***K. M. Masabni<sup>1</sup>, I. Rubinfeld<sup>2</sup>, Z. T. Hammoud<sup>2</sup>**<sup>1</sup>Henry Ford Hospital/Wayne State University School of Medicine, Detroit, MI, <sup>2</sup>Henry Ford Hospital, Detroit, MI*

**Purpose:** Outcomes data on esophagectomy performed for benign conditions is scarce. Using the National Surgical Quality Improvement Program (NSQIP) database, we sought to analyze outcomes of esophagectomy performed for benign conditions.

**Methods:** The NSQIP database was queried for all esophagectomies performed from 2005 to 2015. Outcomes for benign conditions were analyzed and compared to those for malignant conditions.

**Results:** A total of 7477 patients underwent esophagectomy during the study period. Of those, 6762 underwent esophagectomy for malignant conditions and 715 for benign conditions. For patients with benign conditions, reconstruction was performed using gastric conduit in 631 and colon/intestine in 84; anastomosis was intrathoracic in 454 and cervical in 261. Esophagectomy for benign conditions was more likely to be emergent (10.1% vs 0.4%,  $P < .001$ ). In addition, esophagectomy for benign conditions had longer hospital length of stay (17.2 days vs 14.5 days,  $P < .001$ ) and higher occurrence of Clavien-Dindo Grade IV complications (25% vs 20%,  $P = .003$ ). Mortality was similar in both groups at 4%. In patients with benign conditions, reconstruction with colon/intestine had higher occurrence of Clavien-Dindo Grade IV complications (37% vs 23%,  $P = .006$ ), surgical wound infections (33% vs 16%,  $P < .001$ ), and death (10% vs 4%,  $P = .017$ ) compared to gastric reconstruction. Site of anastomosis did not have an impact on outcomes.

**Conclusions:** Esophagectomy for benign conditions is associated with significant morbidity. While the site of anastomosis does not alter outcomes, use of colon/intestine conduit should be pursued with caution.

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# **Sublobar Resection and Video-Assisted Thoracic Surgery Approach Are Associated With Decreased Postoperative Atrial Fibrillation/Flutter After Lung Cancer Surgery—A Nationwide Inpatient Sample Analysis**

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**Purpose:** The incidence of general thoracic surgery postoperative atrial fibrillation/flutter (POAF) is 4%-37%. Definitive data of POAF rates by resection type or surgical technique for non-small-cell lung cancer (NSCLC) are lacking. Querying a national database, we tested the hypothesis that a video-assisted thoracic surgery approach (VATS) leads to less POAF.

**Methods:** Retrospective cohort study, using the Healthcare and Utilization Project Nationwide Inpatient Sample (HCUP-NIS) database from 2008 to 2011. ICD-9-CM codes were used to identify adult patients who underwent elective lobectomy and sublobar resection (segmentectomy or wedge), via thoracotomy (OPEN) or VATS for primary NSCLC. We determined the rate of POAF and its effects on both mortality and discharge disposition (home or institutionalized care facility [ICF]). Multivariate logistic regression modeling, including age, sex, comorbidities, OPEN vs VATS, and extent of lung resection were used to identify independent predictors of POAF. A *P* value < .05 was considered significant.

**Results:** We identified 28,314 patients. Resection and technique frequencies are shown in Table 1A and POAF rate in Table 1B. Sublobar resection, any technique, was associated with a decreased rate of POAF compared to all lobectomies (14.8% [n=1431] vs 19.2% [n=3577]; *P* < .01). All VATS were associated with less POAF compared to all OPEN (15.1% [n=1686] vs 19.4% [n=3322]; *P* < .01). POAF was 35% (OR 0.65, 95% CI 0.61-0.70) less common in sublobar resections and 28% (OR 0.72, 95% CI 0.68-0.78) less common with VATS. VATS lobectomy had a decreased risk of POAF compared to OPEN segmentectomy (19.3% [n=246] vs 16.9% [n=939]; *P* < .04). Patients who developed POAF had higher mortality and discharge to an ICF (*P* < .01). Congestive heart failure (CHF; OR 2.6, 95% CI 2.3-3.0) and cerebrovascular disease (CVD; OR 2.1, 95% CI 1.4-2.9) were independent predictors of POAF.

**Conclusions:** POAF portends poorer outcomes for patients undergoing surgery for NSCLC, including increased perioperative mortality and discharge to an ICF. For patients who have high risk for POAF, ie, patients with CHF and CVD, our study suggests that limited OPEN resection or any minimally invasive resection should be considered.

<b>Table 1A. Frequency of thoracic surgical technique for NSCLC resection.</b>			
	<b>OPEN</b>	<b>VATS</b>	
<b>TOTAL</b>	<b>60.5% (n = 17,118)</b>	<b>39.5% (n = 11,196)</b>	
<b>Lobectomy</b>	76.4% (n = 13,078)	49.8% (n = 5,571)	
<b>Segmentectomy</b>	7.4% (n = 1,272)	10.5% (n = 1,180)	
<b>Wedge</b>	16.2% (n = 2,768)	39.7% (n = 4,445)	
<b>Table 1B. Rate of POAF after lung resection via OPEN or VATS</b>			
	<b>OPEN POAF</b>	<b>VATS POAF</b>	<b>p value</b>
<b>Lobectomy</b>	20.2% (n = 2,638)	16.9% (n = 939)	<i>p</i> <0.01
<b>Segmentectomy</b>	19.3% (n = 246)	14.6% (n = 172)	<i>p</i> <0.01
<b>Wedge</b>	15.8% (n = 438)	12.9% (n = 575)	<i>p</i> <0.01
NSCLC = non-small cell lung cancer; POAF = postoperative atrial fibrillation and flutter; VATS = video-assisted thoracic surgery			

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# **Fabrication of a 3-Dimensional Bioprinted Tracheal Scaffold With Fibrous Cover and Cartilaginous Regeneration**

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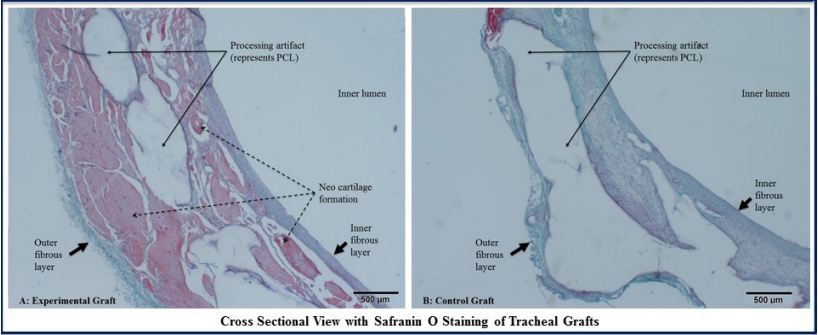
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**Purpose:** Both bioengineering and 3-dimensional (3D) printing hold promise in manufacturing a functional tracheal replacement graft, which would aid in the currently limited management of long-segment tracheal stenosis. This pilot study investigates the viability of introducing tracheal replacement grafts subcutaneously in a rat animal model.

**Methods:** Five Sprague-Dawley rats (SDR) were enrolled and completed the study. Two groups of tracheal replacement grafts (270° rings) were created by 3D printing as previously described. The control group grafts (n=5) were composed of biodegradable polycaprolactone (PCL), and the experimental group grafts (n=5) were composed of concurrently bioprinted PCL scaffold and SDR tracheal hyaline chondrocytes in a hydrogel. A PCL cylinder was secured to the inner surface of each graft for structural support. Both types of graft units were inserted subcutaneously into each of five SDR subjects, allowed to integrate for 4 weeks before harvesting, and underwent histological analysis.

**Results:** None of the SDR experienced any adverse reaction to the subcutaneous implantation of the grafts. Following harvest, the grafts were histologically analyzed with Safranin O staining. Both experimental and control grafts exhibited a continuous thin fibrous lining that surrounded the specimen and was air tight. All experimental grafts were shown to have adequate hyaline cartilage formation indicated by chondrocytes within lacuna, surrounded by an aggrecan-rich extracellular matrix, and with strong Safranin O staining. All control grafts showed the persistence of PCL scaffold without new cartilage formation. Of note, during tissue processing, the PCL scaffold is removed, which results in a processing artifact whose dimensions are proportional to the residual PCL. Neither control nor experimental grafts showed evidence of inflammation or lymphatic proliferation. See Figure for histologic Safranin O stained results of both tracheal grafts.

**Conclusions:** We report normal neo cartilage growth, formation of a fibrous layer, and absent inflammatory response in a tracheal replacement graft implant (PCL and chondrocytes). This is promising, as neo cartilage formation provides structural support and a continuous fibrous layer can act as a luminal barrier, both necessary in tracheal grafting.



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# TLR-4 Is a Mediator of Proliferation in Esophageal Cancer Cells

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**COMMERCIAL RELATIONSHIPS** T. B. Reece: Research Grant, Medtronic, W. L. Gore & Assoc; Consultant/Advisory Board, McKesson

**Purpose:** The development of esophageal adenocarcinoma is attributed to the chronic inflammation generated by prolonged reflux disease. Toll-like receptor (TLR)-4 is a component of the innate immune system and may be an integral mediator of chronic inflammation. We hypothesize that TLR-4 plays a significant role in the response to reflux-induced inflammation.

**Methods:** Normal human esophageal cells (HET1A), adenocarcinoma cell lines (OE33 and FLO1), and squamous cell carcinoma cells (OE21) were cultured using standard techniques. HET1A cells were treated with pH7 media (baseline), pH7 media plus 50  $\mu$ M deoxycholic acid (DCA), acidic (pH4) media, and acidic media plus 50  $\mu$ M DCA for 30 minutes. TLR4 levels were assessed using standard Western blot techniques. All cells were treated with lipopolysaccharide (LPS), a specific agonist of TLR4, at various doses for 48 hours in 1% FBS cell culture media. Proliferation was assessed using the MTS assay to measure the growth response to TLR4 stimulation.

**Results:** Protein analysis showed consistently detectable TLR4 in all cell lines and baseline expression to be most prominent ( $P < .05$ ) in esophageal adenocarcinoma cell lines (Figure 1a). Reflux-related stimuli elicited increases in TLR4 expression ( $P < .01$ ) in HET1A cells (Figure 1b). After treatment with LPS, we found that all cell lines showed a significant increase in proliferation ( $P < .05$ ) when compared to their baseline untreated controls (Figure 1c-f). The optimal dose of LPS was 100 ng/mL, which showed the greatest increase in proliferation across all cell lines.

**Conclusions:** TLR4 is consistently detectable in esophageal cell lines, with the highest expression in esophageal adenocarcinoma. TLR4 expression increases in a reflux, pro-inflammatory model. Activation of TLR4 results in increased proliferation in all esophageal cell lines. These findings suggest TLR4 is a possible target to suppress the growth of esophageal cancer.

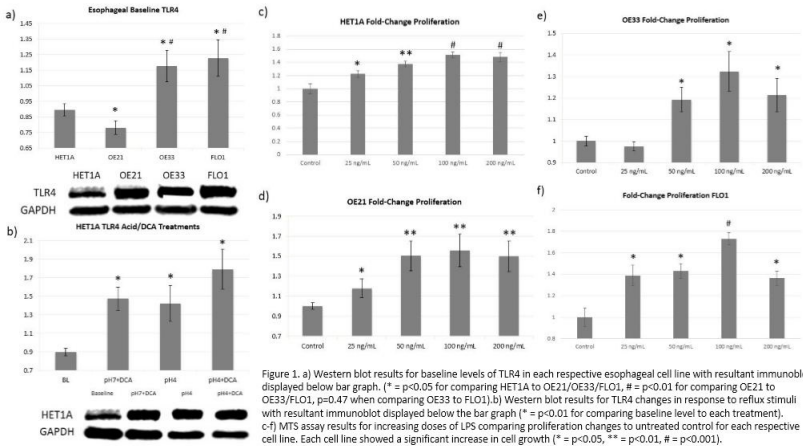


Figure 1. a) Western blot results for baseline levels of TLR4 in each respective esophageal cell line with resultant immunoblot displayed below bar graph. (\* =  $p < 0.05$  for comparing HET1A to OE21/OE33/FLO1, # =  $p < 0.01$  for comparing OE21 to OE33/FLO1,  $p < 0.47$  when comparing OE33 to FLO1). b) Western blot results for TLR4 changes in response to reflux stimuli with resultant immunoblot displayed below the bar graph (\* =  $p < 0.01$  for comparing baseline level to each treatment). c-f) MTS assay results for increasing doses of LPS comparing proliferation changes to untreated control for each respective cell line. Each cell line showed a significant increase in cell growth (\* =  $p < 0.05$ , \*\* =  $p < 0.01$ , # =  $p < 0.001$ ).

P70

# **PD-L1 Expression <1% Is Associated With Improved Antineoplastic Response to Metformin in Resected, Early Stage Non-Small-Cell Lung Cancer**

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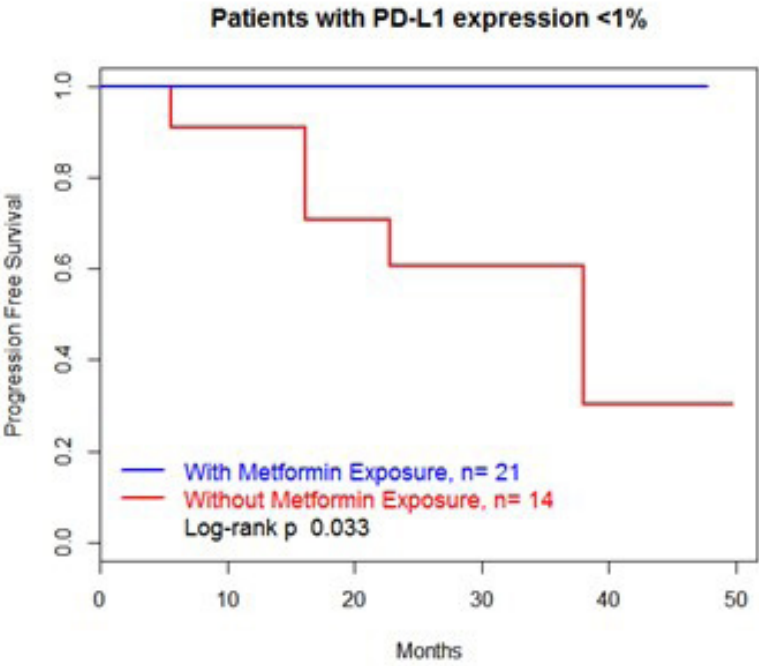
**REGULATORY DISCLOSURE** This presentation describes the off-label use of metformin and any anti-neoplastic effects it has on non-small-cell lung cancer.

**Purpose:** Metformin and immune-checkpoint inhibitors of programmed death-ligand 1 (PD-L1) have been independently shown to have therapeutic effects in non-small-cell lung cancer (NSCLC). However, the association between PD-L1 expression and anti-neoplastic response to metformin has not been explored in patients with resected, early stage NSCLC.

**Methods:** An institutional database was queried for all type II diabetics with T1-3N0M0 NSCLC that underwent resection between 2004 and 2013. Patients were stratified by preoperative metformin exposure, and immunohistochemical (IHC) evaluation of tumor PD-L1 expression (clone SP263; Ventana) was performed. Associations with progression-free (PFS) and overall survival (OS) were assessed using Kaplan-Meier estimates, log-rank tests, and Cox regression.

**Results:** During the study period, 110 patients with early stage NSCLC were treated with surgical resection (65 with preoperative metformin exposure; 45 without metformin exposure). With a median follow up of 19.5 months, metformin exposure was associated with improved PFS ( $P = .045$ ), but not with OS. In patients with PD-L1 expression <1%, preoperative metformin exposure was associated with improved PFS ( $n = 21$ ; no cases of progression) compared to those without metformin exposure ( $n = 14$ ; median PFS = 38 months;  $P = .033$ ; Figure). On multivariate interaction analysis, a synergistic effect was observed between PD-L1 expression <1% and metformin exposure with respect to improved PFS (interaction effect  $P = .017$ ). No associations were observed between metformin exposure and survival in patients with PD-L1 expression  $\geq 1\%$ .

**Conclusions:** Preoperative metformin exposure is associated with improved PFS in type II diabetics with resected, early stage NSCLC. The anti-neoplastic effects of metformin may be greatest in patients with tumor PDL-1 expression <1%. Currently, we are evaluating the phenotypic profile and role of tumor-infiltrating lymphocytes as it relates to the anti-neoplastic properties of metformin.



P71

# **DNA Methylation Profiling of Squamous Cell Lung Cancer With Idiopathic Pulmonary Fibrosis**

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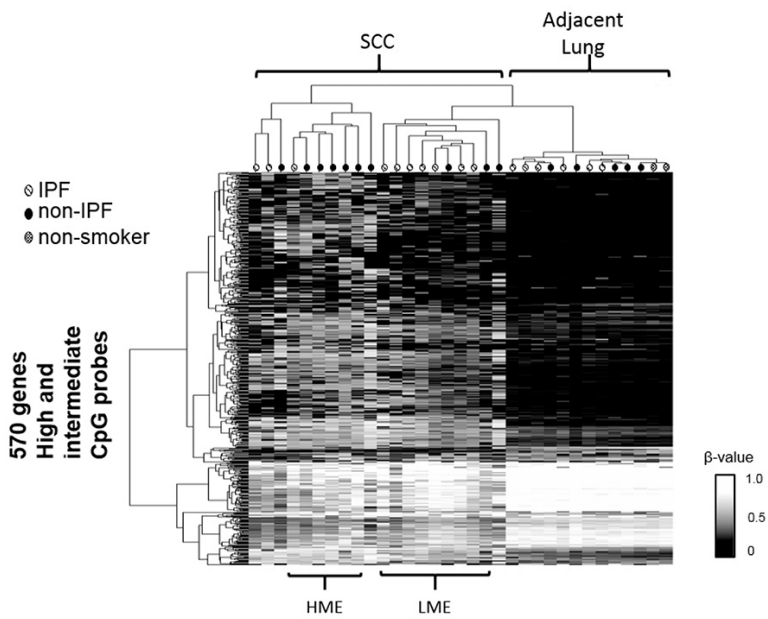
**COMMERCIAL RELATIONSHIPS** T. Nakajima: Speakers Bureau/Honoraria: AstraZeneca, Olympus; A. Hata: Research Grant, Chiba Foundation

**Purpose:** Patients with idiopathic pulmonary fibrosis (IPF) have higher risk of developing lung cancer, especially squamous cell carcinoma (SCC), but the pathogenesis has not been fully investigated. This study aimed to assess the impact of DNA methylation, which plays an important role in carcinogenesis, on IPF and lung SCC.

**Methods:** DNA methylation status was examined for 20 SCC tumor samples with or without IPF background (10 SCC with IPF and 10 SCC without IPF), 11 adjacent noncancerous lung tissues (six IPF and five non-IPF), and two normal lung tissues of nonsmoker patients with adenocarcinoma. The diagnosis of SCC and IPF was made by independent pathologists. DNA was extracted from each snap frozen archived samples obtained by surgery, and subjected to Infinium HumanMethylation450 BeadChip assay. The quantitative validation for methylation was carried out by pyrosequencing.

**Results:** Unsupervised hierarchical clustering analysis classified SCC tumor samples into two methylation subtypes, such as low and high-methylation epigenotypes (referred as LME and HME, respectively), Figure. Compared with noncancerous samples, more aberrant hypermethylated genes were recognized in SCC (both LME and HME) samples (564 vs 771). Of them, genes related to cell adhesion function and tumor-suppressive function were significantly enriched, the former of which was specifically enriched in HME. Methylation status of these genes were quantitatively validated by pyrosequencing. Interestingly, aberrant hypermethylation was accumulated in noncancerous lung tissues of IPF compared with those without IPF, and 102 genes were found to be hypermethylated commonly in IPF and SCC samples. SCC with IPF significantly tended to be associated with LME (7 cases were LME and one case was HME) whereas LME was two and HME was five in SCC without IPF ( $P = .04$ , Fisher's exact test).

**Conclusions:** DNA methylation profiling in SCC revealed two subtypes of states, such as HME and LME. SCC with IPF was prominent in high frequency of LME, suggesting that it might require additional steps for carcinogenesis. Further investigation, such as genetic alteration profiling, is necessary to clarify molecular mechanism of SCC with IPF.



P72

# **Patterns of Recurrence, Recurrence Rate, and Overall Survival in Incidental Lung Cancer in Explanted Lungs**

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Cleveland Clinic, OH*

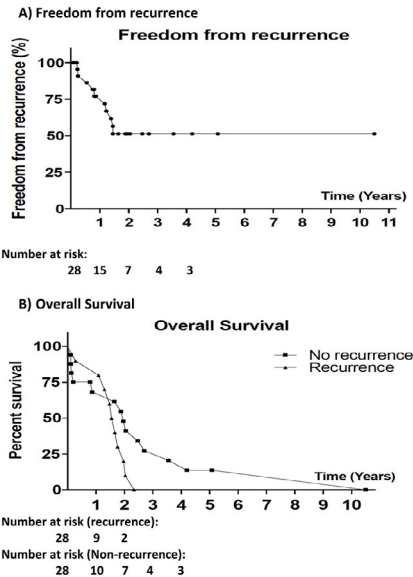
**Purpose:** Recurrence and overall survival for incidental lung cancer in explanted lungs vary between the various reported series. Recurrence patterns also are not well described. The primary objective of this study was to study the recurrence patterns and time to recurrence for various stages of lung cancer in lung transplant recipients.

**Methods:** A retrospective review of institutional series was performed to identify patients who had incidental lung cancer found in transplant pneumonectomy specimens from 1990 to 2016. Demographic, radiographic, and perioperative clinical variables were collected. Number of episodes of rejection was used as a surrogate for degree of immunosuppression. Time to recurrence, overall survival, and recurrence patterns were recorded and studied as a function of type and stage of tumor and immunosuppression. Freedom from recurrence and overall survival were estimated using Kaplan-Meier analysis.

**Results:** Twenty-eight patients (1.7%) had primary lung carcinoma in the explanted lung. Indication for transplantation was chronic obstructive pulmonary disease in 15 (54%) and interstitial lung disease for 13 (46%). Preoperative computed tomography scans showed indeterminate nodules in 16 patients (57%). Pathologic review showed stage I in 15 (54%), stage II in nine (32%), and stage III in five (18%) patients. Recurrence was noted in 10 patients (36%). The majority of patients had nodal (20%) and/or systemic recurrence (70%). All recurrences occurred within 2 years of the transplantation. Freedom from recurrence at 1, 2, and 5 years was 75%, 51%, and 51%, respectively. Overall survival at 1, 2, 3, and 5 years in patients with recurrence was 81%, 14%, and 0%, while OS for disease-free patients was 67%, 45%, 25%, and 13% respectively. No difference in episodes of rejection were noted in patients who did or did not have recurrent disease.

**Conclusions:** Most recurrences occur in the first 2 years after transplantation and are the cause of death in these patients. Patients with nodal disease tend to have higher recurrence rates. No difference in number of episodes of may suggest that degree of immunosuppression likely played little role in progression of disease.

Figure 1: Recurrence and survival Kaplan Meier curves



	All patients N=28	Recurrence patients N=10	Non-recurrence patients N=18
Age	63.5 ± 5.9	65.5±4.0	63.1±6.6
IAS	45.78± 19.02	54±25.9	42.1±14.9
<b>Diagnosis</b>			
COPD	15/28 (54%)	4/10 (40%)	11/18 (61%)
ILD	13/28 (46%)	6/10 (60%)	7/18 (39%)
Median Smoking (pack years)	40 (1-160)	42 (1-160)	30 (1-76)
Median PRA – HLA I (%)	5 (0-89)	8.5 (1-73)	4.5 (0-89)
Median PRA – HLA II (%)	2.5 (0-24)	1.5 (0-4)	1.5 (0-24)
<b>Pre-operative radiographic findings</b>			
Indeterminate nodules	16/28 (57%)	5/10 (50%)	11/18 (61%)
Adenopathy	3/28 (11%)	1/10 (10%)	2/10 (20%)
No findings	9/28 (32%)	5/10 (50%)	4/18 (22%)
Median Interval between last CT and Sx (days)	84 (14-844)	82.5 (17-156)	83 (14-844)
<b>Surgery Variable</b>			
Double lung transplant	14/28 (50%)	3/10 (30%)	11/18 (61%)
<b>Histology</b>			
Adenocarcinoma	16/28 (57%)	4/10 (40%)	12/18 (66%)
Solid	4/16 (25%)		4/12 (25%)
Micropapillary	3/16 (19%)	2/4 (50%)	1/12 (8%)
Mucinous	3/16 (19%)	1/4 (25%)	2/12 (17%)
Lepidic	1/16 (7%)	1/4 (25%)	
Acinar	5/16 (31%)		5/12 (42%)
Adenosquamous	1/28 (4%)	1/10 (10%)	
Squamous cell carcinoma	8/28 (29%)	4/10 (40%)	4/18 (22%)
Non-small cell carcinoma	1/28 (4%)		1/10 (10%)
Other	2/28 (7%)	1/10 (10%)	1/10 (10%)
<b>Pathologic stage</b>			
IA	13/28 (46%)	3/10 (30%)	10/18 (56%)
IB	2/28 (7%)		2/18 (11%)
IIA	5/28 (18%)	3/10 (30%)	2/18 (11%)
IIB	4/28 (14%)	3/10 (30%)	1/18 (6%)
IIIA	1/28 (4%)		1/18 (6%)
IV	1/28 (4%)		1/18 (6%)
<b>Recurrence</b>			
Local	2/10 (20%)	2/10 (20%)	
Nodal	4/10 (40%)	4/10 (40%)	
Extra-thoracic	7/10 (70%)	7/10 (70%)	
Median time of recurrence (days)	375 (81-523)	375 (81-523)	
Median time between recurrence and death (days)	239.5 (10-553)	239.5 (10-553)	
<b>Treatment</b>			
Palliative chemotherapy	2/10 (20%)	2/10 (20%)	
Palliative Radiation	3/10 (30%)	3/10 (30%)	
Curative intent chemotherapy	3/10 (30%)	3/10 (30%)	
Curative intent Radiation	1/10 (10%)	1/10 (10%)	
Hospice/ No treatment	2/10 (20%)	2/10 (20%)	
Median follow up time (days)	678(28-3779)		

P73

# **A Propensity Score-Matched Study of Lung Transplant Recipients Aged <70 and ≥70 Years**

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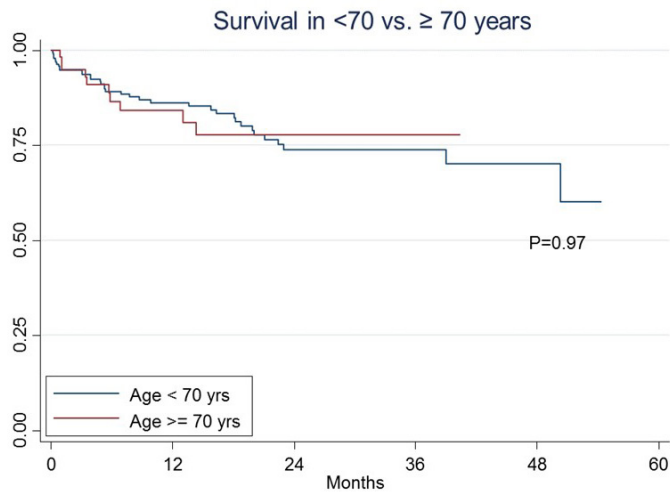
<sup>1</sup>Temple University, Philadelphia, PA, <sup>2</sup>Temple University, Mount Laurel, NJ

**Purpose:** To validate the utilization of lung transplantation (LTx) recently in older recipients, we compared the survival outcome of LTx recipients <70 years vs ≥70 years and compared the demographics and other clinical parameters for any statistical significance after propensity score matching in both groups.

**Methods:** Out of 251 LTx recipients, 192 recipients were <70 years of age and 59 were ≥70 years of age. Using statistical tools, we matched 58 similar patients with propensity scores in each group (<70 vs ≥70 years age) using recipients' age, height, body mass index (BMI), gender, ethnicity, medical etiology, lung allocation score (LAS), transplant type, concomitant surgery, cardiopulmonary bypass (CPB) use, surgical approach, donor age, donor height, and donor gender. Survival days using Kaplan-Meier curve and numbers of death, along with demographics, were compared for significance (STATA Inc) between the two groups (<70 vs ≥70 years of age).

**Results:** There were significant differences in age groups ( $62 \pm 8$  vs  $73 \pm 2$ ;  $P < .0001$ ) with similar LAS ( $50 \pm 19$  vs  $53 \pm 20$ ;  $P = .28$ ). There were no differences in recipient BMI ( $28 \text{ kg/m}^2 \pm 5 \text{ kg/m}^2$  vs  $27 \text{ kg/m}^2 \pm 5 \text{ kg/m}^2$ ;  $P = .98$ ), recipient height ( $67 \text{ inches} \pm 4 \text{ inches}$  vs  $67 \text{ inches} \pm 4 \text{ inches}$ ;  $P = .32$ ); recipient gender (46 male vs 45 male;  $P = .85$ ); donor age ( $P = .97$ ), height ( $P = .21$ ), and gender ( $P = 1.00$ ). Ethnicity had no difference with 51 white, five African American, and two of other ethnicity in <70 age group vs 52 white, four African American, and two of other ethnicity in ≥70 age group,  $P = .57$ . Etiology for LTx recipients had no difference with 47 IPF, eight COPD, and three others in <70 age group vs 48 IPF, seven chronic obstructive pulmonary disease (COPD), and three others in ≥70 age group;  $P = .96$ . There were no differences in CPB usage ( $P = .41$ ) and lung transplant type (23 single vs 35 double LTx;  $P = \text{ns}$ ). Surgical incision types were similar in both groups ( $P = .15$ ). Median length of stay and survival days were similar (18 days vs 17 days;  $P = .80$ ) and (474 vs 431;  $P = .72$ ). Kaplan-Meier curve showed survival outcome in two groups ( $P = .97$ ).

**Conclusions:** A single-center, propensity score-matching study showed successful lung transplants in older patients with comparable outcome and no inferiority to younger recipients. Careful planning of the lung transplant surgical techniques may help older patients obtain the highest benefit out of such a complex procedure.



1, 3, 6-months, 1,2,3,4-years survival rate in <70 years were 95%, 95%, 89%, 86%, 74%, 74% versus in ≥70 years were 98%, 95%, 87%, 84%, 78%, 78%.

P74

# **Socioeconomic Status and Its Impact on Access to Lung Transplantation in the United States: An Unequal Playing Field Exposed**

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**COMMERCIAL RELATIONSHIPS** J. D. Luketich: Ownership Interest, Express Scripts, Intuitive Surgical, Johnson & Johnson, P&G; Research Grant, Accuray; Other, Elsevier Patent from the University of Pittsburgh, The Annals of Thoracic Surgery Deputy Editor

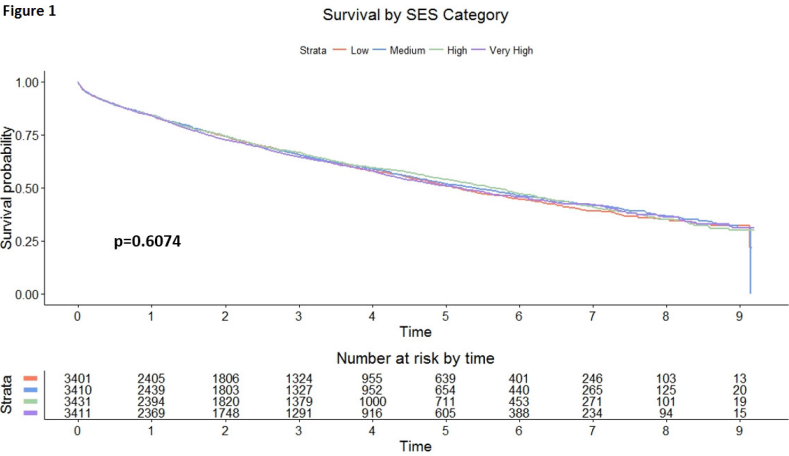
**Purpose:** Health disparities continue to plague our health care system, despite the passage of the Affordable Care Act. Utilizing surrogate markers of socioeconomic status (SES), we sought to assess the impact of SES on lung transplantation in the United States.

**Methods:** This is a retrospective cohort study utilizing the United Network for Organ Sharing Database that identified all adult lung transplant recipients residing in the United States at the time of evaluation between May 1, 2005, and December 31, 2014. Re-transplant and heart-lung recipients were excluded. The peer-reviewed Diez-Roux SES Neighborhood Score was calculated with two educational, occupational, and resource variables collected at the 2010 US Census. The main outcome was 5-year survival following surgery. Secondary outcomes include center volume, insurance status, and waitlist time. Analysis performed using chi-squared or Fisher's exact tests for categorical variables and one-way ANOVA or Kruskal-Wallis tests for continuous variables.

**Results:** The most common indication for lung transplantation was fibrotic disease (49.7%) followed by obstructive (32.3%), suppurative (12.4%), pulmonary hypertension (4.2%), and other (1.5%). When diagnosis was considered, there were statistically significant differences when comparing SES quartiles, but no associated predictive trend was found. The majority of patients had insurance statuses categorized as private/self-pay compared to Medicare and Medicaid (54.6% vs 35.1% vs 6.2%,  $P < .001$ ). As expected, there was a direct relationship between number of recipients with Diez-Roux score and private/self-pay insurance and an indirect relationship in the setting of Medicare and Medicaid insurance. Mean Diez-Roux score for the lung transplant cohort was significantly greater than that of the general US population (1.1 vs 0.69,  $P < .0001$ ). Once placed on the waitlist, there was no statistically significant association between SES and waitlist time ( $P = .15$ ). After lung transplantation, there was no association between SES and 5-year survival ( $P = .607$ ), Figure.

**Conclusions:** Compared with the general population, US lung transplant recipients reside in locations associated with higher SES. However, there was no association between SES and waitlist time and long-term survival, respectively. These findings have important implications for access to care for those afflicted with end-stage lung disease.

Figure 1



P75

# **Redo Bilateral Lung Transplants: Triumph of Technique Over Judgment?**

*J. W. Sui, I. Makey, N. A. Das, D. T. DeArmond, C. N. Huynh, S. B. Johnson*

*University of Texas Health Science Center, San Antonio*

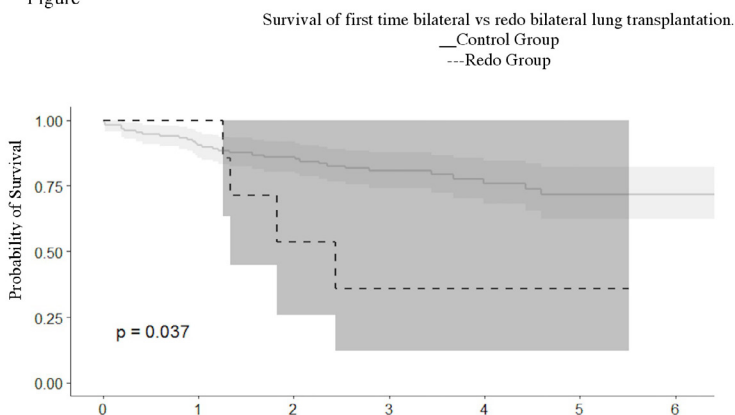
**Purpose:** Bilateral lung transplants are more commonly performed and have better long-term outcomes than single lung transplants. No current study has looked at outcomes of bilateral redo transplants. The purpose of this study was to compare outcomes of bilateral redo transplants against first-time bilateral transplants.

**Methods:** Patients undergoing bilateral lung transplantation at our institution between June 2009 and January 2015 were retrospectively reviewed. Those undergoing redo bilateral lung transplantation were then compared to those undergoing initial bilateral transplant. All survival probabilities were estimated using the Kaplan-Meier estimator. Patient demographics, operative outcomes, and long-term survival were analyzed for the two groups.

**Results:** There were 148 patients who underwent first-time bilateral lung transplantation and eight patients who underwent redo bilateral lung transplantation during the study period. Patients that underwent redo bilateral lung transplantation were younger, had longer operative times, and required more blood transfusions (Table). Out of the eight redo bilateral patients, three had cystic fibrosis and five had idiopathic pulmonary fibrosis. All patients who underwent redo bilateral lung transplantation survived past 1 year; however, the probability of survival at 3 years for this group was significantly less (36% vs 81%;  $P = .037$ ), Figure.

**Conclusions:** Bilateral re-transplants have worse long-term outcomes than first-time transplants. Their initial survival advantage may be a result of patient selection.

Figure



Table

Demographics of first time bilateral vs redo bilateral lung transplantation

	Bilateral	Bilateral Re-dos	P-value
Total Number of patients	148	8	
Age (mean (SD))	57 (12)	43(16)	<b>0.002*</b>
BMI (mean (SD))	24 (4)	23(5)	0.25
Gender = Male (%)	89 (60%)	3 (37%)	0.37
IAS Score (mean (SD))	42 (13)	49 (6)	0.15
Operative Time (mean (SD))	346 (83)	416 (94)	<b>0.02*</b>
RBC Units Transfused Intraoperatively (mean (SD))	3 (5)	8 (5)	<b>0.02*</b>
FFPs Units Transfused Intraoperatively (mean (SD))	3 (3)	5 (4)	<b>0.04*</b>
Cryoprecipitate Transfused Intraoperatively (mean (SD))	2 (6)	8 (14)	<b>0.01*</b>
Platelets Transfused Intraoperatively (mean (SD))	2 (4)	6 (10)	<b>0.01*</b>
Bypass = Yes (%)	50 (34%)	5 (63%)	0.2
Length of Stay (mean (SD))	17 (12)	18 (6)	0.81
Operative Mortality = Yes (%)	4 (3%)	0 (0%)	1

\* P-value < 0.05

P76

# **Pathologic Treatment Response Is Associated With Increased Overall Survival in Patients Undergoing Neoadjuvant Chemotherapy Followed by Pneumonectomy**

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<sup>1</sup>University of Southern California, Keck School of Medicine, Los Angeles, <sup>2</sup>The University of Texas MD Anderson Cancer Center, Houston

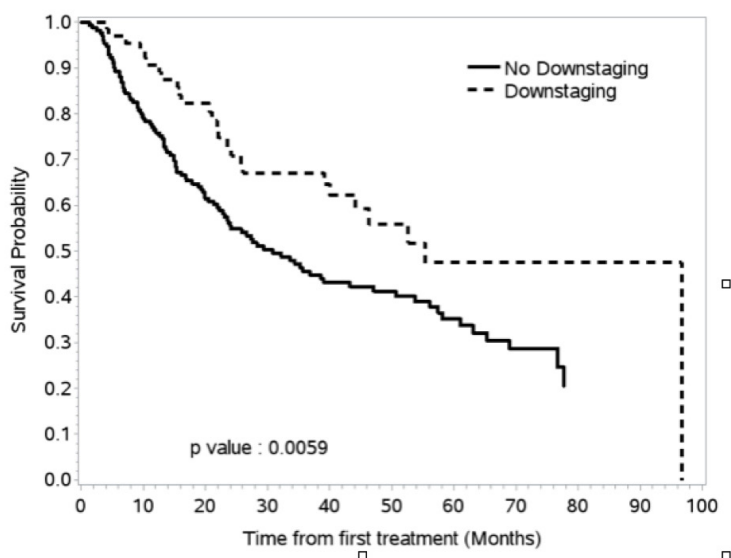
**COMMERCIAL RELATIONSHIPS** D. C. Rice: Speakers Bureau/Honoraria, Pacira Pharmaceuticals, Intuitive Surgical; J. A. Roth: Research Grant, Varian

**Purpose:** Major pathologic response following neoadjuvant chemotherapy may represent a surrogate outcome for survival in non-small-cell lung cancer (NSCLC). Perioperative morbidity/mortality may limit the realization of benefit in patients requiring pneumonectomy. Utilizing the National Cancer Database (NCDB), we sought to evaluate outcomes of neoadjuvant chemotherapy followed by pneumonectomy in NSCLC.

**Methods:** The NCDB Participant User File was queried for patients with stage IB-IIIa NSCLC undergoing definitive surgical resection requiring pneumonectomy. Exclusion criteria included performance status >0 and those deemed high-risk for chemotherapy. Patients were grouped by pretreatment status, comparing neoadjuvant chemotherapy to primary resection. Perioperative outcomes included downstaging, resection margins, length of stay (LOS), readmission, and 30- and 90-day all-cause mortality. Overall survival (OS) was calculated using the Kaplan-Meier method in the neoadjuvant chemotherapy group; log-rank test was used to compare OS based on treatment response.

**Results:** A total of 3414 patients met inclusion criteria; neoadjuvant chemotherapy was administered to 362 (11%) of potentially eligible patients. Neoadjuvant chemotherapy did not increase 30- or 90-day all-cause mortality as compared to primary resection. Unplanned readmission, median postoperative length of stay, rate of R0 resection, and utilization of a minimally invasive approach (thoracoscopic/robotic) were equivalent between groups (Table). Treatment response as measured by pathologic downstaging (T, N, or both) was significantly increased in the neoadjuvant group as compared to primary resection (23% vs 8%,  $P < .001$ ). When T- and N-status pathologic response were evaluated individually, results were similar (Table). Survival estimates were calculated for the neoadjuvant chemotherapy cohort only. Median overall survival (months) was significantly increased in patients demonstrating treatment response (55 vs 31,  $P = .006$ , Figure). Nodal treatment response was similarly associated with an increase in overall survival (55 vs 34,  $P = .038$ ) whereas primary downstaging (T) was not (44 vs 37,  $P = .27$ ).

**Conclusions:** Pathologic treatment response, as marked by downstaging following neoadjuvant chemotherapy, is predictive of prolonged OS in patients requiring pneumonectomy for NSCLC. In this patient population, pneumonectomy can be safely performed following neoadjuvant chemotherapy without an increased risk of perioperative adverse events as compared to primary resection.



**Table 1**

Perioperative Outcomes

	Neoadjuvant n=362 (%)	Primary Resection n=3052 (%)	p-value
Unplanned readmission	16 (4.8)	144 (5.2)	0.79
R0 resection	309 (89)	2609 (89)	0.94
Median LOS (days)	5	5	0.75
Mortality			
30-day	16 (5.1)	170 (6.5)	0.35
90-day	34 (11)	278 (11)	0.85

Treatment Response (downstaging)

Overall	84 (23)	266 (8.7)	<0.001
Tumor (T)	83 (23)	217 (7.1)	<0.001
Node (N)	68 (19)	237 (7.8)	<0.001

P77

# **Better Survival With Video-Assisted Thoracoscopic Surgery and Early Initiation of Adjuvant Chemotherapy in the National Cancer Database**

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**COMMERCIAL RELATIONSHIPS** T. L. Demmy: Consultant/Advisory Board, Medtronic; E. U. Dexter: Other, UpToDate, Royalties

**Purpose:** Previous reports on the effect of surgical approach and timing of adjuvant chemotherapy are not clear. We sought to study this interaction in large, prospectively maintained national cancer registry.

**Methods:** We identified 13,137 patients in National Cancer Database from 2010 to 2014 who underwent adjuvant chemotherapy within 6 months of lobectomy. Patients were classified in four groups depending on approach (VATS or Open) and when adjuvant chemotherapy was initiated (“Early” ≤8 weeks or “Delayed” >8 weeks). Univariate and multivariate models were created. The survival rates were analyzed using Kaplan-Meier plots, and differences between all groups were assessed using log-rank models.

**Results:** Among the four groups, differences in age, sex, race, grade, stage, and Charlson-Deyo score were relatively small but statistically significant;  $P < .001$  (Table). There were fewer squamous cell cancers (23% vs 30% adeno;  $P < .001$ ), smaller tumors (3.9 cm vs 4.5 cm;  $P < .001$ ), and more lymph nodes (13.2 vs 12.5;  $P < .001$ ) examined in VATS group, but did not independently predict survival in the multivariate model. Notably, prolonged hospital stays and unplanned readmissions within 30 days were less frequent in the VATS group ( $P = .01$ ). Also, more patients received early chemotherapy if they underwent VATS (70.4% vs 68.4% Open;  $P = .003$ ). Using multivariate analysis, overall survival was better for VATS (OR 0.85;  $P < .001$ ) and early chemotherapy delivery (OR 0.90;  $P < .001$ ). Survival was best for VATS patients with early adjuvant chemotherapy (Figure).

**Conclusions:** In the NCDB, adjuvant chemotherapy is most efficacious if it is delivered earlier after a VATS approach. Further study is needed to validate these findings and determine possible mechanisms for such effects.

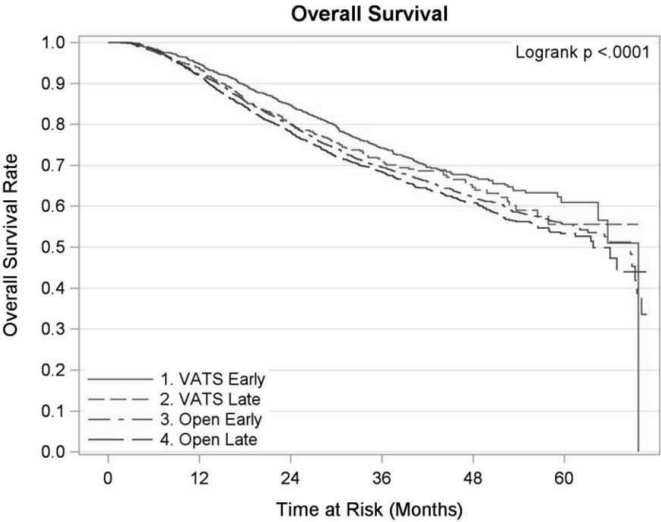


Table. 1 Variables associated with overall survival in Univariate analysis.

	VATS Early	VATS Late	Open Early	Open Late	Total	P-value
Overall count	2384 (18.1%)	1001 (7.6%)	6602 (50.3%)	3150 (24%)	13137 (100%)	<0.001
Age (Median)	65	65	64	64	64	
Male	46.0%	49.7%	51.7%	51.1%	50.5%	<0.001
White race	86.4%	85.2%	86.4%	83.6%	85.7%	0.001
Other race	13.6%	14.8%	13.6%	16.4%	14.3%	
CD score 0	52.5%	47.9%	52.7%	48.7%	51.3%	<0.001
CD score 1	35.2%	36.7%	35.8%	37.7%	36.2%	
CD score $\geq 2$	12.3%	15.5%	11.5%	13.6%	12.4 %	
Well and Moderately well differentiated	50.0%	48.9%	48.2%	46.9%	48.2%	<0.001
Poorly and Undifferentiated	44.4%	45.6%	47.6%	49.0%	47.2%	
Stage-I	17.3%	20.5%	16.1%	16.4%	16.7%	<0.001
Stage-II	50.4%	52.5%	49.3%	52%	50.4%	
Stage-III	32.3%	27.0%	34.6%	31.7%	32.9%	
Length of post-op stay > 14 days	1.6%	5.5%	2.6%	7.4%	3.8%	<0.001
Unplanned readmissions within 30 days	2.8%	4.7%	3.0%	5.1%	3.6%	<0.001
Squamous cell carcinoma*	19.8%	26.4%	27.9%	32.1%	27.3%	<0.001
Adenocarcinoma*	72.0%	63.2%	62.4%	58.1%	63.2%	
Regional nodes examined (Mean $\pm$ STD)*	13.1 $\pm$ 9.1	13.3 $\pm$ 10.2	12.2 $\pm$ 8.6	12.8 $\pm$ 9.1	12.6 $\pm$ 8.9	<0.001

\*These variables were not found to be statistically significant in multi-variate analysis.

P78

# **Role of Wedge Resection in Bronchial Carcinoid Tumors**

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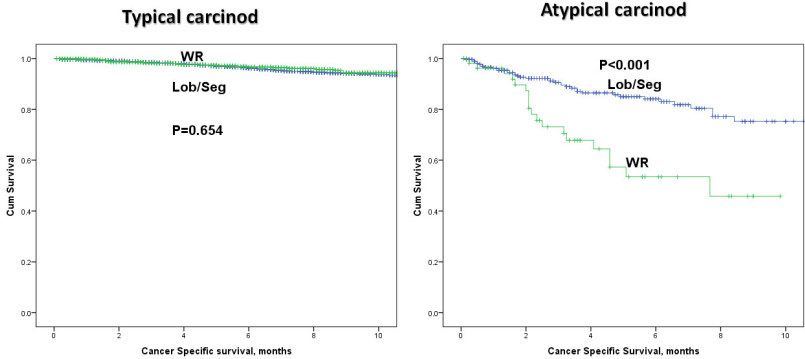
**COMMERCIAL RELATIONSHIPS** J. Port: Ownership Interest, Angiocrine Bioscience, Nanocyte; B. M. Stiles: Employment, Pfizer - Wife Employed by Pfizer; Consultant/Advisory Board, Merck

**Purpose:** There is little data in regard to the role of wedge resection (WR) for bronchial carcinoid (BC) tumors. In this study, we analyzed a large, population-based Surveillance, Epidemiology, and End Results (SEER) database to query patients with BC who underwent WR.

**Methods:** The SEER database was retrospectively reviewed for patients treated for BC between 1973 and 2013. Patients who underwent WR were compared to those who underwent lobectomy or segmentectomy (Lob/Seg). Differences in clinicodemographic data were analyzed using chi (X2) and t-tests. Differences in overall and cancer-specific survival (OS, CSS) were investigated using Kaplan-Meier method. Multivariable Cox regression analysis (MVA) was performed to identify CSS predictors. Propensity score matchings (age, gender, and stage; 1:1; Caliper=0.20) were done to compare CSS differences in WR vs Lob/Seg.

**Results:** 22,350 patients with BC were identified (1.86% of lung cancer patients). 4478 cases (3536 Lob/Seg vs 942 WR) met our inclusion criteria. The median age was 59 years (IQR=49-68) with 3024 women (67.5%). The median tumor size was 2 cm (1.5-3 cm). A WR was more common in older patients, women, lower lobe tumors, typical carcinoid, and early stages (Table). Multivariate analysis demonstrated that older age (HR=1.05, 95% CI=1.04-1.06), male gender (HR=1.63, 95% CI=1.24-2.15), black race (HR=2.11, 95% CI=1.34-3.32), atypical carcinoid (HR=4.82, 95% CI=3.52-6.61) and advanced stage (HR=4.15, 95% CI=3.16-5.45) were associated with worse CSS. Among all patients, a WR was not associated with worse CSS (HR=1.17, 95% CI=0.85-1.61). A wedge compared to anatomic resection (lob/Seg) in patients with small carcinoids (T1a, ≤2 cm) had equivalent CSS ( $P = .719$ ). However, a WR was associated with worse CSS in patients with atypical carcinoids when compared to Lob/Seg ( $P < .001$ ; Figure).

**Conclusions:** A wedge resection may offer equivalent CSS in well-selected patients with typical histology. An anatomic resection appears warranted in cases with atypical histology.



	Included patients (n=4,478)	Lobectomy or segmentectomy (n=3,536)	Wedge resection (n=942)	P value
<b>Age (n=4,478)</b>		58(47-67)	64(65-72)	<0.001
<b>Gender (n=4,478)</b>	➤ Male	1236 (35)	218(23.1)	<0.001
	➤ Female	2300(65)	724(76.9)	
<b>Race (n=4,478)</b>	➤ White	3237(91.5)	843(89.5)	0.144
	➤ Black	189(5.3)	63(6.7)	
	➤ Others/Unknown	110(3.1)	36(3.8)	
<b>Histology (n=4,478)</b>	➤ Typical carcinoid	3258(92.1)	886(94.1)	0.047
	➤ Atypical carcinoid	278(7.9)	56(5.9)	
<b>Grade(n=2,904)</b>	➤ Low grade (G1)	997(76)	202(76.8)	0.792
	➤ High grade (>G1)	314(24)	61(23.2)	
<b>Median T size (CM)</b>		2.1(1.5-3)	1.5(1-2)	<0.001
<b>Stage (n=4,425)</b>	➤ Stage I	2736(78.3)	800(86)	<0.001
	➤ Higher stage { >stage I}	759(21.7)	130(14)	
<b>Unmatched gp. survival</b>	➤ All cohort 10 yrs. CSS	92.5%	91.8%	0.333
	➤ Typical Carcinoid 10 yrs.	93.8%	94.4%	0.654
	➤ Atypical Carcinoid 10 yrs.	75.2%	45.8%	<0.001
<b>Matched gp. survival</b>	➤ All cohort 10 yrs. CSS	91.4%	91.9%	0.829
	➤ Typical Carcinoid 10 yrs.	93%	94.6%	0.261
	➤ Atypical Carcinoid 10 yrs.	80.7	NR(not reached)	0.025

P79

# **Impact of EGFR Mutation Status on Prognosis of Recurrent Adenocarcinoma of the Lung After Curative Surgery**

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**COMMERCIAL RELATIONSHIPS** M. Masuda: Research Grant, Chugai Pharmaceutical, Edwards Lifesciences, Japan Lifeline, Johnson & Johnson, Kaken Pharmaceutical, Ono Pharmaceutical, Pfizer Japan, Senko Medical, Abbott, Takeda Pharmaceutical, Teijin Pharma, Terumo, VITAL Corporation

**Purpose:** Patients with pulmonary adenocarcinoma harboring EGFR mutation (Mt) were considered to have a favorable prognosis compared with EGFR wild-type (Wt) after complete resection of the lung. This study aimed to evaluate if less aggressive behavior and effects of EGFR-TKI account for a better prognosis in Mt patients.

**Methods:** A total of 237 patients with recurrent pulmonary adenocarcinoma were included in this study; curative resection of the lung and lymph node dissection were performed from January 2002 to March 2016 at Kanagawa Cancer Center, along with EGFR mutation analysis. We identified 108 patients with recurrent Mt and 129 patients with recurrent Wt. Relapse-free survival (RFS) and post-relapse survival (PRS) were analyzed with the Kaplan-Meier method and compared between two groups using the log-rank test. Univariate and multivariate Cox regression analyses were additionally performed to identify variables associated with RFS and PRS.

**Results:** The mean observation periods for all patients after surgery and recurrence were 48.9 months and 25.2 months, respectively. Mt was more frequent in non-smoking women than Wt ( $P < .001$  and  $P = .001$ , respectively); however, there were no differences in operative procedures or pathological stages ( $P = .958$  and  $P = .337$ ). Median RFS for Mt and Wt were 20.2 months and 13.3 months, respectively ( $P < .001$ , Figure). By multivariate analysis, Mt was an independent prognostic factor for a favorable RFS (hazard ratio = 0.68; 95% confidence interval, 0.52-0.89,  $P = .005$ ). Median PRS for Mt and Wt were 33.9 months and 28.2 months ( $P = .360$ ). Median PRS for EGFR-TKI and non-EGFR-TKI were 46.0 months and 21.6 months, respectively ( $P < .001$ ). By multivariate analysis, administration of EGFR-TKI was an independent prognostic factor for PRS (hazard ratio = 0.60; 95% confidence interval, 0.40-0.89,  $P = .012$ ).

**Conclusions:** Mt tumors were associated with significantly better RFS for recurrent pulmonary adenocarcinoma after curative resection of the lung, which represented the less aggressive nature of Mt tumors. However, patients with Mt tumors did not rebound to favorable prognosis after recurrence unless they received EGFR-TKI.

Figure: Relapse-free survival for Mt and Wt

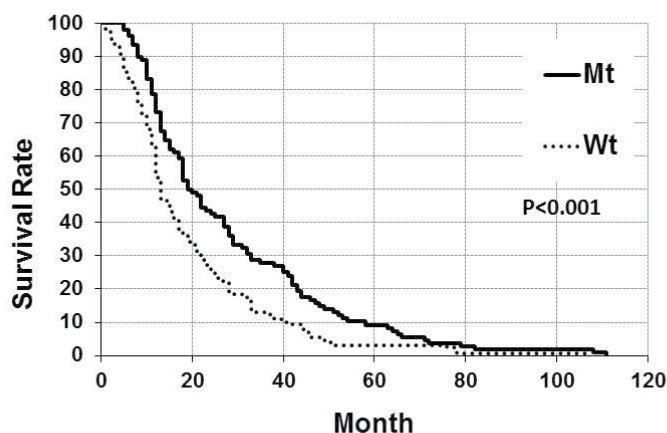


Table: Univariate and multivariate analysis for RFS and PRS

Variable	Univariate analysis p value	Multivariate analysis		
		HR	95% CI	p value
Gender (Male)	<0.001	1.09	0.71-1.68	0.687
Smoking history	<0.001	1.39	0.91-2.13	0.125
RFS Pathological T factor	<0.001	1.15	0.94-1.42	0.172
Lymphatic invasion	0.027	1.34	1.03-1.74	0.029
EGFR mutation + / -	<0.001	0.68	0.52-0.89	0.005
Age (>65)	0.014	1.63	1.11-2.38	0.012
Smoking history	0.008	1.38	0.93-2.05	0.113
Pathological T factor	<0.001	1.07	0.80-1.45	0.638
PRS Recurrence 24< vs 24≥	0.017	1.35	0.91-2.01	0.142
Administration of EGFR-TKI	<0.001	0.60	0.40-0.89	0.012
EGFR mutation + / -	0.360			

P80

# **Intrathoracic Phrenic Nerve Reconstruction for Successful Reversal of Chronic Diaphragmatic Paralysis: A Functional Alternative to Plication**

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**COMMERCIAL RELATIONSHIPS** T. Bauer: Consultant/Advisory Board, Oncocyte

**Purpose:** Chronic diaphragmatic paralysis often results in symptomatic respiratory dysfunction, including exertional dyspnea, orthopnea, sleep-disordered breathing, and a susceptibility to respiratory infection. Phrenic nerve reconstruction has become a functional alternative to diaphragm plication, and greater awareness of its efficacy is needed, particularly for iatrogenic or traumatic intrathoracic injuries.

**Methods:** A retrospective review of patients undergoing intrathoracic phrenic nerve reconstruction for chronic diaphragmatic paralysis was performed. Patients were selected for treatment based upon radiographic confirmation of diaphragmatic paralysis and symptoms persisting for at least 8 months with no improvement. Electrodiagnostic testing was performed to assess suitability for surgical treatment. Video-assisted thoracoscopic surgery (VATS) and/or mini-thoracotomy were performed for surgical access, and the phrenic nerve was reconstructed using a combination of nerve decompression, interposition grafting, and/or neurotization. Diaphragm pacemakers also were simultaneously implanted for long-standing or bilateral injuries. A successful outcome was based upon subjective reporting and corroborated using radiographic, electrodiagnostic, and pulmonary function testing.

**Results:** There were 20 women and 38 men with a mean age of 52 years (range, 10-79 years). The average interval from injury to surgical treatment was 37 months. The most common intrathoracic etiology for diaphragmatic paralysis was cardiac surgery (29%), followed by trauma (28%), thymic surgery (10%), and cardiac ablation (5%). VATS and mini-thoracotomy was performed in all but two patients to accomplish microsurgical nerve repair. In the remaining two patients, the procedure was performed using only VATS. In 57% of patients, there was subjective reporting of respiratory corrections within the first year. At 2-year follow-up, the percentage of patients reporting and demonstrating a return of diaphragmatic activity increased to 93%. The average percentage improvements in FEV1, FVC, and TLC were 10%, 8%, and 19%, respectively. In 63% of patients, chest fluoroscopy unequivocally demonstrated a resumption of functional diaphragmatic activity.

**Conclusions:** Functional recovery of the paralyzed diaphragm is possible after intrathoracic phrenic nerve reconstruction. This surgical option can be the initial treatment in select cases, reserving plication for reconstructive failures. Alternatively, it is not feasible to perform nerve reconstruction after failed plication; thus, careful preoperative screening is necessary to optimize overall success.

P81

# **Financial Analysis of a Free Lung Cancer Screening Program Shows Profitability Within 3 Years Despite Applying Broader National Comprehensive Cancer Network Criteria**

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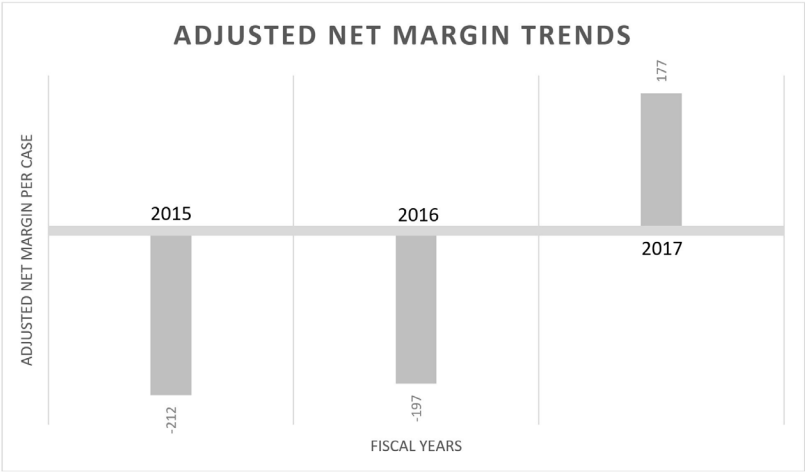
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**Purpose:** Lung cancer screening with low-dose computed tomography (LDCT) chest scans in high-risk populations has been established as an effective measure of preventive medicine by the National Lung Screening Trial. However, the cost effectiveness is still controversial. We present a 2.5-year profitability analysis of our screening program using the broader National Comprehensive Cancer Network (NCCN) criteria.

**Methods:** Retrospective chart review was performed on the initial 2.5-year dataset of a free LDCT chest scan program targeting the underserved Southeastern United States. Patients were selected by the broader NCCN high-risk criteria, screening twice as many patients as would qualify by Centers for Medicare & Medicaid criteria. LDCT scans were performed during the off-service hours of our PET-CT scanner. Statistical analyses of fiscal years 2015-2017 was done to evaluate parameters, including indirect cost, direct cost, and adjusted net margin per case after factoring downstream revenue from positive scans and other findings.

**Results:** A total of 705 scans were performed with 418 patients referred for subsequent procedures or further specialist evaluations. The mean overhead cost as a percentage of total cost was 42.3%, which was lower than the literature-reported means of approximately 46%. Total charges were \$1,700,879 with net revenue per case of \$2288. Total costs including overhead was \$393,225. The adjusted net margin per case was -\$212 in the first year, but increased to \$177 in the third fiscal year (Figure) since the downstream revenue lags by about 2 years. The total break-even point of adjusted net margin was between a percentage of 6%-7% of indirect cost as a function of charges.

**Conclusions:** Our 2.5-year data demonstrates profitability from downstream revenue generated by free LDCT chest scans, despite the broader NCCN guidelines. Initial investments can be recovered by increased income secondary to increased procedures, from detected lung cancers and other findings, as well as referrals. Downstream revenue, however, lags by about 2 years.



P82

# **The True Incidence of Thoracic Lymph Node Metastases in Patients With Pulmonary Neuroendocrine (Carcinoid) Tumors**

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**COMMERCIAL RELATIONSHIPS** R. J. Cerfolio: Consultant/Advisory Board, Acelity, Bard/Davol, Bovie, Community Health Systems, C-SATS, Myriad Genetics; Speakers Bureau/Honoraria, Bard/Davol, Intuitive, Myriad Genetics; Other, Covidien, Teacher

**Purpose:** Performing a complete thoracic lymph node dissection for patients undergoing resection of pulmonary neuroendocrine (carcinoid) tumors is a topic of controversy. The purpose of this study is to identify the true incidence of N1 and N2 disease in these patients.

**Methods:** This is a retrospective review of two prospective databases from two surgeons at two institutions from January 2001 through March 2017. All patients had neuroendocrine cancer, preoperative computed tomography (CT) and/or integrated positron emission tomography-CT scans, pulmonary resection, and a complete mediastinal and hilar lymphadenectomy with an R0 operation.

**Results:** There was a total 285 patients (34% male) who underwent surgery for resection of a carcinoid tumor. Bilobectomy was performed in 16, lobectomy in 236, segmentectomy in 31, and bronchial sleeve resection in two patients. There were 267 patients who were pathologically staged N0 (T1 in 162, T2 in 73, T3 from more than one nodule in the same lobe in 14). Nineteen patients were found to have N1 disease and 17 had N2 disease. Of these 36 patients with nodal metastases, 31 had well-differentiated (typical) tumors. Neither the degree of differentiation, age at operation, clinical staging, lobar location, size of tumor on pathology report, or maximum standardized uptake values was a predictor of nodal metastases. The overall 5-year survival through 2016 was 90.2%; it was 92.3% for those with pN0, 68.5% with pN1, and 80% with pN2 disease.

**Conclusions:** About 13% of patients with neuroendocrine tumors of the lung/bronchus have lymph nodal metastases. Interestingly, the majority have well-differentiated tumors. Since there are few predictors of nodal metastases and a paucity of effective adjuvant chemotherapy for these patients, we recommend a complete thoracic lymphadenectomy for all.

P83

**Superior Vena Cava Replacement for Thymic Malignancies**

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**Purpose:** Advanced-stage thymic tumors infiltrating the superior vena cava (SVC), when radically resectable, can be surgically treated by a SVC prosthetic replacement within a multimodality therapeutic approach. To date, only small case series in this setting have been reported. We hereby present our series of patients undergoing SVC replacement for stage III-IVa thymic malignancies.

**Methods:** Between 1989 and 2015, 27 patients with thymic tumors (21 thymoma, six thymic carcinoma) infiltrating the SVC underwent radical resection with SVC prosthetic replacement by a bovine pericardial conduit in 12 cases, a polytetrafluoroethylene (PTFE) conduit in 13, a porcine pericardial conduit in one, and saphena vein conduit in one. Since 2003, all caval reconstructions were performed with heterologous pericardial conduit. All the patients underwent vascular conduit reconstruction by the cross-clamping technique without cardiopulmonary bypass. Twelve patients received induction treatment. In four cases, the tumor infiltrated the left brachiocephalic vein at the caval confluence. Six patients were myasthenic.

**Results:** All resections were complete (R0). Pulmonary resection was associated in 16 patients (11 wedge, five pneumonectomy). Twenty-two patients were Masaoka stage-III and five were stage-IVa. Two patients died postoperatively (7.4%); no mortality was related to the vascular reconstruction. Major complication rate was 11.1% (three patients), while minor complication rate was 22.2% (six patients). At a median follow-up of 58 months (range, 4-134 months), recurrence rate was 36% (six locoregional, three distant). Overall 3- and 5-year survival rates were 80% and 58.1%, respectively. Disease-free 3- and 5-year survival was 90.5% and 75.4%. Survival rates of thymoma patients at 3 and 5 years were 94.7% and 77%, respectively. Five-year survival of all stage-III patients was 61.9%. Thymic carcinoma histology was a negative prognostic factor ( $P = .003$ , HR 0.74, 95% CI 0.01-0.42). Long-term patency of the pericardial conduits was 100%. Three patients receiving PTFE conduit reconstruction showed partial or complete obstruction of the vascular prosthesis.

**Conclusions:** En bloc resection and conduit reconstruction of the SVC is a feasible, safe, and oncologically reliable procedure to allow radical resection of locally advanced thymic tumors. Heterologous pericardial conduit represents the favorite option in our experience.

P84

# **Gastrointestinal Function After Esophagectomy: Which Type of Resection and Perioperative Treatment Has Better Outcomes?**

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**Purpose:** Advances in treatment of esophageal cancer have led to longer survival. Quality of life, especially gastrointestinal dysfunction (GID), is increasingly important. We examine the relationship of surgical approach, neoadjuvant treatment, and anastomotic technique to rate of dysphagia, early satiety, and need for intervention after surgery.

**Methods:** A retrospective analysis of patients who had esophagectomies with gastric conduit reconstruction, performed between March 2007 and December 2016 at our academic medical center. Demographic details, perioperative treatment, surgical procedures, anastomotic technique, postoperative complications, and procedures performed were recorded. Dysphagia scores (range: 1-5; 1= no dysphagia to solids and liquids, while 5=unable to swallow saliva) were assigned for every follow-up encounter, while early satiety and vomiting as marker for poor gastric emptying were recorded. All procedures performed postoperatively to treat GID were documented. Logistic regression analysis was done to isolate the effect of each parameter on GID.

**Results:** 202 consecutive esophagectomies were performed during the study period. Four patients were excluded due to lack of follow-up. In an average of 24 months follow-up, 66 of 198 patients (33%) reported some degree of GID. Benign anastomotic stricture was the most common cause of GID (60/66, 91%), mostly in first year after surgery (65/66, 98%). Sixty-six patients had interventions for dysphagia; 44 patients for early satiety. Out of the 66 patients, 36 had multiple procedures. Anastomosis in the neck was related to symptomatic dysphagia and need for intervention in both short- and long-term follow-up (Table). Type of anastomoses and occurrence of leak were not related to development of dysphagia nor need for intervention. Neoadjuvant chemoradiation was protective (OR 0.85 [0.76-0.95];  $P < .01$ ) and location of the anastomosis in the neck (OR 0.89 [0.79-1.00];  $P = .05$ ) were independent factors in logistic regression analysis associated with short- and long-term GID that required intervention.

**Conclusions:** In our retrospective study of 198 esophagectomies, with multivariate logistic regression analysis the location of the anastomosis, but not type of anastomosis or occurrence of leak, correlated with need for intervention for postoperative dysphagia and/or early satiety. Surprisingly, preoperative chemoradiation had a protective effect on surgical-related gastrointestinal dysfunction after esophagectomy.

**Table 1: Neck vs thoracic anastomosis**

Anastomosis	Number of Patients	Number of patients requiring dilations	Chi squared
Neck	145	60 (41.3%)	P = 0.005
Thoracic	53	6 (11.3%)	

P85

**All Patients With Giant Hiatal Hernias Require Referral to a Surgeon***A. C. Ednie, D. G. French**Dalhousie University, Halifax, Canada*

**Purpose:** Giant hiatal hernias (GHH) have an increased risk of gastric volvulus. Controversy exists regarding surgical intervention for asymptomatic GHH. The goals of this study are to determine the number of these patients with hiatal hernias, and those with GHH being referred for surgical assessment and/or needing emergent surgical intervention.

**Methods:** A diagnostic imaging database for the health district was searched from January 2010 to January 2015. Surgical interventions, emergency department encounters, and surgical referrals were reviewed using personal health records.

**Results:** A total of 357,213 computed tomography chest/abdomen reports were searched, yielding 388 patients reported to have a diaphragmatic hernia. Hiatal hernias were identified in 185 patients (50.2%). Type III and IV hiatal hernias were reported in 75 patients (40%), including 30 (16.2%) giant hernias. Type IV hernias had the highest percentage of emergency department visits (36.4%). However, only five patients (6.7%) with type III and IV hernias were referred for surgical assessment. Five patients (16.7%) with giant hiatal hernias required emergent repair, compared to no patients with non-giant hernias ( $P < .001$ ). However, only four patients (13.3%) with giant hiatal hernias were referred for elective surgical assessment.

**Conclusions:** Patients with type III and IV hernias, and especially those with GHH, had more emergency department encounters and need for emergent surgical intervention. These patients should be referred for surgical assessment due to this increased risk. Further education of primary care physicians regarding referral for patients with GHH is required.

P86

# **Surgical Management of Post-Esophagectomy Tracheobronchial-Esophageal Fistula**

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**Purpose:** To evaluate risk factors and outcomes associated with surgical management of post-esophagectomy tracheobronchial-esophageal fistula (PETEF).

**Methods:** There were 11 patients who underwent surgical repair of acquired non-malignant PETEF at Massachusetts General Hospital from 1995 through 2015. Records describing patient demographics, operative management, and postoperative outcomes were reviewed. The prior esophageal operations in these patients were Ivor-Lewis esophagectomy (n=5, 45.5%), transhiatal esophagectomy (n=3, 27.3%), three-hole (McKeown) minimally invasive esophagectomy (n=1, 9.1%), laryngo-tracheo-esophagectomy (n=1), and pharyngo-laryngo-esophagectomy (n=1).

**Results:** The time to fistula occurrence after esophagectomy was variable, with five patients (45.5%) developing PETEF within 30 days, three patients (27.3%) in 1-4 months, and three patients at least 12 months after esophagectomy (range, 6-28 years). Anastomotic leak or conduit necrosis were the most common etiologies of the PETEF (n=8, 72.7%). Esophageal cancer recurrence, conduit staple line erosion, and radiation-associated anastomotic stricture requiring dilation were the other causes. Esophageal or conduit defects were addressed with esophagostomy or pharyngostomy with conduit takedown in six patients (54.5%), while the remainder underwent primary repair of the esophageal or gastric conduit defect (n=5, 45.5%). Airway defects were repaired primarily (n=5, 45.5%) or with an airway reconstruction (n=6, 54.5%). Two patients (18.2%) had recurrent airway fistulas. Three patients (27.3%) died in the early postoperative period. Morbidity after fistula repair included pneumonia, sepsis, and inability to resume oral diet.

**Conclusions:** Airway-esophageal (PETEF) fistula following esophagectomy is a devastating complication that is primarily related to anastomotic leak or conduit necrosis. PETEF often presents as an urgent problem requiring aggressive management to control sepsis and ongoing contamination of the airway. Although indicated, operative management of PETEF is associated with significant morbidity.

P87

# **Disparities in Optimal Esophageal Cancer Treatment**

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**COMMERCIAL RELATIONSHIPS** V. H. van Berkel: Ownership Interest, Breath Diagnostics; Consultant/Advisory Board, Breath Diagnostics

**Purpose:** The greatest chance for cure in patients with locally advanced esophageal cancer is neoadjuvant therapy, followed by resection. Approximately 30% of cases arise in patients 75 years and older, a group that often is not offered surgery. This study investigates the factors associated with esophageal cancer treatment and survival outcomes.

**Methods:** The National Cancer Database (NCDB) was queried for patients 75 years or older diagnosed with locally advanced clinical stage II and III esophageal cancer from 2004 to 2014. Patients were divided into five treatment groups: observation alone (OBS), chemotherapy or chemoradiation alone (CRT Alone), definitive chemotherapy or chemoradiation followed by non-R0 resection (DCRT+NonR0), definitive chemotherapy or chemoradiation followed by R0 resection (DCRT+R0), and surgery alone (Sx). Patients with unknown cancer staging and treatment were excluded from analysis. Overall survival for each group was calculated using Kaplan-Meier.

**Results:** There were 7627 patients aged 75 or older with locally advanced stage II (45.5%) and III (54.5%) esophageal cancers between 2004 and 2014. 15% (n=1129) did not receive medical intervention, 66% (n=5011) received only chemotherapy/chemoradiation, 1% (n=92) received neoadjuvant therapy and non-R0 resection, 12% (n=896) received neoadjuvant therapy and R0 resection, and 7% (n=499) underwent surgery alone. The demographic, socioeconomic, and clinical information is demonstrated in the Figure. Patients in the surgical groups (DCRT+NonR0, DCRT+R0, Sx) were more likely to be Caucasian, have a higher household income, and receive their care at an academic medical center compared to the non-surgical groups (OBS and CRT). The DCRT+R0 group had the best 1-, 3-, and 5-year survival with 72%, 40%, and 25%, respectively (Figure).

**Conclusions:** Surgery is an acceptable option in appropriately selected elderly patients. Neoadjuvant therapy followed by surgery is associated with the best survival outcomes. The clinical and socioeconomic disparities between the groups play important roles in the achievement of optimal treatment and survival.

Treatment Groups	no treatment	chemo/che morad only	sx non_r0	sx r0	sx only	p-value
N	1129	5011	92	896	499	
Age (mean)	82.2+/-4.6	79.9+/-3.9	77.9+/-2.5	77.6+/-2.5	79.5+/-3.5	<0.0001
White	86% (973)	91% (4557)	93% (86)	95% (853)	94 (469)	<0.0000
African American	9% (106)	6% (284)	3% (3)	1.4% (13)	2.8% (14)	<0.0001
Male	63% (718)	74% (3730)	79% (73)	83% (740)	74% (369)	<0.0001
Household Income >35000	70% (758)	73% (3470)	81% (71)	75% (648)	69% (333)	0.0002
Private Insurance	11% (126)	9% (451)	1% (1)	9% (79)	10% (49)	0.0003
Medicare	85% (955)	85% (4254)	96% (88)	88% (787)	87% (432)	0.0003
Medicaid	1.3% (15)	1.2% (62)	1% (1)	1% (7)	1% (5)	0.0003
Acedemic Facility	38% (431)	43% (1692)	41% (38)	52% (464)	58% (288)	
Distance From Treatment Center in miles. (median)	8 (3.5-23)	8.3 (3.8- 19.8)	10.2 (4.7- 23.3)	16.8 (6.4- 46.5)	14.2 (5.5- 46.8)	<0.0001
Metro Area	78%(910)	84% (3987)	84% (75)	79% (685)	80% (375)	
Education Level (county with >21% non HS graduates)	64% (690)	68% (3252)	78% (68)	71% (607)	69% (332)	<0.0001
Charleson-Dayco Score >/=2	9% (102)	7% (346)	8% (7)	5% (45)	8% (40)	<0.0001
Stage II	47% (531)	44% (2219)	46% (42)	45% (399)	57% (286)	<0.0001
Stage III	53% (598)	56% (2792)	54% (50)	55% (497)	43% (213)	<0.0001
Adenocarcinoma	51% (575)	55% (2777)	70% (64)	75% (669)	66% (331)	<0.0001
Squamous Cell	34% (383)	32% (1593)	15% (14)	12% (108)	22% (109)	<0.0001
Survival						
1 year	18.0%	54%	62%	72%	58%	<0.0001
3 year	6%	21%	30%	40%	25%	<0.0001
5 year	3%	13%	24%	25%	15%	<0.0001

P88

# **Admission for Advanced Esophageal Cancer: A Dedicated Team Approach Benefits Patients and Reduces Costs**

*N. D. Tingquist<sup>1</sup>, M. A. Steliga<sup>2</sup>, K. D. Joubert<sup>3</sup>, K. W. Sexton<sup>2</sup>*

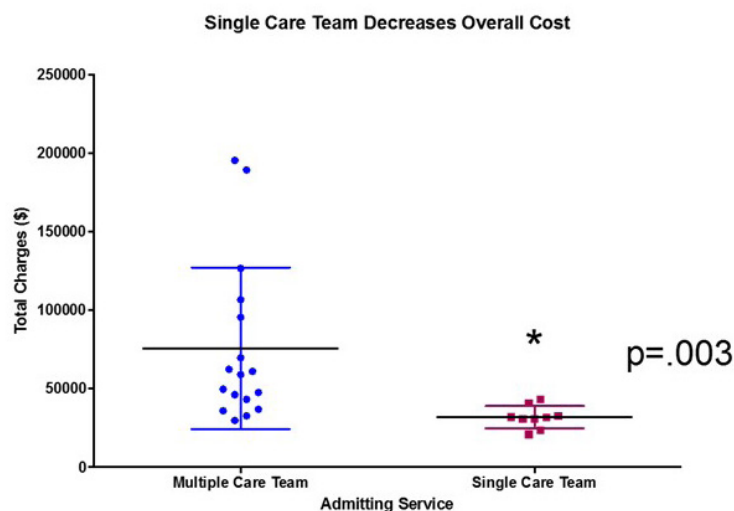
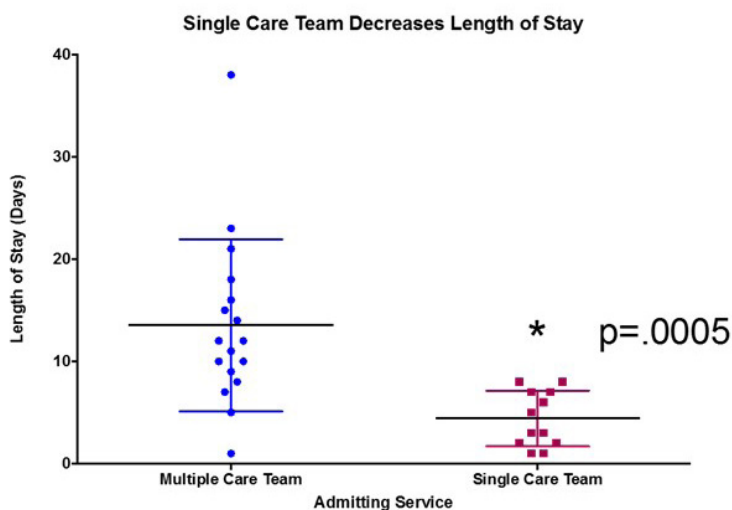
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**Purpose:** Esophageal cancer is the eighth most common cancer worldwide and often requires inefficient, costly multidisciplinary care. Clinical pathways have been shown to improve quality of care while reducing resource utilization and health care costs. Admission to a surgery service is part of a clinical pathway for management of esophageal cancer.

**Methods:** Following IRB approval, retrospective data was obtained from the UAMS Enterprise Data Warehouse and electronic medical records for patients admitted for suspected esophageal cancer with the diagnosis of esophageal obstruction from 2014 through 2015. Data were gathered, analyzed, and reported, including overall length of stay, hospital charges, professional charges, and overall cost. Student's t-test was used for comparison of length of stay and charges when admission was to a surgical vs medical service. All statistical tests were two-sided, with a *P* value < .05, which was assumed to be statistically significant.

**Results:** This study identifies 29 patients with the diagnosis of esophageal obstruction who underwent both esophagogastroduodenoscopy (EGD) and chemotherapy access placement during their admission. Twelve patients (41.3%) were managed exclusively by the thoracic surgery service with all procedures being performed by a single care team cohort, and 17 patients (58.7%) were managed on a medical service with a multiple care team cohort. 100% of the nonsurgical patients (n=17) had varying physicians for inpatient care, EGD, and chemotherapy access placement. Admission to a team dedicated to the diagnosis and management of esophageal cancer decreased the inpatient stay and reduced cost. The mean length of stay was 4.4 days when admitted to the thoracic surgery service vs 13.5 days when admitted to a hospitalist service. In addition, the mean overall cost was \$43,902 less per patient when admitted to thoracic surgery (\$75,809 vs \$31,907).

**Conclusions:** Though clinical pathways for esophageal cancer have demonstrated reduced length of stay and cost in the setting of esophagectomy, their utility for the initial management of esophageal cancer has not been explored. In this capacity, a pathway could reduce costs and improve overall care for patients presenting with advanced disease.



P89

# **The Impact of Cytomegalovirus Serology on Survival Following Lung Transplantation**

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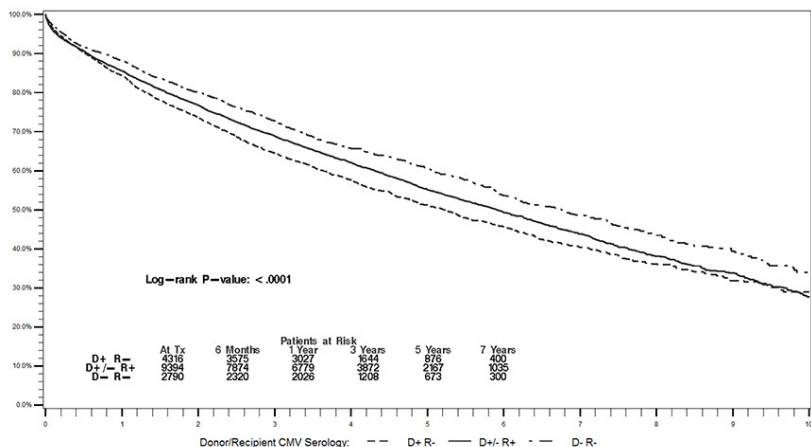
**COMMERCIAL RELATIONSHIPS** T. M. Beaver: Research Grant, Edwards Lifesciences

**Purpose:** Cytomegalovirus (CMV) infection is a significant source of morbidity and mortality following lung transplantation; however, some studies suggest CMV matching is unnecessary in the era of aggressive CMV prophylaxis. The aim of this study was to assess the relationship between donor-recipient CMV serology and post-transplant survival in the post-Lung Allocation Score era.

**Methods:** The United Network for Organ Sharing Standard Transplant Analysis and Research database was queried to identify patients who underwent de novo lung transplantation following implementation of the lung allocation score in the period from 2005 to 2016. The primary outcome investigated was overall survival. Kaplan-Meier analysis with log-rank testing compared survival between cohorts based on CMV serology for both donors (D) and recipients (R). Patients were divided into three donor-recipient cohorts to compare survival: D+|R-, D±|R+, and D-|R-. Preoperative recipient and donor characteristic differences were analyzed, then subjected to multivariate Cox regression models to assess impact on survival.

**Results:** Of the 17,332 primary lung transplantation procedures performed between 2005 and 2016, 10,884 (62.8%) were from CMV+ donors, and 6448 (37.2%) were from CMV- donors. Estimated survival at 1 year and 5 years for recipients of CMV+ donor lungs was 84.6% and 53.2%, respectively, compared with 87.1% and 57.9% for recipients of CMV- donor lungs (log-rank  $P < .0001$ ). Cohort analysis based on CMV donor-recipient serology matching was performed, identifying multiple important demographic baseline characteristics between cohorts (Table). Estimated survival at 1 year and 5 years for each cohort was as follows: D+|R- 84.4% and 51.1%; D±|R+ 85.5% and 55.2%; D-|R- 88.0% and 60.2% (Figure, log-rank  $P < .0001$ ). Bonferroni adjustment for multiple comparisons confirmed statistical significance with all  $P \leq .05$ .

**Conclusions:** In the modern era of lung transplantation, donor CMV seropositivity remains an important determinant of post-transplant survival. Further, CMV matching has a statistically significant impact on survival, with the D-|R- cohort showing the greatest survival advantage. Our findings suggest that donor-recipient CMV serology be considered when making decisions regarding transplantation.



Variable	D+ R- n (%) or Median±SD	D± R+ n (%) or Median±SD	D- R- n (%) or Median±SD	P-value
<b>Number</b>	<b>4328</b>	<b>9410</b>	<b>2793</b>	
<b>% of total</b>	<b>26.2%</b>	<b>56.9%</b>	<b>16.9%</b>	
<b>Donor Characteristics</b>				
Age (years)	32±14	33±14	30±14	0.0035*
Gender (male)	2624 (60.6%)	5452 (57.9%)	1886 (67.5%)	<0.0001**
Race				<0.0001**
White	2330 (53.8%)	5714 (60.7%)	2159 (77.3%)	
Black	1011 (23.4%)	1757 (18.7%)	353 (12.6%)	
Other	987 (22.8%)	1939 (20.6%)	281 (10.1%)	
BMI (kg/m <sup>2</sup> )	25.2±5.1	25.0±5.3	25.1±5.2	0.7408*
Smoking History (Yes)	421 (9.8%)	949 (10.2%)	274 (9.9%)	0.7656**
Cause of death				<0.0001**
Trauma	2176 (50.3%)	4298 (45.7%)	1185 (42.4%)	
CVA	1432 (33.1%)	3376 (35.9%)	899 (32.2%)	
Anoxia/asphyxia	593 (13.7%)	1457 (15.5%)	614 (22.0%)	
Other	127 (2.9%)	279 (2.9%)	95 (3.4%)	
<b>Recipient Characteristics</b>				
Age (years)	58±14	60±12	58±14	<0.0001*
Gender (male)	2736 (63.2%)	5243 (55.7%)	1876 (67.2%)	<0.0001**
Race				<0.0001**
White	3948 (91.2%)	7234 (76.9%)	2582 (92.5%)	
Black	194 (4.5%)	1110 (11.8%)	122 (4.4%)	
Other	186 (4.3%)	1066 (11.33%)	89 (3.2%)	
BMI (kg/m <sup>2</sup> )	24.8±4.7	25.5±4.5	25.2±4.7	<0.0001*
FEV <sub>1</sub> (percent predicted)	33±21	35±21	33±21	0.2839*
Transplant Type				<0.0001**
Single	1316 (30.4%)	3329 (35.4%)	887 (31.8%)	
Bilateral	3012 (69.6%)	6081 (64.6%)	1906 (68.2%)	
Recipient treated infection	569 (13.4%)	866 (9.4%)	303 (11.2%)	<0.0001**
Recipient ventilator pre-op	277 (6.4%)	476 (5.1%)	160 (5.7%)	0.0052**
Recipient pulmonary HTN	1901 (48.3%)	4241 (49.1%)	1295 (50.9%)	0.1221**
Recipient diabetes status				<0.0001**
Type 1	176 (4.1%)	230 (2.5%)	114 (4.1%)	
Type 2	493 (11.5%)	1098 (11.8%)	297 (10.7%)	
Not diabetic	3442 (80.0%)	7695 (82.4%)	2261 (81.5%)	
Ischemic time (h)	5.1±1.7	4.9±1.7	5.1±1.6	<0.0001*

Statistical p-values were obtained using the Kruskal-Wallis (\*) and Chi-Squared (\*\*) tests. Abbreviations: SD = standard deviation, BMI = body mass index, CVA = cerebrovascular accident, FEV<sub>1</sub> = forced expiratory volume in one second; HTN = hypertension. Information was not available for the following variables. Information was not available for the following variables: Donor or recipient CMV status (n=848), donor smoking history (n=165), recipient treated infection (n=499), recipient pulmonary HTN (n=1590), recipient diabetes status (n=118).

P90

# **Endosonographic Lymph Node Staging for Early Stage Inoperable Non-Small-Cell Lung Cancer Treated by Stereotactic Body Radiation Therapy**

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**COMMERCIAL RELATIONSHIP** M. A. Liberman: Research Grant, Boston Scientific, Cook Medical, Ethicon

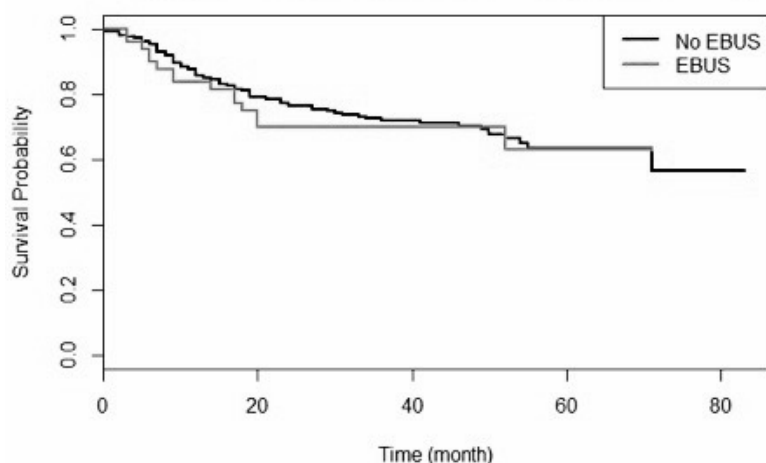
**Purpose:** Noninvasive imaging is the current standard to detect mediastinal lymph node (LN) metastasis in patients with non-small-cell lung cancers (NSCLC) treated by stereotactic body radiation therapy (SBRT). The objective was to determine whether invasive mediastinal staging with endosonographic techniques leads to decreased locoregional failure rates and increased survival.

**Methods:** This study consists of a retrospective, single-institution, tertiary referral center review of a prospectively maintained interventional thoracic endoscopy database. Patients with biopsy-proven, clinically staged T1-2 N0 M0 NSCLC who underwent SBRT as a curative treatment between July 2009 and August 2015 were evaluated. Local, regional, distant, and overall progression rates, progression-free survival, and overall survival were recorded and compared between patients who received pre-SBRT endosonographic LN staging and those who received only standard computed tomography (CT) and positron emission tomography (PET) scans. Patients were followed up for a minimum of 6 months after their initial diagnosis.

**Results:** A total of 303 consecutive patients were included. Out of the 49 patients who received endosonographic LN staging prior to treatment, four (8.2%) had locoregional progression within 6 months of the end of their treatment, and seven (14.3%) showed locoregional progression 6 months post-SBRT for a total of 11 cases (22.4%) that progressed locoregionally. In comparison, out of the 254 patients who received standard noninvasive staging techniques only, seven (2.8%) showed locoregional progression within 6 months of the end of their treatment, and 53 (20.9%) showed locoregional progression 6 months post-SBRT for a total of 60 cases (23.6%) that progressed locoregionally. Mean progression-free survival was 31 months for patients who received endosonographic staging, compared to 37 months for patients who did not. Finally, mean overall survival was 35.5 months for patients who received endosonographic staging, compared to 40 months for patients who did not. None of these results were statistically significant.

**Conclusions:** Given the lack of significant benefits in locoregional progression and survival between patients receiving endosonographic staging and those who did not, our results suggest that there is no indication for endosonographic staging to be routinely performed in inoperable early stage NSCLC treated by SBRT unless CT/PET demonstrate possible LN metastases.

### Progression-Free Survival (Months Since End of Tx)



#### Recurrence Data for EBUS vs. No EBUS

	EBUS (n = 49)	No EBUS (n = 254)	p-value
<i>Relapse within 6 Months of End of Tx (n = 17)</i>			
Local	n = 0 (0%)	n = 5 (2.0%)	0.3344
Regional	n = 4 (8.2%)	n = 5 (2.0%)	0.2377
Locoregional	n = 4 (8.2%)	n = 7 (2.8%)	0.5230
Distant	n = 3 (6.1%)	n = 11 (4.3%)	0.8275
All	n = 5 (10.2%)	n = 12 (4.7%)	0.9644
<i>Relapse &gt;6 Months after End of Tx (n = 71)</i>			
Local	n = 4 (8.2%)	n = 34 (13.8%)	0.4922
Regional	n = 5 (10.2%)	n = 33 (13.0%)	0.8366
Locoregional	n = 7 (14.3%)	n = 53 (20.9%)	0.4554
Distant	n = 8 (16.3%)	n = 30 (12.2%)	0.4503
All	n = 10 (20.4%)	n = 61 (24.0%)	0.8270
Overall Relapse (n = 88)	n = 15 (30.6%)	n = 73 (28.7%)	0.9263
Metachronous Primary	n = 6 (12.2%)	n = 34 (13.4%)	0.9999
Mean Follow-Up (Months Since End of Tx)	20.2	24.5	0.0583

Quality Improvement

P91

**The STS 30-Day Predicted Risk of Mortality Score Is a Reliable Predictor of Long-Term Survival in Israeli Patients Undergoing Cardiac Surgery**

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**Purpose:** Long-term survival is key when assessing the value of cardiovascular interventions. We previously validated the STS 30-day predicted risk of mortality (STS-PROM) in a cohort of Israeli patients undergoing cardiac surgery. We sought to investigate the ability of the STS-PROM score to reliably predict long-term survival.

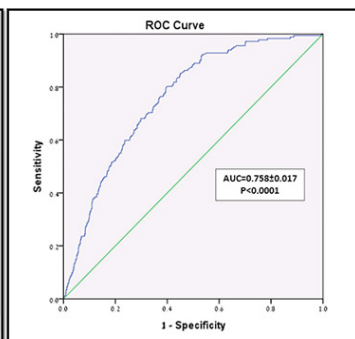
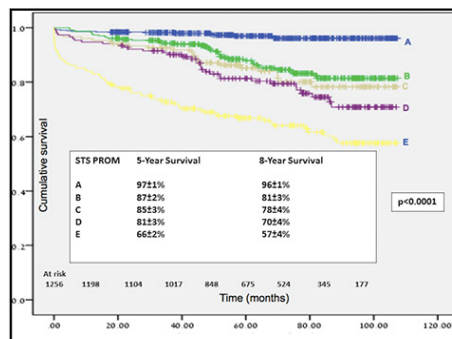
**Methods:** Demographic, clinical, and procedural data on 1279 patients undergoing cardiac surgery were prospectively entered into our departmental STS-linked database and used to calculate PROM. Long-term data were obtained by linking to the National Israeli Social Security Mortality Database. Patients were stratified into five separate cohorts based on their STS-PROM (A: 0%-0.99%, B: 1.0%-1.99%, C: 2.0%-2.99%, D: 3.0%-4.99% and E: >5.0%). Kaplan-Meier plots were created for each cohort and were compared by log-rank test. Model discrimination of the STS-PROM was assessed using Area Under the Curve (AUC) methodology. Cox regression analysis was performed to identify predictors of long-term survival.

**Results:** Complete follow-up was achieved for 1256 patients (98%) over a mean period of 62 months  $\pm$  28 months (range, 0-107 months). Mean survival of the entire cohort was 95 months  $\pm$  1 months (182 deaths). Higher STS-PROM was associated with a significantly reduced mean survival: A – 104 months  $\pm$  1 months, B – 96 months  $\pm$  2 months, C – 93 months  $\pm$  3 months, D – 89 months  $\pm$  3 months, E – 74 months  $\pm$  3 months ( $P < .0001$ , Table). Five- and 8-year survival rates were inversely related to the STS-PROM (Figure, Panel A). STS-PROM AUC was  $0.76 \pm 0.02$ , suggesting excellent model discrimination (Figure, Panel B). In a Cox regression analysis, advanced age, incidence of surgery, ejection fraction, diabetes mellitus, dialysis, and STS-PROM were found to be independent predictors of long-term survival.

**Conclusions:** Thirty-day STS-PROM was found to be a strong and reliable predictor of long-term survival in Israeli patients undergoing cardiac surgery. These data suggest that PROM should be discussed with the patient and family with respect to long-term outcome and included in the procedural cost-effectiveness analysis.

Panel A

Panel B



PROM Group	Mean Survival (months)	Standard Error	95% Confidence Interval
A	104.4	.75	103.0 – 105.9
B	96.2	1.6	93.0 – 99.4
C	93.1	2.6	88.0 – 98.1
D	89.4	2.7	84.2 – 94.7
E	74.4	3.2	68.1 – 80.7
Total	94.6	.88	92.9 – 96.4

P92

# **Patient-Reported Experience After Cardiac Surgery: Identifying Areas for Improvement**

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*Mayo Clinic, Rochester, MN*

**COMMERCIAL RELATIONSHIPS** R. C. Daly: Ownership Interest, NeoChord

**Purpose:** In response to the public reporting of hospital star ratings and reimbursement implications of the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient experience surveys, we assessed our institutional HCAHPS survey data with the goal of identifying areas for improvement in our cardiac surgery practice.

**Methods:** Institutional HCAHPS surveys from patients who underwent coronary artery bypass grafting, open aortic valve replacement (AVR), transcatheter aortic valve replacement (TAVR), robotic mitral valve (MV) repair, open MV repair and replacement, double valve surgeries, and aortic repair and were discharged between October 1, 2012, and September 30, 2015, were reviewed. The primary outcome was global hospital rating. Multivariable logistic regression analysis evaluated the independent associations of variables with low global score. Key driver analysis identified quality improvement targets.

**Results:** Among 1315 patients, low global hospital scores were independently associated with low perceived overall health (fair or poor vs excellent, odds ratio [OR] 5.4,  $P = .001$ ), age 18-59 (vs  $\geq 70$ , OR 1.6,  $P = .048$ ), procedure-specific prolonged length of stay (OR 1.6,  $P = .02$ ), and robotic MV repair (vs open MV repair, OR 2.4,  $P = .045$ ). TAVR patients reported global scores similar to open aortic valve operations (OR 0.9,  $P = .64$ ). Overall key drivers of global patient experience were care transitions and communication regarding medications.

**Conclusions:** Analysis of our cardiac surgery HCAHPS data suggests that care transitions and communications regarding medications should be the primary targets of improvement efforts. Patient-reported experience was similar across operations, and the less invasive procedures—robotic MV repair and TAVR—were not independently associated with higher scores.