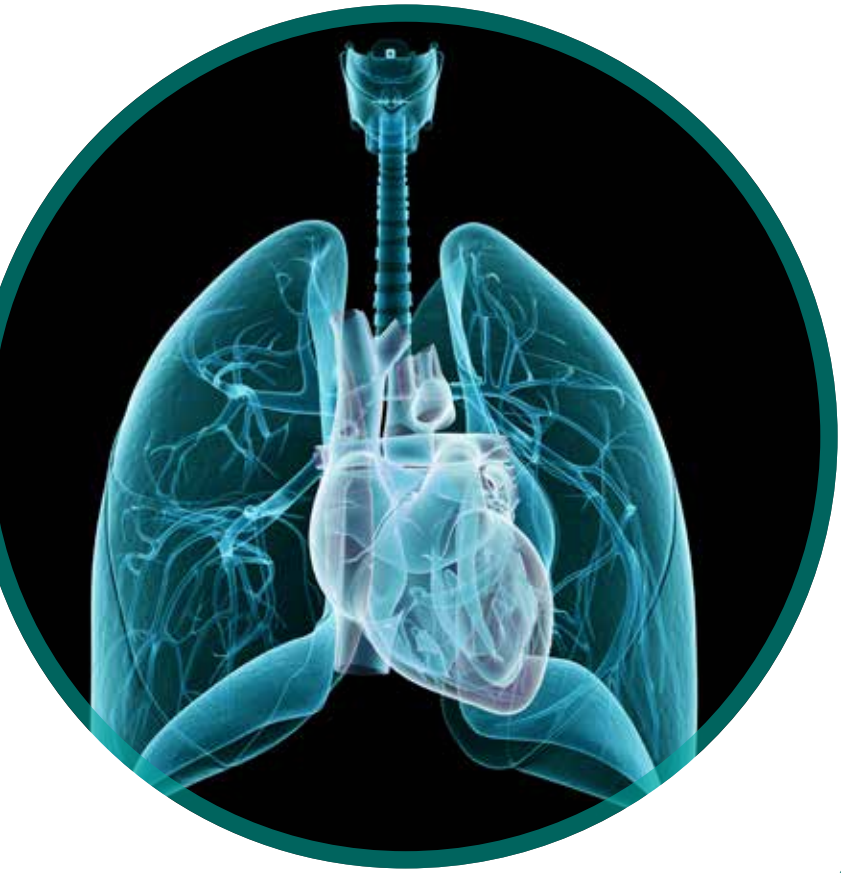
The Society of Thoracic Surgeons

55TH ANNUAL MEETING

Abstract Book



San Diego Convention Center
San Diego, California

January 27-29, 2019

The Society of Thoracic Surgeons

The Society of Thoracic Surgeons gratefully acknowledges the following companies for providing educational grants for the STS 55th Annual Meeting.

This list is accurate as of January 15, 2019.

Platinum Benefactors

Provided $50,000 or more

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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

The information in this Abstract Book is accurate as of January 15, 2019. Speakers and agendas subject to change.

*Presenting authors are listed in **bold**. 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.*

Abstract content appears as it was submitted; only titles have been edited for clarity and consistency.

Program at a Glance

Friday, January 25

3:00 PM – 6:00 PM
Registration

Saturday, January 26

7:00 AM – 5:00 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: New Technologies in Ischemic, Heart Failure, and Atrial Fibrillation Surgery
Tech-Con General Thoracic Track I: New Technologies in Lung and Chest Wall Surgery

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

10:15 AM – 12:00 PM
Tech-Con Adult Cardiac Track II: New Technologies in Aortic and Structural Heart Disease
Tech-Con General Thoracic Track II: New Technologies in Esophageal Surgery

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

1:00 PM – 5:00 PM
Tech-Con Joint Session: The Future of Cardiothoracic Surgery Is Here

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

5:00 PM – 6:30 PM
Tech-Con Reception

Sunday, January 27

7:00 AM – 6:30 PM
Registration

7:00 AM – 12:00 PM
The Multidisciplinary Team: How We Do It

8:00 AM – 9:45 AM
STS University (Session I) <ticket required>

8:00 AM – 12:00 PM
Adult Congenital Heart Disease Symposium: Planning for the Future—Aortic Arch Anomalies and the Failing Fontan
CHEST @ STS: Interventional Bronchoscopy
Critical Care Symposium: Cutting-Edge Strategies for Cardiothoracic Critical Care Emergencies and Evolving Technologies
Practice Management Summit
SCA @ STS: Integrating Perioperative Echocardiography in Cardiac Surgical Clinical Decision-Making for Challenging Cases

10:00 AM – 12:00 PM
Residents Symposium: Transitioning From Residency to a Successful Practice

10:15 AM – 12:00 PM
STS University (Session II) <ticket required>

12:00 PM – 1:00 PM
Lunch
Residents Luncheon

1:00 PM – 2:00 PM
Ethics Debate: Bespoke Babies—Genome Editing in Cystic Fibrosis Embryos
Key Contacts: Advocates for Cardiothoracic Surgery
Research Using the STS National Database
STS/CATS/CSCS: Innovative Techniques in Thoracic Surgery
The Annals Academy: How to Write a Great Review—Essential Components of Outstanding Peer Reviews
Unconscious Bias (organized by Women in Thoracic Surgery)

2:10 PM – 4:30 PM
Opening Session

- **2:10 PM**
  Welcome
- **2:30 PM**
  J. Maxwell Chamberlain Memorial Papers
- **3:30 PM**
  Thomas B. Ferguson Lecture: Laurie H. Glimcher

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

4:45 PM – 5:30 PM
Jeopardy Championship

5:30 PM – 6:30 PM
Poster Presentations

5:30 PM – 6:30 PM
2019 The Thoracic Surgery Foundation Awards Announcement and VIP Reception
By invitation only

7:00 PM – 10:00 PM
President's Reception: Hotel del Coronado <ticket required>

Monday, January 28

6:30 AM – 5:00 PM
Registration

9:00 AM – 4:30 PM
Exhibit Hall

7:15 AM – 9:15 AM
Career Navigation and Development: Hot Topics to Enhance Your First 7 Years of Practice
Congenital: Pediatric Congenital I
EACTS @ STS: Which Arch Operation Should I Do? Decision-Making During Type A Dissection Repair
ESTS @ STS: Controversial Issues in General Thoracic Surgery—Perspectives From Europe and North America
STS/ISHLT Joint Symposium: The Evolution of Mechanical Circulatory Support—International Perspectives and Universal Challenges

8:15 AM – 9:15 AM
Basic Science Research: Adult Cardiac
Basic Science Research: General Thoracic
Diversity and Inclusion in Cardiothoracic Surgery: What Is the Real Value?

9:30 AM – 12:15 PM
Plenary Session

9:30 AM
Featured Abstract Presentations
10:15 AM
BREAK—Visit Exhibits and Scientific Posters
11:00 AM
Introduction of the President: Robert S. D. Higgins
11:10 AM
Presidential Address: Keith S. Naunheim

12:15 PM – 1:15 PM
BREAK—Visit Exhibits and Scientific Posters

1:15 PM – 2:15 PM
Late-Breaking Data

1:15 PM – 3:15 PM
Adult Cardiac: Aorta I
Adult Cardiac: Ischemic
Congenital: Pediatric Congenital II
General Thoracic: Lung Cancer I
General Thoracic: Lung Transplantation
SVS @ STS: Sharing Common Ground for Cardiovascular Problems

1:15 PM – 5:00 PM
Clinical Scenarios: The Heart Team

3:15 PM – 4:00 PM
BREAK—Visit Exhibits and Scientific Posters

4:00 PM – 5:00 PM
Adult Cardiac: Arrhythmia/Atrial Fibrillation
Adult Cardiac: Contemporary Practices in Surgical Therapy for Advanced Heart Failure
Cardiothoracic Surgery Education
Congenital: Adult Congenital
Critical Care Research
Next-Generation General Thoracic Surgery
Quality Improvement in Cardiothoracic Surgery

5:15 PM – 6:15 PM
Business Meeting (STS Members Only)

6:30 PM – 7:30 PM
STS-PAC Reception (open to 2019 STS-PAC contributors)

Tuesday, January 29

6:30 AM – 1:00 PM
Registration

9:00 AM – 1:30 PM
Exhibit Hall

7:00 AM – 9:00 AM
Adult Cardiac: General
Adult Cardiac: Mitral and Tricuspid Valves
Congenital: Pediatric Congenital III
General Thoracic: Lung Cancer II
General Thoracic: Mediastinal/Pulmonary
Pain Management

9:00 AM – 9:30 AM
BREAK—Visit Exhibits and Scientific Posters

9:30 AM – 10:45 AM
Plenary Session

9:30 AM
Award Presentations
9:45 AM
C. Walton Lillehei Lecture: Eric Topol

11:00 AM – 12:00 PM
Meet the Experts Sessions
Health Policy Forum

12:00 PM – 1:00 PM
BREAK—Visit Exhibits and Scientific Posters

1:00 PM – 3:00 PM
Adult Cardiac: Aorta II
Adult Cardiac: Aortic Valve/Novel Technologies
Advanced Therapies for End-Stage Cardiopulmonary Disease
General Thoracic: Esophageal

1:00 PM – 5:00 PM
How-To Video Session: Technical Tips to Avoid Pitfalls and Simplify Congenital and Pediatric Cardiac Surgery Procedures
How-To Video Session: General Thoracic
“My Tube” Adult Cardiac How-To Video Session
Patient Safety Symposium: Innovation and Safety in the Digital Era—From EHRs to Cybersecurity

Continuing Medical Education Credit

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 23.25 *AMA PRA Category 1 Credits*™. 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 28.0 Category I CEUs for this activity.

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

Learning Objectives for the STS 55th 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

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 55th 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.

Electronic CME/CEU Evaluation

The STS 55th 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 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 Tech-Con 2019.*

Attendees can complete evaluations through the STS Meetings app, by going to sts.org/2019evaluation, or by visiting computer stations located on the upper level near Ballroom 20 and on the lower level near Registration. In order to make this process more convenient for attendees, the meeting evaluations will be available through Friday, February 15, 2019.

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

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

Saturday, January 26

7:00 AM – 5:00 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: New Technologies in Ischemic, Heart Failure, and Atrial Fibrillation Surgery
Moderators: *Husam H. Balkhy, Chicago, IL, Mark S. Slaughter, Louisville, KY, and John M. Stulak, Rochester, MN*

Atrial Fibrillation

8:00 AM — Minimally Invasive Left Atrial Appendage Closure Through the Transverse Sinus: Why and How I Do It
Niv Ad, Morgantown, WV

8:08 AM — Sophisticated Mapping in the OR During Surgical Ablation: How to Do It With or Without Your Electrophysiologist
Gianluigi Bisleri, Kingston, Canada

8:16 AM — Panel Discussion

Heart Failure

8:22 AM — High-Risk Cardiac Surgery Using Temporary Circulatory Support: How I Do It
Edward G. Soltesz, Cleveland, OH

8:30 AM — Smartphone App to Facilitate Donor Organ Harvesting
Robert W. Emery, Minneapolis, MN

8:38 AM — Treating Heart Failure With MitraClips: Is It Ready for Prime Time?
Isaac George, New York, NY

8:46 AM — Panel Discussion

Ischemia

8:56 AM — Noninvasive Imaging for Coronary Bypass: What's New in Anatomic and Functional Evaluation of Coronary Artery Disease
Matthew Budoff, Torrance, CA

9:04 AM — Advanced Hybrid Coronary Revascularization: Are Two Internal Mammary Artery Grafts Better Than One?
Husam H. Balkhy, Chicago, IL

9:12 AM — Arterial Grafts: Lessons Learned From Arterial and Radial Conduits
David Glineur, Ottawa, Canada

9:20 AM — Panel Discussion

8:00 AM – 9:30 AM
Tech-Con General Thoracic Track I: New Technologies in Lung and Chest Wall Surgery
Moderators: *Lisa M. Brown, Sacramento, CA, and Linda W. Martin, Charlottesville, VA*

8:00 AM — A Novel Wireless Surgical Marker for Small Lung Lesions
Yojiro Yutaka, Kyoto, Japan

8:12 AM — First Use of the ArtiSential Suite of Articulated Instruments in Video-Assisted Thoracoscopic Surgery
Marco Nardini, Middlesbrough, United Kingdom

8:24 AM — Update on Robotic Bronchoplasty Techniques
Lana Y. Schumacher, Pittsburgh, PA

8:36 AM — Novel Applications of Titanium Mesh in Thoracic Surgery
Anthony D. Cassano, Richmond, VA

8:48 AM — State-of-the-Art in Chest Wall and Diaphragm Reconstruction: Current Materials and Techniques
Reza J. Mehran, Houston, TX

9:00 AM — A Novel Approach to Patient Engagement
Alden M. Parsons, Raleigh, NC

9:12 AM — Targeted Lung Denervation to Treat Chronic Obstructive Pulmonary Disease
Malcolm M. DeCamp, Madison, WI

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

10:15 AM – 12:00 PM
Tech-Con Adult Cardiac Track II: New Technologies in Aortic and Structural Heart Disease
Moderators: *Gilbert H. Tang, New York, NY, and Tsuyoshi Kaneko, Boston, MA*

10:15 AM — Aortic Valve Repair Technology and Devices: Where Are We Going?
Y. Joseph Woo, Stanford, CA

10:23 AM — PHASTER: Proximal Hybrid Aortic Stent Graft for Extended Repair
Eric E. Roselli, Cleveland, OH

10:31 AM — Branched Endografts for the Aortic Arch
Ourania A. Preventza, Houston, TX

10:39 AM — Panel Discussion

10:49 AM — Minimally Invasive Transcatheter Aortic Valve Replacement in Mitral Annular Calcification: Pearls and Pitfalls
Tom C. Nguyen, Houston, TX

10:57 AM — Transapical Mitral Replacement With Anterior Leaflet Splitting: A Novel Technique to Avoid Left Ventricular Outflow Tract Obstruction
Richard Lee, Augusta, GA

11:05 AM — Update on New Transcatheter Mitral Replacement Devices
Michael J. Reardon, Houston, TX

11:13 AM — Panel Discussion

11:23 AM — A New Sutureless Device to Repair Mitral Chords
Thierry P. Carrel, Bern, Switzerland

11:31 AM First-in-Man Implantation of a Novel Balloon-Adjustable Mitral Ring
Alfred A. Kocher, Vienna, Austria

11:39 AM Tricuspid Extracellular Matrix Cylinder Valves in Endocarditis: Earliest Steps to In-Human Valve Generation
Marc W. Gerdisch, Indianapolis, IN

11:47 AM Panel Discussion

10:15 AM – 12:00 PM
Tech-Con General Thoracic Track II: New Technologies in Esophageal Surgery
Moderators: *Andrew C. Chang, Ann Arbor, MI, and Siva Raja, Cleveland, OH*

10:15 AM Tissue-Engineered Esophagus
Dennis A. Wigle, Rochester, MN

10:27 AM POP and STER: Endoscopic Pyloromyotomy and Submucosal Tumor Resection
Brian E. Louie, Seattle, WA

10:39 AM FLIP for LINX: Endoflip for Anti-Reflux Surgery
Min P. Kim, Houston, TX

10:51 AM Panel Discussion

11:06 AM Atrial Septal Defect Closure Device for Tracheoesophageal Fistula Repair
Daniel P. Raymond, Cleveland, OH

11:18 AM Subxiphoid Approach to Mediastinal Tumor Resection
Takashi Suda, Aichi, Japan

11:30 AM EndoVAC for Esophageal Leak
Wayne L. Hofstetter, Houston, TX

11:42 AM Panel Discussion

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

1:00 PM – 2:30 PM
Tech-Con Joint Session: The Future of Cardiothoracic Surgery Is Here
Moderators: *Melanie A. Edwards, St Louis, MO, and Tom C. Nguyen, Houston, TX*

1:00 PM **Keynote Address:** Artificial Intelligence—Hope, Hype, or Horror for Med Tech?
Thomas M. Krummel, Stanford, CA

1:30 PM 2018 Year in Review: Summary of New Technologies and Major Research
Adult Cardiac: *Vinod H. Thourani, Washington, DC*
General Thoracic: *Todd L. Demmy, Buffalo, NY*
Congenital: *Carlos M. Mery, Austin, TX*

1:51 PM A Call for Change: Maintaining the Future of Our Field
Tom C. Nguyen, Houston, TX

1:56 PM The Kinder, Gentler 4th Era of Heart Surgery
Jude S. Sauer, Pittsford, NY

2:04 PM Planning for Future Reoperation: Choosing the Valve for the Present
Keith B. Allen, Kansas City, MO

2:12 PM Radiomics and Lung Cancer Detection/Modeling: Is This the Holy Grail?
Shanda H. Blackmon, Rochester, MN

2:20 PM Panel Discussion

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

Debates
Moderators: *Bradley G. Leshnower, Atlanta, GA, and Virginia R. Litle, Boston, MA*

3:00 PM DEBATE: Coronary Revascularization Should Only Be Performed by Dedicated Coronary Artery Bypass Grafting Surgeons
PRO: *John D. Puskas, New York, NY*
CON: *Gorav Ailawadi, Charlottesville, VA*

3:30 PM DEBATE: Peroral Endoscopic Myotomy Should Replace Laparoscopic Heller Myotomy
PRO: *Siva Raja, Cleveland, OH*
CON: *Christopher W. Seder, Chicago, IL*

"Shark Tank"
Moderators: *Daniela Molena, New York, NY, and Grayson H. Wheatley, Nashville, TN*

4:00 PM Past "Shark Tank" Presenters: Where Are They Now? What Have We Learned?
Juan P. Umana, Bogota, Colombia

4:10 PM Rapid and Leakproof Aortic Anastomosis Stapler
Syed T. Raza, New York, NY

4:20 PM Toroidal Valveless Pulsatile-Flow Ventricular Assist Device
Jeffrey R. Gohean, Austin, TX

4:30 PM Neurostimulation for Pain Management After Cardiac Surgery
Usman Ahmad, Cleveland, OH

4:40 PM Tracheomend
Faiz Bhora, New York, NY

4:50 PM Discussion

5:00 PM – 6:30 PM
RECEPTION—Visit Tech-Con Exhibits

Sunday, January 27

7:00 AM – 6:30 PM
Registration

7:00 AM – 12:00 PM
The Multidisciplinary Team: How We Do It

This session will provide an opportunity for Advanced Practice Providers (APPs) and other health care professionals to gain knowledge that will help them improve the care of cardiothoracic surgery patients. Topics will include multidisciplinary care delivery models, goal-directed perfusion, management of hemorrhage, and enhanced recovery protocols. Every member of the cardiothoracic surgery team, including nurses, physician assistants, perfusionists, and others involved in patient care improvement, will benefit from participating in this session.

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

- Discuss recent innovations in cardiothoracic surgical management that improve patient care
- Identify important areas of clinical research that impact the cardiothoracic surgery patient
- Develop strategies for implementing care improvements locally
- Describe various approaches to cardiothoracic service line APP training and staffing models
- Identify opportunities and strategies that support a “culture of safety” in the multidisciplinary team

Moderators: *Jill R. Engel, Durham, NC*, *and Stefano Schena, Baltimore, MD*

7:00 AM **Introduction**

7:05 AM **Critical Care Training Model: The Mid-Level Team at Johns Hopkins**
Emily Stewart, Baltimore, MD

7:30 AM **Cardiothoracic Surgery Service Line APP Training/Coverage Model: Duke University**
Jill R. Engel, Durham, NC

7:55 AM **Managing Goal-Directed Perfusion**
TBD

8:20 AM **Managing Hemorrhage: Balancing Products and Factors in 2019**
Daryl Kor, Rochester, MN

8:45 AM **Break**

9:00 AM
ABSTRACT: Early Recovery for Isolated Coronary Artery Bypass Grafting Surgery: Initiating an On-Table Extubation Program and Reducing Postoperative Length of Stay
J. Parmet[1], *S. Furukawa*[2], *D. Berkowitz*[3], *B. Lucca*[1], *K. Schmanek*[1], *A. V. Rodrigo*[1], *K. Gelineau*[1], *K. Hilliard*[2], *B. M. Blanchard*[3], *P. Colonna-Romano*[3]
[1]*Society Hill Anesthesia Consultants, Philadelphia, PA,* [2]*University of Pennsylvania, Philadelphia,* [3]*Pennsylvania Hospital, Philadelphia*

Purpose: Continued postoperative mechanical ventilation for CABGs is ingrained in cardiac surgical culture with a national OTE rate of 2.9%. We report a quality improvement (QI) initiative that 1) Established OTE for CABG as an institutional standard, 2) Developed a multimodal analgesic protocol to facilitate OTE, and 3) Decreased postop LOS.

Methods: In 2012 and 2013, prior to our QI initiative, CABG OTE rate equaled 0%, and 6.9% respectively. In 2014 (Baseline), our CABG OTE rate equaled 48% (27/57). However, 50% of OTEs required postoperative BiPAP (inadequate or profound analgesia). Beginning 6/12/15 – 12/31/17, a peri-operative/QI form determined, 1. OTE/postoperative BiPAP rates for CABGs, and 2. postop LOS. A multimodal analgesic regimen evolved (1. Preoperative intrathecal narcotic administration increased: 2015 = 26%, ***2016 = 58%**, and ***2017 =76%** p< 0.05, 2. Preoperative Gabapentin administration increased: 2016= 46%, and ***2017= 88%** p< 0.05, 3. Post-cardiopulmonary bypass IV acetaminophen = no change: 2015 = 63%, 2016= 78%, and 2017= 76%).

Results: From 6/12/15 to 12/31/17, 179 consecutive patients underwent CABG. OTE occurred in 121 CABGs (OTE rate = 67%). The OTE rate increased over time (2015 = 60% (27/45), * 2016= 68%(49/72), and *2017 = 76%(47/62) Chi-squared for 2017 & 2016 vs 2014, p<0.0001, figure-1). Postoperative BiPAP use decreased over time (Chi-squared test *2016 & *2017 vs 2014 p< 0.0001). Postop LOS decreased by 3.6 days for OTE patients compared to non-OTE patients (*OTE LOS = 5.6 ±2.8 days vs non-OTE LOS = 9.2 ±8.3 days, p= 0.0001 student t-test). Pre-operative IT narc administration reduced 24 hour postoperative fentanyl (24 hr fent) requirements compared to patients not receiving preoperative IT narc (24hr postop fen IT narc = 67 ?g ±77.46 ?g, 24hr postop fen No IT narc = 138.01 ?g, ±218 ?g, p=0.004 student t-test). Student t-test fails to demonstrate a statistically significant decrease in 24 hr postop narcotoc requirements for GABA patients (24hr postop fen GABA= 85.15 ?g, ±179 ?g, 24 hr postop fent No GABA).

Conclusions: OTE is sustainable and effectively decreases postop LOS by 1.6 days compared to the STS's 2017 national postop LOS mean of 6.9 days. A substantial reduction in national health care cost could result from more programs adopting OTE. A multimodal analgesic protocol facilitates OTE, and decreases postoperative use of BiPAP.

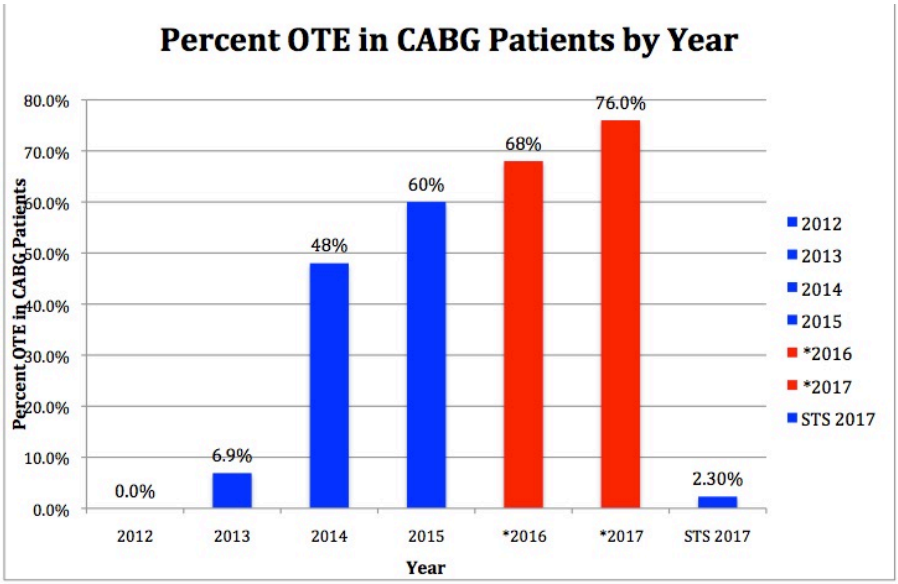


Figure 1: The x-axis represents year. The y-axis represents % of OTE in CABG patients. 2013 represents OTE rate prior to our initiative. 2012- 2013 represent no OTE initiative. 2014 represents baseline- 1st year of OTE at our institution n=57. 2015, represents 1st yr of data collection n=45, p= 0.25; *2016, n=72, p=0.02; * 2017= 76%, n=62, p=0.01. STS 2017- The Society of Thoracic Surgeons (STS) national database

9:10 AM

ABSTRACT: Interprofessional Simulation in Cardiothoracic Surgery Improves Team Confidence

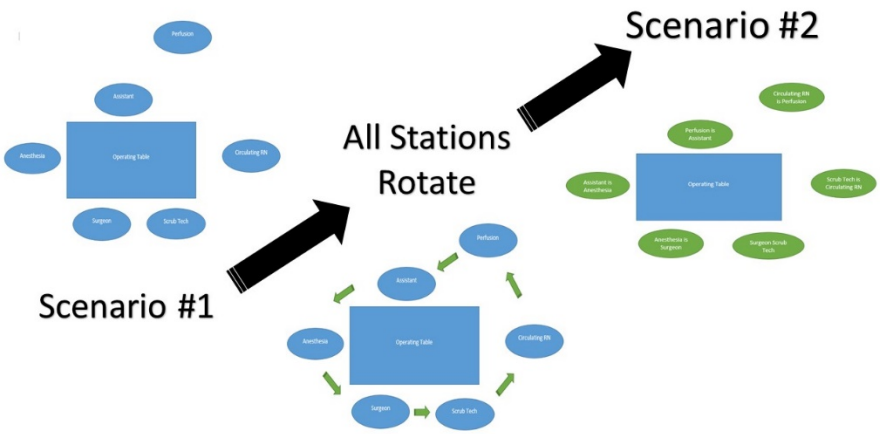
***H. L. Merritt-Genore**, R. Zavala, T. Brakke, A. Adams*
University of Nebraska Medical Center, Omaha

Purpose: Interest in simulation has grown substantially, as has enthusiasm for team-based approaches to surgical training. In cardiothoracic surgery, the dynamic ability of the entire team cannot be under-stated, particularly during emergent events. We developed an innovative, multidisciplinary approach to simulation for the entire cardiothoracic team.

Methods: Learners from CT surgery, anesthesia, perfusion, as well as physician assistants and OR staff participated in two simulations replicating the critical steps and potential crises of cardiopulmonary bypass. Tools included standard cardiopulmonary bypass equipment, echocardiography, vital signs (SimMon iPad app), and actual cannulation via Chamberlain Heart equipment. Each participant started at their typical role, then rotated into unfamiliar roles for subsequent simulations (see Figure 1). Survey and Lickert scale self-assessment tools were used to determine success. Statistical analysis was performed to compare results.

Results: Two events were attended by twenty learners and seventeen facilitators. Instructor to learner ratios were thus very low. Each learner rotated into different roles through 12 routine, and high-risk, scenarios for instituting and separating from CPB. While not validated, participant evaluation results for the events were highly favorable, with demand for further similar events. Objectively, the mean score for self-assessment rose significantly comparing the pre and post-simulation assessments. Despite a small sample size, these differences did reach statistical significance in two categories (see Table 1): "iatrogenic dissection" recognition and treatment (p 0.008), and "emergent return to CPB" (ie: protamine reaction, p 0.016). Additionally a trend towards statistical significance was seen in the categories of "hypotension management" and "decision for mechanical support" (p 0.02 for both).

Conclusions: Two interprofessional simulation events were organized for a variety of learners from the CT surgery operating room. Following simulations, a Lickert self-assessment scale demonstrated significant improvement in confidence and performance. A team-centered, hi-fidelity simulation can help improve the anticipation and management of adverse events in the operating room.



Skills Scenario Topic	Mean Pre-Course Confidence Level	Mean Post-Course Confidence Level	Mean Difference	P
Hypotension Management	2.2	4.1	1.9	0.06
Right Heart Failure	1.6	3.75	2.25	0.13
Blood Conservation	2.0	3.67	2.0	0.13
Separation from CPB	2.0	4.22	2.5	0.13
Iatrogenic Dissection	1.25	3.69	2.44	0.01
Emergent Return to CPB	1.86	4.33	2.29	0.02
Decision for Mechanical Support	1.8	3.7	1.9	0.06

9:20 AM

ABSTRACT: Impact of an Advanced Nurse Practitioner Ultrasound Service in the Postoperative Cardiac Surgery Patient

T. Bartley[1], *H. Maseyk*[2], *L. Bardsley*[2], *O. SanchezRey*[2], *J. Johnston*[2], *R. Kong*[3], *N. Hutchinson*[2]
[1]*Queen Elizabeth Hospital University Trust, Birmingham, United Kingdom,* [2]*Royal Sussex County Hospital, Brighton, United Kingdom,* [3]*National Health Service, Brighton, United Kingdom*

Purpose: Routine post operative CXR's are usually performed on day 1 and 4 in UK centres. Additional imaging is requested if clinically indicated. Training ANP's to perform bedside ultrasound reduces the numbers of CXR's patients are exposed to and earlier diagnostic confirmation of clinical concern enables timely intervention.

Methods: The ANP team routinely performed daily ultra sound examination of the chest developing skills to perform reliable diagnostic procedures. Patient consent was obtained, ANP was taught to identify key landmarks, perform the scan and interpret the findings providing a diagnoses. Findings were compared against the routine CXR to see if they concurred, gave further information and if any required intervention could have been orchestrated earlier. Each ANP was expected to perform supervised scanning, reporting and recording of findings to be signed off as competent against the unit document that was established. This is stored in the ANP's portfolio and records.

Results: A pilot study of 20 CXR's & Ultrasounds is being completed and early results suggest that the ANP's are a reliable and consistent team to perform the scan. Their clinical findings concur with the radiological findings and any required intervention can be actioned earlier. Patients do not need to be taken to the X–Ray department, using valuable human resources and an unnecessary journey. For those patients having a bedside CXR the disruption to the unit and patient is reduced. Moreover, there it avoids the cost of CXR investigations.

Conclusions: The ANP team having established a reliable diagnostic service that confirms routine recovery, earlier detection of clinical issues, reduces patient exposure to radiological images and has resulted in an additional skill to advance their practice. The pilot study will be expanded to underpin the findings.

9:30 AM **Toolkit for Implementing Enhanced Recovery After Surgery (ERAS)**
S. Jill Ley, Greenbrae, CA

9:50 AM **ERAS: Cardiac Model**
Michael Grant, Mount Airy, MD

10:10 AM **ERAS: Thoracic Model – Anesthesia Impact**
Elizabeth Herrera, Houston, TX

10:30 AM **Break**

10:45 AM

ABSTRACT: An Implementation Science Approach to Redesigning Handoffs After Cardiothoracic Surgery

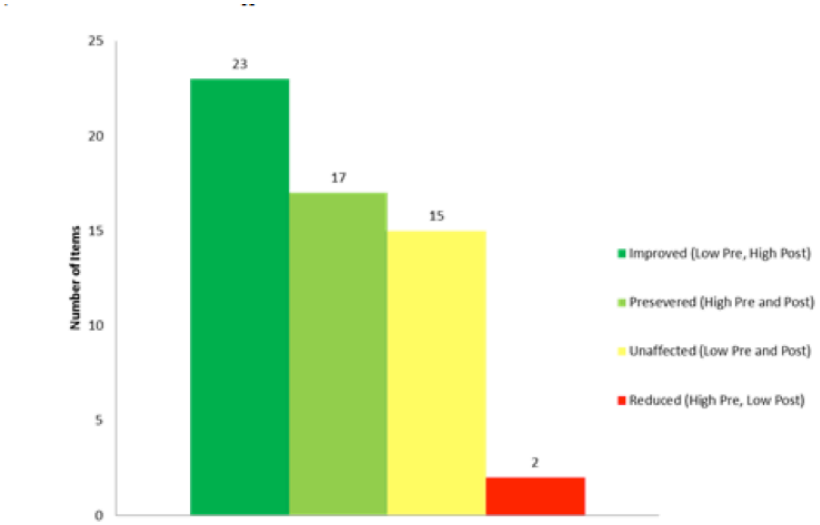
***T. R. Geoffrion**, I. Lynch, E. Tsai, W. Hsu, A. Timmons, E. Phelps, P. E. Greilich*
The University of Texas Southwestern Medical Center, Dallas

Purpose: Previous studies indicate that a structured handoff process improves the reliability of information transfer and patient outcomes following surgery.[1] An interprofessional team approach was used to design and implement coordinated handoffs from a cardiothoracic operating room to a cardiothoracic intensive care unit (ICU) to optimize provider communication and patient outcomes.

Methods: Using implementation science, a multidisciplinary project team of surgeons, anesthesiologists, intensivists, and ICU nurses identified 57 elements critical to transfer of care and developed interventions for a redesigned handoff process. This included structured education, cognitive aids, videos, and team training. Conformance to the critical elements was evaluated using video recordings of handoff before and after intervention. Duration of initial mechanical ventilation and length of stay information from the Society of Thoracic Surgery database was obtained to assess clinical outcomes. A provider satisfaction survey was administered to providers during and after the redesign phase.

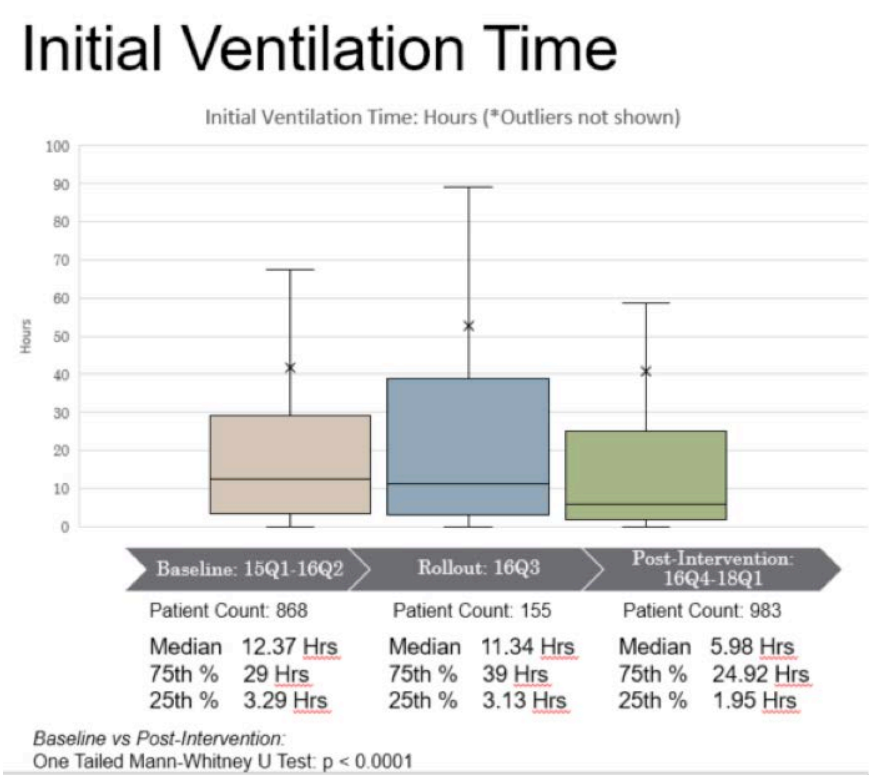
Results: A total of 126 handoffs in 2006 patients who underwent cardiac surgery from January 2015 to March 2018 were evaluated. Overall conformance to the 57 critical elements was significantly improved after the institution of a systematized handoff process ($p<0.0001$). Qualitative summary of the degree of change in the elements showed that 23 elements improved, 17 were preserved, 15 were unaffected, and only 2 were reduced, suggesting the new handoff process did not disrupt previously accepted standards for transfer of care in the institution. (Figure 1) Clinically, duration of mechanical ventilation per patient was reduced from 12.4 at baseline to 6.0 hours after the intervention ($p < 0.0001$). (Figure 2) Similarly, the median length of ICU stay decreased from 3.11 to 2.53 days ($p < 0.0001$). Provider satisfaction survey scores (n=82) ranged from 83 to 87 out of 100.

Conclusions: An implementation science-based approach to handoff redesign is effective for improving transfer of essential patient care information and patient outcomes after cardiothoracic surgery. High provider satisfaction scores suggest sustained utilization of the model.[2] Further research is required to support a link between improved handoffs, care coordination, and patient outcomes.[3]



Definitions (arbitrary; no easy statistic approach):

1) Improved - pre <30% and post delta >30%
2) Preserved - pre >70% and post >70%
3) Unaffected - pre <30% and post <30%
4) Reduced - pre >50% and post delta > (-) 20%



10:55 AM

ABSTRACT: Autologous Blood Donation Leads to Better Outcomes in Cardiac Surgery

***E. Zimmermann**, D. V. Avgerinos[2], R. Zhu[3], T. Ogami[3]*
[1]Oregon Health and Science University, Portland, [2]Weill Cornell Medical Center, New York, NY, [3]NewYork-Presbyterian/Queens, Flushing, NY

Purpose: Up to half of heart procedures require blood transfusion, which imparts adverse short and long-term outcomes. The Society of Thoracic Surgery/Society of Cardiovascular Anesthesiologists updated their guidelines in 2011 promoting more effective blood conservation techniques. Implementing a more aggressive intraoperative blood donation protocol led to better outcomes at our hospital.

Methods: Our cardiac surgery database was reviewed retrospectively over an 8-year period, comparing outcomes from two different time periods, after departmental implementation of a more aggressive intraoperative autologous donation (IAD) pprotocol in January 2013. Emergency surgeries were excluded from analysis. We employed Mann-Whitney U Test for non-parametric variables such as length of stay, chest tube output, and packed red blood cell (PRBC) transfusions to determine statistical significance. Demographics, type of procedure, and outcomes were evaluated to determine if differences existed after implementation of the IAD protocol.

Results: A total of 689 patients were studied over an 8-year period (January 2009-December 2017). 268 patients prior to the IAD protocol (Group 1) were compared to 420 patients after the IAD protocol was implemented (Group 2). Group 2 required less blood transfusion in the post-operative period (70 vs 40%, P < 0.001), fewer total transfusions (1.76 vs 0.79 PRBC, P < 0.001), lower chest tube output (1295 vs 1207 ml, P=0.038), and shorter length of stay (7.8 vs 6.8 days, P < 0.001).

Conclusions: Blood conservation is safe and effective in reducing transfusions in cardiac surgery, minimizing perioperative morbidity and mortality. Aggressive IAD is an effective blood conservation strategy that leads to improved outcomes in cardiac surgery.

11:05 AM

ABSTRACT: Postoperative Complications After Transcatheter Aortic Valve Replacement and Impact on Resource Utilization: Does Experience Matter?

***A. K. Okoh**[1], B. Haik[1], C. Chen[1], M. Cohen[1], M. J. Russo[2]*
[1]Newark Beth Israel Medical Center, NJ, [2]RWJBarnabas Health, Newark, NJ

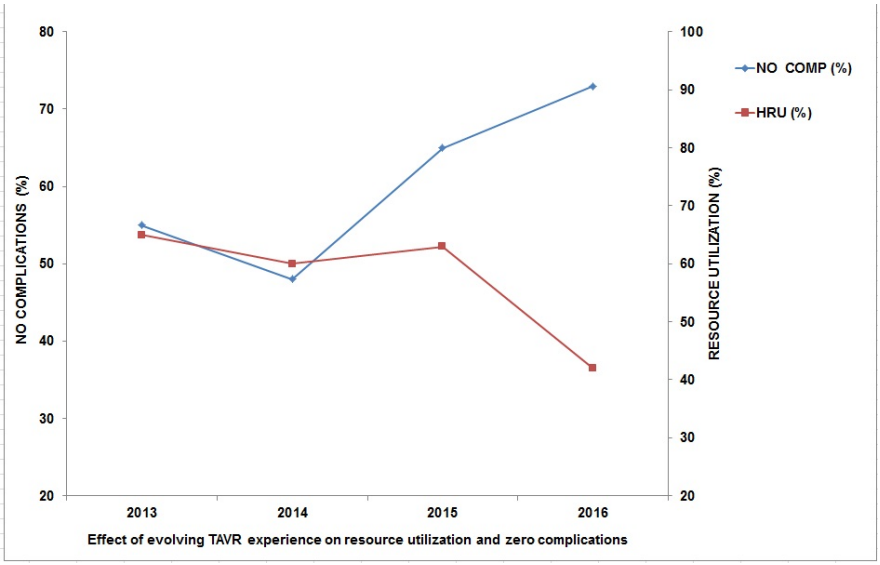
Purpose: Post-operative complications after transcatheter aortic valve replacement (TAVR) are common. The present study aimed to determine (i) the effect of post-TAVR complications rates (CR) on direct procedure costs and resource utilization (RU) and (ii) impact of operator experience on trends in CR and RU.

Methods: Clinical data were matched with hospital-billing data of patients who had TAVR between 2013 and 2016 at a single center. The incidence of post-operative complications by type and frequencies [acute kidney injury (AKI), arrhythmia requiring insertion of a permanent pacemaker (PPM), vascular necessitating intervention, in-hospital mortality, others] as defined by the VARC-2 criteria was

calculated and their associated costs and post-operative length of stay (PLOS) compared using one-way ANOVA. Trends in high resource utilization (discharge to a rehabilitation facility or post-operative length of stay > 7 days) (HRU) and complication rates were assessed over the study period.

Results: There were 575 patients of which 345 (60%) had no complication, others in 62 (11%), AKI alone occurred in 58 (10%), PPM implanted in 26 (5%), vascular complications observed in 27 (5%) and in-hospital mortality in 11 (2%). Patients who had AKI or vascular complications requiring intervention had longer mean PLOS than those with PPM, others or none, (7 vs. 7 vs. 6 vs. 5 vs. 3) days respectively ($p < 0.0001$). Direct procedure costs were significantly higher ($p< 0.0001$) for PPM ($60,103 ± $24,066) than vascular ($55,199 ± $19,048), AKI ($53,549 ± $19, 698), others ($49,429 ± $16,752) and none ($47,378 ± $9,930). A significant decrease in the overall incidence of post-operative complication rate (CR) was seen after 4 years [2013: 45% vs. 2016 27%; $p < 0.001$] and this correlated with a decrease in HRU [2013: 65% vs. 2016 42%; $p < 0.001$].

Conclusions: Post-operative complications after TAVR are associated with extended PLOS, higher costs and resource utilization. Operative experience is a significant determinant of decreased complication rates and improved resource utilization.



11:15 AM **Building a Culture of Safety Within a Heart Center: What's In It for Me?**
Brittany A. Zwischenberger, Durham, NC

11:40 AM **Closing Remarks**

8:00 AM – 9:45 AM
STS University (Session I)

Course 1: Essentials of TAVR
Course Directors: *Isaac George, New York, NY, and George L. Zorn, Kansas City, KS*
Table Instructors: *Keith B. Allen, Kansas City, MO*, *William T. Brinkman, Plano, TX*, *Andrei Churyla, Chicago, IL*, *Jessica Forcillo, Montreal, Canada*, *Kevin L. Greason, Rochester, MN*, *Kendra J. Grubb, Atlanta, GA*, *Casey P. Hertzenberg, Overland Park, KS*, *Hersh S. Maniar, St Louis, MO, and Gregory F. Muehlebach, Prairie Village, KS*

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
- Explain the procedural technique for valve deployment from start to finish in both native aortic stenosis and valve-in-valve TAVR

Course 2: TEVAR and Aortic Arch Debranching Procedures

Course Directors: *Nimesh Desai, Philadelphia, PA, and Ourania A. Preventza, Houston, TX*
Table Instructors: *Marvin D. Atkins, Houston, TX, Derek R. Brinster, New York, NY*, *Ali Khoynezhad, Long Beach, CA*, *Vicente Orozco Sevilla, Miami, FL*, *and Ibrahim Sultan, Pittsburgh, PA*

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 for 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: *Pavan Atluri, Philadelphia, PA, and Evelio Rodriguez, Nashville, TN*
Table Instructors: *Michael A. Acker, Philadelphia, PA, W. Randolph Chitwood Jr, Greenville, NC, A. Marc Gillinov, Cleveland, OH, W. Clark Hargrove III, Philadelphia, PA, and Chand Ramaiah, Nashville, TN*

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 – Reimplantation

Course Directors: *Michael P. Fischbein, Stanford, CA, and Bo Yang, Ann Arbor, MI*
Table Instructors: *Duke E. Cameron, Boston, MA, Edward P. Chen, Atlanta, GA, James E. Davies, Birmingham, AL, Laurent de Kerchove, Brussels, Belgium, Ruggero De Paulis, Rome, Italy, G. Michael Deeb, Ann Arbor, MI, Thomas G. Gleason, Pittsburgh, PA, Philip Hess, Indianapolis, IN, John S. Ikonomidis, Chapel Hill, NC, R. Scott Mitchell, Palo Alto, CA, and Himanshu J. Patel, Ann Arbor, MI*
Course Assistants: *Thuy Le, Ann Arbor, MI*, *and Jeffrey Schneider, Ann Arbor, MI*

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) – reimplantation technique.

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

- Describe the anatomy of the aortic root
- Outline the key components to maintain a competent aortic valve
- Summarize the technical steps necessary for a successful VSRR
- List different methods in choosing a graft size
- Discuss aortic valve leaflet repair

Course 5: Aortic Root Enlargement Procedures and Aortic Valve Leaflet Reconstruction

Course Directors: *S. Adil Husain, San Antonio, TX, and Joseph W. Turek, Durham, NC*
Table Instructors: *G. Chad Hughes, Durham, NC*, *J. Scott Rankin, Morgantown, WV*, *James S. Tweddell, Cincinnati, OH*, *and Lawrence Wei, Morgantown, WV*

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, Manougian, 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 annual 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: *DuyKhanh P. Ceppa, Indianapolis, IN, and Jeremiah Martin, Portsmouth, OH*
Table Instructors: *Mark F. Berry, Stanford, CA*, *Thomas J. Birdas, Indianapolis, IN, William R. Burfeind, Bethlehem, PA*, *Janet P. Edwards, Calgary, Canada, Loretta Erhunmwunsee, Duarte, CA, Benjamin E. Lee, New York, NY*, *Linda W. Martin, Charlottesville, VA, Shari Meyerson, Chicago, IL*, *Daniela Molena, New York, NY, Jacob R. Moremen, Jackson, MI, and Scott I. Reznik, Dallas, TX*

This course will review the indications, patient selection, technical steps, and recent advances for performance of lobectomy using video-assisted thoracoscopic 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: *Christopher R. Morse, Boston, MA, and Jonathan Nesbitt, Nashville, TN*
Table Instructors: *Scott M. Atay, Los Angeles, CA*, *Andrew C. Chang, Ann Arbor, MI, Alberto L. de Hoyos, Dallas, TX, Henning Gaissert, Boston, MA, Sidharta P. Gangadharan, Boston, MA*, *Kenneth A. Kesler, Indianapolis, IN*, *Reza J. Mehran, Houston, TX, Robert E. Merritt, Columbus, OH, Paul H. Schipper, Portland, OR*, *K. Robert Shen, Rochester, MN*, *Leonidas Tapias, Boston, MA*, *and Dustin M. Walters, Charlottesville, VA*

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 on the different technical aspects (“pearls”) of the anastomosis from content experts.

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

- Perform different types of esophageal anastomoses, including hand-sewn and hybrid hand-sewn/stapled
- Recognize the technical pitfalls associated with various complex airway resection and anastomoses
- Identify the key steps of tracheobronchoplasty

Course 8: Complex Chest Wall Issues for the Thoracic Surgeon: Reconstruction After Tumor Resection, Pectus Deformities, and Rib Fractures

Course Directors: *Staci Beamer, Phoenix, AZ, and Dawn E. Jaroszewski, Phoenix, AZ*
Table Instructors: *Lisa McMahon, Phoenix, AZ, Daniel L. Miller, Marietta, GA*, *David Notrica, Phoenix, AZ*, *Theolyn N. Price, Colorado Springs, CO*, *and Christopher M. R. Satur, Market Drayton, United Kingdom*
Course Assistant: *Jesse Lackey, Phoenix, AZ*

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 Surgery

Course Directors: *Tom C. Nguyen, Houston, TX, and Juan P. Umana, Bogota, Colombia*
Table Instructors: *Giacomo Bianchi, Massa, Italy, Borut Gersak, Ljubljana, Slovenia, Mattia Glauber, Milan, Italy*, *Raja R. Gopaldas, Charlotte, NC*, *Peter A. Knight, Rochester, NY, Eric J. Lehr, Seattle, WA*, *Kazuma Okamoto, Akashi, Japan*, *Konstantinidos Plestis, Wynnewood, PA, Peyman Sardari Nia, Maastricht, The Netherlands*, *and Tristan D. Yan, Sydney, Australia*

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 surgeries. Participants will work in alternating pairs at each station to learn critical exposure and cannulation techniques for minimally invasive aortic (right anterior thoracotomy and hemi-sternotomy) and mitral (lateral thoracotomy) valve surgeries. Participants will then have an opportunity to perform aortic and mitral valve repair/replacement using simulators under both direct vision and via thoracoscopic 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, hemi-sternotomy, and lateral thoracotomy), cannulation, and cardioprotection techniques for minimally invasive valve surgery
- Identify key operative steps for successful minimally invasive aortic and mitral valve surgeries, including sutureless and rapid deployment technologies
- Describe the indications and contraindications for minimally invasive valve surgery

Course 10: Peroral Endoscopic Myotomy (POEM) Skills

Course Directors: *Ralph W. Aye, Seattle, WA, and Inderpal S. Sarkaria, Pittsburgh, PA*
Table Instructors: *Igor Brichkov, Brooklyn, NY*, *Steven R. DeMeester, Lake Oswego, OR*, *Hiran C. Fernando, Falls Church, VA, Virginia R. Litle, Boston, MA, Brian E. Louie, Seattle, WA*, *Siva Raja, Cleveland, OH, and Jon O. Wee, Boston, MA*
Course Assistants: *Andrew F. Feczko, Seattle, WA, and Anee S. Jackson, Seattle, WA*

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, access the submucosal space and create a long submucosal tunnel extending through the gastroesophageal junction, perform myotomy, and close the mucosotomy. The standard tools and electrothermy 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

Course 11: Robotic Lobectomy

Course Directors: *Edward Y. Chan, Houston, TX, Lana Y. Schumacher, Pittsburgh, PA, and Kazuhiro Yasufuku, Toronto, Canada*
Table Instructors: *Wael C. Hanna, Hamilton, Canada, Min P. Kim, Houston, TX, John F. L. Lazar, Washington, DC*, *and Bernard J. Park, New York, NY*

This course will provide cardiothoracic surgeons of all experience levels with a detailed overview of the critical elements needed to successfully perform a lobectomy using a da Vinci Xi robot. Participants will gain hands-on experience with the technical skills, robotic instrumentation, port placement, anatomic exposure, and surgical techniques of a robotic lobectomy.

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

- Explain the different components of the robotic surgical platform
- Describe the fundamental skills on the robotic console
- State the basic technical skills necessary to perform robotic thoracic surgery
- Outline the critical steps for performing a robotic lobectomy

Course 12: VATS Sleeve Lobectomy

Course Directors: *Thomas A. D'Amico, Durham, NC, and Todd L. Demmy, Buffalo, NY*
Table Instructors: *Stafford S. Balderson, Durham, NC*, *Malcolm M. DeCamp, Madison, WI*, *Diego Gonzalez Rivas, Coruna, Spain*, *Chumy E. Nwogu, Buffalo, NY, Mark Onaitis, La Jolla, CA*, *Harmik J. Soukiasian, Los Angeles, CA, Scott J. Swanson, Boston, MA*, *Paula Antonia Ugalde, Quebec, Canada, and Saikrishna S. Yendamuri, Buffalo, NY*

This course will review the indications, patient selection, instrumentation, and technical steps for the performance of bronchial and arterial sleeve lobectomy using video-assisted thoracoscopic surgery (VATS).

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

- Identify indications and contraindications for bronchial and arterial left upper lobe (LUL) sleeve lobectomy
- Identify key operative steps in obtaining exposure for LUL sleeve lobectomy
- Successfully complete thoracoscopic suture closures/anastomosis of secondary airway (either bronchoplasty or sleeve resection) and arterial sleeve in a tissue simulator
- Discuss tools and supplies that enhance VATS bronchial and arterial reconstruction

Course 13: Percutaneous Transseptal Access, Transcatheter Mitral Valve Repair, and Mitral Valve-in-Valve Replacement

Course Directors: *Tsuyoshi Kaneko, Boston, MA, and Gilbert H. Tang, New York, NY*
Table Instructors: *Gorav Ailawadi, Charlottesville, VA, Richard Lee, Augusta, GA, Saibal Kar, Los Angeles, CA, and D. Scott Lim, Charlottesville, VA*

Transcatheter and surgical mitral valve therapies are emerging as complementary options for treating mitral valve disease, and cardiothoracic surgeons are best positioned to offer their patients both options. As we learn lesson from transcatheter aortic valve replacement, the transvenous access/transseptal approach to transcatheter mitral valve repair/replacement will, in time, predominate over the transapical approach. With the emergence of more transseptal transcatheter mitral valve repair and replacement devices, surgeons must acquire this skillset quickly to stay relevant in a rapidly evolving field. This course will expose participants to this important skill and myriad emerging transcatheter mitral technologies.

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

- Recognize the imaging modalities necessary for transseptal access
- Perform transseptal access with necessary guidance
- Explain the importance of transseptal access for cardiothoracic surgeons

8:00 AM – 12:00 PM

Adult Congenital Heart Disease Symposium: Planning for the Future—Aortic Arch Anomalies and the Failing Fontan

This session will highlight surgical techniques used in neonatal surgery that may help prevent late complications of the arterial switch operation and coarctation or arch repair, as well as how to deal with those complications, if they do occur. Case studies have been added to help guide both adult and pediatric heart surgeons, who often must choose between multiple open and endovascular treatment options for adult congenital patients with complex problems. In addition, an update on the latest advances in lymphodynamics and a debate over single vs multiorgan transplant for the failing Fontan will be included.

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

- Describe open surgical options for repair of adult coarctation of the aorta
- Describe endovascular options for repair of adult coarctation and recurrent coarctation
- Explain techniques for preventing late complications of coarctation
- Identify techniques for preventing late complications of the arterial switch operation
- Discuss which patients are better candidates for multiorgan transplantation after single ventricle palliation

Moderators: *Joseph A. Dearani, Rochester, MN, Eric N. Feins, Boston, MA, Joshua L. Hermsen, Madison, WI, Robert D. B. Jaquiss, Dallas, TX, and Jennifer S. Nelson, Chapel Hill, NC*

8:00 AM **Arch Anomalies and Vascular Rings in the Adult: Open Approaches**
Alberto Pochettino, Rochester, MN

8:15 AM **Coarctation and Arch Anomalies in the Adult: Endovascular Approaches**
Young Erben, Jacksonville, FL

8:30 AM **Failing to Plan: Late Sequelae of Coarctation**
Thomas E. MacGillivray, Houston, TX

8:45 AM **Planning for the Future: Coarctation and Arch Anomalies in Children**
James S. Tweddell, Cincinnati, OH

9:00 AM **Coarctation Case Discussion**

9:20 AM **Failing to Plan: Late Sequelae of the Arterial Switch Operation**
Frank G. Scholl, Hollywood, FL

9:35 AM **Planning for the Future: Arterial Switch Operation**
Viktor Hraska, Milwaukee, WI

9:50 AM **Panel Discussion**

10:10 AM **Break**

10:20 AM **Failing Fontan: Liver Surveillance**
Christopher J. Francois, Madison, WI

10:40 AM **Failing Fontan: Heart/Liver Transplant Is Better**
Stephanie M. Fuller, Philadelphia, PA

10:52 AM **Failing Fontan: Heart-Only Transplant Is Better**
Charles B. Huddleston, St Louis, MO

11:04 AM **Lymphodynamics**
Vibeke E. Hjortdal, Aarhus, Denmark

11:24 AM **Transplant Case Discussion and Panel Discussion**

8:00 AM – 12:00 PM
CHEST @ STS: Interventional Bronchoscopy

Cardiothoracic surgeons are essential in diagnosing and treating lung nodules and lung cancer. New technologies such as endobronchial ultrasound (EBUS), navigational bronchoscopy, and cutting-edge endobronchial therapeutics have changed the approach to lung cancer staging. However, many cardiothoracic surgeons have had little exposure to these techniques, and additional training is needed. This session will explore the most advanced techniques and equipment use for interventional bronchoscopy.

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

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

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

8:00 AM **Introduction**

8:10 AM **EBUS-Guided Transbronchial Needle Aspiration of Mediastinal and Hilar Lymph Nodes**
Momen M. Wahidi, Durham, NC

8:30 AM **Peripheral Bronchoscopy: Navigational Bronchoscopy and Radial EBUS**
Alex Chen, St Louis, MO

8:50 AM **EBUS Case Scenarios**

9:20 AM **Panel Discussion**

9:45 AM **Break**

10:00 AM **Therapeutic Bronchoscopy**
Moishe A. Liberman, Montreal, Canada

10:20 AM **Management of Massive Hemoptysis—Endoscopic and Surgical Management**
Daniel P. McCarthy, Seattle, WA

10:40 AM **Marking Peripheral Targets for Video-Assisted Thoracoscopic Resection: Percutaneous and Bronchoscopic Approaches**
TBD

11:00 AM **Subglottic Stenosis: Endoscopic Management**
Alex Chee, Boston, MA

11:20 AM **Subglottic Stenosis: Surgical Management**
Sudish C. Murthy, Cleveland, OH

11:40 AM **Panel Discussion**

8:00 AM – 12:00 PM

Critical Care Symposium: Cutting-Edge Strategies for Cardiothoracic Critical Care Emergencies and Evolving Technologies

Critical care emergencies in the cardiothoracic intensive care unit (ICU) pose unique challenges. Understanding these emergencies and their immediate interventions with state-of-the-art pharmacologic and mechanical therapeutic options is essential to the management of an increasingly complex cardiothoracic population. This symposium will address how to optimize patient outcomes and innovative approaches to handling emergencies. Topics will include extracorporeal cardiopulmonary resuscitation (E-CPR), post-cardiotomy extracorporeal membrane oxygenation (ECMO), urgent respiratory deterioration requiring sophisticated ventilator modes or veno-veno (VV) ECMO, anticoagulation treatment/monitoring strategies, pulmonary embolic events, hemodynamic collapse, and the potential role of early resternotomy.

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

- Identify management protocols for veno-arterial ECMO and E-CPR for optimal patient outcomes
- Delineate innovative management strategies and tactics in respiratory emergencies—advanced ventilatory management modes vs VV ECMO
- Delineate novel anticoagulation management protocols
- Identify and manage perioperative hemodynamic emergencies and the potential role of early resternotomy

Moderators: *Rakesh C. Arora, Winnipeg, Canada, Subhasis Chatterjee, Houston, TX, Michael S. Firstenberg, Aurora, CO, Rita C. Milewski, Philadelphia, PA, and Glenn J. R. Whitman, Baltimore, MD*

8:00 AM **Introduction**

Cardiac Arrest and E-CPR

8:05 AM **Indications, Contraindications, and Outcomes for E-CPR**
Jonathan W. Haft, Ann Arbor, MI

8:35 AM **Case Presentation With Audience Participation**
Erik Osborne, Norfolk, VA

Respiratory Emergencies—Acute Respiratory Distress Syndrome (ARDS) and Pulmonary Embolus

9:00 AM **Current Therapy for ARDS: Ventilator Modes vs VV ECMO—What Is the Evidence?**
Cara Agerstrand, New York, NY

9:20 AM **Panel Discussion**

9:30 AM **Appropriate Therapy for Pulmonary Embolus: When to Do What**
Subhasis Chatterjee, Houston, TX

9:50 AM **Panel Discussion**

10:00 AM **Break**

Anticoagulation Dilemmas in the ICU

10:15 AM **Heparin-Induced Thrombocytopenia Diagnosis and Management**
Rizwan Manji, Winnipeg, Canada

10:35 AM **Non-Vitamin K Antagonist Oral Anticoagulant Reversal: Review of Strategies**
Jerrold Levy, Atlanta, GA

10:55 AM **Optimal Monitoring for the Bleeding Patient—Diagnostic and Therapeutic Use of PTT/TEG/Xa Tests and How to Interpret**
Glenn J. R. Whitman, Baltimore, MD

Hemodynamic Emergencies—Post-Cardiotomy Arrest

11:15 AM **Evidence for Early Emergency Resternotomy for the Management of Post-Cardiac Surgery Arrest**
Rakesh C. Arora, Winnipeg, Canada

11:30 AM **Implementation of Early Emergency Resternotomy Protocols for the Management of Post-Cardiac Surgery Arrest**
Rosemary Timmerman, Anchorage, AK

11:45 AM **Panel Discussion**

8:00 AM – 12:00 PM
Practice Management Summit

Cardiothoracic surgeons are faced with myriad complex clinical and non-clinical organizational issues. For many in our specialty, understanding one's value and being appropriately rewarded remains a challenge. The Practice Management Summit's expert speakers will help address the cardiothoracic surgeon's organizational value proposition. Speakers will address the US health care delivery model's evolution and its impact upon the specialty. Additionally, the concepts of fair market value, relative value units (RVUs), the quality scorecard, and how to best negotiate with employers will be critically discussed by industry leaders.

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

- Negotiate a contract from a position of strength
- Explain the value proposition as it pertains to individual practice types
- Discuss the direction of health care and cardiothoracic surgery
- Leverage the cardiovascular service line structure to promote value
- Identify the dangers associated with variability in health care delivery

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

8:00 AM **Introduction**

8:10 AM **Restructuring Your Organization to Align With the New Realities in Health Care**
Nathan Kaufman, San Diego, CA

8:30 AM **Role of Patient and Family Advisory Councils**
Stephen Wright, Melbourne, FL

8:50 AM **Updates From the STS Council on Health Policy and Relationships**
Alan M. Speir, Falls Church, VA

9:10 AM **Panel Discussion**

9:40 AM **Break**

10:10 AM **Annual Update in Economic Survey Data, Trends, and Use**
Michael N. Heaton, Indianapolis, IN

10:30 AM **Eliminating Variability in Health Care Delivery: Essential Leadership Skills That Are Easy to Learn and Give Immediate Results**
Patrick Graupp, Liverpool, NY

10:50 AM **Partnering for Excellence in Today's Health Care Environment: HCA Healthcare's Cardiovascular Service Line 2019 Update**
Steven V. Manoukian, Nashville, TN

11:10 AM **Compensation Agreements: Landmines and Lifesavers**
Mark S. Kopson, Bloomfield Hills, MI

11:30 AM **Panel Discussion**

8:00 AM – 12:00 PM

SCA @ STS: Integrating Perioperative Echocardiography in Cardiac Surgical Clinical Decision-Making for Challenging Cases

This session will address recent advances in the field of echocardiography, including continuously evolving technology for the treatment of valvular disease and new evidence regarding the appropriateness of already established procedures. New evidence regarding catheter-based procedures for mitral valve regurgitation and aortic valve stenosis (such as the MITRA-FR, COAPT, and SOLVE-TAVI trials) will be reviewed using a case-based format. Also, recent publications on the role of echocardiography in hypertrophic cardiomyopathy will be highlighted.

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

- Describe the utility of echo anatomy and intraoperative echocardiographic analysis in surgical decision-making in open and percutaneous procedures
- Discuss the integration of echocardiographic measurements with new clinical evidence in certain patient populations as described in new clinical data
- Apply echocardiographic findings to case studies

Moderators: *Jennifer S. Lawton, Baltimore, MD*, *and Alina Nicoara, Durham, NC*
Panelists: *Joanna Chikwe, New York, NY, and Hersh S. Maniar, St Louis, MO*

8:00 AM Introduction

Session I

8:10 AM **Case I: Transcatheter Aortic Valve Replacement**
MaryBeth Brady, Baltimore, MD

8:30 AM **Panel Discussion**

8:50 AM **Case II: Complex Mitral Valve Repair for Degenerative Mitral Valve Disease**
Georges Desjardins, Park City, UT

9:10 AM **Panel Discussion**

9:30 AM **Case III: Management of Tricuspid Regurgitation in a Patient Undergoing Ventricular Assist Device Placement**
Jacob T. Gutsche, Philadelphia, PA

9:50 AM **Panel Discussion**

10:10 AM **Break**

Session II

10:30 AM **Case IV: Structural Heart Disease—Mitral Valve**
Charles B. Nyman, Boston, MA

10:50 AM **Panel Discussion**

11:10 AM **Case V: Challenges During Surgery for Hypertrophic Cardiomyopathy**
Alina Nicoara, Durham, NC

11:30 AM **Panel Discussion**

11:50 AM **Wrap-Up**

10:00 AM – 12:00 PM
Residents Symposium: Transitioning From Residency to a Successful Practice

This symposium is designed to provide cardiothoracic surgery residents with practical information regarding the transition from being a trainee to a practicing surgeon. The first session will examine various practice settings, including both community and academic environments. There also will be talks on the job search process and negotiating a contract. The second session will address transitioning into practice, early career development, and achieving personal financial security, as well as a successful 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:

- Recognize the key steps needed for a successful job search
- Explain the differences between practicing in an academic environment, community hospital practice, and private practice
- Describe how to successfully negotiate a contract
- Identify the benchmarks for building clinical programs and early career development
- Describe the key steps in achieving personal financial security
- Identify methods for optimizing work-life balance as part of overall career planning

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

10:00 AM **Introductory Remarks**
Faiz Bhora, New York, NY, and Edward P. Chen, Atlanta, GA

Session I: Finding a Job

10:05 AM **What's Great About Working in a Private Practice or Hospital Employee Environment**
Asad A. Shah, Newport Beach, CA

10:15 AM **What's Great About Working in an Academic Environment**
Mara B. Antonoff, Houston, TX

10:25 AM **Key Steps to Finding a Job**
Rishindra M. Reddy, Ann Arbor, MI

10:35 AM **Negotiating a Contract: Academic and Private Practice**
Faiz Bhora, New York, NY

10:45 AM **Discussion**

Session II: Transition to Practice

11:00 AM **Building a Successful Clinical Practice and Being an Effective Leader**
Edward P. Chen, Atlanta, GA

11:10 AM **Early Career Development and Getting Involved in Your Profession**
W. Brent Keeling, Atlanta, GA

11:20 AM **Achieving Personal Financial Security: Tips and Secrets**
Frederick Y. Chen, Boston, MA

11:30 AM **Achieving a Successful Work-Life Balance**
Armin Kiankhooy, Charlottesville, VA

11:40 AM **Discussion**

10:15 AM – 12:00 PM
STS University (Session II)
The courses from Session I will be repeated, offering attendees the chance to participate in more than one. See page X for course descriptions.

12:00 PM – 1:00 PM
Lunch
Residents Luncheon

1:00 PM – 2:00 PM
Ethics Debate: Bespoke Babies—Genome Editing in Cystic Fibrosis Embryos
Genome editing is on the threshold of clinical use, and there still are many unsettled questions as to its proper use and the underlying ethics. The Ethics Debate will consider a patient who has had a double lung transplant for cystic fibrosis and wants to have children who are free of his disease. In order to achieve this, he wants the genomes of any future embryos edited to replace a mutated cystic fibrosis gene, CTFR, with a normal gene. The presenters are experts in this field who have conflicting views of the proper use of genome editing tools such as CRISPR-Cas9.

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

- Describe how various genome editing tools can be used to prevent or treat cardiothoracic diseases
- Discuss the ethical implications of genetically altering somatic cells vs germline cells
- Provide rudimentary advice to their patients about the uses of genome editing in their families, before referral to genetic counselors

Moderators: *Andrea J. Carpenter, San Antonio, TX, and Thomas A. D'Amico, Durham, NC*

1:00 PM **Introduction**

1:05 PM **Cystic Fibrosis Genes Should Be Replaced With Normal Genes in Cystic Fibrosis Embryos**
Kyle Brothers, Louisville, KY

1:20 PM **Cystic Fibrosis Genes Should Not Be Manipulated**
Mary Devereaux, San Diego, CA

1:35 PM **Rebuttal**

1:45 PM **Q&A**

1:00 PM – 2:00 PM
Key Contacts: Advocates for Cardiothoracic Surgery

One way that cardiothoracic surgeons can have a direct impact on US 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 and outline the Society's current advocacy priorities. In addition, Key Contacts will answer questions about their experience and 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
- Identify the different types of advocacy opportunities available to them through the Key Contact program

Moderators: *Nicholas Beek, Washington, DC*, *and Madeleine Stirling, Washington, DC*

1:00 PM **Panel Discussion: On the Front Lines of STS Advocacy**
John H. Calhoon, San Antonio, TX, J. Michael DiMaio, Dallas, TX, and Alykhan S. Nagji, Kansas City, KS

1:20 PM **Mock Congressional Meetings**
Natalie S. Lui, Stanford, CA, and Amir A. Sarkeshik, Sacramento, CA

1:35 PM **Advocacy Priorities**
Jess L. Thompson III, Oklahoma City, OK

1:45 PM **Awards and Networking**

1:00 PM – 2:00 PM
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 via the STS Research Center. This session will cover several Database-related research programs, including the Access and Publications (A&P) Research Program and the 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:

- Distinguish between the different STS National Database research opportunities offered through the STS Research Center
- Explain the rules, processes, and expectations for the research programs
- Identify good practices for preparing a competitive proposal
- Explain how to access STS Research Center resources and staff assistance

Moderator: *Felix G. Fernandez, Decatur, GA*

1:00 PM **Introduction to STS Research**
Felix G. Fernandez, Decatur, GA

1:05 PM **PUF Research Program: Policies and Procedures**
Kevin W. Lobdell, Charlotte, NC

1:13 PM **PUF Research Program: Early Experience**
Robert H. Habib, Chicago, IL

1:21 PM **Investigator Experience With the PUF Research Program**
Bradley S. Taylor, Baltimore, MD

1:28 PM **A&P Research Program**
Jeffrey P. Jacobs, St Petersburg, FL

1:36 PM **Funded Research Program**
Matthew L. Williams, Philadelphia, PA

1:45 PM **Q&A**

1:00 PM – 2:00 PM
STS/CATS/CSCS: Innovative Techniques in Thoracic Surgery

Trends in the utilization of minimally invasive surgical techniques (video-assisted thoracoscopic and robotic) for anatomic pulmonary resection will be reviewed in this session with a focus on the benefits over open approaches and variation between robotic and non-robotic platforms. The challenges to adopting robotic approaches from an implementation and cost perspective also will be discussed. In addition, the session will focus on emerging technologies for advanced endobronchial interventions, both diagnostic and therapeutic, and will review the emergence of novel systems such as robotic three-dimensional bronchoscopy.

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

- Explain the status of and trends in minimally invasive techniques for pulmonary resection
- Describe the potential benefits and pitfalls of adopting/implementing minimally invasive approaches
- Recall the advanced endobronchial platforms (robotic)
- Recognize the diagnostic and therapeutic potential of innovative endobronchial systems

Moderators: *Bernard J. Park, New York, NY, and Kazuhiro Yasufuku, Toronto, Canada*

1:00 PM **Minimally Invasive Pulmonary Resection: Status and Trends in the United States**
Michael J. Weyant, Aurora, CO

1:10 PM **Minimally Invasive Pulmonary Resection: Status and Trends in Canada**
Wael C. Hanna, Hamilton, Canada

1:20 PM **Discussion**

1:30 PM **Innovations in Diagnostic Bronchoscopy**
Katarzyna Czarnecka, Toronto, Canada

1:40 PM **Innovations in Therapeutic Bronchoscopy**
Shanda H. Blackmon, Rochester, MN

1:50 PM **Discussion**

1:00 PM – 2:00 PM
The Annals Academy: How to Write a Great Review—Essential Components of Outstanding Peer Reviews

Consumers of medical literature expect peer-reviewed publications to be accurate, meaningful, and have high impact. Meeting this expectation requires a thorough and critical evaluation of submitted manuscripts through the peer-review process. An effective peer-review system will facilitate informed clinical practice changes that will enhance value-based care for patients and iteratively educate the entire field of cardiothoracic surgery. While this session is geared toward junior faculty and early career researchers, physicians and research personnel at all stages of their careers will gain contemporary perspectives on the process.

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

- Describe the peer-review process and identify its importance to academic faculty
- Recognize the key elements of scientific manuscripts and identify the necessary components to include in a review of each element
- Identify basic scientific study designs and the statistical methods that are appropriate for each
- Identify the process for responding to reviewer comments and describe effective techniques that will improve the chances of publication for a revised paper

Moderator: *G. Alexander Patterson, St Louis, MO*

1:00 PM **Introduction**

1:05 PM **Why Surgeons Should Care About Peer Review**
Elizabeth A. David, Pasadena, CA

1:15 PM **Key Elements of Scientific Manuscripts**
Lisa M. Brown, Sacramento, CA

1:25 PM **Basic Study Design and Statistical Methods**
Katie S. Nason, Springfield, MA

1:35 PM **Responding to Reviewer Comments and Preparing Revisions**
Tara B. Karamlou, Phoenix, AZ

1:45 PM **Q&A**

1:00 PM – 2:00 PM
Unconscious Bias

Unconscious bias is a rarely recognized phenomenon that can have unintended influence on interactions among cardiothoracic surgeons at all levels of training, particularly as it pertains to gender, race, and ethnicity. This session, organized by Women in Thoracic Surgery, will address the need to recognize and define unconscious and implicit bias in our actions and provide tools to avoid the negative influence it may have on our actions and interactions with others.

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

- Define unconscious bias
- Define implicit bias
- Recognize bias within themselves
- Describe how their personal bias could impact others
- Identify ways to avoid unconscious bias in everyday practice

Moderator: *Valerie A. Williams, Cincinnati, OH*

1:00 PM **Introduction**
Valerie A. Williams, Cincinnati, OH

1:05 PM **Unconscious Bias: What Is It?**
Jessica S. Donington, Chicago, IL

1:13 PM **Gender Bias**
DuyKhanh P. Ceppa, Indianapolis, IN

1:21 PM **Unconscious Bias: Race**
Jane Yanagawa, Los Angeles, CA

1:29 PM **Overcoming Bias in Surgery: The Role of Mentorship and Sponsorship**
Robert S. D. Higgins, Baltimore, MD

1:37 PM **Panel Discussion**

2:10 PM – 4:30 PM
Opening Session

Moderators: *Keith S. Naunheim, St Louis, MO, and Joseph F. Sabik III, Cleveland, OH*

2:10 PM Welcome

2:30 PM

ABSTRACT: J. Maxwell Chamberlain Memorial Paper for Adult Cardiac Surgery: Relationship Between Hospital Surgical Aortic Valve Replacement Volume and Transcatheter Aortic Valve Replacement Outcomes

S. A. Hirji[1], *E. P. McCarthy*[2], *D. Kim*[1], *S. McGurk*[1], *J. I. Ejiofor*[1], *S. H. Kiehm*[1], *F. Ramirez-Del Val*[1], *A. A. Kolkailah*[1], *N. Berry*[1], *M. P. Pelletier*[1], *P. Shah*[1], *P. T. O'Gara*[1], *T. K. Kaneko*[1]

[1]*Brigham and Women's Hospital, Boston, MA,* [2]*Institute of Aging Research, Hebrew SeniorLife, Beth Israel Deaconess Medical Center, Boston, MA*

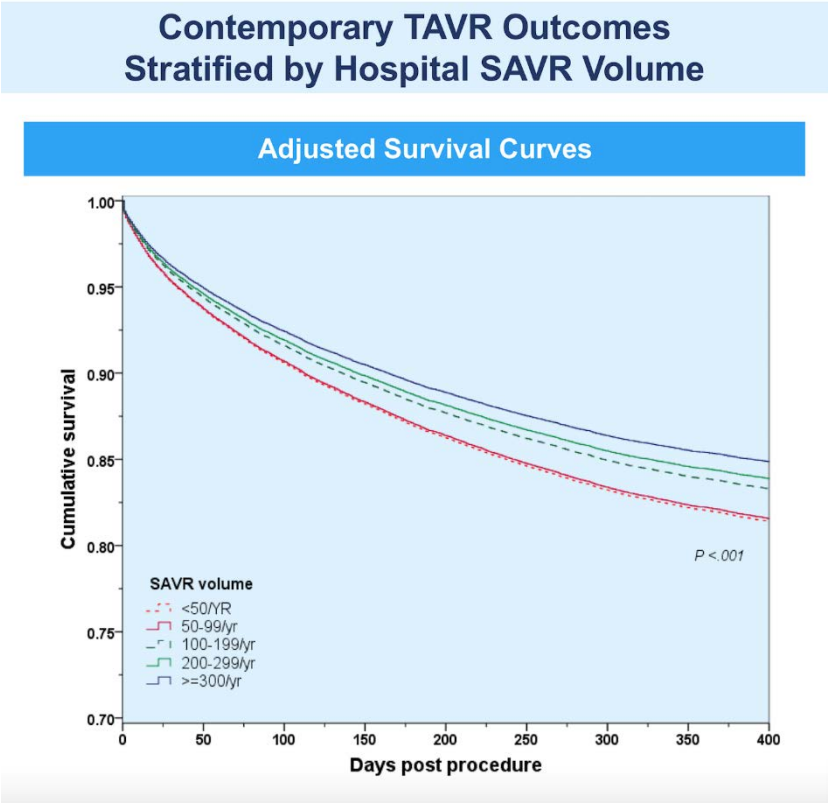
DISCUSSANT: *Joseph E. Bavaria, Philadelphia, PA*

Purpose: Recent studies have demonstrated a strong association between volume-outcome relationship for transcatheter aortic valve replacement (TAVR). We sought to determine whether hospital volume of surgical aortic valve replacement (SAVR) was associated with corresponding TAVR outcomes.

Methods: We analyzed 208400 fee-for-service Medicare beneficiaries for all aortic valve replacement (AV) procedures from 2012 – 2015. Claims for patients <65yo at the time of surgery (13521), concomitant CABG (62889), other heart valve (7994), or other major open-heart procedures (13672) were excluded, as were secondary admissions for AVR (744). Hospital SAVR volumes were stratified based on mean SAVR procedures done per year during the study period. Our primary outcomes were 30-day and 1-year postoperative TAVR survival. Adjusted survival following TAVR was assessed by multivariable Cox regression controlling for SAVR experience, age, gender, and race.

Results: A total of 65757 SAVR and 42967 TAVR admissions were evaluated from 1208 hospitals. TAVR volume increased from 6427 cases in 2012 to 23209 cases in 2015. 3% (1146) of TAVR procedures were performed at hospitals with <50 SAVR cases in average annual volume, 20% (7569) at centers with 50-99, 35% (13352) at centers with 100-199, 23% (8695) at centers with 200-299, and 7150 (19%) at hospitals performing 300+ SAVR/year. The 30-day mortality for each SAVR volume strata (<50, 50-99, 100-199, 200-299, 300+) was 7.5%, 7.8%, 6.6%, 6.0%, 5.8%, respectively. Low volume centers had significantly higher 30d mortality; compared to the 300+ group, the adjusted OR for <50 centers was 1.30 (95% CI, 1.06-1.61), 1.33 (95% CI, 1.19-1.49) for the 50-99 group, and 1.14 (95% CI 1.03-1.26) for the 100-200 group (all P<.001). When controlling for age, race, gender, the adjusted survival differences in TAVR outcomes persisted at 1-year post-procedure. (Figure)

Conclusions: Total hospital volume of SAVR procedures appears to be correlated with TAVR outcomes, with higher 30-day and 1-year mortality observed at low volume centers. The use of minimum SAVR hospital thresholds may be considered as a possible additional metric for performing TAVR.



2:50 PM

ABSTRACT: J. Maxwell Chamberlain Memorial Paper for General Thoracic Surgery: Thoracic Surgery Regionalization Within an Integrated Health Care System Improves Outcomes From Major Pulmonary Resections for Lung Cancer

S. Ely[1], *S. Jiang*[2], *J. B. Velotta*[2], *T. C. Tung*[3]

[1]*University of California San Francisco East Bay Surgery, Oakland,* [2]*Kaiser Permanente, Oakland, CA,* [3]*Kaiser Permanente, San Ramon, CA*

DISCUSSANT: *David Tom Cooke, Sacramento, CA*

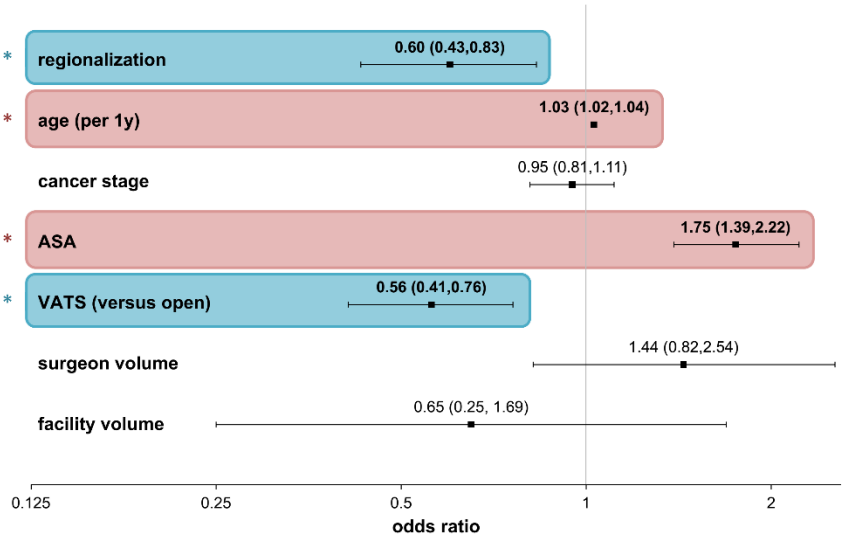
Purpose: The current literature on volume-outcome relationship in lobectomy for lung cancer is mixed and inconclusive. Furthermore, many of the studies are based on data following centralization within national, single-payer systems. We examined the impact of thoracic surgery regionalization on outcomes from major pulmonary resection in an American integrated healthcare system.

Methods: We retrospectively reviewed patients undergoing major pulmonary resection (lobectomy, bi-lobectomy or pneumonectomy) within our managed care network in the three years before (2011-2013, n=782) and after (2015-2017, n=845) regionalization of thoracic surgery care to five designated Centers of Excellence (CoE). We compared perioperative outcomes from pre- to post-regionalization (PreR, PostR) using bivariate analysis (Student's t-, chi-squared, Kruskal-Wallis tests). We used hierarchical linear (for length of stay (LOS)) and logistic (for morbidity) mixed multivariate models to examine these outcomes changes while controlling for patient-, surgeon-, and hospital-level effects, as well as for clustering within surgeon and facility levels.

Results: Regionalization successfully shifted cases from 16 PreR sites to 5 CoE, where 100% were performed by 2015-2016. Average facility volume increased from 16 to 56 cases/year at CoE. Regionalization also resulted in increased use of video-assisted thoracoscopic surgery (VATS) approach, 86% from 57% (729/845 and 449/782 cases, p<0.001), as well as decreased ICU utilization (-1.7 days, p<0.001) and hospital LOS (-3.3 days, p<0.001). Patients in the PostR era also had fewer total (26.2% from 38.6%, p<0.001) and major complications (9.6% from 13.6%, p=0.01) than those in the PreR era; this change was driven exclusively by decreased morbidity among the VATS cases, which comprised the vast majority (86%) of all PostR resections. Mortality decreased modestly (30-day: 0.7% from 1.3%; 90-day: 1.4% from 2.3%) but was low in both eras. In our multivariate analyses, regionalization was significantly associated with decreased LOS and complication rates, independent of surgical approach or patient factors.

Conclusions: Thoracic surgery regionalization, previously only described at large scale in foreign models, was feasible within an American integrated healthcare system and dramatically increased major pulmonary resection facility volume. Regionalization was independently associated with significant improvements in VATS utilization, LOS, and morbidity, suggesting an effect beyond that of volume alone.

Figure 1. Adjusted multivariable associations with any complication (hierarchical logistic model)



3:10 PM

ABSTRACT: J. Maxwell Chamberlain Memorial Paper for Congenital Heart Surgery: Late Survival and Patient-Perceived Functional Health Status of the Congenital Heart Surgeons' Society Transposition of the Great Arteries Cohort

P. J. Devlin[1], *A. Jegatheeswaran*[1], *W. G. Williams*[1], *E. H. Blackstone*[2], *W. M. Decampli*[3], *L. M. Lambert*[4], *K. A. Mussatto*[5], *C. Prospero*[6], *I. Bondarenko*[7], *B. W. McCrindle*[1]

[1]*The Hospital for Sick Children, Toronto, Canada,* [2]*Cleveland Clinic, OH,* [3]*The Congenital Heart Institute at Arnold Palmer Hospital, Orlando, FL,* [4]*University of Utah, Salt Lake City,* [5]*Children's Hospital of Wisconsin, Milwaukee,* [6]*Nemours Cardiac Center, Alfred I. duPont Hospital for Children, Wilmington, DE,* [7]*Children's Hospital of Michigan, Detroit*

DISCUSSANT: *John J. Lamberti, Palo Alto, CA*

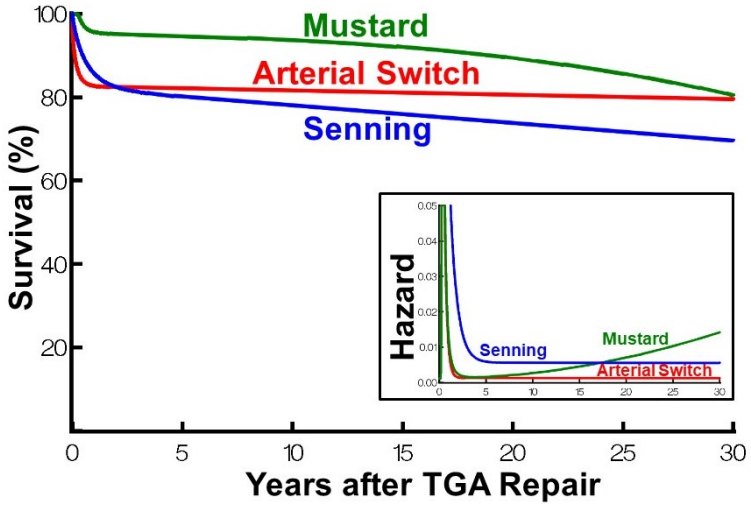
Purpose: The CHSS TGA cohort has provided important information regarding patients who underwent TGA repair during the transition from atrial to arterial repair. Improved survival for these patients has led to an increased focus on functional health outcomes. We aimed to determine late survival and patient-perceived functional health in this cohort.

Methods: From January 1985 – March 1990, 891 patients were enrolled in the CHSS TGA cohort with 830 having repair. Median follow-up was 23.5 years (Range: 0 – 32.1). We performed multiphase parametric hazard analysis for death following repair. Functional health status (FHS) of adult survivors was assessed by Pediatric Quality of Life Inventory (PedsQL) Core Scales and Cardiac Module Adult Forms and compared between TGA survivors and a healthy adult group with further comparison by repair type. Patient and operative factors, and responses to the CHSS General Questionnaire, were analyzed for association with FHS with multiple linear regression.

Results: The 830 children underwent the following procedures: arterial switch: 516, Mustard: 110, Senning: 175, and Rastelli: 29. Estimated survival at 30 years post-repair was: arterial switch: 80±2%, Mustard: 81±5%, Senning: 70±4%, Rastelli: 86±8% (Figure 1). There was a high early hazard for death following arterial switch procedure reflecting the learning curve of the new operation. On late follow-up, the arterial switch group had the lowest hazard for death.

Of the 508 patients followed for at least 18 years, 100 completed the PedsQL questionnaire. TGA patients reported similar FHS to a normal population in all domains except physical health (lower scores) (Table 1). Symptoms, including chest pain and fainting, and having a pacemaker were associated with lower reported physical health, while employment was associated with higher reported physical health. Arterial switch patients (n=72) as a group reported higher FHS than the atrial switch patients (n=24) in all domains.

Conclusions: Our data demonstrates long-term benefits for arterial switch patients including lower risk of premature death and better FHS. Increased surveillance in atrial switch patients is warranted because of their increased risk of premature death. Presence of symptoms, pacemaker, and employment status contribute to the variability of FHS in this cohort.



	Patient Reported Values		
	Healthy Adult Population (n=512)	TGA Patients (n=100)	
PedsQL scale	Mean ± STD	Mean ± STD	p
Physical Health	90 ± 13	87 ± 16	0.03
Psychosocial Health	84 ± 13	84 ± 16	0.8
Emotional Functioning	79 ± 18	79 ± 22	0.9
Social Functioning	89 ± 13	89 ± 16	1.0
School/Work Functioning	84 ± 14	86 ± 16	0.3
Total Score	86 ± 11	85 ± 15	0.6

3:30 PM **Thomas B. Ferguson Lecture:** Cancer Immunotherapy: The End of the Beginning
Laurie H. Glimcher, Boston, MA

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

4:45 PM – 5:30 PM
Jeopardy Championship

5:30 PM – 6:30 PM
2019 The Thoracic Surgery Foundation Awards Announcement and VIP Reception (by invitation only)

5:30 PM – 6:30 PM
Poster Presentations
All posters are now electronic. Several monitors are available in the Exhibit Hall for attendees to view the posters.

7:00 PM – 10:00 PM
President's Reception: Hotel del Coronado
Join your colleagues for the STS President's Reception at the celebrated Hotel del Coronado. Set on picturesque Coronado Island, just off the San Diego coastline, this National Historic Landmark hotel was built in 1888 and has been a popular destination for visiting celebrities, presidents, and dignitaries.

The reception will be held in the Crown Room, an elegant space with a 33-foot domed ceiling made from Oregon sugar pine and crown-shaped chandeliers designed by L. Frank Baum, author of *The Wonderful Wizard of Oz*. Several notable events have been held in the Crown Room, including a celebration for Charles Lindbergh following his solo transatlantic flight. The resort also served as the backdrop for movies, including "Some Like It Hot," starring Marilyn Monroe, Tony Curtis, and Jack Lemmon.

Don't miss this opportunity to enjoy dinner, drinks, and conversation in a historic setting.

Monday, January 28

6:30 AM – 5:00 PM
Registration

9:00 AM – 4:30 PM
Exhibit Hall

7:15 AM – 9:15 AM
Career Navigation and Development: Hot Topics to Enhance Your First 7 Years of Practice Through lectures and robust discussion on hot topics, this session will review the challenges faced by cardiothoracic surgeons early in their careers and provide solutions so that they can be successful. Attendees also will learn how to become a volunteer leader in their medical specialty society.

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

- Describe the essential elements of contract negotiation
- Explain how to apply social media to their practice
- Describe how to find a mentor and develop a valuable relationship
- Outline how to develop a niche in their practice while attaining work-life balance

Moderators: *Melanie A. Edwards, Ypsilanti, MI, and Richard Lee, Augusta, GA*

7:15 AM **Introduction**
Melanie A. Edwards, Ypsilanti, MI

7:25 AM **Negotiating and Renegotiating Your Contract**
Frank L. Fazzalari, Rochester, MI

7:35 AM **Is the Trifecta Really Possible? Clinical Practice, Research/Education, and a Life**
Joanna Chikwe, New York, NY

7:45 AM **The Value of Great Mentorship: How to Find a Mentor and How to Be a Mentee**
David D. Odell, Chicago, IL

7:55 AM **How to Use Social Media to Engage Your Colleagues and Your Patients**
Mara B. Antonoff, Houston, TX

8:05 AM **Leadership in The Society of Thoracic Surgeons: How to Excel**
Robert S. D. Higgins, Baltimore, MD

8:15 AM **Hot Topics Free-for-All**
Primary Moderators: *Mara B. Antonoff, Houston, TX, and Vinay Badhwar, Morgantown, WV*
Floor Moderators: *Melanie A. Edwards, Ypsilanti, MI, Damien J. LaPar, New York, NY, and Gabriel Loor, Minneapolis, MN*
Panelists: *Shanda H. Blackmon, Rochester, MN, Robert J. Cerfolio, Birmingham, AL, Nimesh Desai, Philadelphia, PA, Tom C. Nguyen, Houston, TX, Vinod H. Thourani, Washington, DC, and Thomas K. Varghese Jr, Salt Lake City, UT*

Discussion Topics:

- How Does My Health System Value My Contributions?
- Should I Stay or Should I Go? Dealing With a Difficult Job
- Developing a Niche and Building Your Practice
- What to Do When You Are in Over Your Head
- Academic, Private, or Employed—and How to Excel Anywhere
- Pathways to Health System or Hospital Leadership

7:15 AM – 9:15 AM
Congenital: Pediatric Congenital I
Moderators: *Carl L. Backer, Chicago, IL, and Stephanie M. Fuller, Philadelphia, PA*

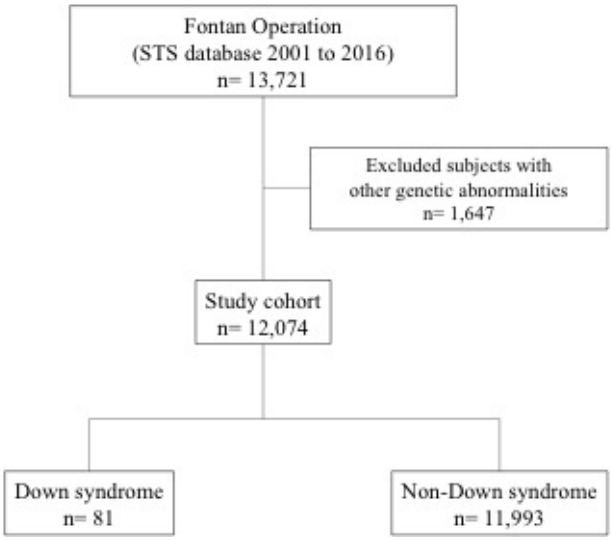
7:15 AM
ABSTRACT: Richard E. Clark Memorial Paper for Congenital Heart Surgery: Outcomes of Fontan Operation With and Without Down Syndrome From the STS Congenital Heart Surgery Database
L. A. Sarno[1]*, H. L. Walters*[2]*, D. Kobayashi*[2]
[1]*East Carolina University, Greenville, NC,* [2]*Children's Hospital of Michigan, Detroit*
DISCUSSANT: *Michel N. Ilbawi, Oak Lawn, IL*

Purpose: The purpose of this study was to show the historical and contemporary short-term outcomes of Fontan operation for a functionally univentricular heart in patients with Down Syndrome (DS) and non-Down syndrome (non-DS). Our hypothesis was that DS is a significant risk factor for morbidity and mortality associated with Fontan operation.

Methods: This was a retrospective study using the Society of Thoracic Surgeons Congenital Heart Surgery Database to compare the morbidity and mortality in patients with DS and non-DS undergoing Fontan operation. The study period was 2001-2016: era 1 (2001-2008) vs. era 2 (2009-2016). The primary outcome was in-hospital mortality. Secondary outcomes were length of hospital stay, 30-days mortality and complications. Patients with other genetic syndrome or no data on primary outcome were excluded. The variables were compared between groups using a Chi-square or non-parametric test. Primary outcome included in-hospital mortality status.

Results: Among 12,074 patients, our study cohort consisted of 81 DS patients and 11,993 non-DS patients. DS group had a higher in-hospital mortality rate than non-DS group 12.3% (10/81) vs. 1.6% (193/11993), p <0.001 with the odds ratio of 8.6 [95% confidence interval: 4.4 to 16.9]. Median Length of stay was longer by 3 days in DS group (12 vs. 9 days, p<0.001). The 30-days mortality rate was higher in DS group 7.7% (6 /78) vs. 1.3% (150/11354), p<0.001. Regarding complications, DS group had higher rates of delayed sternal closure, post-op respiratory insufficiency, renal failure requiring dialysis, infection, chylothorax, cardiac failure and cardiac arrest. In the DS group, in-hospital mortality rate improved from Era 1 to 2 (21% (7/34) to 6% (3/47), p=0.055).

Conclusions: Down syndrome was a significant risk factor for morbidity and mortality associated with Fontan operation. Recent cohort (2009-2016) showed an improvement of in-hospital mortality rate in DS group, indicating a possibility of better peri-operative surgical care and appropriate patient selection.



Outcomes of Fontan Operation

	Down syndrome	Non-Down syndrome	*p* value	Odds ratio (95% CI)
Primary outcome (2001 to 2016)				
In-hospital mortality	12.3% (10/81)	1.6% (193/11993)	**<0.001**	8.61 (4.38-16.95)
Secondary outcome (2001 to 2016)				
Post-operative length of stay	25 days	13 days		
30-day operative mortality	7.7% (6/78)	1.3% (150/11354)	**<0.001**	6.22 (2.67-14.54)
Complications (2001 to 2016)				
Intraoperative death	0% (0/81)	0.06% (7/11993)		NA
Delayed sternal closure	4.9% (4/81)	1.2% (143/11993)	**<0.01**	4.3 (1.55-11.92)
Unplanned reoperation	16% (13/81)	11.7%(1401/11993)	.223	1.44 (0.8-2.62)
Renal failure*	4.9% (4/81)	1.1% (127/11993)	**<0.001**	4.85 (1.75-13.46)
Neurologic deficit	2.5% (2/81)	2.6% (307/11993)	.96	0.96 (0.24-3.94)
Infection	9.9% (8/81)	2.9% (348/11993)	**<0.001**	3.67 (1.75-7.67)
Pneumonia	1.2% (1/81)	.05% (56/11993)	.32	2.66 (0.36-19.48)
Pneumothorax	3.7% (3/81)	2.2% (261/11993)	.35	1.73 (0.54-5.51)
Chylothorax	16% (13/81)	7.7% (924/11993)	**<0.01**	2.29 (1.26-4.16)
Pleural effusion	19% (15/81)	16% (1861/11993)	0.46	1.24 (0.7-2.17)
Mechanical ventilation >7 days	8.6% (7/81)	1.7% (202/11993)	**<0.001**	5.52 (2.51 -12.14)
Re-intubation	9.9% (8/81)	5.9% (708/11993)	0.13	1.75 (0.84-3.64)
Tracheostomy	0% (0/81)	0.2% (18/11993)		NA
Arrhythmia	17% (14/81)	15% (1790/11993)	0.55	1.19 (0.67-2.12)
AV block requiring permanent pacemaker	2.5% (2/81)	1.6% (163/11993)	0.39	1.84 (0.45-7.54)
Cardiac arrest	6.2% (5/81)	0.84%(101/11993)	**<0.001**	7.75 (3.07-19.55)
Cardiac failure / low cardiac output	11% (9/81)	4% (476/11993)	**<0.001**	3.02 (1.5-6.08)
Post-operative ECMO	2.5% (2/81)	0.76% (91/11993)	0.08	
Complications (2010 to 2016)				
Multi-system organ failure	2.2% (1/45)	0.57% (40/7054)	0.14	3.99 (0.54-29.64)
Unplanned catheterization intervention*	8.9% (4/45)	3.6% (254/7054)	0.06	2.61 (0.93-7.35)

Data expressed as number (percent) or median (interquartile range).
*Unplanned intervention included cardiac, non-cardiac, and catheter-based intervention during the hospitalization.
*Renal failure included renal insufficiency requiring temporary or permanent dialysis

7:30 AM

ABSTRACT: Complex Transposition Repair: Up to 30 Years of Follow-Up

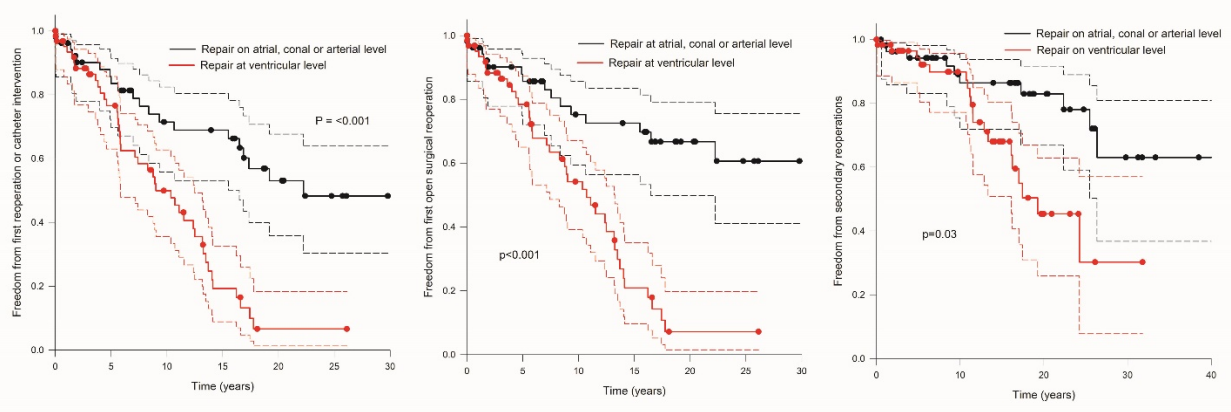
F. A. Kari[1], *H. Bohnens*[2], *B. O. Bierbach*[3], *E. A. Bacha*[4], *B. Stiller*[2], *U. Bauer*[5]
[1]*NewYork-Presbyterian Morgan Stanley Children's Hospital, Columbia University Medical Center, NY,* [2]*University of Freiburg, Germany,* [3]*German Pediatric Heart Center, Sankt Augustin,* [4]*NewYork-Presbyterian/Columbia University Medical Center, NY,* [5]*German National Quality Assurance for Congenital Heart Disease, Berlin*

Purpose: We sought to compare long-term results after surgical biventricular repair of transposition-ventricular septal defect-left ventricular outflow tract obstruction (TGA-VSD-LVOTO) utilizing repair at ventricular level vs. resection of LVOTO and repair on atrial or arterial level in a multicenter registry study (German National Quality Assurance).

Methods: Data submitted by 13 congenital cardiac surgical centers to the German National Quality Assurance for Congenital Heart Disease were screened for TGA-VSD-PS. A total of 139 patients treated between 1978 and 2015 for TGA-VSD-PS were identified. Follow-up was completed by contacting the respective surgical centers and pediatric cardiologists. Studied endpoints included primary, secondary and tertiary reoperations (valvular, baffle-related, recurrent VSD, main and branch pulmonary arteries, or recurrent LVOTO).

Results: Clinical follow up (F/U) was 88% complete, echocardiographic F/U was 71% complete. Mean and median clinical F/U times were 15 years with a maximum of 30 years and a cumulative F/U of 1790 patient-years. Actual primary and secondary reoperation rates were 47% and 20% out to 30 years. Overall actuarial freedom from first reoperation was 20% (95% CI 15-25%) at 30 years, freedom from secondary reoperations was 53%. Overall freedom from primary and secondary reoperations was 16% (CI 12-20%) and 54% (CI 51-57%) at 30 years, respectively. Freedom from first reoperation or intervention was 6% (1-19%) after repair at ventricular level vs. 53% (36-68%) after repair at atrial or arterial level ($p<0.001$) at 20 years. This difference was still detectable after excluding catheter interventions. Freedom from second reoperation at 20 years after repair on ventricular level was 46% (CI 26-63%) vs. 83% (66-92%) after other repairs.

Conclusions: Long-term after repair, rates of first, second and third conventional reoperations are high. Repair at ventricular level is linked to more reoperations, even when compared to repair on atrial level. If anatomical substrate is suitable, resection of LVOTO and utilizing a repair at arterial/conal level should be preferred.



7:45 AM

ABSTRACT: Mitral Valve Replacement in Children With a 15 mm Mechanical Valve

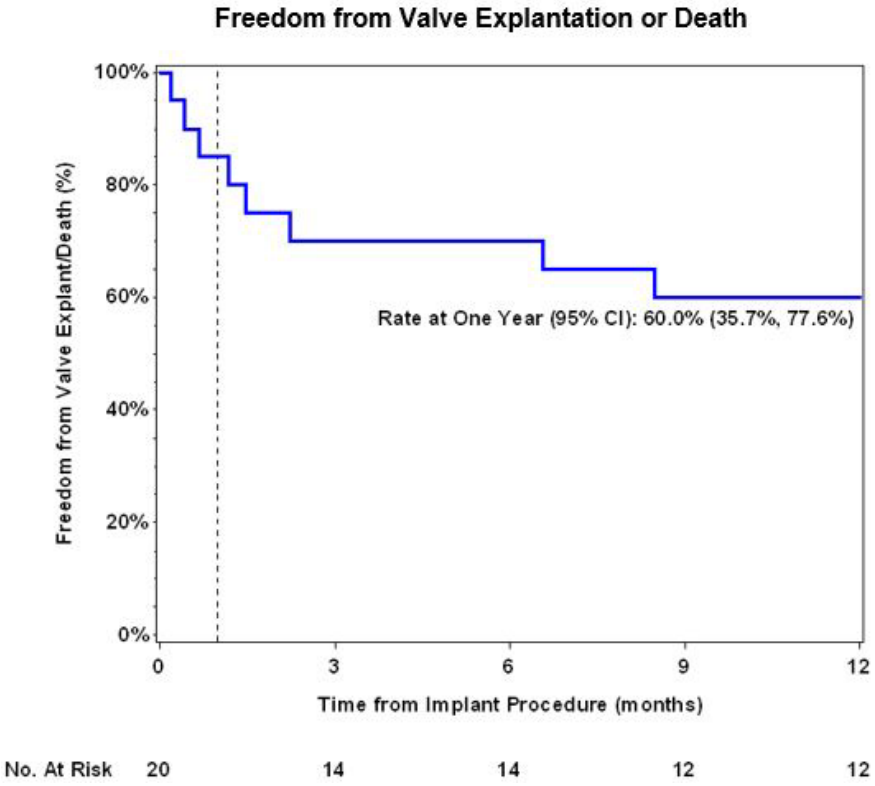
K. R. Kanter[1], *C. L. Backer*[2], *M. B. Mitchell*[3], *J. M. Chen*[4], *B. E. Kogon*[5], *J. M. Hammel*[6], *J. Jaggers*[7], *C. D. Fraser*[8]
[1]Emory University School of Medicine, Atlanta, GA, [2]Ann & Robert H. Lurie Children's Hospital of Chicago, IL, [3]Children's Hospital of Colorado Heart Institute, Aurora, [4]Children's Hospital of Philadelphia, PA, [5]University of Mississippi Medical Center, Jackson, [6]Children's Hospital & Medical Center, Omaha, NE, [7]University of Colorado, Children's Hospital Colorado, Aurora, [8]UT Health Austin, TX

Purpose: Repair is preferable for children with mitral valve disease; replacement (MVR) is occasionally necessary. Replacement can be problematic due to lack of available valve sizes for small children. We present the initial clinical results of a multi-institutional Investigational Device Exemption (IDE) trial of the 15mm St. Jude mechanical (SJM) mitral valve.

Methods: From May, 2015, to March, 2017, 20 children aged 0.4-27.4 months (mean 7.6 months; 85% <1 year) weighing 2.9-10.9 kg (mean 5.5 kg) at 14 centers underwent MVR with a 15mm SJM (intra-annular 45%, supra-annular 55%). 18 (90%) had prior cardiac operations. Nine patients had an atrioventricular septal defect (45%), 2 patients had Shone's syndrome. Moderate to severe mitral regurgitation was present in 15 patients (75%). Anticoagulation (determined by the implanting center) included warfarin with or without aspirin in 88% and 100% of patients at 30 days and one year, respectively. Follow-up until death, valve explantation, or one year postoperatively was 100% complete.

Results: There was 1 early death at 6 days and 4 late deaths at 45 days to 8 months; no death was valve-related. 3 patients had complete heart block postoperatively requiring a pacemaker (2 supra-annular, 1 intra-annular). 3 patients had thrombosis requiring valve explantation at 13, 21 and 36 days postoperatively. 2 of the 3 patients were on low molecular weight heparin for anticoagulation, the 3rd was on unfractionated heparin for ECMO support and had Factor V Leiden mutation. There were 4 nonfatal bleeding complications all within 4 months of MVR (1-year freedom from bleeding: 71.0%). Freedom from valve-related adverse event (bleeding, thrombosis) was 66.8% at one year. Freedom from death or valve explantation was 60.0% at one year (Figure). At one year, echocardiography (Table) showed no patient had more than mild prosthetic mitral regurgitation; peak mitral gradient was 19.4±7.1 mmHg (mean 7.4±4.1 mmHg).

Conclusions: In small children with severe mitral valve disease requiring mitral valve replacement, the 15 mm SJM mechanical valve provides satisfactory hemodynamics. Mortality and complications in these very sick patients are not trivial. It appears that low molecular weight heparin should be avoided as primary anticoagulation. Eventual valve replacement is inevitable.



Postoperative Echocardiographic Variables

Variable	Post procedure	30 days	6 months	12 months
Mean gradient (mm Hg)	2.7 ± 1.9 (15) (0.4, 8.5)	5.7 ± 2.9 (16) (1.1, 11.4)	6.2 ± 2.6 (13) (2.8, 11.2)	7.4 ± 4.1 (12) (3.1, 17.8)
Peak gradient (mm Hg)	8.1 ± 5.4 (15) (1.3, 20.6)	14.0 ± 5.5 (16) (5.6, 23.0)	16.9 ± 4.0 (13) (9.2, 23.4)	19.4 ± 7.1 (12) (10.2, 33.2)
Effective Orifice Area (EOA) (cm^2)	0.7 ± 0.3 (7) (0.3, 1.0)	0.5 ± 0.3 (9) (0.2, 1.0)	0.6 ± 0.2 (7) (0.3, 1.1)	0.5 ± 0.1 (2) (0.4, 0.5)
EOA index (cm^2/m^2)	2.8 ± 1.1 (7) (1.2, 4.4)	1.6 ± 0.6 (9) (0.8, 2.6)	1.6 ± 0.6 (7) (0.6, 2.5)	1.1 ± 0.4 (2) (0.8, 1.3)
Valvular regurgitation				
None	7/20 (35.0%)	3/17 (17.6%)	3/13 (23.1%)	9/12 (75.0%)
Trivial	4/20 (20.0%)	7/17 (41.2%)	5/13 (38.5%)	2/12 (16.7%)
Mild (+1)	4/20 (20.0%)	5/17 (29.4%)	1/13 (7.7%)	1/12 (8.3%)
Moderate (+2)	0/20 (0.0%)	0/17 (0.0%)	0/13 (0.0%)	0/12 (0.0%)
Moderately severe (+3)	0/20 (0.0%)	0/17 (0.0%)	0/13 (0.0%)	0/12 (0.0%)
Severe (+4)	0/20 (0.0%)	0/17 (0.0%)	0/13 (0.0%)	0/12 (0.0%)
Present/Unknown	0/20 (0.0%)	0/17 (0.0%)	0/13 (0.0%)	0/12 (0.0%)
Unknown[1]	5/20 (25.0%)	2/17 (11.8%)	4/13 (30.8%)	0/12 (0.0%)

Continuous variables are reported as mean ± SD (N), [min, max] and categorical variables as n (%).
[1]The echo core lab was unable to assess valvular regurgitation.

8:00 AM

ABSTRACT: Surgical Aortic Valvuloplasty vs Balloon Aortic Dilation for Congenital Aortic Stenosis: Do Outcome Disparities Remain?

***A. J. Clark**, J. W. Brown, J. Herrmann, M. D. Rodefeld, M. H. Hoyer, M. W. Turrentine*
Indiana University School of Medicine, Indianapolis

Purpose: For children with congenital aortic stenosis (AS) who are candidates for biventricular repair, valvuloplasty can be achieved by surgical aortic valvuloplasty (SAV) or by transcatheter balloon aortic dilation (BAD). We aimed to evaluate the longer term outcomes of SAV versus BAD at our institution.

Methods: We retrospectively reviewed the outcomes of patient's ?18 years old who underwent SAV or BAD at our institution between January 1990 and July 2018. Surgical patients under 2 months of age were not included as valvotomy was typically performed. Baseline aortic valve anatomy and function were assessed by echocardiography. Crossover between groups occurred with reinterventions (ie. BAD with SAV reintervention); however, patients were classified based on initial intervention. Primary endpoints included overall survival, freedom from reintervention, and freedom from aortic valve replacement (AVR). Secondary endpoints included valve stenosis and/or insufficiency postoperatively and during follow up.

Results: 212 patients met inclusion criteria (SAV= 123;BAD= 89). Age at initial intervention (SAV, 8; BAD, 6.5, p= .084), body surface area, sex, and aortic valve (AV) gradient (SAV, 80.5; BAD, 82.2; p= 0.57) were similar between groups. Zero BAD patients and four SAV patients had moderate or worse preoperative aortic insufficiency (AI). Postoperative mean gradient reduction was 55.1 for SAV and 40.0 for BAD (p <.001). At 10 years, 27.9% (19/68) of SAV patients and 58.3% (28/48) of BAD patients had moderate or worse AI (p=0.001). At 10 years postoperatively, reintervention occurred in 39.2% (29/74) of SAV patients and 78.6% (44/56) of BAD patients (p <0.001).Kaplan-Meier analysis revealed overall survival at 10 years was 96.8% (4/123) for SAV and 95.5% (4/89) for SAV (p= 0.4). Freedom from AVR at 10 years was 34.8% (23/66) for SAV and 54.8% (23/42) for BAD (p= 0.12).

Conclusions: SAV demonstrated greater gradient reduction, less postoperative AI, and a lower reintervention rate at 10 years than BAD. There was no difference in survival or freedom from AVR at 10 years. SAV offers more effective and longer lasting AV palliation and should be considered the primary intervention for congenital AS.

8:15 AM

Infant Valve Intervention

John W. Moore, San Diego, CA

8:30 AM

ABSTRACT: National Practice Patterns and Early Outcomes of Aortic Valve Replacement in Children and Teens: An Analysis of the STS Congenital Heart Surgery Database

J. S. Nelson[1]*, T. M. Maul*[1]*, P. D. Wearden*[1]*, S. K. Pasquali*[2]*, J. C. Romano*[3]

[1]*Nemours Children's Hospital, Orlando, FL,* [2]*University of Michigan, Ann Arbor,* [3]*Michigan Congenital Heart Center, Ann Arbor*

Purpose: Several options exist for aortic valve replacement (AVR) in children and teens, but contemporary outcomes data are lacking and it is unclear if center experience is related to valve choice or outcomes. We sought to describe national AVR practice patterns and early outcomes.

Methods: Patients (1-18 years) in the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database undergoing AVR or truncal valve replacement with a mechanical, bioprosthetic, homograft, or autograft valve (Ross +/- Konno) from 2000-2016 were included. Preoperative characteristics, operative data, and early outcomes by valve type, gender, and age group were described. To evaluate practice patterns, centers were assigned to tertiles according to AVR volume; those performing < 20 total AVR cases over the study period were excluded. Statistical comparisons were performed using one-way ANOVA or chi-square testing as appropriate.

Results: In total, 3,605 patients (73% boys; 47% children 1-12 years; 53% teens >12-18 years) from 127 centers were included. STS-defined preoperative risk factors were present in 16%, and >33% had a prior sternotomy. Autograft was the most common valve choice (62% child, 36% teens), followed by mechanical (21% child, 36% teens), bioprosthetic (8% child, 21% teens), and homograft (9% child, 7% teens). Overall, inpatient mortality was 1.1% and was highest for homografts (4%, p<0.001). Complications were uncommon across all valve types (Table). Practice patterns for autograft utilization varied widely across centers (10^{th} – 90^{th} percentile: 13% - 72% of total AVR volume), but utilization and in-hospital mortality were similar in high vs. low-moderate AVR volume centers (utilization: 48 $\pm$ 18% vs. 42 $\pm$ 23%, p=0.2; mortality: 0.7% vs. 1.3%, p=0.25). Among teens, girls were significantly more likely to receive an autograft than boys (OR 1.8, 95% CI 1.37-2.37, p<0.001) (Figure).

Conclusions: National AVR practice patterns vary widely across centers and patient groups, including important gender differences. Early outcomes were generally similar, although homografts had higher mortality. Practices and outcomes were not related to AVR volume. Further efforts are needed to understand and optimize AVR practice patterns with regard to longer-term outcomes.

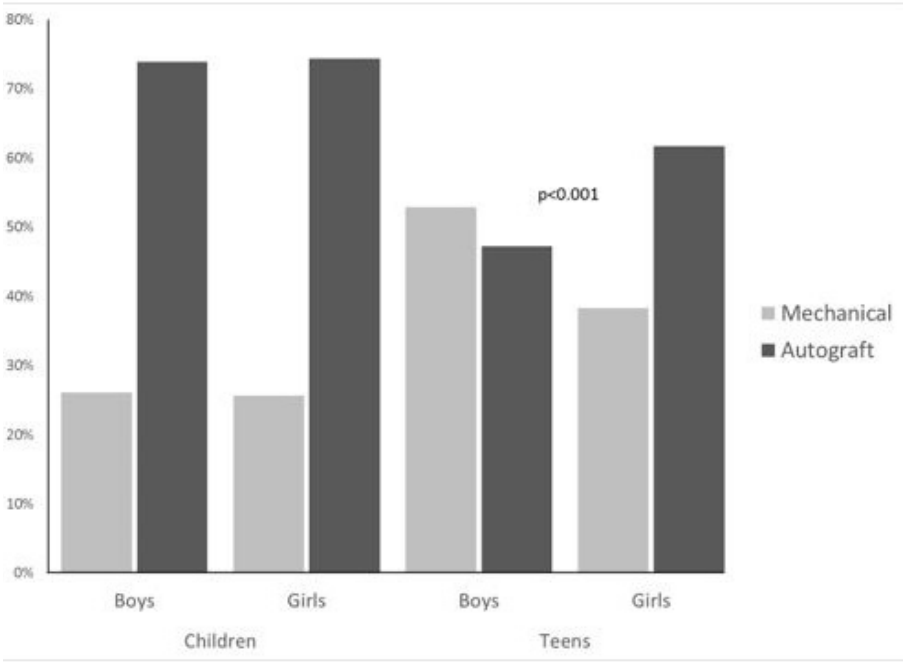


Figure: Gender differences in mechanical valve vs. autograft (Ross +/- Konno) utilization in 1,316 children and 1,297 teens.

Table: Early postoperative outcomes of aortic valve replacement in children and teens, by valve type[a] (N=3,605)

Outcome	Autograft[b] (n=1,735)	Homograft[c] (n=297)	Mechanical[c] (n=1,051)	Bioprosthetic[c] (n=537)
In-hospital mortality[d], n (%)				
Total	15 (1%)	13 (4%)	7 (1%)	3 (0.6%)
Children	11 (1%)	8 (5%)	4 (1%)	3 (2%)
Teens	4 (.6%)	5 (4%)	3 (0.4%)	0 (0%)
Cardiac arrest, n (%)				
Total	35 (2%)	5 (2%)	16 (2%)	5 (1%)
Children	27 (3%)	3 (2%)	4 (1%)	4 (3%)
Teens	8 (1%)	2 (1%)	12 (2%)	1 (0.3%)
Mechanical circulatory support, n (%)				
Total	27 (2%)	10 (3%)	15 (1%)	4 (0.7%)
Children	18 (2%)	6 (4%)	8 (2%)	2 (1%)
Teens	9 (1%)	4 (3%)	7 (1%)	2 (0.5%)
Bleeding requiring reoperation, n (%)				
Total	49 (3%)	9 (3%)	35 (3%)	8 (1%)
Children	27 (3%)	3 (2%)	14 (4%)	3 (2%)
Teens	22 (3%)	6 (4%)	21 (3%)	5 (1%)
Length of stay, d, median (IQR)				
Total	5 (4-7)	7 (5-17)	7 (5-11)	5 (4-8)
Children	6 (4-8)	8 (5-17)	8 (6-13)	6 (4-10)
Teens	5 (4-7)	6 (5-18)	7 (5-10)	5 (4-7)

[a] 15 patients had >1 valve type documented for a single operation; valve numbers sum to > total N
[b] Includes Ross +/- Konno
[c] Includes root replacements
[d] In-hospital mortality status was missing for 0.5% (n=3,588)

8:45 AM

ABSTRACT: Definitive Repair of Neonatal Complete Atrioventricular Canal Defects in the Modern Surgical Era

D. J. LaPar[1], *M. Chavez*[2], *M. J. Borisuk*[2], *S. M. Emani*[2], *A. K. Kaza*[2], *P. J. del Nido*[2], *K. G. Friedman*[2], *C. W. Baird*[2]
[1]*NewYork-Presbyterian Morgan Stanley Children's Hospital, Columbia University Medical Center, NY,* [2]*Boston Children's Hospital, MA*

Purpose: The impact of early age on outcomes for definitive repair of complete atrioventricular canal defects (CAVC) remains poorly defined. The purpose of this study was to evaluate current surgical strategies as well as operative and mid-term results related to left atrioventricular valve (AVV) re-intervention and survival following neonatal CAVC repair.

Methods: A total of 22 neonatal patients (age <35 days) undergoing definitive CAVC repair were evaluated (2005-2017) at a single institution. Patient characteristics, anatomic factors, operative techniques and outcomes were evaluated by univariate and Kaplan-Meier survival analysis to determine the impact on left AVV re-intervention and survival.

Results: Median age at operation was 23 days [4-35]. Median preoperative weight was 3.2 kg [3-4]. Median follow-up (100%) was 2 years [43d–10yr]. A majority of patients had balanced CAVC (82%), trisomy 21 (50%), and preoperative mild (41%) or mild-moderate (23%) AVV regurgitation (AVVR). The primary indication for repair was CHF (63%) with 27% of patients with ductal dependent circulation. A 2-patch repair was utilized in 82% of cases and posterior left AVV annuloplasty in 23%. There was one mortality; actuarial survival at 1, 3 and 5 years was consistently 95%. Reoperation for left AVVR was 32%, occurred at a median of 17 days [10d–5yr], and was associated with increased hospital resource utilization (Table). Actuarial freedom from reoperation for left AVVR at 1, 3 and 5 years was 27%, 27% and 32%. Importantly, at follow-up, 80% of all patients and 83% of reoperations for left AVVR had < mild left AVVR.

Conclusions: Definitive neonatal CAVC repair can be performed with low mortality and excellent mid-term survival. Reoperation for left AVV regurgitation remains a challenge and occurs early after repair. Surgical techniques to avoid postoperative left AVV dysfunction should reduce early postoperative morbidity and hospital resource utilization.

Table: Select postoperative outcomes, measures of hospital resource utilization and left AVV function following definitive neonatal CAVC repair

Factor	Total (n=22)	Reoperation Left AVVR (n=7)	No Reoperation Left AVVR (n=15)	*P*
Mortality	1 (5%)	1 (14%)	0 (0%)	0.13
Permanent Pacemaker	6 (27%)	3 (43%)	3 (20%)	0.26
ECMO	1 (5%)	1 (14%)	0 (0%)	0.13
ICU LOS	11 [0-69]	26 [0-69]	8 [4-29]	***0.03***
Total Hospital LOS	25 [6-87]	43 [27-86]	21 [6-87]	***0.001***
AVVR ≤ mild (Hospital Discharge)	19 (86%)	7 (100%)	12 (80%)	0.64
AVVR ≤ mild (Follow-up)*	16 (80%)	5 (83%)	11 (79%)	0.40

*Follow-up Echo results available for 91% (n=20) of all patients: Reoperation Left AVVR (n=6) and No Reoperation Left AVVR (n=14).
AVVR = Atrioventricular valve regurgitation; ECMO = Extracorporeal membranous oxygenation; ICU = intensive care unit; LOS = length of stay.

9:00 AM

ABSTRACT: Risk Factors for Reintervention After Isolated Subaortic Membrane Resection

Z. M. Binsalamah[1], *Z. A. Spigel*[1], *C. Ibarra*[2], *I. Adachi*[2], *C. M. Mery*[3], *M. Imamura*[1], *J. S. Heinle*[2], *C. D. Fraser*[4]
[1]*Baylor College of Medicine, Houston, TX,* [2]*Texas Children's Hospital, Houston,* [3]*The University of Texas Dell Medical School/Dell Children's Hospital, Austin,* [4]*UT Health Austin, TX*

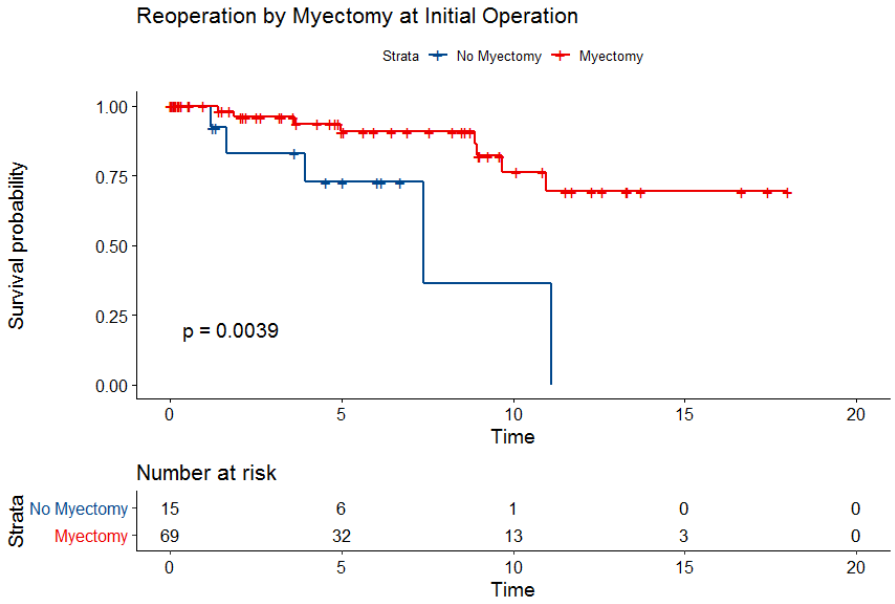
Purpose: The rate of recurrence of isolated subaortic stenosis in children continues to be a significant problem.[1-3] We sought to identify patient and surgical characteristics to predict a patient's risk for reoperation, in order to improve surgical planning and discussion with patients and their families.

Methods: All patients who underwent resection of an isolated subaortic membrane between October 1995 and April 2018 were included in the study. Patients that underwent other procedures (except repair of an atrial septal defect) were excluded. Demographic, anatomic, and physiologic variables were analyzed as potential risk factors. Univariate time-to-event analyses were performed using Kaplan-Meier methods with log-rank tests for categorical variables, and univariate Cox models for continuous variables. Multivariable Cox regression models were created using statistically significant variables to identify risk factors for reintervention.

Results: A total of 84 patients (median age 6.6, 31% females) underwent resection of isolated subaortic membrane. At a median follow-up of 9.3 years (range 0.6-22.5), 12(14%) patients required one reoperation and 1 patient required two reoperations. Median time to first reoperation was 4.6 years. The overall actuarial 5-year incidence of reintervention was 13%. Significant risk factors for reoperation on univariate analysis included age, body surface area (BSA), and septal myectomy. Due to 94% correlation between age

and BSA, BSA was excluded from multivariate analysis. On multivariate analysis, older age at first operation (HR 0.62, 95% CI 0.45-0.88, p=0.006) and myectomy (HR 0.24, 95% CI 0.07-0.77, p=0.017) were protective for reintervention.

Conclusions: Myectomy at the time of subaortic membrane resection is associated with lower risk for reintervention, likely by improving the angle of the left ventricular outflow tract. Larger studies are needed to assess for modifiable risk factors for reoperation that may be able to be addressed at the time of operation.



Variables	Actuarial Freedom from Reoperation		
	1 Year	5 Years	10 Years
Age Category at first Operation			
Infant	1.0	0	0
Toddler	1.0	0.5	0.5
Child	1.0	0.94	0.74
Adolescent	1.0	1.0	1.0
Myectomy at First Operation			
Myectomy	1.0	0.91	0.76
No Myectomy	1.0	0.73	0.36

7:15 AM – 9:15 AM

EACTS @ STS: Which Arch Operation Should I Do? Decision-Making During Type A Dissection Repair

In this session presented by STS and the European Association for Cardio-Thoracic Surgery, international experts will examine alternatives to the standard classic repair for DeBakey type I aortic dissection and discuss the outcomes of innovative extended arch repair techniques, including the distal aortic frozen elephant trunk, novel branched arch endografts, and valve retention root reconstructive surgery. Technical considerations, conduct of operations, 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:

- State when it is appropriate to modify the classic proximal reconstructive repair for DeBakey type I dissection with extended arch repair techniques based on available outcomes data
- Describe the nuances and different applications for novel branched arch endograft devices and frozen elephant trunk in patients with DeBakey type I aortic dissection

Moderators: *Joseph E. Bavaria, Philadelphia, PA, and Ruggero P. De Paulis, Rome, Italy*

7:15 AM

Options and Dilemmas at the Arch in Type A Repair: Present and Future Considerations

Joseph E. Bavaria, Philadelphia, PA, and Ruggero P. De Paulis, Rome, Italy

7:30 AM

The Open Distal/Hemiarch Operation for Type A: Is the Gold Standard Keeping Up? Yes!

Steven L. Lansman, Valhalla, NY

7:45 AM

ABSTRACT: Endovascular Repair of the Thoracic and Thoracoabdominal Aorta Following the Frozen Elephant Trunk Procedure

***M. Haensig**, D. Branzan, H. Staab, S. Steiner, D. Scheinert, A. Schmidt*
University of Leipzig, Germany

Purpose: To evaluate the outcomes of endovascular repair (ER) of the thoracic and thoraco-abdominal aorta following the frozen elephant trunk (fET) procedure.

Methods: Between 10/2014 and 07/2018, 249 patients underwent thoracic and thoraco-abdominal endovascular aortic repair in our institution. Of these, 10 patients (50% male) underwent second-stage ER after previous fET implantation. Feasibility and outcomes were evaluated.

Results: The mean interval between fET implantation and second-stage ER was 136 days (14–282 days). Indications for second-stage ER were TAAA Crawford Type I (n=3), TAAA Crawford Type II (n=4) and complicated residual aortic dissection after fET (n=3). The maximum aortic diameter was in average 66.3±7.2 mm. 4 branched custom-made devices and 4 off-the-shelf thoracic stent-grafts were implanted; 2 patients were treated using the petticoat technique via a percutaneous access. The median intensive care unit stay was 1 day (range: 0–3 days) and median hospital stay was 7 days (range: 5–12 days). At 30 days after ER following the fET no patient developed spinal cord ischemia and one patient died. CT angiography at 8.5±11.4 months follow-up revealed complete false lumen thrombosis of all TBAD and one type 3 endoleak with constant aneurysm diameter. Branch-patency was 100%.

Conclusions: Second-stage ER after previous fET is feasible with good mid-term results. This staged hybrid procedure is extremely effective in patients whose aneurysms are confined both to the arch and thoraco-abdominal aorta leading to an excellent functional result. ER in residual type B Ao dissection leads to complete false lumen thrombosis.

7:53 AM

Frozen Elephant Trunk Operation: A New Standard for Acute Type A Dissection

Davide Pacini, Bologna, Italy

8:08 AM

A New Operation Based on the Availability of New Technology: The Elegance of the Zone 2 (or 1) Arch With Sequential Single-Branched Thoracic Endovascular Aortic Repair

Nimesh Desai, Philadelphia, PA

8:23 AM

ABSTRACT: Single-Stage Management of Dynamic Malperfusion Utilizing a Novel Arch Remodeling Hybrid Graft

***S. J. Bozso**[6], M. W. Chu[1], I. El-Hamamsy[2], M. Ouzounian[3], J. Kempfert[4], A. Shahriari[5], J. Nagendran[6], M. C. Moon[6]*
[1]Western University, London Health Sciences Center, Canada, [2]Montreal Heart Institute, Canada, [3]University of Toronto, Canada, [4]Deutsches Herzzentrum Berlin, Germany, [5]Ascyrus Medical LLC, Boca Raton, FL, [6]University of Alberta, Edmonton, Canada

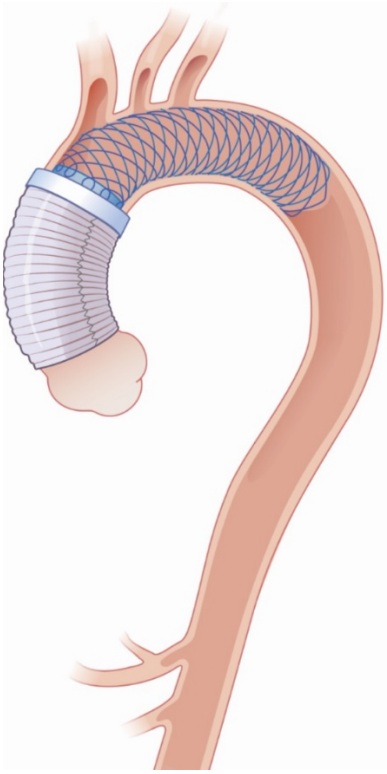
Purpose: Organ malperfusion remains challenging and causes mortality and morbidity associated with acute DeBakey I dissections. We aim to describe the results of malperfusion management following implantation of the Ascyrus Medical Dissection Stent (AMDS), an adjunct to current surgical aortic dissection repair, designed to treat organ malperfusion and induce positive remodelling.

Methods: From March 2017 to August 2018, 34 consecutive patients (61±14-years, 35% female) presented with acute DeBakey I aortic dissections and underwent emergent surgical aortic repair with AMDS implantation. Presence and resolution of organ malperfusion was assessed clinically and radiographically on pre- and post-operative CT. Malperfusion was detected pre-operatively in 50% (n=17) of patients with 40 vessel malperfusions identified, consisting of 40% (n=16) supra-aortic, 27.5% (n=11) visceral, 25% (n=10) renal, and 7.5% (n=3) lower extremity. Three patients (9%) had clinical evidence of paralysis at presentation. Two patients in the malperfusion group were excluded due to early death without a post-operative CT.

Results: All 34 device implants were successful. Overall 30-d mortality was 8.8% (n=3) and stroke occurred in 14.7% (n=5). During the follow-up period, 88% (n=15) of patients with malperfusion had completed at least one post-operative CT scan. Overall, 89% (n=33) of vessel malperfusions had resolved without an additional procedure, including 93% (n=13) supra-aortic, 91% (n=10) visceral, 90% (n=9) renal, and 100% (n=2) lower extremity. The three patients with clinical evidence of paralysis at presentation all had complete resolution

of their paralysis. One patient required left renal artery stenting, and another required superior mesenteric artery stenting for residual static malperfusions.

Conclusions: The AMDS provides an effective single-stage malperfusion management strategy. In this study, dynamic malperfusion involving supra-aortic, visceral, spinal cord and lower extremities were treated concurrently with the index standard-of-care operation without delay in life-saving care. Ongoing analysis will provide additional insight into the effective application of this promising therapeutic modality.



	Malperfusion (resolved; Y or N)			
Patient	Supra-Aortic	Visceral	Renal	Lower Extremity
1	LCCA 90% stenosis (Y)			
2			Left renal occluded (N)	
3	LCCA 80% stenosis (Y)	SMA 90% stenosis (Y)		
4		Celiac and SMA occlusion (Y)	Left and right renal occlusion (Y)	Right iliac occluded (Y)
5	Innominate 70% stenosis (Y) and RCCA 90% stenosis (Y)			
6		SMA 90% stenosis (Y)	Left and right renal occlusion (Y)	
7	Innominate and RCCA occlusion (Y)			Left iliac occluded (Y)
8	LCCA 99% stenosis (Y)	Celiac and SMA occlusion (Y)	Left and right renal occlusion (Y)	
9			Left renal occluded (Y)	
10		Celiac and SMA occlusion (Y)	Left (Y) and right (Y) renal occlusion	
11		SMA 90% stenosis (N)		
12	Innominate occlusion (Y), LCCA (Y) and RCCA 90% stenosis (N)			
13	Innominate and RCCA 99% stenosis (Y)			
14		Celiac and SMA occlusion (Y)		
15	Innominate and RCCA 99% stenosis (Y)			

Table 1. Malperfusion Outcomes after AMDS Implantation. LCCA= left common carotid artery; SMA= superior mesenteric artery; RCCA= right common carotid artery

8:31 AM

Multi-Branched Arch Endograft Solutions as Adjuncts to the Type A Repair: Will This Technology Keep the Index Operation Simple?

Bartosz Rylski, Freiburg, Germany

8:46 AM

ABSTRACT: Impact of Supra-Aortic and Thoracoabdominal Intimal Tear on Aortic Dilation and Reintervention After Surgical Repair in Acute Type I Aortic Dissection

W. Heo[1]*, S. Song*[1]*, S. Lee*[1]*, T. Kim*[1]*, J. Lee*[1]*, K. Yoo*[1]*, B. Cho*[2]
[1]*Gangnam Severance Hospital, Seoul, South Korea,* [2]*Korea Heart Foundation, Seoul*

Purpose: To evaluate the differential impact of intimal tear location including supra-aorta level on aortic dilation and reintervention after non-total arch replacement (non-TAR) for acute type I aortic dissection (AIAD).

Methods: Between 2009 and 2017, a total 304 patients were operated for AIAD. Of those, 92 patients who underwent non-TAR were enrolled in this study. Intimal tear were analyzed at 4 different level (supra-aortic [SA] level; level 1, proximal descending thoracic aorta [DTA]; level 2, distal DTA; level 3, abdominal aorta). Aortic diameter was measured at 4 different levels (pulmonary artery bifurcation [PAB], celiac axis [CA], maximal abdominal aorta [MaxAA], and maximal thoracoabdominal aorta [MaxTAA]) using serial follow-up computed tomography (CT) scans. The linear mixed model for a repeated measures random intercept and slope model was used.

Results: In the unadjusted analysis, initial diameter of PAB, CA, MaxTAA and surgical extent were not associated with aortic dilation or shrinking. The significant factors for aortic dilation were first location of intimal tear in the SA level, level 1 and 2. In adjusted analysis, first location of intimal tear in the SA level and level 1 had the statistical significance. However, in the adjusted analysis for SA and level 1 tear, level 1 tear without SA tear was the only significant factor for aortic dilation. The 5-year freedom from reintervention rate was significantly higher in patients with no intimal tear than in those with tears at level 1 with/without SA tear (93.8% vs. 0%, log-rank, p=0.003; 93.8% vs. 47.5%, log-rank, p=0.029, respectively).

Conclusions: Intimal tear in the proximal DTA (level 1) is the most important factor of aortic dilation and re-intervention in acute type I aortic dissection after surgical repair. We suggest intimal tear in the proximal DTA should be carefully evaluated and additional intervention might be needed.

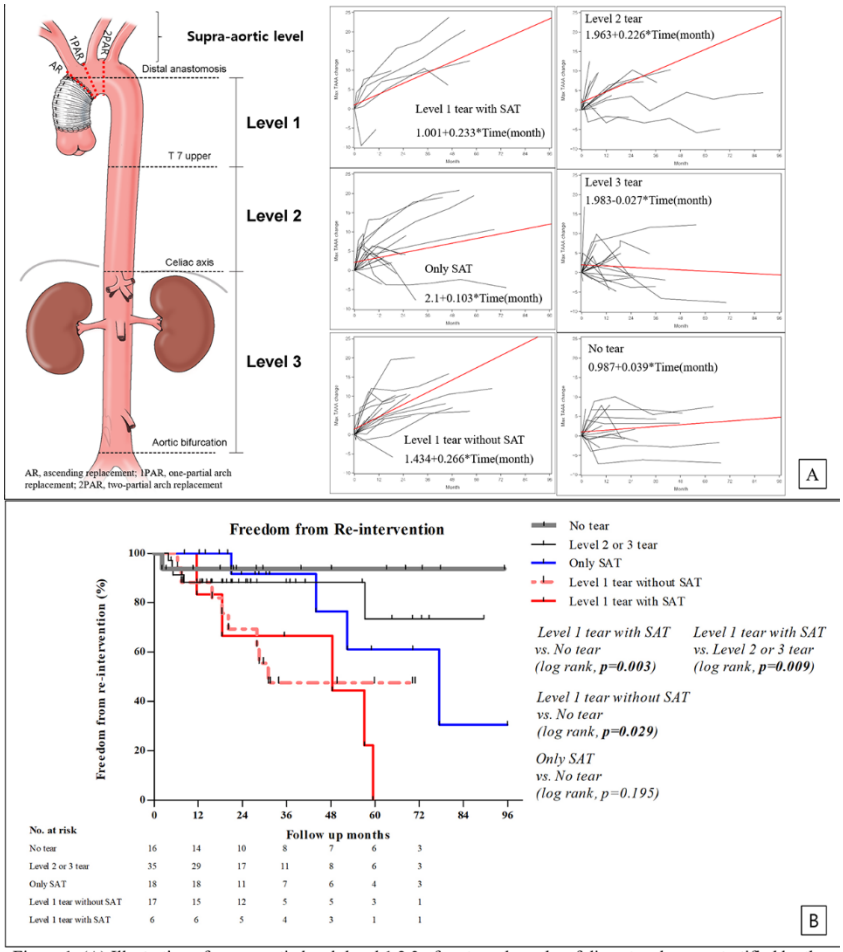


Figure 1. (A) Illustration of supra aortic level, level 1,2,3 of aorta and graphs of diameter changes stratified by the location of tear. (B) Kaplan-Meier curves of freedom from re-intervention.

Table 1. Diameter change of MaxTAA using the linear mixed model (random intercept and slope model)

Variables	*Adjusted Model 1*		*Adjusted Model 2*	
	B(SE)	p-value	B(SE)	p-value
Age	**-0.008(0.003)**	**0.0019**	**-0.008(0.003)**	**0.0029**
Sex (Female =1)	0.056(0.054)	0.3051	0.068(0.055)	0.2186
Aortic diameter of each level (First CT)				
PAB				
CA				
MaxABD	**0.020(0.006)**	**0.0017**	**0.018(0.006)**	**0.0039**
MaxTAA				
Number of visceral branches from false lumen				
CA from false lumen	0.001(0.002)	0.6868	0.001(0.002)	0.8089
First location of intimal tear				
(Comparing with level3)				
Supra-aortic (n=27)	**0.133(0.063)**	**0.0378**		
Level1 (n=17)	**0.153(0.073)**	**0.0369**		
Level2 (n=11)	0.127(0.082)	0.1224		
Level3 (n=21)	Ref(0)	.		
No intimal tear (n=16)	0.109(0.075)	0.1480		
Analysis for supra-aortic and Level 1 tear				
(Comparing with level3)				
Level 1 tear with SAT (n=6)			0.165(0.094)	0.0806
Only SAT (n=18)			0.115(0.067)	0.0881
Level 1 tear without SAT (n=17)			**0.160(0.072)**	**0.0275**
Level 2 tear (n=11, with SAT [n=3])			0.140(0.076)	0.0683
Level 3 tear (n=21)			Ref(0)	.
No intimal tear (n=16)			0.099(0.074)	0.1795

AR, ascending replacement; *1PAR*, one-partial arch replacement; *2PAR*, two-partial arch replacement; *PAB*, pulmonary artery bifurcation; *CA*, celiac axis; *MaxABD*, maximal diameter of abdominal aorta; *MaxTAA*, maximal diameter of thoracoabdominal aorta; *SAT*, supra-aortic tear; *B*, beta; *SE*, standard error.

8:54 AM
Discussion

7:15 AM – 9:15 AM
ESTS @ STS: Controversial Issues in General Thoracic Surgery—Perspectives From Europe and North America

This session will provide current perspectives from Europe and North America on a variety of controversial issues in general thoracic surgery. Experts from both continents will discuss topics such as invasive staging in early stage lung cancer, multimodal approaches to the treatment of stage IIIAN2 lung cancer, and the use of induction therapy in patients with T2N0 esophageal cancer.

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

- Explain how to obtain a critical appraisal of the indications for invasive staging in early stage lung cancer
- Describe the latest insights in the continuing debate on multimodality treatment for stage IIIAN2 non–small-cell lung cancer (NSCLC)
- Discuss the advantages and disadvantages of induction therapy in selected groups of patients with T2N0 esophageal cancer

Moderators: *Gilbert Massard, Strasbourg, France, and Michael J. Weyant, Aurora, CO*

7:15 AM **Mediastinal Staging for Clinical Stage I NSCLC: The European Perspective**
Herbert Decaluwe, Leuven, Belgium

7:30 AM **Mediastinal Staging for Clinical Stage I NSCLC: The North American Perspective**
M. Blair Marshall, Washington, DC

7:45 AM **Panel Discussion**

7:55 AM **Stage IIIAN2—Selection of Candidates for Surgery After Induction Therapy: The European Perspective**
David Waller, Leicester, United Kingdom

8:10 AM **Stage IIIAN2—Selection of Candidates for Surgery After Induction Therapy: The North American Perspective**
Thomas A. D'Amico, Durham, NC

8:25 AM **Panel Discussion**

8:35 AM **Role of Induction Therapy for T2N0 Esophageal Cancer: The European Perspective**
Georges Decker, Luxembourg City, Luxembourg

8:50 AM **Role of Induction Therapy for T2N0 Esophageal Cancer: The North American Perspective**
Philip A. Linden, Cleveland, OH

9:05 AM **Panel Discussion**

7:15 AM – 9:15 AM

STS/ISHLT Joint Symposium: The Evolution of Mechanical Circulatory Support—International Perspectives and Universal Challenges

Ventricular assist devices (VADs) are rapidly evolving, with new technology launched annually, but the introduction and diffusion of this new technology varies across the globe. This session will address how VADs are utilized in European and Asian populations and will highlight the latest innovations in univentricular and biventricular support.

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

- Describe utilization trends of VADs in Singapore, Germany, and the United Kingdom
- Explain the role of VADs in complex congenital heart disease
- Describe the opportunities present in current VAD technology and summarize developments in next-generation mechanical circulatory support technology
- Outline current and future biventricular support applications and determine when they are indicated

Moderators: *Aditya Bansal, New Orleans, LA, and Mary E. Keebler, Nashville, TN*

7:15 AM **VADs in Geographies of Constrained Organ Donation: Perspective From Singapore**
Sivathasan Cumaraswamy, Singapore, Singapore

7:30 AM **VADs in Geographies of Constrained Financial Resources: Perspective From the United Kingdom**
TBD

7:45 AM **VADs in Geographies With Rapidly Changing Transplant Waiting Times: Perspective From Germany**
Evgenij V. Potapov, Berlin, Germany

8:00 AM **Panel Discussion**

8:15 AM **Mechanically Assisted Circulation in Patients With Complex Congenital Heart Disease**
Angela Lorts, Cincinnati, OH

8:30 AM **Innovations in Assisted Circulation for the Coming Decade**
Pramod Bonde, New Haven, CT

8:45 AM **Insights for Mechanically Supporting Biventricular Failure**
Daniel G. Tang, Richmond, VA

9:00 AM **Panel Discussion**

8:15 AM – 9:15 AM
Basic Science Research: Adult Cardiac
Moderators: *T. Brett Reece, Aurora, CO, and TBD*

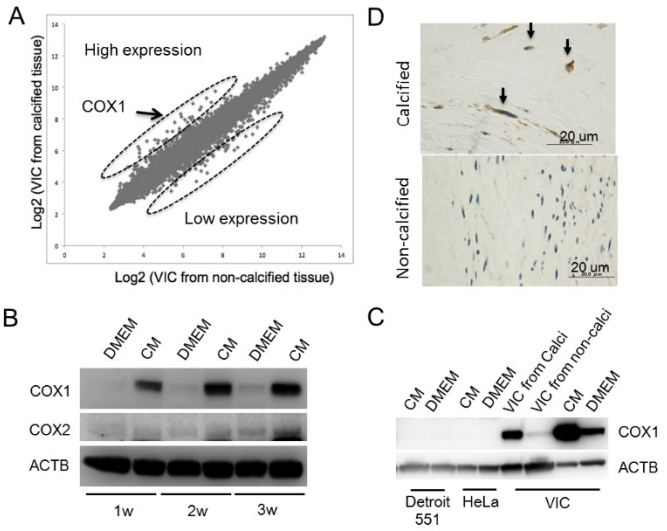
8:15 AM
ABSTRACT: Valve Interstitial Cell-Specific Cyclooxygenase1 Is Associated With Calcification of Native and Bioprosthetic Aortic Valves: Molecular Profiling and Functional Analysis of Valve Interstitial Cells
T. Sakaue[1], *M. Hamaguchi*[1], *F. Shikata*[2], *J. Aono*[1], *K. Nakashiro*[1], *H. Izutani*[1]
[1]*Ehime University Graduate School of Medicine, Toon, Japan,* [2]*Lady Cilento Children's Hospital, South Brisbane, Australia*

Purpose: The molecular mechanism underlying calcification of native and bioprosthetic aortic valves is poorly understood. This study aimed to identify the master regulators of calcification by comparison of genes in valve interstitial cells (VIC) with calcified and non-calcified aortic valves.

Methods: Calcified aortic valves were surgically excised from aortic valve stenosis (AS) patients who required aortic valve replacements. Non-calcified and calcified sections were cut out from aortic valve leaflets. The collagenase-digested tissues were seeded into 35-mm dishes in DMEM. The VICs adhering to the dish bottom were cultured for 3 weeks, followed by performing comprehensive gene expression analysis. Functional analyses of identified protein as a regulator of calcification were performed by in vitro calcification assay. Tissue localization was determined by immunohistochemical (IHC) staining for normal (n=10) and AS valves (n=30) including bioprosthetic valves.

1. We successfully isolated and cultured VICs from calcified and non-calcified tissues in aortic valve leaflets of AS patients for aortic valve replacements and found 87 genes which showed >2-fold change in calcified tissues. Among these genes, 68 were down-regulated and 19 were up-regulated.
2. There was a significant increase in the expression of cyclooxygenase-1**(**COX-1), but not cyclooxygenase-2**(**COX2), at the mRNA (approximately 4-fold) and protein (approximately 8-fold) levels in the VICs from calcified tissues.
3. COX1 mRNA and protein levels in VICs were strongly increased (approximately 80-fold) by stimulation with osteoblast differentiation media (calcification assay). These were VIC-specific phenotypes and were not observed in other cells such as dermal fibroblasts and cancer cell lines.
4. IHC staining revealed that COX1-positive VICs were specifically localized in the calcified area of native and bioprosthetic valve tissues.

Conclusions: Our data suggested that VIC-specific COX1 overexpression plays a crucial role in calcification by promoting osteoblast differentiation in the aortic valve tissues.



A. DNA microarray analyses (log2 signal intensity) of VICs from non-calcified tissue as compared to VICs from calcified tissue.
B. Western blot analysis of COX1 and COX2 in VICs treated with calcification media (CM) or DMEM for 1, 2, and 3 weeks.
C. Western blot analysis of COX1 in Detroit 551, HeLa, and VICs treated with calcification media (CM) or DMEM for 1 week. Cell lysates of VIC from calcified and non-calcified tissues are, respectively, used as positive and negative controls.
D. Immunohistochemical staining of COX1 in calcified (upper panel) and non-calcified (lower panel) aortic valve tissues. Arrows indicate COX1-positive VICs.

8:30 AM

ABSTRACT: Wall Stress Distribution in Bicuspid Aortic Valve Associated Ascending Thoracic Aortic Aneurysms

A. O. Gomez[1], *Z. Wang*[1], *Y. Xuan*[1], *A. D. Wisneski*[2], *E. S. Meike*[3], *M. Hope*[1], *J. Guccione*[1], *L. Ge*[3], *E. E. Tseng*[2]
[1]University of California, San Francisco, [2]University of California, San Francisco Medical Center and San Francisco VA Medical Center, [3]San Francisco VA Medical Center, CA

Purpose: Bicuspid aortic valve (BAV) disease is associated with ascending thoracic aortic aneurysms (aTAA) and BAV-aTAA carries a risk of acute type A dissection. Biomechanically, dissection occurs when wall stress exceeds wall strength. Our aim was to examine patient-specific BAV-aTAAs to determine magnitudes of greatest wall stress by anatomic regions.

Methods: Patients with BAV-aTAA diameter >4.5cm (n=41) were recruited for the study. Patients underwent ECG-gated CT angiography (CTA) and their patient-specific 3D BAV-aTAA geometries were reconstructed. Geometries were loaded to systemic pressure after accounting for pre-stress geometry. With user-defined fiber-embedded Ogden hyperplastic material model, finite element analyses were performed to obtain wall stress distributions. The 99th-percentile and mean longitudinal and circumferential wall stresses were determined. Statistical analyses were performed with R.

Results: The 99th-percentile longitudinal wall stresses on BAV-aTAA at systolic pressure were 372±128kPa vs 345±174kPa vs 220±50.2kPa in aortic sinuses, sinotubular junction (STJ), and ascending aorta, respectively, where stresses were significantly different between sinuses and ascending aorta ($p<1^{e-5}$) and between STJ and ascending aorta ($p<1^{e-4}$), but not between STJ and sinuses (p=0.60). The 99th-percentile circumferential wall stresses at systolic pressure were 477±107kPa vs 961±443kPa vs 419±83.2kPa for aortic sinuses, STJ, and ascending aorta, respectively, where stresses were significantly different between STJ and ascending aorta ($p<1^{e-13}$) and between STJ and sinuses ($p<1^{e-12}$), but not between sinuses and ascending aorta (p=0.58). The 99th-percentile longitudinal wall stresses at systolic pressure were 209±41.3kPa vs 234±73.4kPa (p=0.065), while 99th-percentile circumferential wall stresses were 353±48.1kPa vs 542±186kPa ($p<1^{e-6}$) on greater vs. lesser curvature, respectively.

Conclusions: Wall stresses were greater in the aortic root than ascending aorta on BAV-aTAAs. Longitudinal stresses were greatest at the sinuses, while circumferential stresses were greatest at the STJ. Depending on the respective wall strengths, these results suggest regions with greater tendency for initial intimal tears to occur in BAV-aTAA patients.

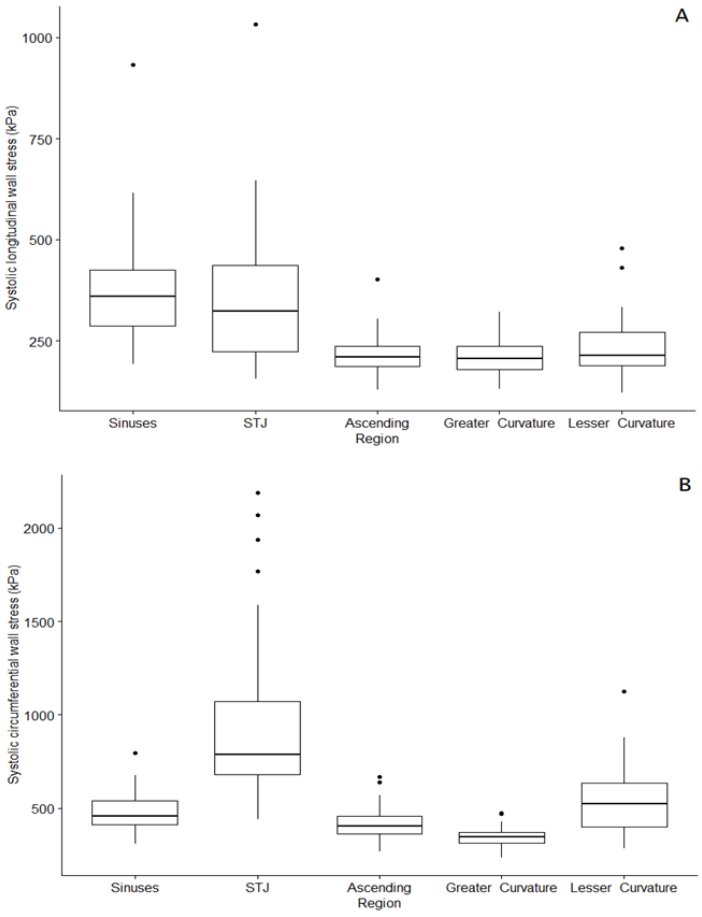


Figure 1. (a) Relationship between 99th-percentile longitudinal wall stress and aorta region. (b) Relationship between 99th-percentile circumferential wall stress and aorta region.

8:45 AM

ABSTRACT: Delayed Mitochondrial Transplantation by Intracoronary Injection for Myocardial Salvage After Ischemia Reperfusion Injury

D. Blitzer[1], A. Guariento[2], B. Shin[2], K. Moskowitzova[2], G. Ramirez-Barbieri[2], A. Orfani[2], P. J. del Nido[2], ***J. D. McCully[2]***
[1]Columbia University Medical Center, New York, NY, [2]Boston Children's Hospital, MA

Purpose: We have previously demonstrated efficacy for mitochondrial transplantation for the treatment of ischemia-reperfusion injury (IRI). We now investigate the efficacy of delayed mitochondrial transplantation as a strategy for myocardial salvage.

Methods: Yorkshire pigs (n = 14) were sedated and anesthetized. Regional ischemia was created by temporarily snaring the left anterior descending coronary artery (LAD). Following 30 minutes of ischemia, the snare was released, and the heart was reperfused for 120 minutes. After 120 minutes, autologous mitochondria was delivered to the LAD via a A 5F JR angiography catheter within a right carotid artery 5F arterial sheath. Mitochondria (1x109 in 6 mL respiration buffer) or respiration buffer alone (Vehicle, 6mL) was injected antegrade, into the left anterior descending artery as a bolus. Reperfusion was then continued for an additional 120 minutres.

Results: Echocardiographic analysis demonstrated a significant difference in ejection fraction (56.5% ± 3.0% Mitochondria vs 40.3% ± 3.4% Vehicle, p=0.25), fractional shortening (31.3 ± 4.5% Mitochondria vs 18.9 ± 1.9% Vehicle, p=0.29). and fractional area change (48.2 ± 7.4% in Mitochondria hearts vs 28.2 ± 3.0% in Vehicle, p=0.03). There were no significant differences between groups in the area at risk (58.6 ± 6.5% Mitochondria vs 46.9 ± 4.0% Vehicle; p=0.48). Infarct size (% area at risk) was significantly decreased to 7.4% ± 1.2% in hearts receiving mitochondrial transplantation as compared to 38.0% ± 4.7% for hearts receiving vehicle only (p<0.001). Electron microscopy and histopathology confirm these outcomes.

Conclusions: Delayed mitochondrial transplantation can be a viable treatment modality in IRI, thus reducing long-term morbidity and mortality in patients following myocardial infarction.

9:00 AM

Discussion

8:15 AM – 9:15 AM
Basic Science Research: General Thoracic
Moderators: *Min P. Kim, Houston, TX, and Jane Yanagawa, Los Angeles, CA*

8:15 AM

ABSTRACT: Intratumoral LKB1/STK11 Expression Correlates With Immune Cell Infiltration and Oncologic Outcomes Following Resection of Lung Adenocarcinoma

K. G. Mitchell, *E. R. Parra, D. B. Nelson, E. Corsini, J. Zhang, A. A. Vaporciyan, W. L. Hofstetter, R. J. Mehran, S. G. Swisher, D. C. Rice, B. Sepesi, G. L. Walsh, M. C. Behrens, N. Kalhor, A. Weissferdt, C. Moran, F. Skoulidis, I. I. Wistuba, J. Fujimoto, J. A. Roth, M. B. Antonoff*
The University of Texas MD Anderson Cancer Center, Houston

Purpose: Inactivating mutations in the serine-threonine kinase *LKB1* have been recently implicated in mediating resistance to checkpoint inhibitor therapy among patients with advanced lung adenocarcinoma. We sought to examine the prognostic significance of *LKB1* expression and its impact on the tumor microenvironment among patients with early-stage lung adenocarcinoma undergoing surgical therapy.

Methods: Formalin-fixed, paraffin-embedded specimens of patients who underwent resection of stage I-III, chemotherapy-naïve adenocarcinomas (1997-2012) were analyzed using tissue microarray sectioning. Sublobar resections were excluded. Intratumoral *LKB1* expression was expressed as H-score and dichotomized by the median of observed values for survival analysis. In a representative subset, immune cells expressing CD3, CD4, CD8, PD1, PDL1, CD57, CD45RO, CD68, and granzyme B were quantified using whole tumor sections in peritumoral and intratumoral compartments and reported as number of cells/mm^2. Nonparametric tests were used to identify associations between *LKB1* expression and clinicopathologic characteristics. Cox regressions were used to analyze predictors of survival outcomes.

Results: 104 patients met inclusion criteria, of whom 50.1% (53/104) were men (Table). *LKB1* expression (median H-score 102.9 [IQR 21.3-144.2]) was higher in women (123.3 [40.0-170.0]) than men (100.0 [9.2-120.0], p=0.004) and in never-smokers (145.0 [121.7-190.0]) than former/current smokers (100.0 [14.2-135.8], p=0.002). LKB1 expression positively correlated with intratumoral infiltration of CD3+ (r=0.351, p=0.001), CD4+ (r=0.436, p<0.001), CD8+ (r=0.263, p=0.016), and FOXP3+ (r=0.232, p=0.035) cells. Patients in the bottom quartile of *LKB1* expression (H-score less than 20 [n=26/104]) had lower intratumoral densities of CD3+ (774.2 [478.2-1840.1] vs 1465.4 [1014.9-2191.9], p=0.034), CD4+ (792.8 [537.7-1466.8] vs 1238.6 [805.9-1619.8], p=0.029), CD8+ (431.8 [309.0-1289.8] vs 950.6 [553.6-1270.2], p=0.042), CD45RO+ (525.8 [257.0-814.9] vs 790.0 [470.4-1002.0], p=0.068), and CD57+ (247.4 [170.3-378.2] vs 405.9 [214.1-692.6], p=0.036) cells than other patients. On multivariable analysis, *LKB1* expression below the median remained independently predictive of poor overall survival (HR 1.83, CI 1.10-3.03, p=0.019) and disease-free survival (HR 1.69, CI 1.01-2.83, p=0.047)(Figure).

Conclusions: Low *LKB1* expression is associated with poor lymphocyte infiltration into the intratumoral microenvironment and is associated with poor oncologic outcomes after adenocarcinoma resection. As the use of adjuvant checkpoint inhibitors is explored, further investigation is needed to examine *LKB1*'s relevance in considering the administration, timing, and choice of therapies.

Figure: (A) Low *LKB1* expression was independently associated with worse overall survival. Patients with *LKB1* expression below the median had decreased intratumoral infiltration by **(B)** CD3+ cells and **(C)** CD4+ cells.

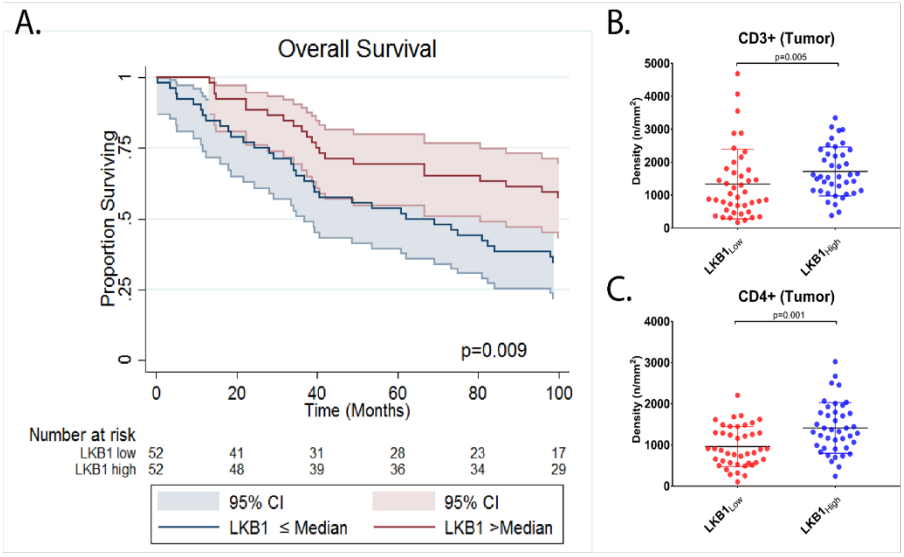


Table: Clinicopathologic predictors of overall survival

Univariable Analysis*				
Variable	**N(%)**	**HR**	**CI**	**P**
Age ≥65	49 (47.1)	1.57	0.96-2.57	0.075
Sex (M)	53 (51.0)	1.98	1.20-3.29	0.008
Differentiation (Poor)	43 (41.3)	1.09	0.66-1.80	0.737
Smoker (Ever)	89 (85.6)	0.92	0.47-1.81	0.814
Zubrod (1)	47 (45.2)	1.16	0.71-1.90	0.548
Extent of Resection (Pneumonectomy)	4 (3.8)	1.50	0.47-4.80	0.493
Pathologic Stage				<0.001
I	62 (59.6)	Reference	-	-
II	24 (23.1)	2.42	1.36-4.31	0.003
III	18 (17.3)	3.27	1.75-6.12	<0.001
Margin (R1)	4 (3.8)	2.35	0.73-7.53	0.150
Adjuvant Chemotherapy	23 (22.1)	0.83	0.46-1.51	0.543
Adjuvant XRT	13 (12.5)	2.06	1.07-3.94	0.030
LKB1 (≤Median)	52 (50.0)	1.93	1.17-3.18	0.010
Multivariable Analysis**				
Variable	**N(%)**	**HR**	**CI**	**P**
Age ≥65	49 (47.1)	1.71	1.04-2.82	0.036
Pathologic Stage				<0.001
I	62 (59.6)	Reference		
II	24 (23.1)	2.15	1.20-3.86	0.010
III	18 (17.3)	3.43	1.83-6.44	<0.001
LKB1 (≤Median)	52 (50.0)	1.83	1.10-3.03	0.019
*Included in multivariable analysis if p<0.20 on univariable analysis **Backwards selection performed until p<0.10				

8:27 AM

ABSTRACT: A Multimodal Nanoagent for Intraoperative Image-Guided Sentinel Lymph Node Mapping in Lung Cancer

H. Ujiie[2]*, H. H. Chan*[1]*, A. Gregor*[2]*, H. Hu*[2]*, T. Kato*[2]*, T. Kinoshita*[2]*, Y. Motooka*[2]*, T. Inage*[2]*, T. K. Waddell*[3]*, S. Keshavjee*[2]*, K. Yasufuku*[2]
[1]TECHNA Institute, University Health Network, Toronto, Canada, [2]Toronto General Hospital, Canada, [3]University Health Network, Toronto, Canada

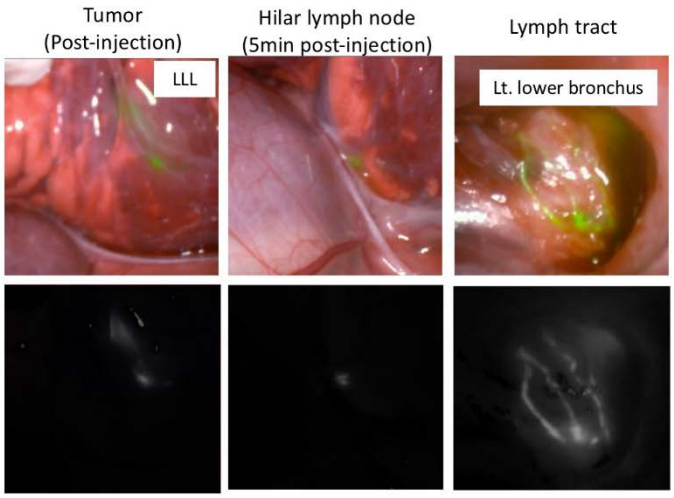
Purpose: The use of near-infrared (NIR) fluorescence imaging with indocyanine green (ICG) for sentinel lymph node (SLN) mapping has been investigated in lung cancer. We developed a dual-modality nano-liposomal imaging agent (CF800) containing ICG and iohexol for real-time NIR fluorescence and intraoperative cone beam computed tomography (CBCT) image-guided SLN localization.

Methods: This method aims to identify the SLNs in patients with non-small cell lung cancer using combined NIR and computed tomography lymphography (CTLG) with local injection of CF800. CF800 was locally injected peritumoral in rabbit and swine lung tumor models. *In vivo* NIR and CBCT imaging was performed to detect SLNs. A clinical NIR imaging system (PINPOINT®) was used to guide lung tumor and SLNs resection. After surgery, nano-liposome accumulation within SLNs was evaluated using an *ex vivo* fluorescence system (Maestro®) and NIR confocal microscope.

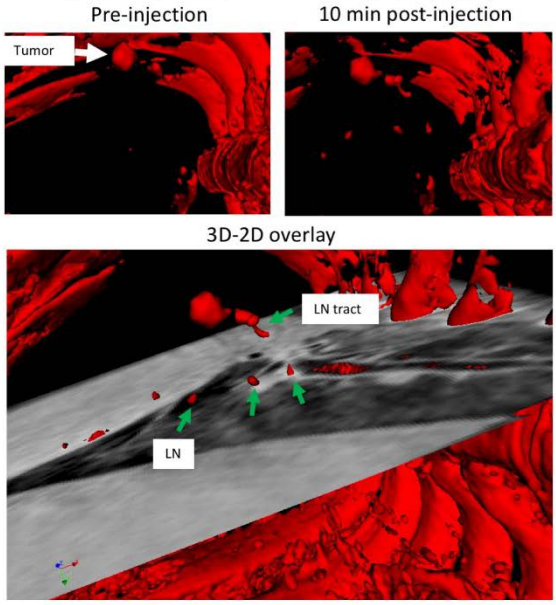
Results: In all 3 rabbits studied, SLNs were successfully identified by NIR thoracoscope and CTLG. In both swine cases, SLNs were successfully identified, with the first NIR-positive lymph node detected within 5 minutes. The SLN as well as lymph drainage tract was clearly visualized (Figure IA). SLN identification was possible by completely exposing lymph nodes as well as examining *ex vivo* fluorescence. The bright lymph node (#10L) identified *in vivo* had a high fluorescence signal on *ex vivo imaging by NIR thoracoscope*. NIR fluorescence signal was demonstrated using the *ex vivo* NIR fluorescence imaging system as well. CT imaging was performed immediately after CF800 liposome injection. This demonstrates the utility of CF800 for pre- or intra-operative CBCT-based 3D localization. When comparing between pre- and post-injection of CF800, the oval-shaped lymph nodes and LN tract from the contrast injection point were clearly enhanced on the post-injection CTLG images (Figure IB).

Conclusions: The CF800 may have clinical advantages in SLN localization during CBCT and NIR image-guided surgery in animal lung tumor model. These results support further investigation and advancement of this nano-agent to enhance intraoperative visualization in patients with non-small cell lung cancer.

(Figure IA) Intraoperative near-infrared (NIR) fluorescence imaging



(Figure IB) Intraoperative 3D-CT lymphography



8:39 AM

ABSTRACT: The TumorCBC: In-Silico Flow Cytometry to Understand Lung Cancer Data and Predict Survival

V. Kurbatov[2]*, A. Balayev*[1]*, A. Saffarzadeh*[2]*, J. Blasberg*[2]*, D. J. Boffa*[2]*, J. M. Lu*[2]*, S. A. Khan*[2]
[1]*University of Toronto, Canada,* [2]*Yale University, New Haven, CT*

Purpose: Lung cancer remains the most lethal malignancy. Targeting the immune system is becoming an important strategy for treatment. In this setting, immune biomarkers may have unique clinical relevance. Our study uses public gene expression datasets to compute macrophage, natural killer (NK), and neutrophil fractions as potential biomarkers of survival.

Methods: We selected lung adenocarcinoma (ADC) and squamous cell carcinoma (SQC) genomic datasets based on criteria of complete clinical annotation and long term follow up data. We picked Gene Expression Omnibus datasets GSE37745, GSE31210, ArrayExpress dataset E-MTAB-6043, and the Cancer Genome Atlas datasets for our analyses. We used Cibersort *in silico* flow cytometry to infer from bulk gene expression the fraction of 22 immune cell types in tumor samples. We assessed immune infiltrate heterogeneity in samples using hierarchical clustering and evaluated the clinical relevance of immune cell fraction to overall survival utilizing Kaplan Meier analysis.

Results: Hierarchical clustering of Cibersort immune cell fractions showed heterogeneity in neutrophilic, NK, and M2 macrophage percentage in both SQC and ADC samples. High neutrophil percent was associated with shorter OS in SCC, HR 2.02 (CI 1.01 – 4.04), p =.02. (Figure 1a) This was also seen in TCGA data, finding high percent associated with lower OS, p=.005. SQC had significantly higher neutrophil percent compared to ADC, p=0.0004. M2 percent was associated with shorter OS in ADC patients, HR=1.877 (CI = 1.11 to 3.19), p=0.0085. Reciprocally, M2 percent was associated with improved survival in SQC patients, HR = .4639 (CI = 0.25-.85), p=.0033. (Figure 1b,c) NK percent was higher in stage 1 than stage 2 SQC samples, p=.02. Stage-matched comparison showed higher

NK percent in ADC compared to SQC in stage 1 and 2 samples, p<.0001. Increased NK percent was associated with longer OS survival in SQC, p =.0152.

Conclusions: Distinct tumor immune infiltrates characterize lung cancer. We describe a computed heterogeneous immune microenvironment in lung ADC and SQC, and present evidence that signatures of key immune infiltrates prognosticate survival.

Figure 1a.

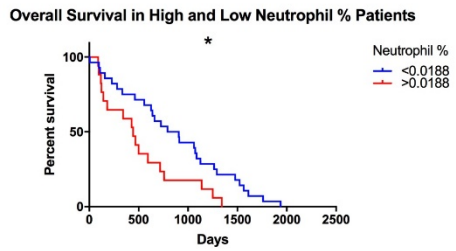


Figure 1b.

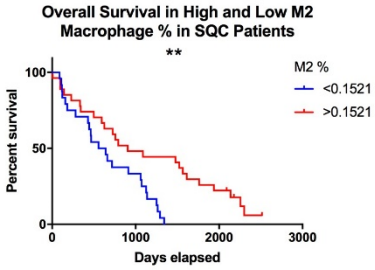
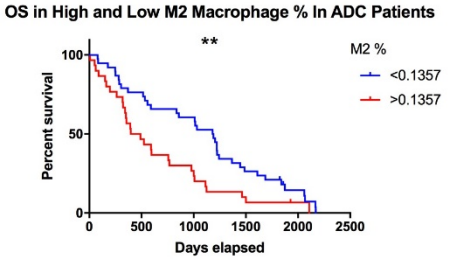


Figure 1c.



8:51 AM

ABSTRACT: Immune Regulatory Markers of Lepidic-Pattern Adenocarcinomas Presenting as Ground Glass Opacities

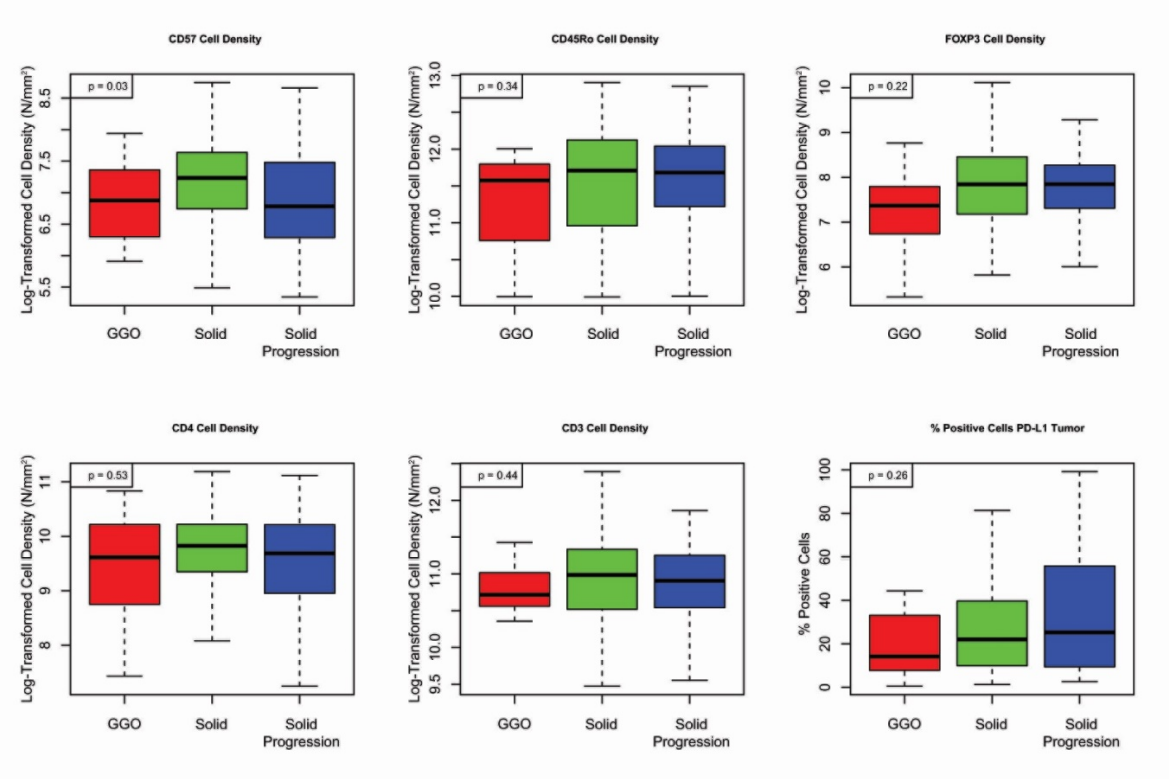
D. B. Nelson*, K. G. Mitchell, J. Wang, J. Fujimoto, M. C. Behrens, X. Zheng, J. Zhang, B. Sepesi, A. A. Vaporciyan, W. L. Hofstetter, R. J. Mehran, D. C. Rice, G. L. Walsh, S. G. Swisher, C. Moran, N. Kalhor, A. Weissferdt, I. I. Wistuba, J. A. Roth, M. B. Antonoff*
The University of Texas MD Anderson Cancer Center, Houston

Purpose: The immune regulatory environment of lepidic-pattern adenocarcinoma remains poorly understood. In this study, we characterized tumor infiltrating leukocytes (TILs) and PD-L1 among the lepidic portion of invasive adenocarcinoma that presented as ground glass opacities (GGO), and compared these findings to those of solid adenocarcinoma.

Methods: Pathologic specimens of patients with clinical stage I lung adenocarcinoma were analyzed using tissue microarray sectioning. Among the GGO specimens, lepidic-pattern adenocarcinoma was confirmed to be within the sectioned tissue microarray. Intra-tumoral CD57, CD45Ro, FoxP3, CD4, or CD3+ cell densities, and % (+) PD-L1 tumor cells were analyzed. Progression was defined as pN+ or subsequent recurrence. Wilcoxon rank sum test was used to compare cohorts. One-sided Cuzick's test was used to test for an ordinal relationship between PD-L1 and each cohort.

Results: 181 patients were identified, among whom 13 (7%) had resected GGOs, 113 (62%) had resected solid adenocarcinomas that never progressed, and 55 (30%) had resected solid adenocarcinomas that ultimately did progress. CD57+ cell density, a marker for antigen-specific, oligoclonal T cells and NK cells, differed among the three cohorts, with the highest cell density observed within solid adenocarcinomas without progression, and lower cell density both in the solid adenocarcinomas that progressed and GGOs (Figure). Other TIL phenotypes were not statistically different between cohorts. Percent positive PD-L1 cells with the tumor showed a trend toward increasing expression within each cohort, with the lowest expression within GGOs (median 14), followed by solid adenocarcinomas without progression (median 22), and the highest among solid adenocarcinomas that subsequently progressed (median 27, p=0.07).

Conclusions: GGOs, solid adenocarcinomas without progression, and solid invasive adenocarcinomas with progression show differential immune regulation. GGO lepidic pattern adenocarcinomas appear to be immunologically inert. Further studies to investigate whether GGOs and stage I adenocarcinomas have varying susceptibility to immune checkpoint inhibitor therapy are warranted.



9:03 AM

ABSTRACT: Outcomes of Basiliximab Administration Before and After Allograft Reperfusion in Lung Transplantation

***J. P. Costello**, A. E. Rodrigues, W. Jeske, J. P. Schwartz, D. F. Dilling, J. M. Walenga, M. Bakhos, W. T. Vigneswaran*
Loyola University Medical Center, Maywood, IL

Purpose: The use of basiliximab as an induction immunosuppression agent in lung transplantation is well-established and is associated with a decreased incidence of acute rejection[1] and improved survival.[2] However, the impact of timing of administration of basiliximab with regard to pre- and post-reperfusion of the lung allograft has not been elucidated.

Methods: Serum blood samples were obtained from 30 consecutive patients undergoing lung transplantation at a high-volume lung transplantation center between February 2017 and January 2018 as part of an IRB-approved study. These samples were obtained at four time points: pre-operative, post-reperfusion in the operating room, at 24 hours post-operative, and at 72 hours post-operative. The samples at these various time points were evaluated for IFN-g, IL1-a, IL1-b, IL-2, IL-4, IL-6, IL-8, IL-10, MCP-1,TNF-a, EGF and VEGF as well as primary graft dysfunction (PGD) scores. These cytokine levels and PGD scores were then compared with regard to when basiliximab was administered.

Results: Twenty patients received induction immunosuppression with basiliximab. Of these7 patients received before reperfusion of the allograft and 13 received after reperfusion. There was no significant difference observed in the cytokine levels between the groups. Overall, patients who received basiliximab after reperfusion had significantly lower PGD scores immediately (mean PGD score: 0.77) and at 24 hours post-operatively (mean PGD score: 1.00) compared to patients receiving induction basiliximab before reperfusion (mean PGD score immediately: 2.57, mean PGD score at 24 hours post-operatively: 2.00) (differences in mean PGD scores with $p < 0.001$ and $p = 0.004$, respectively). There was no significant change in PGD scores over time in the post-operative period for post-reperfusion induction basiliximab patients. However, in patients who received basiliximab prior to reperfusion, there was a statistically significant reduction in mean PGD scores from the immediate (mean PGD score of 2.57) to 72 hours post-operatively (mean PGD score of 1.33) ($p = 0.045$).

Conclusions: When basiliximab was administered to lung transplantation patients before allograft reperfusion, statistically significant progressive reductions in postoperative PGD scores were found. These reductions were not seen in patients receiving basiliximab after reperfusion suggesting a potential benefit to utilizing induction basiliximab therapy before reperfusion. This observation needs further validation.

8:15 AM – 9:15 AM

Diversity and Inclusion in Cardiothoracic Surgery: What Is the Real Value?

Attendees of this session, organized by the STS Task Force on Diversity and Inclusion, will learn how diversity and inclusion can be valuable to their practices, service lines, training efforts, and relationships in the communities they serve. Speakers will address strategies to diversify faculty and/or surgical staff to optimally reflect the practice community and tips for including diverse trainees and junior surgeons in leadership and research.

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, junior faculty, and staff helps increase the URM pipeline to the clinical workforce

Moderator: *David Tom Cooke, Sacramento, CA*

8:15 AM **Introduction**

8:20 AM **Diversity and Inclusion in Cardiothoracic Surgery: What Is the Real Value?**
Joan Reede, Boston, MA

9:05 AM **Q&A**

9:30 AM – 12:15 PM

Plenary Session

Moderators: *Keith S. Naunheim, St Louis, MO, and Joseph F. Sabik III, Cleveland, OH*

9:30 AM

LATE-BREAKING ABSTRACT: Platelet Transfusion During Rewarming Phase of Cardiopulmonary Bypass in Neonates Is Associated With Improved Postoperative Outcomes: A Randomized, Controlled Trial

N. K. Gautam[1]*, J. A. Pierre*[2]*, K. Edmonds*[2]*, O. Pawelek*[2]*, E. Griffin*[2]*, Z. Xu*[2]*, R. A. Hanfland*[2]*, A. Dodge-Khatami*[1]*, J. D. Salazar*[3]
[1]*The University of Texas Health Science Center at Houston,* [2]*The University of Texas McGovern Medical School, Houston,* [3]*University of Mississippi Medical Center, Jackson*

Purpose: Transfusion of platelets after the dilutional insult from cardiopulmonary bypass has been standard therapy. In this study, we hypothesize that administration of apheresis platelets just before termination of the bypass will assist in the early correction of coagulopathy, rapid hemostasis and lesser donor exposure after cardiac surgery.

Methods: Single Institution, prospective randomized trial in neonates (age less than one month) comparing transfusion of 10 mL/kg of apheresis platelet before the termination of bypass (when cardiac surgery was near complete, the patient's core temperature had reached 34*C, and re-calcification initiated= treatment group) versus standard protocol of transfusion of apheresis platelets after administration of protamine (control group). No significant changes in standard operating procedures occurred during the study period (April 2017-Oct 2018). A sample size of 21 patients per group was based on institutional pilot data. All demographics and outcomes were collected for statistical analysis.

Results: 46 patients were consented, and two patients in each group were excluded secondary to the use of ECMO after CPB. Both groups were similar when comparing the case complexity, syndrome, single ventricle status and CPB times (Table 1). Outcomes: Neonates in the treatment group compared to the control group required 45 ml/kg less of post-bypass blood product resuscitation (p= 0.04) and the case completion time after protamine administration was 28 minutes earlier (p=0.016). Neonates in the treatment group required fewer mediastinal explorations for bleeding in the immediate postoperative period (p=0.045) and had lower fluid balance (p=0.04). The number of days taken for delayed sternal closure was similar in both groups, however, neonates in the treatment group were extubated earlier, had lower mechanical ventilation times (p=0.016) and had a shorter length of ICU stay (p=0.033). There were no 30-day mortalities in either group.

Conclusions: Platelet transfusion during the rewarming phase of neonatal cardiac surgery was associated with improved postoperative outcomes. Given the apparent major impact of this strategy at our institution, confirmational multicenter studies are warranted. Further study is necessary to understand the mechanism of the benefit of this strategy.

Table 1
Demographics and Outcomes

	Treatment Group (N = 21)	Control Group (N = 21)	P value
Weight at Surgery (kg)	3.1 ± 0.4	3.0 ± 0.5	0.73
Syndromic			1.00
Yes	4 (19%)	4 (19%)	
No	17 (81%)	17 (81%)	
Single Ventricle			0.76
Yes	10 (48%)	11 (52%)	
No	11 (52%)	10 (48%)	
STAT Score			0.43
2,3	5 (24%)	4 (19%)	
4,5	16 (76%)	17 (81%)	
CPB Time (min)	166 ± 55	165 ± 58	0.97
Aortic Cross Clamp Time (min)	82 ± 52	71 ± 42	0.44
Platelet Count before CPB	288 ± 87	246 ± 106	0.16
Intraop transfusion after CPB(mL/kg)	58 ± 29	103 ± 80	**0.04**
Protamine to case completion(mins)	52 ± 28	80 ± 43	**0.016**
Mediastinal Exploration for Bleeding in PICU	1 (5%)	7(33%)	**0.045**
Chest tube output POD_2 (mL/kg)	12 ± 4	17 ± 9	**0.03**
Fluid Balance POD_1 (mL/kg)	123 ± 42	177 ± 100	**0.04**
Fluid Balance POD_2 (mL/kg)	-0.5 ± 31	10 ± 448	0.35
Cumulative Fluid Balance POD_2 (ml/kg)	123 ± 79	186 ± 148	**0.07**
Delayed Sternal Closure (days)	1.48 ± 0.98	1.95 ± 1.20	0.08
Duration of Mechanical Ventilation (days)	4.1 ± 1.8	8.00 ± 6.67	**0.016**
Length of ICU Stay (days)	8.9 ± 3.5	15.4 ± 12.7	**0.033**

Two-sample t test was used to compare means of study and control groups.
STAT Score=Risk Stratified Score for Congenital Heart Surgery
CPB=Cardiopulmonary Bypass Time
PICU=Postoperative Intensive Care Unit
POD_1 = Postoperative Day 1
POD_2 = Postoperative Day 2

9:45 AM

ABSTRACT: Adjuvant Treatment for Node-Positive Esophageal Cancer After Induction Therapy and Surgery Improves Survival: A Multisite Study

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Purpose: The benefit of adjuvant treatment for esophageal cancer patients with positive lymph nodes following induction therapy and surgery is uncertain. Current research is limited to single-institution experiences [1] or database analyses lacking detailed patient data [2]. This in-depth multicenter study assessed the benefit of adjuvant therapy in this population.

Methods: A retrospective cohort study from 9 participating institutions included patients who: received neoadjuvant treatment, underwent esophagectomy from 2000-2014, and had positive lymph nodes on pathology. Adjuvant therapy was defined as receipt of chemotherapy, radiation, or both within 6 months of surgery, without a preceding documented cancer recurrence. Patient and perioperative characteristics were compared between groups receiving adjuvant treatment versus no adjuvant treatment. Factors independently associated with administration of adjuvant therapy were assessed using multivariable logistic regression. Kaplan-Meier survival analyses were performed based on adjuvant treatment status. Variables independently associated with overall survival were identified using Cox proportional hazards modeling.

Results: 1,087 patients were analyzed with node positive cancer following induction therapy and esophagectomy. 210 (19.3%) received adjuvant therapy and 877 (80.7%) did not. Administration of adjuvant treatment varied significantly from 3.2% (11/339) to 50.0% (8/16) between sites (p<0.001). Factors associated with receipt of adjuvant therapy on multivariable regression (c-statistic=0.80) included both positive and negative prognostic characteristics: younger age, higher ASA class, lower ECOG score, higher lymph node ratio, higher pathologic stage, pathologic grade 2 or greater, no neoadjuvant radiation, and absence of postoperative pneumonia or urinary tract infection. On Kaplan-Meier analysis (Figure), patients receiving adjuvant therapy had a longer median survival: 31.4 months (95% CI: 27.0-40.4) vs 27.2 months (95% CI: 24.8-30.3), Wilcoxon p=0.03. Multivariable Cox proportional hazards modeling (Table) identified adjuvant treatment as independently associated with improved survival, with a 20% reduction in mortality (hazard ratio: 0.79, 95% CI: 0.65-0.96, p=0.01).

Conclusions: Adjuvant therapy for node positive patients following induction therapy and esophagectomy was associated with improved overall survival. Therefore, consideration should be given to administration of adjuvant therapy to esophageal cancer patients who have persistent node positive disease after induction therapy and esophagectomy, and are able to tolerate additional treatment.

Figure: Kaplan Meier Analysis of Overall Survival by Adjuvant Treatment Status

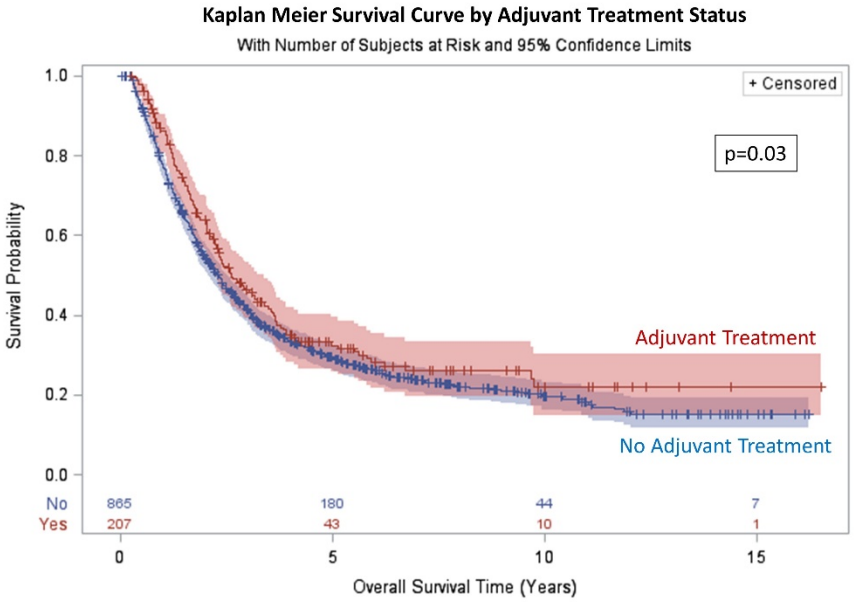


Table: Multivariable Cox Proportional Hazards Model for Factors Associated with Survival

Variable	Multivariable HR (95% CI)	p-value
Adjuvant Treatment	0.79 (0.65-0.96)	0.01
Age (per year)	1.01 (1.01-1.02)	0.002
Sex (Female vs Male)	0.95 (0.76-1.18)	0.7
Histology (vs Adenocarcinoma)		0.9
Squamous Cell	0.92 (0.70-1.23)	
Other	0.99 (0.60-1.63)	
ECOG Score (vs 0)		0.6
1	1.09 (0.90-1.31)	
≥2	1.02 (0.52-2.01)	
Missing	0.94 (0.78-1.13)	
Number of Nodes Resected (per node)	0.99 (0.98-1.00)	0.006
Number of Positive Nodes (per node)	1.07 (1.04-1.11)	<0.001
Positive Margin	1.64 (1.29-2.08)	<0.001
Pathologic Stage (vs IIB)		0.006
IIIA	1.13 (0.93-1.37)	
IIIB	1.41 (1.12-1.77)	
IIIC	1.74 (1.22-2.48)	
Diabetes	1.20 (0.98-1.46)	0.08
Anastomotic Leak	1.27 (1.00-1.61)	0.05
Atrial Arrhythmia	1.21 (1.00-1.47)	0.07
Bleeding	1.31 (0.99-1.72)	0.07
Reoperation	1.36 (1.06-1.73)	0.02

10:00 AM

ABSTRACT: Primary Transplantation for Congenital Heart Disease in the Neonatal Period: Long-Term Outcomes at a Single Institution

***J. Mohan**, A. Razzouk, M. Bock, R. Chinnock, T. Martens, L. Bailey*
Loma Linda University Medical Center, CA

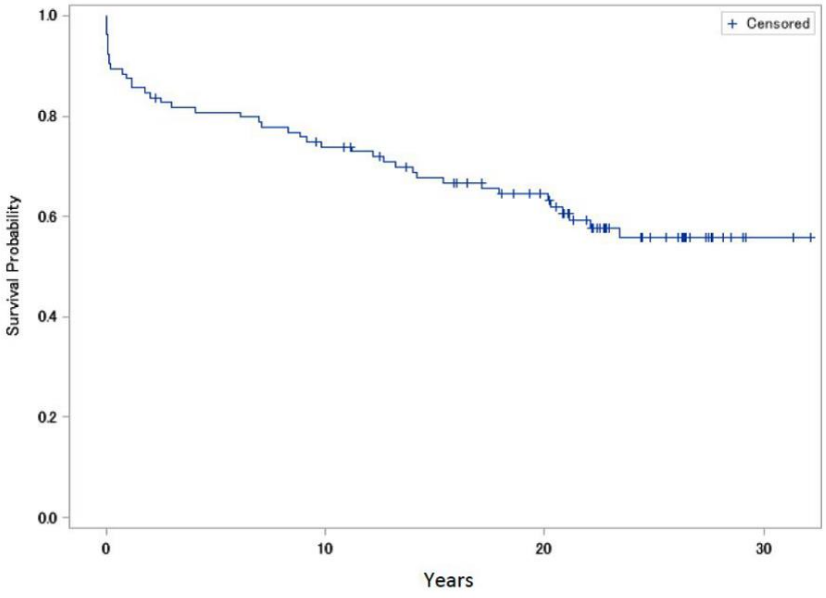
Purpose: Primary transplantation was developed in the 1980's as an alternative to palliative reconstruction for uncorrectable congenital heart disease. Although transplantation achieved more favorable results, its utilization has been limited by the availability of suitable donors. This review examines the long term outcomes of heart transplantation in neonates at our institution.

Methods: The institutional pediatric heart transplant database was queried for all neonatal (0-30 days of life) heart transplants performed between November 1985 and December 2017. Baseline donor and recipient demographics and clinical characteristics, operative procedures and postoperative course were analyzed. Follow up data were obtained from medical records or an annually administered questionnaire. Descriptive analysis was performed on demographic and clinical variables. The Kaplan Meier method was used to estimate overall survival. Univariate and multivariate analyses were performed using Cox regression to identify independent predictors of survival.

Results: Heart transplantation was performed in 104 neonates at a median age of 17 days. Hypoplastic left heart syndrome (HLHS) was the primary diagnosis in 62% of patients. Overall Survival at 1, 5,10 ,20 and 25 years was 87%, 80%, 73%, 64% and 55%. On multivariate analysis, higher glomerular filtration rate was associated with better survival (HR 0.97; CI 0.95-0.99). There was no independent effect on survival of era, diagnosis or graft ischemic time. Freedom from cardiac allograft vasculopathy was 82% at 10 years and 72% at 20 years. Freedom from post-transplant lymphoproliferative disease was 95% at 10 years and 81% at 20 years. Freedom from retransplantation was 90% at 10 years and 81% at 20 years. Eight patients (7%) developed end-stage renal disease (6 required kidney transplant).

Conclusions: Primary transplantation for congenital heart disease in the neonatal period has excellent long term outcomes. The median survival for this group of patients has not yet been realized. Strategies to expand the donor pool can make this durable therapy more readily available to neonates with uncorrectable heart disease.

Kaplan Meier estimate of overall survival following heart transplantation in neonates (0-30 days of age)



Independent predictors of overall survival following heart transplantation in neonates (0-30 days of age) by Cox regression

Variables	Hazard Ratio	95% Hazard Ratio Confidence Intervals	P-value
Era (first 52 vs. next 52 cases)	0.843	(0.331, 2.148)	0.720
Gestational age (> 37 weeks)	1.759	(0.325, 9.510)	0.5117
HLHS diagnosis	0.555	(0.208, 1.484)	0.241
Ischemic time	1.001	(0.998, 1.005)	0.460
Glomerular filtration rate	0.975	(0.958, 0.993)	**0.006**

10:15 AM **BREAK—Visit Exhibits and Scientific Posters**

11:00 AM **Introduction of the President**
Robert S. D. Higgins, Baltimore, MD

11:10 AM **Presidential Address**
Keith S. Naunheim, St Louis, MO

12:15 PM – 1:15 PM
BREAK—Visit Exhibits and Scientific Posters

1:15 PM – 2:15 PM
Late-Breaking Data
Moderators: *Marc R. Moon, St Louis, MO, and Vijay S. Patel, Augusta, GA*

1:15 PM

Association of Volume and Outcomes in 234,556 Patients Undergoing Surgical Aortic Valve Replacement in North America: An STS Adult Cardiac Surgery Database Analysis

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Purpose: The relationship between institutional volume and operative mortality following surgical aortic valve replacement (AVR) remains unclear. The purpose of this study was to evaluate the association of institutional volume and AVR on short-term outcomes among patients from North America.

Methods: From January 2013 to June 2018, 234,556 patients underwent AVR within the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD): isolated AVR (n=144,177 in 1,136 sites) and AVR+CABG (n=90,379 in 1,129 sites). Annualized volume was determined at the STS participant level. Institutional volumes were categorized as total AVR procedures: Group 1 (1-25 AVR), Group 2 (26-50 AVR), Group 3 (51-100 AVR), and Group 4 (>100 AVR). The primary endpoints were operative mortality and composite major morbidity/mortality. Adjusted association between institutional AVR volume and outcomes were assessed using mixed effects logistic regression models.

Results: The annualized median number of AVRs per site was 35 [IQR: 22-59, isolated AVR: 20 (12-35), AVR+CABG: 13 (9-22)], the median age 69 years, and median STS predicted mortality 1.36%. Among isolated AVR cases, observed mean operative mortality [Group 1: 3.5%; Group 2: 2.6%; Group 3: 2.0%; and Group 4: 1.5%, p<0.001] and major morbidity/mortality (15.0%; 12.2%; 10.7%; and 9.7%, p<0.001) were systematically lower with increasing volume (Figure 1A-B, Table) albeit with considerable within volume group variability. Similar trends were seen for CABG+AVR (Figure 1C-D, Table). After adjustment, lower volume centers experienced systematically increased odds of operative mortality [Group 1 vs. 4 (Ref): AOR (AVR), 2.24 (1.91-2.64); AOR (AVR+CABG), 1.96 (1.67-2.30)] and major morbidity/mortality [AOR (AVR), 1.53 (1.39-1.69); AOR (AVR+CABG), 1.46 (1.32-1.61)] compared to the highest volume institutions (Table).

Conclusions: Operative mortality and morbidity following isolated AVR and AVR+CABG is inversely associated with institutional procedure volumes. Given the wide variance in outcomes in low volume centers, it is important to note that our study represents an average analysis per group and adjusted quality metrics for an individual site remain paramount.

Figure 1: Scatter Plots for AVR or AVR+CABG and Outcomes

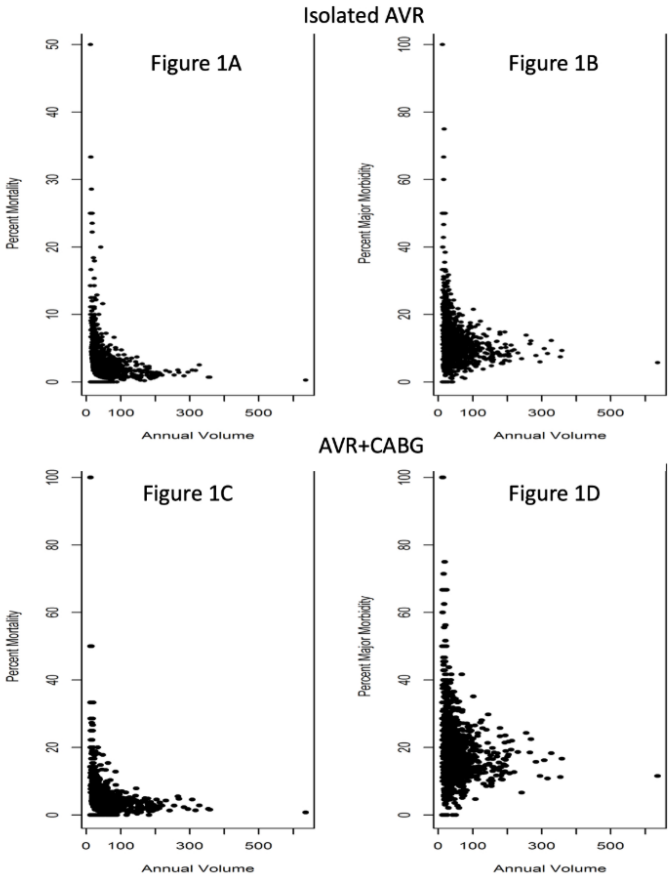

Table 1.

Annual Volume	# sites	Observed	Adjusted OR	p-value
Isolated AVR Mortality				
1-25	363	316 (3.50%)	2.24 (1.91-2.64)	<0.0001
>25-50	410	897 (2.55%)	1.60 (1.41-1.83)	<0.0001
>50-100	244	839 (2.03%)	1.31 (1.14-1.50)	0.0001
>100	119	787 (1.54%)	Ref	
Isolated AVR Mortality / Major Morbidity				
1-25	363	1,401 (14.98%)	1.53 (1.39-1.69)	<0.0001
>25-50	410	4,440 (12.19%)	1.24 (1.15-1.34)	<0.0001
>50-100	244	4,691 (10.72%)	1.08 (1.00-1.17)	0.0657
>100	119	5,279 (9.69%)	Ref	

Annual Volume	# sites	Observed	Adjusted OR	p-value
AVR+CABG Mortality				
1-25	356	373 (5.53%)	1.96 (1.67-2.30)	<0.0001
>25-50	410	993 (4.25%)	1.46 (1.29-1.67)	<0.0001
>50-100	244	986 (3.71%)	1.27 (1.11-1.45)	0.0004
>100	119	881 (3.01%)	Ref	
AVR+CABG Mortality / Major Morbidity				
1-25	356	1,579 (22.57%)	1.46 (1.32-1.61)	<0.0001
>25-50	410	4,743 (19.58%)	1.22 (1.12-1.33)	<0.0001
>50-100	244	4,996 (17.85%)	1.08 (0.99-1.18)	0.0777
>100	119	5,145 (16.57%)	Ref	

1:27 PM

First International Adult Cardiac Surgery Database Collaboration Between the United States and Japan: STS National Database and Japan Cardiovascular Surgery Database—Coronary Artery Bypass Grafting

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[1]*University of Tokyo Hospital, Japan,* [2]*The Society of Thoracic Surgeons, Chicago, IL,* [3]*The University of Tokyo, Japan,* [4]*Keio University, Tokyo, Japan,* [5]*University of Toho, Sakura, Japan,* [6]*San-Ikukai Hospital, Tokyo, Japan,* [7]*Massachusetts General Hospital, Boston,* [8]*Lahey Hospital & Medical Center, Burlington, MA,* [9]*University of Colorado School of Medicine, Aurora*

Purpose: International collaboration is important in healthcare quality evaluation; however, few international comparisons of cardiovascular surgery outcomes have been accomplished. To compare profiles and surgical outcomes between the United states (US) patients (whole and especially Asian) and Japanese patients who undergo adult cardiac surgery would be of an interest.

Methods: Using Japan Cardiovascular Surgery Database (JCVSD) and the Society of Thoracic Surgeons (STS) National Database, we compared the preoperative profiles, including demographics and co-morbidities, and the operative outcomes of Asian patients undergoing isolated CABG between 2013 and 2016 in Japan and the US. STS had 16,903 Asian patients among 573,823 of all the races undergoing isolated CABG (2.95%), JCVSD had 55,570 patients almost all of which are Japanese. Descriptive statistics were analyzed at each database independently, and then were brought together for comparison.

Results: STS patients were younger (70 vs 65 years old) with larger body surface area (1.65 vs 1.81 m^2) and body mass index (22 vs 26 kg/m^2), had higher prevalence of hypertension (78% vs 88%) and hyperlipidemia (64% vs 89%). The proportion of males (79% vs 78%), prevalence of chronic lung disease (82% vs 86%), cerebrovascular disease (86% vs 88%) and diabetes mellitus (54% vs 60%) were equivalent. JCVSD had higher prevalence of peripheral vascular disease (17% vs 8%) and renal disease requiring dialysis (11% vs 6%). In STS, more isolated CABG procedures were performed in an urgent or emergent (17% vs 63%) setting. In JCVSD, off-pump procedures were more prevalent (60% vs 15%). The numbers of anastomoses were similar (2.6 vs 2.6) and the usage of right internal

mammary artery was more prevalent in JCVSD (38% vs 7%). The unadjusted operative mortality was 2.5% in JCVSD and 2.1% in STS.

Conclusions: Comparisons of CABG cases between STS National Database and JCVSD were carried out as the first attempt of international collaboration in adult cardiac surgery databases. Background profiles of patients, the operative mortality and morbidities were similar, although the incidences of on-pump surgery and urgent/emergent basis surgery were significantly different.

1:39 PM

Longevity of Bioprosthetic Valves in the Pulmonary Position in Adults With Congenital Heart Disease

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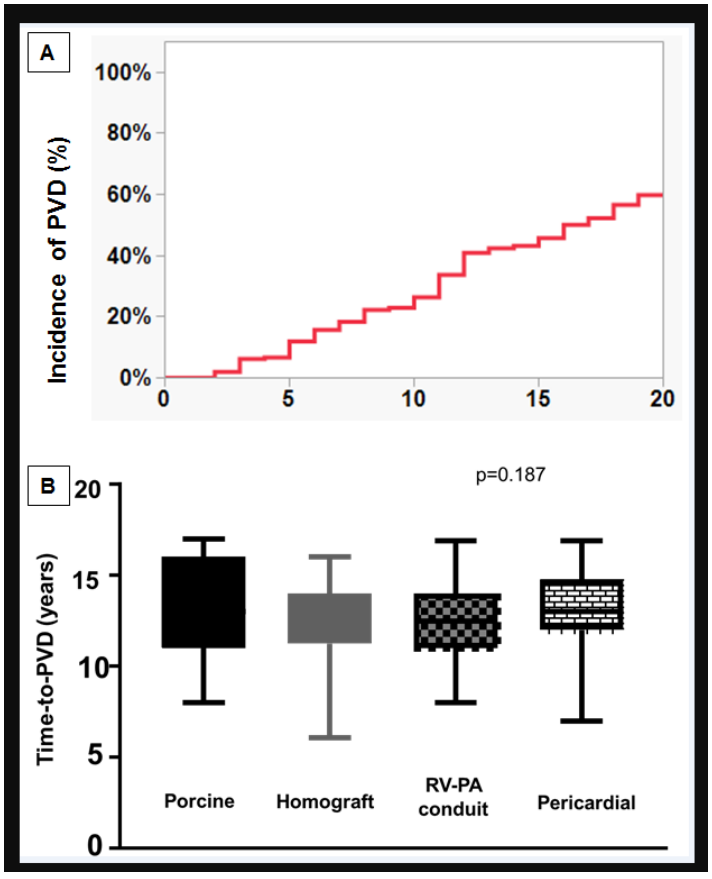
Mayo Clinic, Rochester, MN

Purpose: We therefore hypothesized a temporal decline in bioprosthetic valve longevity in adults with congenital heart diseas. The purpose of the study was to assess temporal change in bioprosthetic valve longevity

Methods: Retrospective review of adults with bioprosthetic pulmonary valve replacement (PVR) at Mayo Clinic, 1990-2017. Study endpoint was pulmonary valve dysfunction (PVD) defined as peak velocity >4 m/s and/or severe prosthetic regurgitation. We divided the study period into early era (prior to 01/01/2000) and late era (after 01/01/2000). Early PVD was defined as dysfunction within 5 years.

Results: There were 807 bioprosthetic PVRs in 573 patients. PVD occurred in 267 (33%) prostheses. Time-to-PVD was 12.6±3.9 years, incidence of PVD was 3.2 cases per 100 prosthesis-years, and 15-year cumulative incidence was 48%. No difference in prosthesis longevity based on type of prosthesis implanted. Compared to early era, the late era had shorter time-to-PVD (11.4±3.9 vs 13.2±4.2years, p=0.031), higher incidence of PVD (3.6 vs 2.9 cases per 100 prosthesis-years, p=0.028), and higher incidence of early PVD (7.0% vs 3.4%, p=0.013).

Conclusions: The limited longevity of pulmonary bioprosthetic valve and the observed increase in early PVD pose significant concerns about cumulative lifetime risk of reinterventions for patients with congenital heart disease. Further studies are required to validate our results and explore potential causes, as well as strategies for prevention and treatment of



1:51 PM

A Prolonged Air Leak Score for Patients Undergoing Lung Cancer Resection: An STS General Thoracic Surgery Database Analysis

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Purpose: Prolonged air leak (PAL) after lung cancer resection is associated with increased patient discomfort, hospital length of stay, and cost. The objective of this study was to create a simple preoperative tool to assess the risk of PAL using the Society of Thoracic Surgeons General Thoracic Surgery Database (STS GTSD).

Methods: The STS GTSD was queried for patients who underwent elective lung cancer resection between 2009-2016. Exclusion criteria included pneumonectomy, sleeve lobectomy, chest wall resection, bilateral procedures, and patients with incomplete datasets. The primary outcome was PAL > 5 days, in accordance with the STS GTSD definition. Multivariable logistic regression was used to identify risk factors for a PAL. Model coefficients were used to generate a PAL score (PALS). The approach was cross-validated in 100 replications of a training set consisting of randomly selected 2/3 of the cohort, and a validation set of remaining patients.

Results: A total of 54,838 patients from the STS GTSD met inclusion criteria, with an overall rate of PAL of 10.4% (n=5,703). Final variables incorporated into the PALS included BMI <= 30kg/m^2, (7 points), lobectomy or bilobectomy (7 points), COPD (5 points), FEV1 <= 60% predicted (4 points), male (3 points), and right upper lobe procedure (3 points). **[Table]** In multivariable analysis, each of these variables was strongly associated with PAL (adjusted p< 0.001). Using a cumulative PALS >20 points, this tool classifies patients as high-risk or low-risk for a PAL (19% vs. 8% rate of PAL) with a cross-validated average NPV of 92%, sensitivity of 34%, specificity of 83%, and correct prediction rate of 78%.

Conclusions: The PAL score (PALS) is a simple preoperative clinical tool that can reliably risk stratify patients for PAL who are undergoing lung cancer resection. It may be used to improve surgical quality by facilitating preoperative counseling, allowing enhanced risk stratification, and developing more effective mitigation strategies.

Risk Factor	Points
Body mass index ≤ 30 kg/m^2	7
Lobectomy or bilobectomy	7
COPD	5
FEV1 ≤ 60%	4
Male	3
Right upper lobe	3
	Risk of PAL
If Total PALS > 20	19%
If Total PALS ≤ 20	8%

2:03 PM

Mayo Clinic Esophageal CONDUIT Report Card: Normative Standards

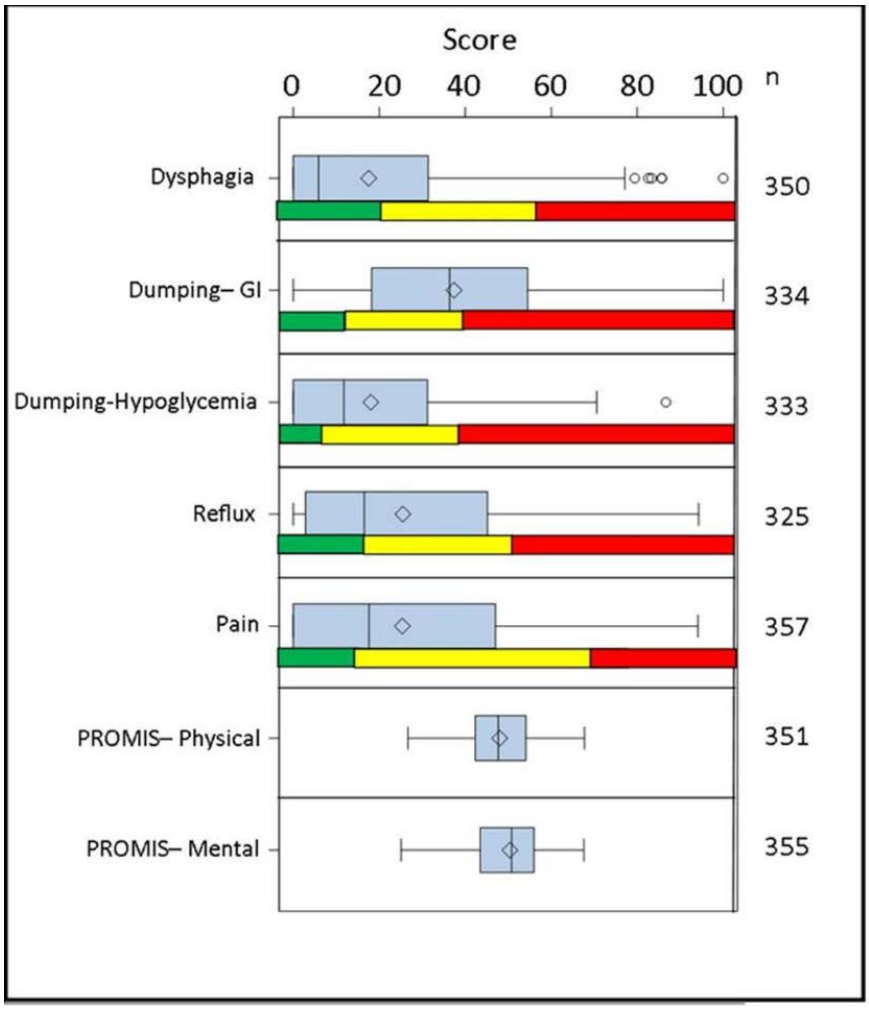
S. H. Blackmon, *N. N. Mahajan, M. K. Lee, K. Yost, K. E. Pierson, J. Viehman, M. S. Allen, S. D. Cassivi, F. C. Nichols, J. Reisenauer, K. R. Shen, D. A. Wigle*
Mayo Clinic, Rochester, MN

Purpose: Patients undergoing esophagectomy often have little understanding or guidance about post-operative symptom management. The objective of this study was to collect patient reported outcomes after esophagectomy to establish an initial set of normative standards.

Methods: The Mayo Clinic esophageal CONDUIT tool is a novel validated questionnaire comprising of five multi-item symptom assessment domains and two PROMIS health assessment domains designed to measure patient reported outcomes after esophagectomy. A prospective clinical trial was conducted on esophagectomy patients (?18 years of age) using the CONDUIT tool from 08-21-2015 to 07-27-2018 (NCT02530983). It was administered during postoperative evaluation and data was entered prospectively into Medidata Rave® clinical data management system. Statistical Analysis System (SAS) 9.4 was used to calculate and analyze the scores.

Results: Over the study period, 568 patients were assessed for eligibility and 241 patients were consented and offered the tool. Out of these, 188 patients (Age 24-87 years, median of 65 years, IQR = 58.3-71.4 years, 80% males) had a calculable score. The distribution of these normative standards is detailed in the table. The figure shows the scores with previously established standards. Out of these 188 patients, 50 (26.6%) patients were identified as potential beneficiaries for educational intervention to improve symptoms and 131 (69.7%) patients were identified as in need of further testing and provider intervention based on the tool.

Conclusions: Complex patient data integration can become part of each esophagectomy patient's clinic visit using the CONDUIT standardized normative report. Patients who need targeted education, further testing and active intervention can be readily triaged. This tool enhances our ability to provide efficient, multidisciplinary and long-term survivorship care for esophagectomy patients.



Domain	N (n)	Mean	Median	Interquartile Range
PROMIS-Physical Health	351 (183)	47.97	47.70	42.30 – 54.10
PROMIS-Mental Health	355 (185)	50.42	50.80	43.50 - 56
Dysphagia	350 (186)	17.58	5.88	0 – 31.43
Dumping-GI	334 (175)	37.36	36.36	18.18 – 54.55
Dumping-Hypoglycemia	333 (175)	18	11.76	0 – 31.25
Reflux	325 (175)	25.35	16	2.86 – 45.16
Pain	357 (186)	25.45	17.65	0 – 47.06

N = number of questionnaires scored per domain

n = number of patients scored per domain

GI = gastrointestinal

1:15 PM – 3:15 PM
Adult Cardiac: Aorta I
Moderators: *Thomas G. Gleason, Pittsburgh, PA, and Wilson Y. Szeto, Philadelphia, PA*

1:15 PM

ABSTRACT: Impact of Cerebral Perfusion Strategy on Stroke and Mortality After Circulatory Arrest for Aortic Arch Surgery: An STS Adult Cardiac Surgery Database Analysis

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Purpose: Choice of cerebral protection strategy for aortic surgery requiring circulatory arrest remains controversial with wide variation in contemporary practice. This study was designed to determine the optimal cerebral protection strategy for aortic surgery requiring circulatory arrest from a national clinical registry.

Methods: A total of 13,771 adults (mean age 62, SD 13.2 years) who underwent either hemi-arch (12,081, 87.8%) or total arch (1690, 12.2%) replacement with circulatory arrest between 2014-2016, were identified from The Society of Thoracic Surgeons Database (version 2.81). A subgroup of 5941 (45%) with acute Type A dissections were analyzed separately. Multivariable logistic regression was used to adjust for 29 baseline and operative variables including demographics, comorbidity, etiology, extent of surgery, and nadir temperature: outcomes were compared according to cerebral protection strategy. The primary end-point was a composite of 30-day and in-hospital mortality, permanent stroke or paraplegia.

Results: Cerebral perfusion was not utilized in 34.2%, (n=4133) of hemiarch patients and 19.4% (n=327) of total arch replacements (Table). Antegrade cerebral perfusion was used in 41.0% (n=4,955) and 66.1% (n=1,120) respectively; and retrograde cerebral perfusion was used in 23.5% (n=3,235) overall. The overall rate of death, permanent stroke or paraplegia was 17% (n=2,340). In multivariable analysis, antegrade (OR 0.72, 95% CI 0.64- 0.81), and retrograde (OR 0.69, 95% CI 0.60- 0.79) cerebral perfusion were associated with significant reductions in death and stroke (Figure) compared to no cerebral perfusion. This was true in subgroup analyses of patients with and without aortic dissection. Nadir temperature was closely linked to perfusion strategy: in patients undergoing no or retrograde cerebral perfusion there was a non-significant trend to lower mortality and stroke with decreasing temperature, whereas in antegrade perfusion the non-significant trend favored higher temperatures.

Conclusions: Death and stroke rates remain very high after aortic surgery in contemporary US practice. Cerebral perfusion is associated with significantly reduced risk of death or stroke irrespective of aortic pathology, circulatory arrest temperature or duration, or delivery; and appears to be the optimal strategy for aortic surgery requiring circulatory arrest.

Figure 1: Multivariable adjusted odds ratio for death, stroke or paraplegia stratified by total circulatory arrest time and cerebral protection strategy in patients without dissection

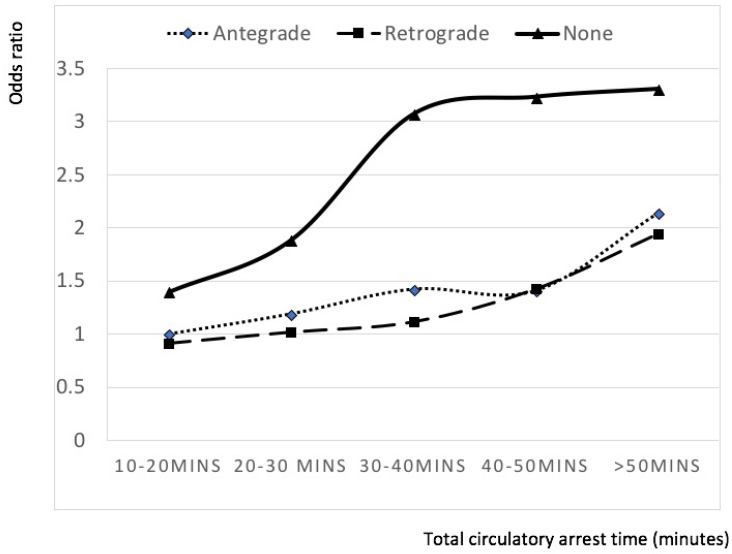


Table: Cerebral Protection Strategy

Hemiarch			
Cerebral Perfusion	**Antegrade**	**Retrograde**	**None**
Patients (proportion)	4955 (41%)	2992 (25%)	4133 (34%)
Nadir temperature (median, interquartile range) °C	23 (20-26)	19 (18-22)	19 (18-22)
Arrest time (median, interquartile range) minutes	27 (19-37)	24 (18-34)	21 (16-29)
Mortality / stroke (patients, percentage)	741 (15%)	415 (14%)	771 (19%)
Total arch			
Cerebral Perfusion	**Antegrade**	**Retrograde**	**None**
Patients (proportion)	1120 (66%)	243 (14%)	327 (19%)
Nadir temperature (median, interquartile range) °C	22 (18-24)	19 (18-21)	19 (17-22)
Arrest time (median, interquartile range) minutes	48 (32-62)	40 (26-54)	28 (20-41)
Mortality / stroke (patients, percentage)	270 (24%)	56 (23%)	85 (26%)

1:30 PM

ABSTRACT: National Study of Index Mortality, Readmission, and Costs for Thoracic Endovascular Aortic Repair With Chronic Kidney Disease

Y. Sanaiha[1]*, B. Kavianpour*[3]*, R. Jaman*[1]*, R. Morchi*[2]*, R. J. Shemin*[1]*, P. Benharash*[1]
[1]University of California, Los Angeles, [2]University of California, Irvine, [3]Stony Brook University, NY

Purpose: Endovascular technology has rapidly increased and supplanted open repair of aortic pathology. Characterization of populations at greatest risk for mortality, complications, and readmissions following thoracic aortic endovascular repair (TEVAR) is warranted. The present study aimed to evaluate TEVAR clinical outcomes and rehospitalization for patients with varying degrees of renal dysfunction.

Methods: The Nationwide Readmissions Database was used to identify all adult patients who underwent isolated TEVAR from 2010-2015. The cohort was stratified into four groups using the National Kidney Foundation criteria: no chronic kidney disease (no-CKD), Chronic Kidney Disease Stage 1-3 (CKD13), Stage 4-5 (CKD45), and End Stage Renal Disease requiring dialysis (ESRD). Primary outcomes included index mortality, early (30 day) and intermediate (30-90 day) readmissions, costs, and length of stay (LOS). Kaplan-Meier analyses were performed to assess readmission performance. Logistic regressions were used to identify predictors of mortality and readmission while linear regression was used for incremental cost analysis.

Results: Of the estimated 184,546 patients undergoing TEVAR, 4.7% had CKD13, 1.3% CKD45, and 4.1% had ESRD. Those with renal disease were more likely to have heart failure with a higher Elixhauser comorbidity score (Table 1). Unadjusted in-hospital mortality, early, and intermediate readmission rates were significantly higher for ESRD patients compared to those without CKD (Table 1). Amongst all patients with CKD, ESRD patients had the highest odds of index mortality, early and intermediate readmissions (Figure 1). Kaplan-Meier analysis revealed that nearly 50% of all ESRD patients are readmitted within one year (Figure 1). ESRD was also associated with significantly higher adjusted costs (ESRD $13,294, P<0.0001) and LOS (ESRD 5.6 days, P<0.0001) compared to non-CKD patients. Among those readmitted within 30 days, 4.1% required additional vascular procedures while 3.6% presented with

postoperative infection. Compared to non-CKD patients, ESRD patients had a higher prevalence of sepsis upon readmission (1.7 vs 0.1%, P<0.001).

Conclusions: Nearly 10% of all TEVAR patients have evidence of chronic kidney disease of varying severity. Those with ESRD are at the highest risk for significantly higher odds of mortality, readmissions, costs, and length of stay. Care bundles aimed at reducing index complications and readmission might improve outcomes in this vulnerable

Figure 1. TEVAR Clinical Outcomes and Readmission Performance.
1A) Risk-Adjusted Odds of Mortality, Readmission compared to patients without CKD (Red line).
1B) Kaplan-Meier Readmission Analysis for time to first readmissions by CKD stage.

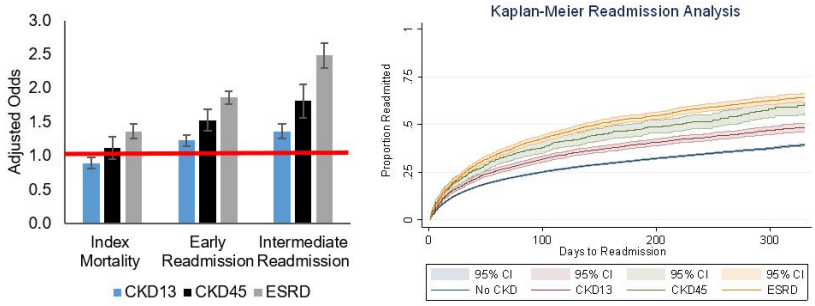


Table 1. Patient Characteristics and Unadjusted Clinical Outcomes by CKD Stage

	No CKD (N=165,979)	CKD1-3 (N=8,678)	CKD4-5 (N=2,322)	ESRD (N=7,567)
Age (mean, years)	61.2	72.5*	71.9*	61.7
Elixhauser Score (mean)	3.1	5.5*	5.6*	5.2*
Heart Failure (%)	3.3	9.2*	13.3*	12.3*
In-hospital Mortality (%)	5.8	7.3*	10.1*	9.4*
In-hospital Morbidity (%)	37.2	38.3*	43.0*	45.2*
Early Readmission (%)	10.9	14.4*	17.8*	19.8*
Intermediate Readmission (%)	14.4	20.6*	24.8*	30.6*

**P<0.001 compared to No-CKD*

1:45 PM

DEBATE: The Diameter Threshold for Prophylactic Ascending Aortic Replacement Should Be Lowered

Yes: *Edward P. Chen, Atlanta, GA*
No: *Anthony L. Estrera, Houston, TX*

2:15 PM

ABSTRACT: Volume-Outcome Relationships in Surgical and Endovascular Repair of Aortic Dissection

A. A. Brescia*, H. J. Patel, D. S. Likosky, T. Watt, X. Wu, R. J. Strobel, K. M. Kim, S. Fukuhara, G. Deeb, M. P. Thompson*
University of Michigan, Ann Arbor

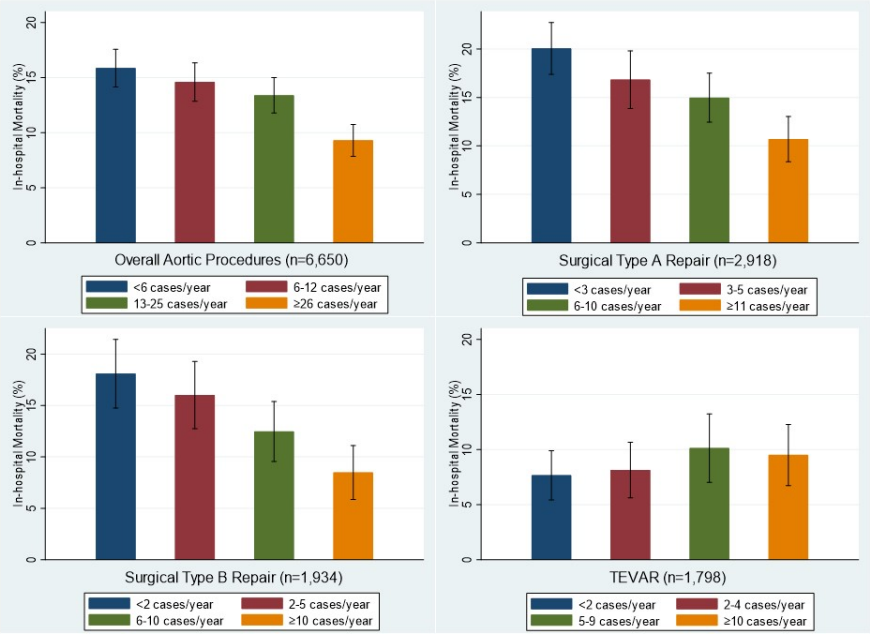
Purpose: A volume-outcome relationship has been suggested for type A aortic dissection repair. As STS mortality rates decrease, it is unknown whether volume-outcome relationships exist for operative management of all thoracic aortic dissections. We characterized volume-outcome relationships for surgical and endovascular management of type A and type B aortic dissections.

Methods: Patients >18 years old undergoing surgical or endovascular repair of thoracic aortic dissection in the United States between 2010 and 2014 were identified in seven Healthcare Cost and Utilization Project (HCUP) state inpatient databases. A published ICD-9-CD algorithm was utilized to classify patients into groups: surgical repair of type A dissection (TAAD), surgical repair of type B dissection (TBAD), and thoracic endovascular aortic repair (TEVAR). Utilizing annual case volume quartiles, mixed-effects logistic regression models were used to evaluate the association between hospital procedural volume and in-hospital mortality with marginal predicted means, adjusting for patient demographics, comorbidities, and hospital (random effect).

Results: Among 6,650 patients across 232 hospitals, the in-hospital mortality rate was 13.4% (890/6650). Mortality was highest after surgical repair of TAAD at 15.9% (463/2918), followed by surgical repair of TBAD at 14.0% (270/1934), and TEVAR at 8.7% (157/1798). Mean annual hospital case volumes by repair approach were: 8.9 (95% confidence interval, CI=8.5-9.2) for TAAD, 7.3 (6.9-7.6) for TBAD, and 7.6 (7.1-8.0) for TEVAR. A volume-outcome relationship for in-hospital mortality was demonstrated for surgical repair of TAAD and TBAD, but not TEVAR [Figure]. Multivariable analysis showed that survival was superior at centers with $\geq$26 overall thoracic dissection procedures per year, when compared to any of the three lower-volume quartiles (p<0.001). The largest difference in adjusted mean mortality rate by hospital was demonstrated in surgical repair of TAAD ($\geq$11 cases/year=12% vs <3 cases/year=21%, p<0.001) and TBAD ($\geq$10 cases/year=9% vs <2 cases/year=18%, p<0.001), while TEVAR did not differ between volume quartiles.

Conclusions: This study demonstrated a survival benefit at high-volume hospitals for overall repair of aortic dissection. When stratified, a volume-outcome relationship persisted for surgical repair of type A and B dissections, but not TEVAR. These data suggest patients requiring surgical repair of thoracic aortic dissection should be treated at high-volume centers.

In-Hospital Mortality after Aortic Dissection Repair by Annual Hospital Case Volume



2:30 PM

ABSTRACT: Multicenter Analysis of Early Outcomes of Acute Type A Aortic Dissection: A Report From the Japan Registry of Aortic Dissection Database

Y. Inoue[1], *H. Matsuda*[1], *A. Omura*[1], *Y. Seike*[1], *K. Uehara*[1], *H. Sasaki*[1], *H. Ogino*[2]
[1]*National Cerebral and Cardiovascular Center, Suita, Japan,* [2]*Tokyo Medical University, Japan*

Purpose: From 2011, Japanese Registration of Aortic Dissection (JRAD) started in corporation with 19 referral centers all over Japan on the model of the International Registration of Aortic Dissection (IRAD). The aim of this study was to report real clinical early and mild-term outcomes of acute type A aortic dissection (AAAD) in Japan.

Methods: Between 2011 and 2016, a total of 1217 patients (67.9 ±13.1 years, 48% male) suffered from AAAD. DeBakey classification were type I in 72.9%, type II in 16.6%, type III with retrograde dissection in 9.0% . False lumen were patent (double barrel) in 66.2%, partially or completely thrombosed in 31.7% and unknown in 2.1%. Among them, 916 patients (75.7%) were surgically treated and 301 patients were medically treated. Among surgically treated patients, 823 patients were treated under cardiopulmonary bypass, 31 with endovascular procedures, and 62 with other methods. Follow-up rates of in-hospital survivors were 91% in urgically treated patients and 84% in medically.

Results: Median hospital admission was 25.0 days. In-hospital mortality rate was 11.6%; 10.8% in surgically and 15.8% in medically treated patients. Among medically treated patients, false lumen at ascending aorta were thrombosed in 41%, insufficient CT examination in 25%, and patent but localized in 4% and 30% was patent (double barrel). Significant preoperative predictors of in-hospital mortality were cardiac arrest including coronary malperfusion (P<. 001), brain malperfusion (P=. 09), double barrel false lumen (P=. 01), shock (P<. 001), and chronic kidney disease (P =. 02), but additional arch replacement was not the risk. Operative variables including operation time, cardiopulmonary bypass time , ischemic heart time were not significant related with in-hospital mortality. Cumulative overall survival rates of in-hospital survivors at 1 and 3 years after the onset were 97% and 93% in surgically treated patients and 98% and 93% in medically.

Conclusions: Fair surgical result with low in-hospital morality rate and equivalent mid-term result of medically treated patients suggest that the patient selection in JRAD was appropriate to save patients' lives, the primary purpose of the treatment of AAAD.

2:45 PM

ABSTRACT: Ascending Aortic Endovascular Repair Is Safe and Associated With Positive Remodeling in Prohibitive-Risk Patients With Ascending Aortic Disease

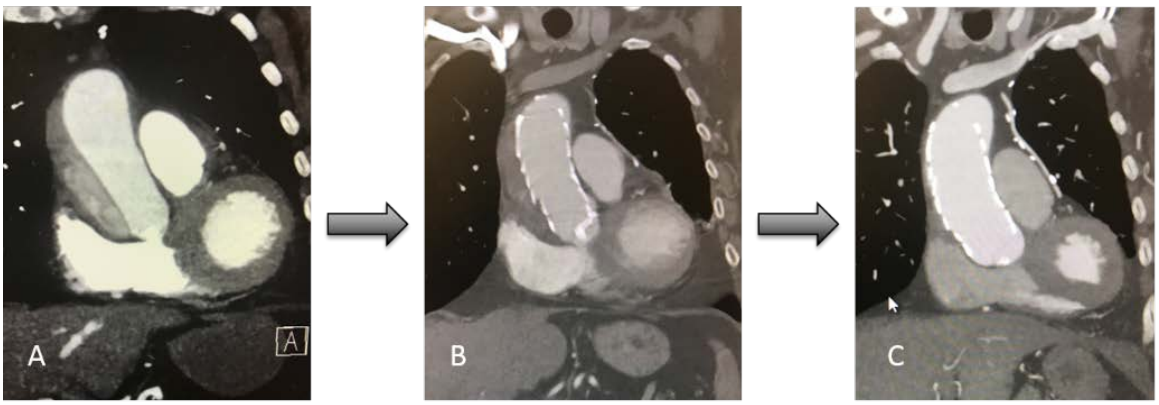
M. Ghoreishi[1], *J. Jeudy*[1], *A. Shah*[1], *C. Pasrija*[1], *J. Leibowitz*[1], *S. Toursavadkohi*[1], *E. J. Lehr*[2], *B. S. Taylor*[1]
[1]*University of Maryland, Baltimore,* [2]*Swedish Heart and Vascular Institute, Seattle, WA*

Purpose: Nearly 10% of patients presenting with ascending aortic disease are deemed “inoperable”. Endovascular repair of the ascending aorta provides an alternative option for these patients. We assessed the feasibility and aortic remodeling after utilizing this approach in inoperable patients with ascending aortic disease.

Methods: From 2015 to 2018, 15 patients who were considered prohibitive risk for open aortic repair underwent ascending aortic endovascular repair. Aortic pathologies were acute type A dissection (N = 11), pseudoaneurysm (N = 2), penetrating ulcer disease with intramural hematoma (N = 1), and chronic aortic aneurysm (N = 1). Ascending aortic stent placement was performed in 13 patients. In 2 patients, endovascular occluder device insertion and coil embolization were undertaken. Preoperative and follow – up computed tomography (CT) analysis was performed to compare the remodeling effect of the stent on the aorta. The mean follow up time was 6 months.

Results: The stent graft was successfully implanted in all patients (100%). Operative mortality was 13% (2/15). Etiologies of mortality included cerebrovascular accident on post-operative day 3 and multi-system organ failure on post-operative day 5. One patient required a trans-catheter aortic valve (AV) replacement for severe aortic insufficiency 6 months after stent placement, and one patient underwent open infected prosthetic AV replacement 2 weeks after endovascular repair of ruptured pseudoaneurysm. Among patients with dissection, the location of the primary tear was in zone 0A in 3 patients, zone 0B in 6, and zone 0C in 1. No endo-leak was observed after endovascular repair in 12/15 patients (80%). Among 3 patients with residual perfusion of the false lumen, the location of tear was in zone 0A in all patients. Follow up CT scan analysis, revealed a tendency of favorable aortic remodeling (***Table, Figure***).

Conclusions: Ascending aortic stent grafting is safe and effective in otherwise inoperable patients, and is associated with favorable aortic remodeling. Despite persistent perfusion to the false-lumen in a subset of patients, there is minimal aortic dilation at short-term follow-up. Improvement to device and deployment techniques may further enhance outcomes.



Variables	N = 15		
Age (mean ± SD, years)	68 ± 9		
EF, mean ± SD, %	46 ± 23		
Male, % (N)	50% (7)		
Prior cardiac surgery, % (N)	50% (7)		
CT Scan Data	**Preoperative, mm**	**Postoperative, mm**	**P**
Aortic diameter along center line			
Annulus to coronary	14 ± 5	15 ± 3	0.6
Annulus to STJ	30 ± 7	30 ± 3	0.3
Annulus to entry tear	62 ± 18	-	-
Annulus to innominate	106 ± 16	101 ± 14	0.3
STJ to innominate	77 ± 12	71 ± 14	0.4
Aortic diameter along outer wall			
Annulus to coronary	18 ± 7	19 ± 5	0.7
Annulus to STJ	34 ± 12	35 ± 8	0.3
Annulus to entry tear	85 ± 28	-	-
Annulus to innominate	148 ± 20	148 ± 23	0.5
STJ to entry tear	51 ± 29	-	-
STJ to innominate	115 ± 19	112 ± 23	0.8
Maximum diameter			
Annulus	27 ± 3	29 ± 4	0.03
Aortic sinus	40 ± 5	41 ± 5	0.7
STJ	41 ± 4.5	40 ± 6	0.4
STJ true lumen	**30 ± 5.5**	**33 ± 7**	**0.05**
STJ false lumen	5.5 ± 4.5	3.7 + 4	0.3
Mid ascending	51 ± 8	49 ± 13	0.8
Mid ascending true lumen	31 ± 11	40 ± 18	0.1
Mid ascending false lumen	**15 ± 15**	**5 ± 7**	**0.05**
Maximum ascending	53 ± 8	51 ± 11	0.9
At level of innominate	44 ± 4	43 ± 5	0.7
At level of innominate true lumen	28 ± 11	31 ± 7	0.4
At level of innominate false lumen	12 ± 10	8 ± 6	0.14
Arch	40 ± 4	40 ± 4	0.8
At the level of the left SC artery	37 ± 4	36 ± 5	0.7
Mid descending aorta total diameter	32 ± 3	31 ± 8	0.4
Mid descending aorta true lumen	23 ± 12	26 ± 9	0.05
Desc. aorta total diameter 2cm above celiac artery	29 ± 2	26 ± 10	0.4
Desc aorta true lumen 2cm above celiac artery	20 ± 12	23 ± 7	0.1

3:00 PM
Proximal and Aortic Arch Endografting: State-of-the-Art
Wilson Y. Szeto, Philadelphia, PA

1:15 PM – 3:15 PM
Adult Cardiac: Ischemic
Moderators: *Joseph C. Cleveland Jr, Aurora, CO, and Ourania A. Preventza, Houston, TX*

1:15 PM
ABSTRACT: Angiographic Outcome of Coronary Artery Bypass Grafts: An Analysis of 2236 Conduits
M. F. Gaudino[1], *U. Benedetto*[2], *S. E. Fremes*[3], *D. L. Hare*[4], *P. A. Hayward*[5], *M. N. Moscarelli*[6], *G. G. Nasso*[7], *N. Moat*[8], *K. Yoo*[9], *G. N. Speziale*[7], *J. D. Puskas*[10], *L. N. Girardi*[1], *D. P. Taggart*[112]
[1]*Weill Cornell Medicine, New York, NY,* [2]*University of Bristol, United Kingdom,* [3]*Schulich Heart Center, Sunnybrook Health Sciences Center, Toronto, Canada,* [4]*University of Melbourne, Australia,* [5]*Austin Hospital, Melbourne, Australia,* [6]*National Heart and Lung Institute, Imperial College London, United Kingdom,* [7]*Anthea Hospital, Bari, Italy,* [8]*Royal Brompton and Harefield Trust, London, United Kingdom,* [9]*Severance Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, South Korea,* [10]*Mount Sinai St Luke's Hospital, New York, NY,* [11]*John Radcliffe Hospital, Oxford, United Kingdom*

Purpose: The current knowledge on bypass patency is based on studies where a minority of patients underwent re-angiography, leaving open the question of the graft status in non-studied patients. We evaluated the angiographic outcome of coronary grafts using data from 5 prospective trials with a very high rate of re-angiography.

Methods: The patient-level data of 5 angiographic randomized controlled trials (RAPCO, RAPS, RSVP, Stand-in-Y and Yoo's trials) were joined in a common database. Angiographic results were evaluated overall (*Overall Analysis*) and in relation to the target vessel (*LAD and non-LAD Analyses*). Cox regression was used to evaluate independent predictors of graft occlusion. Variables tested were: age, gender, diabetes, hypertension, previous myocardial infarction (MI), renal failure, location of target vessel, percentage of target vessel stenosis ?90%, and type of conduit used.

Results: Data from 1519 patients, of whom 1073 (70.6%) had angiographic follow up, were studied. Overall 2236 conduits were analyzed: 929 left internal thoracic artery (LITA), 680 radial artery (RA), 543 saphenous vein (SV), and 84 right internal thoracic artery (RITA). All the LITA grafts were to the LAD, whereas RITA, RA and SV grafts were to non-LAD territories. Mean follow-up time was 4.8 ± 2.7 years. Patency rate was 92.2% for LITA (857/929), 89.3% for RITA (75/84), 93.4% for RA (635/680) and 81.8% for SV (444/543). Results of the Cox regression are summarized in the table. Age was an independent predictor of graft occlusion in almost all models. In the *non-LADAnalysis*, previous myocardial infarction and use of a SV were independently associated with graft occlusion. Anastomosis to the right coronary artery was associated with higher risk of graft failure, but this did not reach statistical significance.

Conclusions: This database represents one of the largest and most complete prospective angiographic datasets of coronary bypass conduits. Our findings challenge some of the current concepts on patency and determinants of graft occlusion.

Results of Cox regression for occlusion

Variable	HR (95% CI)	p value
Overall analysis		
Age	**1.067 (1.046-1.089)**	**0.001**
Female	***0.712 (0.508-0.998)***	***0.049***
Diabetes	1.286 (0.955-1.732)	0.097
Hypertension	**1.380 (1.006-1.895)**	**0.046**
Previous MI	1.224 (0.906-1.654)	0.187
Renal failure	0.718 (0.384-1.342)	0.299
>90% stenosis of the target vessel	1.163 (0.846-1.599)	0.353
Target vessel: CX	Ref. group	1.00
RCA	1.313 (0.910-1.895)	0.145
LAD	0.937 (0.643-1.365)	0.733
LAD analysis		
Age	**1.040 (1.000-1.082)**	**0.048**
Female	0.708 (0.408-1.228)	0.219
Diabetes	1.392 (0.839-2.309)	0.201
Hypertension	1.186 (0.660-2.134)	0.568
Previous MI	1.262 (0.718-2.219)	0.419
Target vessel stenosis >90%	1.605 (0.942-2.736)	0.082
Non-LAD analysis		
Age	1.015 (0.989-1.042)	0.254
Female	0.743 (0.470-1.175)	0.204
Diabetes	1.179 (0.802-1.733)	0.401
Previous MI	**1.672 (1.152-2.426)**	**0.007**
>90% stenosis of target vessel	1.043 (0.682-1.594)	0.846
Target vessel: CX	Ref. group	1.00
RCA	1.164 (0.792-1.709)	0.439
Saphenous vein	**5.666 (3.288-9.762)**	**<0.001**

HR: hazard ratio, CI: confidence interval, CX: circumflex coronary artery, RA: radial artery, RCA: right coronary artery.

1:30 PM

ABSTRACT: Fate of Saphenous Vein Graft in Coronary Artery Bypass Grafting According to the Anastomosis Technique: Sequential vs Individual

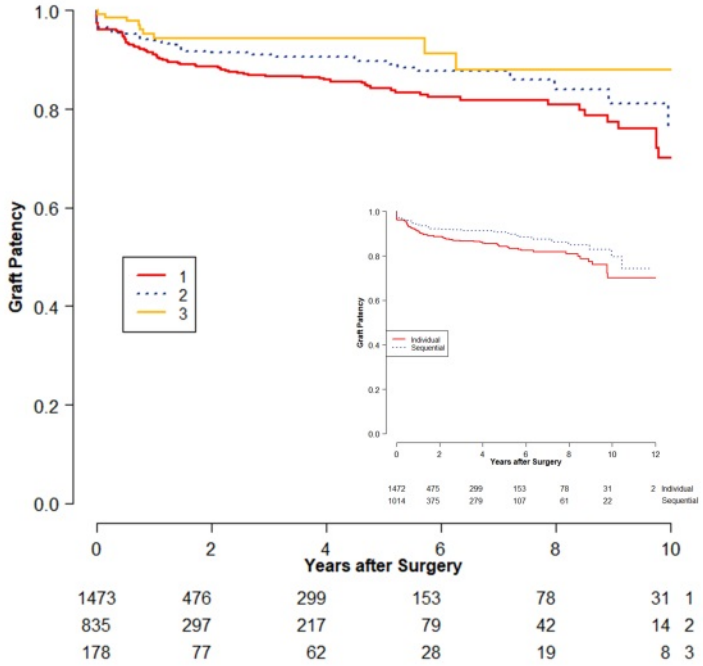
***S. Park**, C. Chung, J. Kim, H. Kim*
Asan Medical Center, Seoul, South Korea

Purpose: There are only scarce data available comparing long-term patency of saphenous vein graft (SVG) according to anastomosis technique with large scale registry. We sought to compare the long-term patency of SVG as a bypass graft in CABG according to anastomosis technique (sequential versus individual).

Methods: From Jan 2005 through Dec 2016, 2,379 patients (mean age, 63.9±9.1 years) who underwent CABG using SVG either by sequential (n=1,014 grafts) or individual (n=1,472 grafts) technique were enrolled in this study. Sequential and individual bypassing was performed in 981 and 1,364 patients, and 31 patients received both. The patency of the grafts was assessed by the 5,518 postoperative coronary computed tomographic angiography (CCTA) and 109 coronary angiography (CA). Graft failure was defined as total occlusion or severe stenosis (>70%) of the graft on the CCTA or CA. The incidence of graft failure was compared on a per-graft basis.

Results: A total of 3,677 distal anastomoses were made using 2,486 SVG. Of the 2,379 patients, 1,465 patients were evaluated by at least two postoperative CCTAs. Sequential bypass grafts showed lower incidence in graft failure than individual bypass grafts (hazard ratio: 0.67; 95% CI: 0.50 to 0.90; p=0.007). Graft patency at 5 years was 90.2 ± 1.3 % in sequential grafts and 83.8% ± 1.5% in individual grafts. At 10 years, sequential grafts were patent at 74.3 ± 6.6% and individual grafts at 70.2 ± 4.3%, respectively. The mounting anastomosis number of sequential graft was associated with more favorable graft patency (p=0.009).

Conclusions: Sequential bypass grafts were associated with superior long-term patency compared with individual grafts. The numbers of distal anastomosis in sequential grafts were associated with graft patency.



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ABSTRACT: Bilateral Internal Thoracic Artery In Situ vs Y-Composite Grafting: 10-Year Angiographic Patency and Long-Term Clinical Outcomes

***S. Sohn**, Y. Lee, J. Choi, H. Hwang, K. Kim*
Seoul National University Hospital, South Korea

Purpose: We compared 10-year graft patency rates and long-term clinical outcomes after off-pump coronary artery bypass grafting (OPCAB) using bilateral internal thoracic arteries (ITAs) as in situ grafts with those using bilateral ITAs as a Y-composite graft.

Methods: Of 523 patients who underwent OPCAB using bilateral ITAs from 1998 to 2007, bilateral ITAs were used as in situ grafts in 168 patients (group I) and as a Y-composite graft in 355 patients (group Y). Propensity score matching analysis was performed to correct differences of baseline characteristics between groups, and 119 matched pairs were identified. Long-term clinical outcomes and 10-year angiographic patency rates were compared.

Results: In matched cohort, mean follow-up duration was 131±64 months and there were no differences in all-cause mortality(p=0.727), cardiac death(p=0.513), freedom from reintervention(p=0.771), and freedom from major adverse cardiac event(p=0.787). Ten-year freedom from cardiac death rates in groups I vs Y were 96.9% vs 95.2%, respectively. Ten-year follow-up angiographies were performed in 105 patients of matched cohort (groups I vs group Y, 51 vs 54) at 149±25 months after surgery. Overall patency rate at 10 years was 89.6%, and no significant differences were found between the 2 groups (group I vs group Y, 87.8% vs 91.2%, p=0.313). However, patency rates of distal anastomoses using bilateral ITAs were higher in group Y than group I (95.6% vs 88.9%, p=0.040).

Conclusions: The OPCAB using bilateral ITA configurations as in situ versus Y- composite grafts demonstrated no differences in long-term clinical outcomes and 10-year overall patency rates between the 2 groups. However, patency rates of distal anastomoses using bilateral ITAs were higher in Y-composite than in situ group 10 years after surgery.

Table. Early, 1-Year, 5-Year, and 10-Year Angiographic Patency Rates Between Groups I and Y (Matched Data)

	Early angiography							1-year angiography						
	Total (n=235)		Group I (n=118)		Group Y (n=117)		*p*	Total (n=218)		Group I (n=110)		Group Y (n=108)		*p*
Overall	719/730	98.5%	357/366	97.5%	362/364	99.5%	0.063	636/679	93.7%	317/341	93.0%	319/338	94.4%	0.448
Bilateral ITAs	569/578	98.4%	283/290	97.6%	286/288	99.3%	0.176	517/541	95.6%	255/272	93.8%	262/269	97.4%	0.039
Additional grafts	148/150	98.7%	74/76	97.4%	74/74	100.0%	0.497	119/138	86.2%	62/69	89.9%	57/69	82.6%	0.217

5-year angiography							10-year angiography						
Total (n=186)		Group I (n=96)		Group Y (n=90)		*p*	Total (n=105)		Group I (n=51)		Group Y (n=54)		*p*
526/577	91.2%	271/297	91.2%	255/280	91.1%	0.941	293/327	89.6%	137/156	87.8%	156/171	91.2%	0.313
432/461	93.7%	219/237	92.4%	213/224	95.1%	0.235	243/263	92.4%	112/126	88.9%	131/137	95.6%	0.040
94/116	81.0%	52/60	86.7%	42/56	75.0%	0.109	51/64	79.7%	25/30	83.3%	26/34	76.5%	0.496

2:00 PM

Does Bypass Graft Configuration Matter?

David Glineur, Ottawa, Canada

2:15 PM

ABSTRACT: Does Utilization of the Bilateral Mammary Artery Increase Short-Term Risk in Uncontrolled Diabetic Patients? Results From the STS Adult Cardiac Surgery Database

***T. Kazui**, S. D. Lick, C. Hsu, D. A. Bull*

University of Arizona, Tucson

Purpose: Despite increasing evidence of a long-term survival benefit, bilateral mammary arteries (BIMA) are used in only 5% of patients undergoing coronary artery bypass grafting (CABG) in the United States. This study evaluates the short-term morbidity and mortality after BIMA use in patients based on their preoperative HbA1c.

Methods: Patients undergoing elective CABG between 2008 and 2016 and reported to the Society of Thoracic Surgeons Adult Cardiac Surgery Database were placed into two groups: use of a single internal mammary artery (SIMA) or the use of BIMA at the time of CABG. The preoperative HbA1c level was categorized into 4 groups (i.e. <7%, 7~9%, 9~11%, >11%). Mortality, intensive care unit stay, surgical site infection and complications were compared between the SIMA and BIMA groups overall and for each level of HbA1c using logistic regression and propensity matching analysis.

Results: There were 144,048 and 7,709 patients in the SIMA and BIMA groups with preoperative HbA1c levels recorded, respectively. The overall comparison results are in Table. 1. Patients receiving BIMA grafts had a significantly shorter length of stay and a lower overall complication rate. The BIMA patients, however, had a higher surgical site infection rate (BIMA vs SIMA, 2.1% vs 1.6%; odds ratio (OR): 1.60(95% confidence interval (CI) :1.28, 2.00); p<0.0001). The progressive increase in the pre-operative HbA1c correlated with an increased incidence of surgical site infection in patients receiving BIMA grafts. Specifically (SIMA vs. BIMA), HbA1c<7%(1.7% vs 2.7%; odds ratio (OR): 1.63 (95% CI :1.01, 2.61); p=0.04), HbA1c 7-9% (2.2% vs 3.8%; odds ratio (OR): 2.00 (95% CI :1.31, 3.07); p<0.01), HbA1c 9~11%, (2.6% vs 7.0%; odds ratio (OR): 3.01 (95% CI :1.62, 5.59); p<0.001), HbA1c >11%, (3.9% vs 6.4%; odds ratio (OR): 2.05 (95% CI :0.72, 5.88); p=0.18).

Conclusions: Compared to the use of SIMA, the use of BIMA does not increase mortality or complications at 30 days following elective CABG. The incidence of surgical site infection in diabetic patients undergoing elective CABG, however, increases with progressive elevation in the pre-operative HbA1c, especially above 7%.

Table 1. Postoperative outcomes by number of IMA

Outcomes	SIMA (n=144,048)	BIMA (n=7,709)	OR/RR[a] (95% CI); p-value Unadjusted (95% CI); p[b]	Adjusted (95% CI); p[c]
Post-operative length of stay	6.4 ± 4.5	6.0 ± 4.0	0.94 (0.92, 0.95); p<0.0001	1.03 (1.02, 1.05); p=0.0001
ICU readmission	3544 (2.5%)	159 (2.1%)	0.83 (0.71, 0.98); p=0.03	1.06 (0.90, 1.25); p=0.51
Complications	50,859 (35.3%)	2,409 (31.3%)	0.83 (0.79, 0.88); p<0.0001	1.06 (1.00, 1.11); p=0.04
Surgical site infection	1,224 (1.6%)	93 (2.1%)	1.34 (1.08, 1.65); p<0.01	1.60 (1.28, 2.00); p<0.0001
Mortality	1,876 (1.3%)	61 (0.8%)	0.60 (0.47, 0.78); p=0.0001	0.96 (0.73, 1.25); p=0.74

IMA: internal mammary artery, SIMA: single internal mammary artery, BIMA: bilateral internal mammary artery, DM: diabetes mellitus, OR: odds ratio, CI: confidence interval

ICU: Intensive care unit, [a]odds ratio for binary outcomes/relative risk for continuous outcomes, [b]derived from logistic regression for binary outcomes and linear regression for continuous outcomes, [c]controlling for age, gender, diabetic status, A1c level, intra-aortic balloon pump and STS risk predictors

2:30 PM

ABSTRACT: Outcomes Following Coronary Artery Bypass Grafting Surgery Between Insulin-Controlled Diabetics, Tablet-Controlled Diabetics, and Non-Diabetic Patients in a Propensity-Matched Analysis

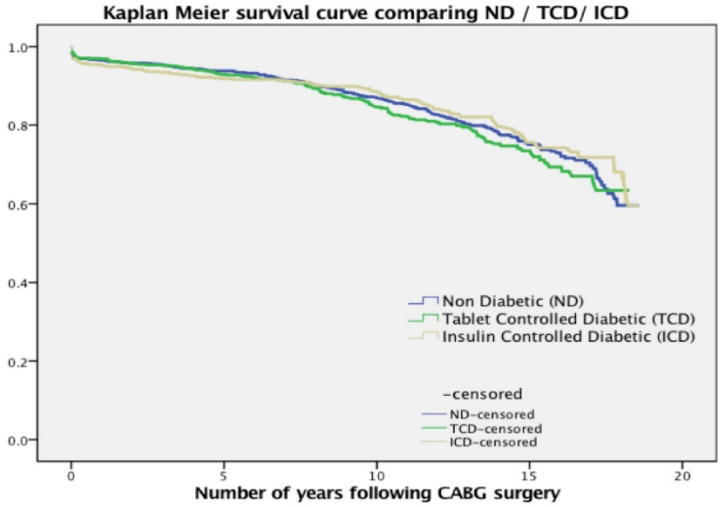
Y. S. Haqzad
Sheffield Teaching Hospitals NHS Trust, Beverley, United Kingdom

Purpose: The occurrence of adverse clinical outcomes following coronary artery bypass surgery (CABG) in matched groups of different diabetic subgroups are not well established. We aimed to compare short andAll isolated first time CABG surgeries performed at a single regional hospital, between April 1999 to April 2017 were retrospectively reviewed from

Methods: All isolated first time CABG surgeries performed at a single regional hospital, between April 1999 to April 2017 were retrospectively reviewed from the cardiothoracic database. A 1:1 propensity score matching was employed to match by pre and intra operative variables. Short and long term mortality (up to 18 years) and morbidities were compared between insulin controlled diabetes vs tablet controlled diabetes vs non diabetic patients.

Results: A total of 8241 patients; Of these, 1939 (23.5%) had previous diagnosis of diabetes and 6302 (76.5%) non-diabetics (ND). After propensity score matching; 594 insulin controlled diabetics (ICD) compared to 594 non diabetic (ND); 896 tablet controlled diabetic (TCD) compared to 896 ND and 521 ICD compared to 521 TCD. After matching, basic demographics and clinical characteristics were comparable between the groups. Diabetic patients had significantly higher rate of deep sternal wound infection, renal failure requiring dialysis, respiratory failure and prolonged hospital stay compared to ND patients (p<0.001). ICD patients had a significantly higher rate of multisystem failure and in- hospital mortality compared to TCD patients (P<0.001). TCD patients had higher rate of readmission with MI compared to ICD and ND patients (P<0.001).

Conclusions: This propensity matched study has shown diabetic therapy subgroups to be an independent risk factor for deep sternal wound infection, renal failure requiring haemofiltration, multisystem failure and readmission with myocardial infarction after isolated first time CABG surgery. It warrants better risk stratification of diabetic patients prior to cardiac surgery.



	ICD (594)	ND (594)	P value	TCD (896)	ND (896)	P value	ICD (521)	TCD (521)	P val
Reopen for bleed/tamponade	3.0	2.9	0.864	4.2	2.5	<0.001	3.5	5.0	0.21
Post- op AF	35.0	33.8	0.948	39.3	36.5	<0.001	37.4	37.4	0.99
New dialysis /CVVHD	5.2	1.5	<0.001	1.6	1.7	0.572	6.1	1.3	<0.0(
Raised Creatinine (>200 μmol/L)	9.8	5.6	<0.001	6.9	4.8	<0.001	11.5	6.1	<0.0(
Respiratory complications (ARDS, infection, effusion)	25.6	21.9	<0.001	25.7	22.7	<0.001	28.0	26.1	0.54
Post -op MI	1.5	1.7	0.817	0.6	1.7	0.070	1.7	0.6	0.08
Sternal wound infection	3.9	1.5	<0.001	1.1	1.0	0.955	4.0	0.8	<0.0(

2:45 PM
DEBATE: 65-Year-Old Patient With Insulin-Dependent Diabetes and Three-Vessel Coronary Artery Disease
***Left Internal Mammary Artery and Saphenous Vein Graft**: Frank W. Sellke, Providence, RI*
***Bilateral Internal Mammary Artery +/- Saphenous Vein Graft**: Joseph F. Sabik III, Cleveland, OH*
***Left Internal Mammary Artery and Radial +/- Saphenous Vein Graft**: Jennifer S. Lawton, Baltimore, MD*

3:09 PM
Discussion

1:15 PM – 3:15 PM
Congenital: Pediatric Congenital II
Moderators: *Meena Nathan, Boston, MA, and Christian Pizarro, Wilmington, DE*

1:15 PM
ABSTRACT: Ex-Utero Extracorporeal Support as a Model for Fetal Hypoxia and Brain Dysmaturity in Congenital Heart Disease
***P. E. McGovern**[1], K. M. Lawrence[2], H. Baumgarten[2], A. C. Rossidis[2], A. Mejaddam[2], D. J. Licht[2], J. B. Grinspan[2], A. Schupper[2], J. Rychik[2], R. A. Didier[2], A. Vossough[2], W. H. Peranteau[2], M. Davey[2], A. Flake[2], J. W. Gaynor[2]*
[1]Temple University Hospital, Philadelphia, PA, [2]Children's Hospital of Philadelphia, PA

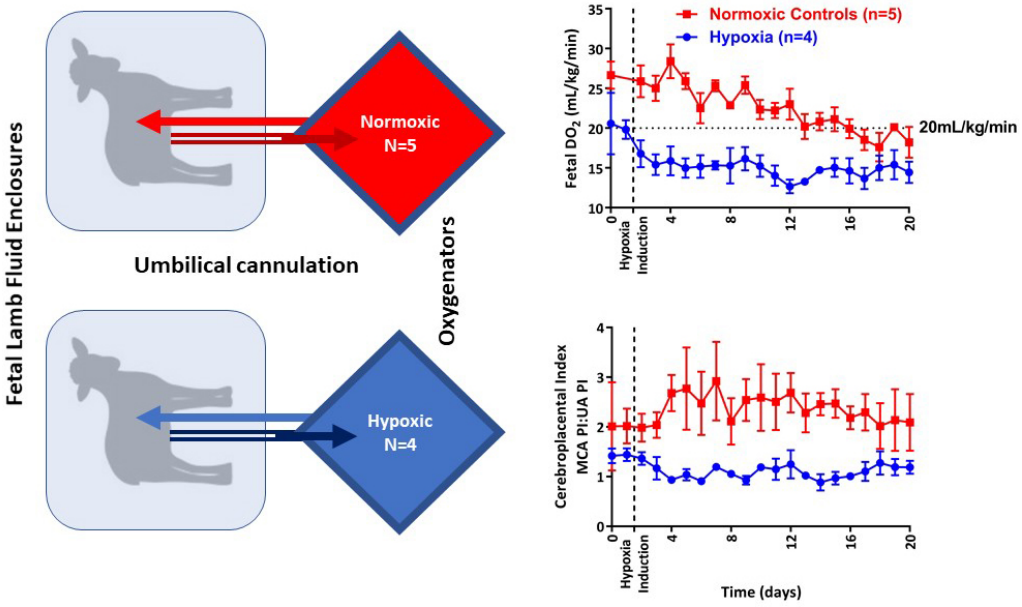
Purpose: Congenital heart disease (CHD) is associated with abnormal fetal brain development, a phenomenon that may be related to decreased cerebral oxygen delivery. We utilized an artificial womb model to test the hypothesis that decreasing fetal oxygen delivery would reproduce the physiological changes identified in fetuses with CHD.

Methods: Experimental (hypoxemic) fetal lambs (mean gestational age 111±3 days, n=4) as well as controls (112 days, n=5) were cannulated via the umbilical vessels and maintained in the artificial womb for a mean of 22±6 days. Oxygen delivery was reduced to 15.6±1.0mL/kg/min in the hypoxemia animals versus 21.6±2.0mL/kg/min in controls. Blood chemistry analysis and echocardiographic evaluation, including pulsatility indices of the umbilical artery (UA) and middle cerebral artery (MCA) were performed daily. An additional

control group (n=7) was maintained in-utero and harvested at gestational age 134±4 days. The brains were perfusion fixed for magnetic resonance imaging and histologic analysis.

Results: Physiological parameters including cardiac output, umbilical circuit flow, and blood pressure were monitored daily, and no statistical differences were seen between groups. Fetal oxygen delivery, arterial pO2, and the cerebro-umbilical resistance ratio (CUR, MCA/UA ratio) were significantly lower in the experimental group versus controls over the duration of the experiment. (Table and Figure) Increased UA resistance and decreased MCA resistance resulted in a lower CUR ratio, similar to the clinical 'brain sparing' effect seen in human fetuses with CHD. On MRI, experimental brains appeared smaller than controls in relation to the calvarium. There was no evidence of increased gross or histopathologic injury in the hypoxemia animals.

Conclusions: Sustained hypoxemia in fetal sheep leads to altered cerebral blood flow and oxygen delivery with brain dysmaturity similar to changes seen in the human fetus with CHD. This unique model provides opportunities to investigate the pathology underlying CHD associated brain dysmaturity, as well as to evaluate potential fetal neuroprotective therapies.



Animal	LV Cardiac Output (mL/kg/min)	Serum Glucose (mg/dL)	Oxygen Delivery (mL/kg/min)	UA Pulsatility Index	MCA:UA PI Ratio
Control 1	284.73	27.63	18.30	0.35	2.07
Control 2	191.78	41.44	22.30	0.35	2.38
Control 3	186.36	37.55	23.00	0.29	3.01
Control 4	273.77	41.78	23.50	0.48	1.60
Control 5	271.07	27.55	21.20	0.37	2.32
Physiologic Group	241.54	35.19	**21.66**	**0.37**	**2.28**
Std. Dev.	43.12	7.13	**2.07**	**0.07**	**0.51**
Hypoxic 1	224.81	31.00	15.52	0.56	1.09
Hypoxic 2	261.62	27.93	17.20	0.69	1.13
Hypoxic 3	427.23	28.72	15.57	0.62	1.07
Hypoxic 4	207.11	31.88	14.17	0.60	1.03
Hypoxic Group	280.19	29.89	**15.61**	**0.62**	**1.08**
Std. Dev.	100.62	1.86	**1.24**	**0.05**	**0.04**
p =	0.46	0.19	**0.001**	**0.0006**	**0.003**

1:30 PM

ABSTRACT: Neurodevelopmental Delay Following Neonatal Biventricular Repair of Isolated Coarctation and Aortic Arch Obstruction

B. V. Simon[1], *M. F. Swartz*[1], *J. M. Orie*[2], *H. Adams*[1], *L. E. Seltzer*[1], *R. Angona*[1], *G. M. Alfieris*[1]
[1]*University of Rochester, New York,* [2]*University of Pittsburgh, PA*

Purpose: Neurodevelopmental delay (NDD) is common following single ventricle palliation. However, the incidence of NDD following neonatal coarctation repair through a left thoracotomy or a sternotomy with cardiopulmonary bypass is less understood. We sought to understand the incidence of NDD following neonatal coarctation repair using these two surgical approaches.

Methods: The Vineland-III Adaptive Behavior Scale prospectively evaluated children without a genetic syndrome. An overall composite score, normalized to age and gender, was generated from individual domain scores. Domain scores focused on communication, activities of daily living, and socialization. Neurodevelopmental delay was defined as a composite or domain score at least one standard deviation below the established mean. Isolated coarctation was repaired using a left thoracotomy, while coarctation in conjunction with either an intracardiac defect or arch obstruction (CoA+IC/AO) was repaired through a sternotomy with cardiopulmonary bypass. Children without previous surgery or evidence of congenital heart disease were used as controls.

Results: Of 60 children, 50 required neonatal coarctation repair and 10 were controls. Evaluation was at 8.8 ± 4.9 years, and was similar between groups. Twenty-five (50%) children exhibited evidence of NDD. Composite and domain scores were significantly lower in all children requiring neonatal coarctation repair vs. controls (Figure 1). Twelve neonates had an isolated coarctation repair, and 38 underwent CoA+IC/AO repair. There were no significant differences in preoperative demographics between neonates requiring repair of an isolated coarctation or CoA+IC/AO. The incidence of NDD was significantly greater in children following repair of an isolated coarctation (58.3% vs 0%; *P*=0.005) or CoA+IC/AO (47.3% vs 0%; *P*<0.001) compared to controls. Composite and domain scores of children following neonatal repair of either an isolated coarctation through a left thoracotomy or CoA+IC/AO through a sternotomy with cardiopulmonary bypass were similar (Table 1).

Conclusions: Half of neonates that require coarctation repair exhibit NDD at an intermediate-term follow-up which may warrant early assessment and intervention.

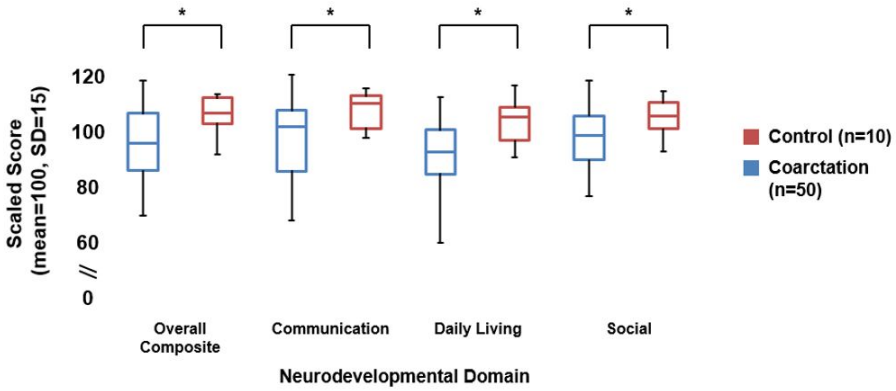


Figure 1. Box and whisker plot depicting neurodevelopmental domain score medians, interquartile ranges, and 95% confidence intervals of the control vs. coarctation groups.
* denotes *P*<0.05

	Isolated Coarctation (n=12)	CoA+IC/AO (n=38)	*P* value
Composite Score	93.5 ± 15.0	91.1 ± 14.8	0.99
Communication Score	97.5 ± 17.6	95.8 ± 18.0	0.84
Daily Living Score	90.0 ± 11.9	86.2 ± 14.4	0.81
Socialization Score	96.3 ± 13.4	93.9 ± 11.5	0.91

Table 1. Composite and domain scores of the isolated coarctation and coarctation + intracardiac defect or arch obstruction (CoA+IC/AO) groups.

1:45 PM

ABSTRACT: Impact of Mesenchymal Stem/Stromal Cell Delivery Through Cardiopulmonary Bypass on Postnatal Neurogenesis in a Juvenile Porcine Model

T. Maeda[1], *K. Sarkislali*[1], *C. Leonetti*[1], *N. Kapani*[2], *Z. Dhari*[1], *I. Al Haj*[1], *R. Ulrey*[1], *P. J. Hanley*[1], *R. A. Jonas*[1], *N. Ishibashi*[1]
[1]*Children's National Health System, Washington, DC,* [2]*George Washington University, Washington, DC*

Purpose: Neurodevelopmental impairment is an important challenge for survivors after pediatric cardiac surgery. Our preclinical studies have shown that cardiopulmonary bypass (CPB) disrupts postnatal neurogenesis. Mesenchymal stem cells (MSCs) promote cell generation in the rodent brain. We investigated the impact of MSC delivery through CPB on neurogenesis in the piglet brain.

Methods: Two-week old piglets (n=12) were randomly assigned to one of 3 groups: (1) Control, (2) Deep hypothermic circulatory arrest (DHCA), and (3) DHCA followed by MSC administration. MSCs ($10x10^6$ per kg) were delivered through CPB during the rewarming period. The brains were fixed three hours after CPB for immunohistochemistry. Recent studies demonstrate that the subventricular zone (SVZ) where most neural stem/progenitor cells (NSPC) originate plays a critical role in neocortical growth of the frontal lobe during

postnatal life. We identified NSPCs and neuroblasts (i.e. young neurons) in the SVZ by SOX2 and doublecortin antibodies respectively. Ki67 determined proliferating cells.

Results: There were no significant differences in the number of SVZ NSPCs among the three groups. On the other hand we observed significant increase in the number of Ki67+SOX2+ proliferative NSPCs after DHCA compared with control ($P<0.05$), indicating that CPB-induced insults promote cell proliferation of SVZ NSPCs during the acute period after surgery. MSC delivery did not alter the CPB-induced increased proliferation of NSPCs ($P<0.05$ vs. Control, $P=0.13$ vs. DHCA). When the number of neuroblasts was analyzed within the SVZ, we found that MSC treatment significantly increased the doublecortin+ cell number in the lateral area of SVZ ($P<0.05$) where neuroblasts form migration chains moving tangentially toward the frontal lobe. Interestingly the thickness of SVZ neuroblasts along the lateral ventricle was reduced after the treatment ($P<0.05$). The findings may indicate that MSC treatment changes neuroblast distribution within the SVZ and promotes migration toward the frontal lobe.

Conclusions: MSC treatment during pediatric cardiac surgery has the potential to promote migration of SVZ neuroblasts toward the frontal lobe thereby improving cortical growth in the neonatal and infantile brain. Further investigation is necessary to determine the long-term effect of MSC delivery though CPB on postnatal neurogenesis.

2:00 PM

Connectome Talk

Jodie Votava-Smith, Los Angeles, CA

2:15 PM

ABSTRACT: Cardiac Xenotransplant in Infants as a Bridge to Allotransplantation: Is It Possible?

C. A. Banks, H. Hara, D. K. Cooper, D. C. Mauchley, R. J. Dabal, S. Borasino, T. Yamamoto, ***D. C. Cleveland***
University of Alabama, Birmingham

Purpose: Infants (<1 year) awaiting cardiac transplant have the highest wait list mortality of any solid organ transplant and there is no satisfactory ventricular assist device. Alternative treatment strategies are needed. To evaluate the feasibility of using genetically engineered (GE) pig cardiac xenotransplant as a bridge, preformed anti-pig antibodies were measured.

Methods: IgM/IgG antibody binding to red blood cells from wild type (WT, genetically-unmodified) and GE pigs that did not express the three main pig carbohydrate antigens (Gal/Neu5Gc/Sda, TKO) were measured in infant serum by flow cytometry. Negative control level IgM/IgG was established by binding to human blood type O RBCs. Group 1 consisted of 50 patients never exposed to any surgical procedure or blood transfusions. These patients were analyzed by age (<30 days, 30-60 days, 60-90 days, 91 days – 1 year). Group 2 consisted of 20 patients that had previous cardiac surgery, blood transfusions and exposure to biologic patches.

Results: Group 1: IgM binding above control was demonstrated in 26 of 50 samples (4/10 < 30 days, 5/10 30-60 days, 2/10 60-90 days, 15/20 90 days – 1 year). IgG binding was demonstrated to be positive in 38 of 50 samples (7/10 <30 days, 7/10 30 – 60 days, 8/10 60 – 90 days, 16/20 91 days – 1 year). In contrast, no patient demonstrated IgM binding to TKO RBCs. One infant (91 days-1 year) showed very weak IgG binding (Figure1). Group 2: There was significant increase in IgM (16/20) and IgG (17/20) binding to WT RBCs after cardiac surgery and exposure to blood transfusions and biologic patches compared to binding from patients not exposed. However, only one of 20 exposed patients demonstrated a weakly positive IgM binding to TKO RBCs and two of 20 demonstrated a weakly positive IgG binding in this group.

Conclusions: Infants have no, or minimal, anti-TKO IgM/IgG response, including patients after previous cardiac surgery, exposure to blood transfusions, and biologic patches. The absence of preformed antibodies to TKO RBCs suggests that there will be no antibody-mediated rejection. Cardiac xenotransplantation from GE pig offers promise as a potential bridge to allotransplantation.

Figure 1

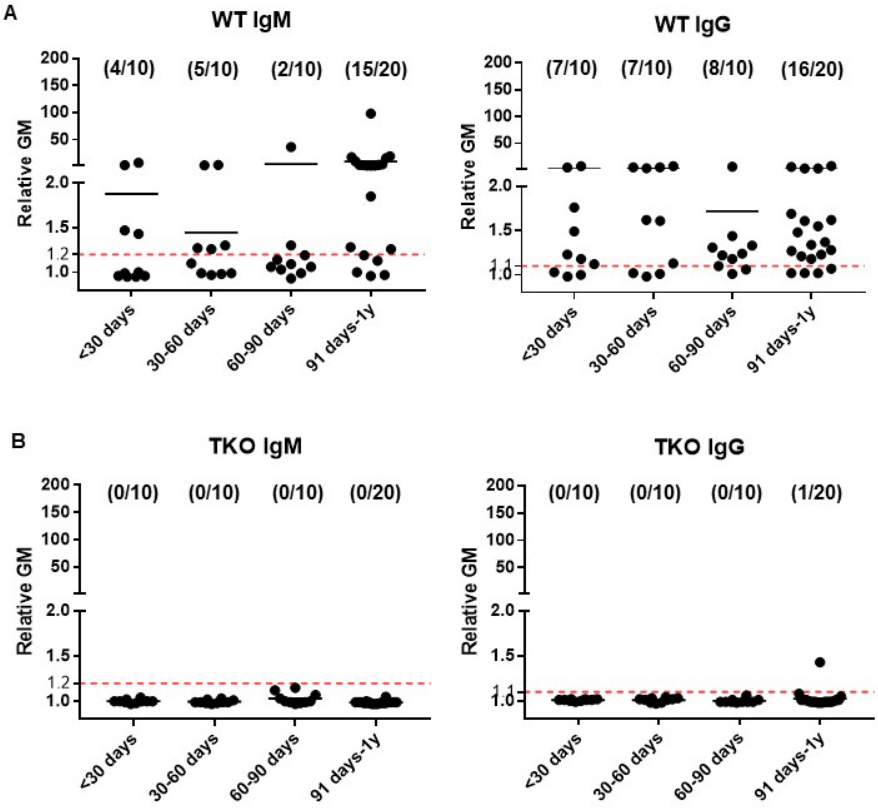


Figure Legend:
IgM (left) and IgG (right) antibody binding to wild-type (WT) (A) and TKO (Gal^{-}/$Neu5Gc^{-}$/Sda^{-}) (B) pig RBCs in infant sera (n=50)
Relative geometric mean (GM) values of >1.2 (for IgM) and >1.1 (for IgG) are considered to be positive (red dotted line).

2:30 PM

ABSTRACT: How Long Should You Be Bridging Your Pediatric Heart Transplant Candidates?

K. W. Riggs*, F. Zafar, A. Lorts, C. Villa, R. Bryant III, D. L. Morales*
Cincinnati Children's Hospital Medical Center, OH

Purpose: Previous studies have demonstrated that ventricular assist device (VAD) support decreases waitlist mortality. Hence, some advocate not listing pediatric patients on VAD support immediately to allow for optimization (end-organ recovery and rehab). Therefore, we sought to determine the duration of VAD support that allows for optimal post-transplant outcomes.

Methods: Pediatric (<18 yrs) transplant recipients with known duration of mechanical circulatory support were identified from the UNOS database. Patients bridged to transplantation with VAD support were grouped by duration of VAD support, <60 days (Group 1), 60-120 days (Group 2), >120 days (Group 3). The inflection points of 60 and 120 days were determined using hazard of mortality (cox-proportional) associated with support time (continuous variable) fitted with cubic spine method. Post-transplant survival as well as change in inotropic support, mechanical ventilation, and functional status were compared among the groups using Kaplan-Meier curves and chi-square analysis, $p<0.05$ being significant.

Results: In 691 patients, differences in baseline characteristics between Group 1 and Group 2 were gender (41% vs 51% female), temporary VAD strategy (15% vs 8%), functional status at transplant (32% vs 51% need minimal assistance or less), mechanical ventilation at transplant (27% vs 10%), IV inotropic support at listing and transplant (60% vs 42% listing; 47% vs 22% transplant), and total bilirubin at transplant (32% vs 19%), $p<0.05$ (Table 1). Intracorporeal versus extracorporeal support was similar for all groups. From time of listing to time of transplant, patients in Group 2 and 3 had a significant decrease in their inotrope use and mechanical ventilation, and an increase in functional status (Figure 1) compared to Group 1. Group 2 had better post-transplant survival than Group 1 ($p=0.022$). Group 3 performed similarly to Group 2 in status improvement but did not have better post-transplant survival than Group 1 ($p=0.537$).

Conclusions: VAD support for >2 months while awaiting cardiac transplantation improves candidacy compared to patients supported for less than 2 months. There is clear survival benefit to being optimized and supported for > 2months; however, despite a continued improvement in functional status after 4 months, the survival benefit plateaus.

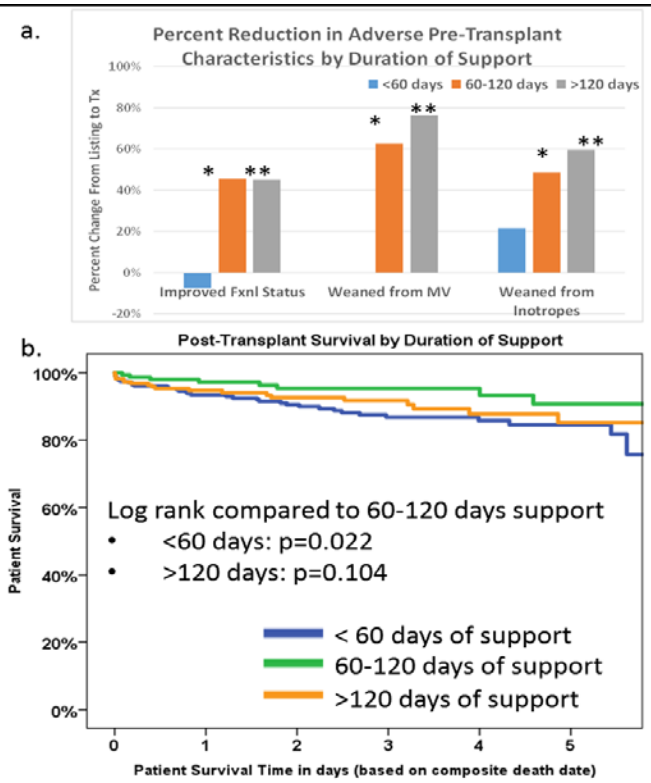


Figure1: Post-transplant survival of the 3 groups demonstrating superior survival in patients supported for 60-120 days compared to those supported < 60 days (a). Improvement in critical pre-transplant factors prior to transplantation based on duration of support showing support <60 days to be inferior to support > 60 days in all categories (b). *Statistically significant comparison between <60 days and 60-120 days of support, p<0.001. **Statistically significant comparison between <60 days and >120 days of support, p<0.001. Fxnl, functional; MV, mechanical ventilation; Tx, transplant.

Patient Characteristics

Variables, Median [IQR] or % (n)	Group 2 60-120 Days of Support (n=156)	Group 1 <60 Days of Support (n=312)	p-value	Group 3 >120 Days of Support (n=223)	p-value
Age (years)	7 [1-13]	10 [1-14]	p=0.320	7 [1-13]	p=0.442
Gender (female)	50.6% (79)	40.7% (127)	p=0.041	42.6% (95)	p=0.122
Weight (kg)	22.2 [8.6-57.1]	*40.2 [14-60]*	p=0.735	26.3 [12.9-55.0]	p=0.215
Diagnosis			p=0.783		p=0.333
Cardiomyopathy	83.3% (130)	79.9% (247)		76.7% (171)	
Congenital Heart Disease	13.5% (21)	15.2% (47)		19.3% (43)	
Re-transplant	1.9% (3)	2.6% (8)		1.3% (3)	
Other	1.3% (2)	2.3% (7)		2.7% (6)	
ECMO at Listing Prior to VAD	11.5% (18)	10.9% (34)	p=0.835	4.9% (11)	p=0.017
Sidedness			p=0.247		p=0.291
LVAD	77.6% (121)	76.8% (239)		84.8% (189)	
BiVAD	19.2% (30)	22.5% (70)		13.9% (31)	
VAD Flow Type			p=0.243		p=0.937
Pulsatile	53.8% (84)	48.1% (150)		53.4% (119)	
Continuous Flow	46.1% (72)	51.9% (162)		46.6% (104)	
VAD Strategy			p=0.044		p=0.044
Temporary	8.3% (13)	14.7% (46)		2.7% (6)	
Durable	87.2% (136)	84.3% (263)		95.1% (212)	
Device Location			p=0.739		p=0.319
Extracorporeal	59.0% (92)	60.6% (189)		53.8% (120)	
Intracorporeal	41.0% (64)	39.4% (123)		46.2% (103)	
Functional Status at Listing			p=0.848		p=0.013
Over 50%	32.1% (50)	31.4% (98)		48.4% (108)	
Lessthan 50%	41.0% (64)	39.7% (124)		33.6% (75)	
Functional Status at Transplant			p<0.001		p=0.016
Over 50%	51.3% (80)	32.1% (100)		63.7% (142)	
Lessthan 50%	22.4% (35)	42.6% (133)		18.4% (41)	
Mechanical Vent at Listing	27.6% (43)	27.2% (85)	p=0.942	17.0% (38)	p=0.014
Mechanical Vent at Transplant	10.3% (16)	27.2% (85)	p<0.001	4.0% (9)	p=0.016
IV Inotropes at Listing	42.3% (66)	59.6% (186)	p<0.001	35.4% (79)	p=0.175
IV Inotropes at Transplant	21.8% (34)	46.8% (146)	p<0.001	14.3% (32)	p=0.060
eGFR < 60 mL/min/1.73 at Listing	14.1% (22)	15.7% (49)	p=0.697	14.8% (33)	p=0.850
eGFR < 60 mL/min/1.73 at Transplant	10.9% (17)	17.0% (53)	p=0.084	13.5% (30)	p=0.377
Total Bilirubin at Transplant , mg/dL	19.1% (29)	31.6% (97)	p=0.005	17.4% (38)	p=0.686
VAD Duration, days	77 [65-91]	24 [11-39]	p<0.001	189 [137-273]	p<0.001

Table 1. Comparison of listing and transplant characteristics of Groups 1 (<60 days) and 3 (>120 days) compared to Group 2 (60-120 days). ECMO, extracorporeal membranous oxygenation; LVAD, left ventricular assist device; BiVAD, biventricular assist device; VAD, ventricular assist device; IV, intravenous; eGFR, estimated glomerular filtration rate

2:45 PM

ABSTRACT: Evolution of Single Ventricular Assist Device Support for Failing Bidirectional Glenn: Lessons Learned

***K. Maeda**, N. Teimour, V. Yarlagadda, S. A. Hollander, M. Navaratnam, D. Rosenthal, J. C. Dykes, B. D. Kaufman, C. S. Almond, O. Reinhartz, J. Murray, S. Chen*
Stanford University, Palo Alto, CA

Purpose: Outcome of ventricular assist device (VAD) for single ventricle (SV) with bidirectional Glenn (BDG) palliation is reported to be worse compared to other stages of SV palliation. It remains unclear which cannulation strategy and type of VAD (pulsatile or continuous) is preferable, and whether BDG should be taken-down not.

Methods: Retrospective review of our institutional experience with VAD implantation for BDG (including one case who underwent BDG at the time of VAD implant) from April 2011 to Aug 2018. Outcomes following implantation were analyzed, including subsequent interventions, quality of VAD output, and patient outcomes.

Results: In total, 6 patients with BDG underwent VAD implantation (5 HLHS, 1 DORV). Weight ranged from 5.6 to 28.8 kg, and age ranged from 7 months to 11 years. Four patients received Berlin Heart, 2 received Heartware HVAD. Four patients underwent ventricular inflow cannulation, while 2 underwent atrial inflow cannulation. BDG was left intact in 3 patients, taken down in 2 patients, and created de novo in 1 patient. Total support days were 292. Three out of 4 patients who kept BDG at the time of VAD implant died early postoperatively of ARDS and multiple organ failure, although one 11yo patient with Heartware HVAD ventricular cannulation with intact BDG underwent successful transplant. Two patients who had BDG take-down with central shunt were well supported more than 30 days, but one patient died of infection after 42 days and another patient is still on support after 55 days, waiting for transplant.

Conclusions: The surgical strategy and management of VAD with BDG are evolving. BDG take-down with central-shunt seems the preferable approach for longer term support. Successful support can be achieved by 1) either pulsatile or continuous flow pumps, 2) atrial or ventricular cannulation, as long as low filling pressure can be maintained.

3:00 PM

ABSTRACT: Treatment of a Patient With Atrioventricular Discordance/Ventriculoarterial Concordance, Large Ventricular Septal Defect, and Situs Inversus: A Modern-Day Indication for the Senning Procedure

J. Hermsen[1], *U. Okorie*[2], *S. Srinivasan*[1], *P. Anagnostopoulos*[1]
[1]*University of Wisconsin, Madison,* [2]*The Marshfield Clinic, WI*

Purpose: This video describes treatment of an extremely rare congenital lesion (atrioventricular discordance/ventriculoarterial concordance, AVD/VAC) that is optimally treated with an isolated atrial level switch procedure.

Methods: The patient described was born at term and found to have AVD/VAC with a large outlet VSD as we as situs inversus totalis. She developed heart failure in the neonatal period and underwent atrial septostomy and pulmonary artery banding. At 8 months of age she had surgical repair consisting of VSD closure and Senning.

Results: The narrated and labeled video describes the patient's anatomy including an illustration from a relevant reference. Neonatal palliation with atrial septostomy and pulmonary arterial banding is discussed. The operative video sequence guides the viewer through the patient's anatomy and the elements of repair in the order they were performed.

Conclusions: Atrioventricular discordance/ventriculoarterial concordance is an extremely rare lesion for which an atrial level switch procedure remains the optimal operative solution. This patient also had a large VSD and situs inversus making the case even more unusual.

1:15 PM – 3:15 PM

General Thoracic: Lung Cancer I

Moderators: *Mara B. Antonoff, Houston, TX, and Sudish C. Murthy, Cleveland, OH*

1:15 PM

ABSTRACT: Clinicopathological and Immune Microenvironment Features Associated With High Tumor Mutational Burden and PD-L1 Expression in Resected Non–Small-Cell Lung Cancer

K. G. Mitchell[1], *M. V. Negrao*[1], *E. R. Parra*[1], *J. Li*[1], *A. Reuben*[1], *A. A. Vaporciyan*[1], *S. G. Swisher*[1], *J. A. Roth*[1], *L. Lacerda*[1], *I. I. Wistuba*[1], *C. Bernatchez*[1], *C. L. Haymaker*[1], *A. Futreal*[1], *C. B. Chow*[1], *J. Zhang*[1], *H. T. Tran*[1], *M. E. Vasquez*[1], *E. Prado*[1], *J. Rodriguez-Canales*[2], *M. Celestino*[1], *A. Weissferdt*[1], *E. Roarty*[1], *T. Cascone*[1], *D. L. Gibbons*[1], *J. V. Heymach*[1], *J. Zhang*[1], *B. Sepesi*[1]
[1]*The University of Texas MD Anderson Cancer Center, Houston,* [2]*MedImmune, Gaithersburg, MD*

Purpose: Though tumor mutational burden (TMB) and PD-L1 expression are leading predictive biomarkers among metastatic non-small cell lung cancer (NSCLC) patients treated with checkpoint inhibitors, predictors of benefit in early disease have not been delineated. We sought to identify characteristics associated with synchronous high TMB and PD-L1 expression among primary NSCLCs.

Methods: Patients undergoing resection for NSCLC (2016-2018) were prospectively enrolled in a multifaceted immunoprofiling project. Multiplex immunofluorescence (mIF) quantified densities (cells/mm^2) of CD3+, CD3+CD8+, CD3+CD8+PD1+, malignant cells (MCs), MCsPD-L1+, CD68+, CD68+PD-L1+, and CD20+ cells in intratumoral and stromal compartments. Whole exome sequencing was performed to identify TMB (somatic non-synonymous mutations/megabase). Of 150 enrolled patients, combined mIF and TMB data were available for 55 chemotherapy-naïve patients. TMB and PD-L1 were dichotomized by the median of observed values; tumor size was modeled as a continuous variable. Nonparametric tests and logistic regression were used to identify factors associated with high TMB and PD-L1.

Results: Of 55 patients, 41.8% (23/55) had pathological stage I, 34.5% (19/55) stage II, 21.8% (12/55) stage III, and 1.8% (1/55) stage IV disease (Table). Median observed TMB (3.91 [IQR 1.59-8.71]) and MCsPD-L1+ (0.62 cells/mm^2 [0.00-30.19]) were low. TMB was higher among smokers (median 5.00 [2.01-10.03] vs 1.45 [0.84-2.33],p=0.001) and tumors with lymphovascular invasion (LVI)(5.02 [3.32-9.01] vs 2.40 [1.36-8.71],p=0.051). TMB was positively correlated with intratumoral MCsPD-L1+ (r=0.293,p=0.030), CD68+PD-L1+ (r=0.289,p=0.033), and CD20+ (r=0.310,p=0.043); and with stromal CD68+ (r=0.266,p=0.050) and CD68+PD-L1+ (r=0.312,p=0.020).Though TMB was not correlated with T cell densities, the density of MCs expressing PD-L1 was associated with increased intratumoral CD3+CD8+ cells (r=0.320,p=0.017). Patients with TMB and MCsPD-L1+ >median (30.9%, 17/55) had higher intratumoral densities of CD3+, CD3+CD8+, CD68+, CD68+PD-L1+, and CD20+ cells, as well as higher stromal CD3+, CD3+CD8+, and CD68+PD-L1+ cells (Figure). Pathological LVI remained independently associated with synchronous high TMB and PD-L1 expression.

Conclusions: TMB and PD-L1 expression appear to be lower in early NSCLC than in the advanced setting. Associations between synchronous high TMB and PD-L1 expression with increased immune cell infiltration, LVI, and nodal metastasis may improve patient selection for novel induction immunotherapy trials. Additional studies are needed to validate our findings.

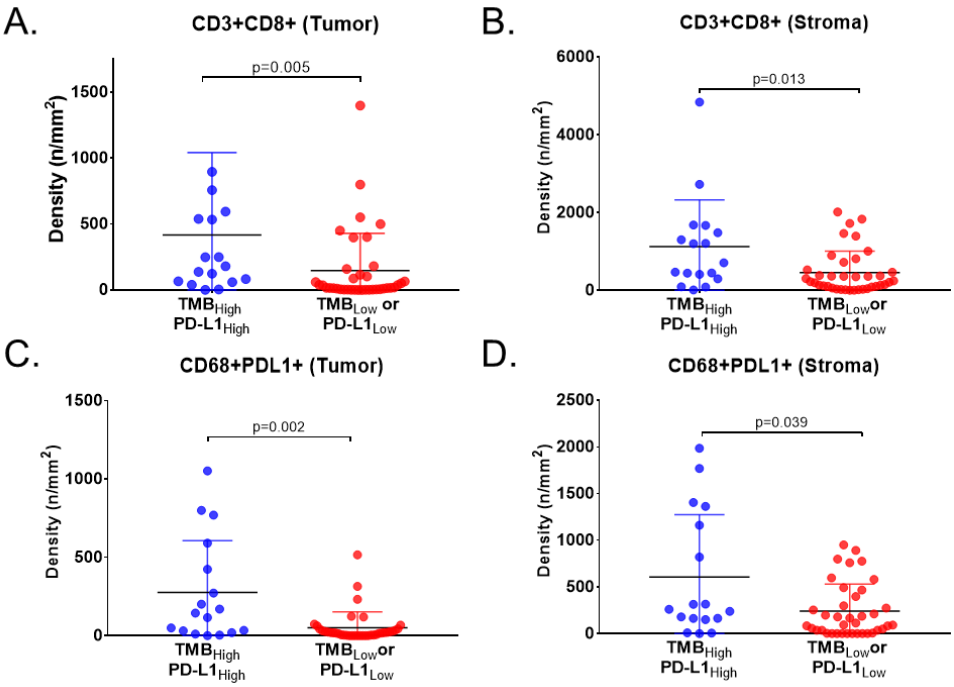


Table: Clinicopathological features associated with NSCLC tumors characterized by synchronous high (>median) tumor mutational burden and membranous PD-L1 expression by malignant cells. ACA: adenocarcinoma; SCC: squamous cell carcinoma.

Univariable Analysis*				
Variable	**N(%)**	**OR**	**CI**	**P**
Age ≥65	34 (61.8)	0.83	0.26-2.68	0.760
Sex (M)	25 (45.5)	1.55	0.49-4.88	0.457
Histology				0.419
ACA	39 (70.9)	1.00 (Reference)	-	-
SCC	14 (25.5)	2.18	0.61-7.82	0.234
Other	2 (3.6)	2.90	0.17-50.82	0.466
Tumor size (cm)	**n/a**	**1.21**	**0.90-1.61**	**0.203**
pN (pN+)	**23 (41.8)**	**2.75**	**0.85-8.90**	**0.092**
Differentiation (Poor)	17 (30.9)	1.96	0.59-6.55	0.274
Lymphovascular Invasion (LVI+)	**24 (43.6)**	**3.53**	**1.06-11.70**	**0.039**
Multivariable Analysis**				
Variable	**N(%)**	**OR**	**CI**	**P**
Lymphovascular Invasion (LVI+)	**24 (43.6)**	**3.53**	**1.06-11.70**	**0.039**
*Included in multivariable analysis if p<0.25 on univariable analysis **Backwards selection performed until p<0.10.				

1:30 PM

ABSTRACT: Identification of High-Risk Patients for Recurrence in Pathological Stage I Lung Adenocarcinoma: Long-Term Follow-Up Data From JCOG0201

Y. Tsutani[1], *K. Suzuki*[2], *T. Koike*[3], *M. Wakabayashi*[4], *T. Mizutani*[4], *K. Aokage*[5], *H. Saji*[6], *K. Nakagawa*[4], *Y. Zenke*[4], *K. Takamochi*[2], *H. Ito*[7], *T. Aoki*[8], *J. Okami*[9], *H. Yoshioka*[10], *M. Okada*[1], *H. Fukuda*[4], *S. Watanabe*[4]

[1]Hiroshima University, Japan, [2]Juntendo University, Tokyo, Japan, [3]Niigata Seirou Hospital, Kitakabahara, Japan, [4]National Cancer Center Hospital, Tokyo, Japan, [5]National Cancer Center Hospital East, Kashiwa, Japan, [6]St Marianna University School of Medicine, Kawasaki, Japan, [7]Kanagawa Cancer Center, Yokohama, Japan, [8]Niigata Cancer Center Hospital, Japan, [9]Osaka International Cancer Institute, Japan, [10]Kansai Medical University Hospital, Hirakata, Japan

Purpose: The purpose of this study was to identify the high-risk population for recurrence as potential candidates for adjuvant therapy in patients with pathological stage I lung adenocarcinoma.

Methods: We analyzed data from 536 patients with pathological stage I lung adenocarcinoma who underwent lobectomy, enrolled in a prospective multi-institutional study (JCOG0201). Pathological invasive tumor size was used as tumor size on the basis of the 8th edition of the TNM classification. Relapse-free survival (RFS) was estimated using Kaplan-Meier method, and univariable and multivariable Cox proportional hazards model was used to identify independent prognostic factors for RFS.

Results: Ten-year RFS of all patients was 83.9% with median follow-up periods of 10.2 years. Multivariable Cox analysis revealed that age (>65 y: hazard ratio [HR], 2.60 (95% confidence interval [CI], 1.67–4.07); p <0.0001), pathological invasive tumor size (>2 cm: HR, 2.70 (95% CI, 1.40–5.23); p = 0.0031), pleural invasion (HR, 2.17 (95% CI, 1.23–3.81); p = 0.0072), and vascular invasion (HR, 2.59 (95% CI, 1.47–4.55); p = 0.0009) were independent prognostic factors for RFS. When patients were divided into high-risk group for recurrence (pathological invasive tumor size of >2 cm or positive for pleural invasion or positive for vascular invasion) and low-risk group (pathological invasive tumor size of ≤2 cm and negative for pleural invasion and negative for vascular invasion), there was a significant difference in RFS between high-risk group (n = 124) and low-risk group (n = 408; (high-risk: HR, 3.61 (95% CI, 2.35–5.55))).

Conclusions: In pathological stage I lung adenocarcinoma, patients with pathological invasive tumor size of >2 cm, pleural invasion, or vascular invasion were high-risk group for recurrence, which may be potential candidates for adjuvant therapy.

1:45 PM

ABSTRACT: Is the Prognostic Significance of Visceral Pleural Invasion Equal in Patients With Pure-Solid or Part-Solid Lung Cancer?

S. Okada[1], *A. A. Hattori*[2], *T. Matsunaga*[2], *K. Takamochi*[2], *S. Oh*[2], *M. Inoue*[1], *K. Suzuki*[2]
[1]*Kyoto Prefectural University of Medicine, Japan,* [2]*Juntendo University, Tokyo, Japan*

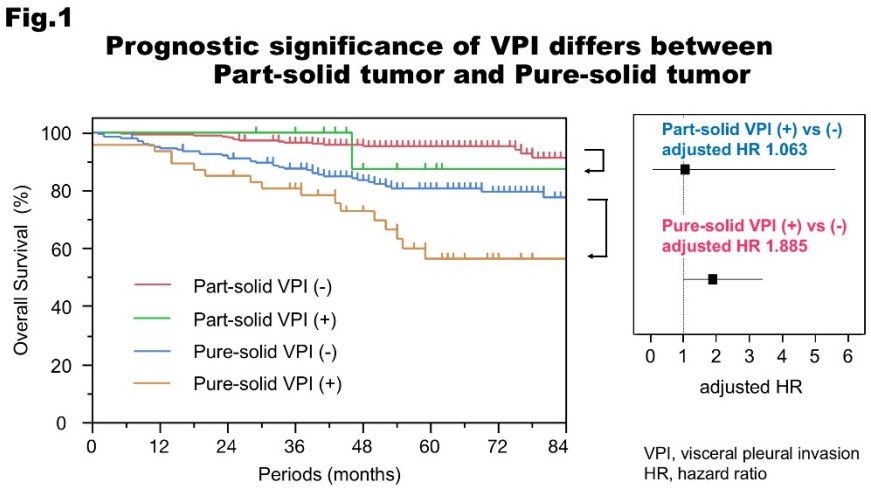
Purpose: Visceral pleural invasion (VPI) is a poor prognostic factor in non-small cell lung cancer (NSCLC). However, the difference in prognostic impact between pure-solid and part-solid tumors is controversial. This study aimed to clarify the prognostic impact of VPI on patients with NSCLC of consolidation size of 3 cm or less.

Methods: A retrospective review of 534 patients with NSCLC who underwent complete anatomical lung resection with lymph node dissection between 2009 and 2014 was conducted. Patients with cT1-sized NSCLCs (radiological consolidation sizes of 3 cm or less) according to the eighth edition of the TNM classification which focused on radiological consolidation size were included. VPI included pathological pl1 and pl2, and patients with pl3 were excluded. The prognostic significance of VPI was evaluated only in patients with pN0. Kaplan-Meier curve analysis and multivariate Cox hazard model were used to evaluate the prognostic impact of VPI according to tumor type (part-solid or pure-solid).

Results: During a median follow-up of 55 months, 251 pure-solid and 283 part-solid tumors were evaluated. VPI occurred in 62 patients (11.6%). In the pure-solid group, the 5-year overall survival (OS) and relapse-free survival (RFS) rates of the patients with VPI were significantly poorer than those of the patients without VPI (p=0.005 and 0.042, respectively). In the part-solid group, the rates did not significantly differ between the two groups (p=0.78 and 0.40, respectively). After adjusting for potential confounders (age, sex, smoking, CEA, SUVmax, total tumor size, consolidation size, vessel invasion, and adenocarcinoma histology), the multivariate Cox hazard model revealed that the adjusted hazard ratio (95% confidence interval, p-value) for poor OS was 1.885 (1.003–3.402, p=0.049) for pure-solid tumors with VPI in reference to pure-solid tumors without VPI and 1.063 (0.058–5.610, p=0.95) for part-solid tumors with VPI in reference to part-solid tumors without VPI (Fig. 1).

Conclusions: Our results suggest that VPI had a negative prognostic impact on the cT1-sized pure-solid tumors, but not on part-solid tumors. This difference suggests a difference in the malignant potentials of part-solid and pure-solid tumors. Upstaging of the T-category by VPI in cT1-sized NSCLCs should be limited to pure-solid tumors.

Fig.1



2:00 PM

DEBATE: Do Clinical Trials Really Matter for Day-to-Day Practice?

Yes: *Linda W. Martin, Charlottesville, VA*

No: *Varun Puri, St Louis, MO*

2:30 PM

ABSTRACT: Outcomes of Patients Discharged Home With a Chest Tube Following Anatomical Lung Resection: A Multicenter Cohort Study

F. Minervini[1], *W. C. Hanna[1], A. Brunelli[2], F. Farrokhyar[1], T. Miyazaki[2], L. Bertolaccini[3], M. Scarci[4], M. Coret[1], K. Hughes[1], L. Schneider[1], Y. Lopez-Hernandez[1], J. Agzarian[1], C. J. Finley[5], Y. Shargall[1]*

[1]McMaster University, Hamilton, Canada, [2]St James's University Hospital, Leeds, United Kingdom, [3]Maggiore Teaching Hospital, Bologna, Italy, [4]San Gerardo Hospital, Monza, Italy, [5]St Joseph's Healthcare Hamilton, Canada

Purpose: Prolonged air leak following lung resections remains a common postoperative complication. With more minimally invasive resections and earlier hospital discharges, more patients are expected to be discharged home with a chest tube. We evaluated post-discharge outcomes and potential risk factors associated with adverse outcomes in this patients' population.

Methods: A retrospective analysis of prospectively collected data from four international tertiary academic centers between January 2014 and December 2017 was undertaken by extracting all patients who were discharged home with a chest tube after anatomical lung resection. Demographics and patient factors, surgical details, hospital readmission, re-intervention, use of antibiotics at discharge, empyema occurrence and mortality were analysed. Chi-square and Mann-Whitney U tests were used to assess patient and operative parameters associated with post-discharge outcomes. Logistic regression was performed to evaluate factors associated with risk of empyema development and need for readmission and intervention.

Results: Overall, 9.1% of patients met inclusion criteria, and of the 253 patients analyzed, 67/857 were from center A (7.8%), 30/759 from center B (3.95%), 147/931 from center C (15.78%), and 9/247 from center D (3.64%) (p<0.001). Median age was 69 years (19-88), 56% males. Despite similar initial LOS (p=0.588), 49 patients (19.4%) were readmitted (21%, 0%, 23%, 11%, centers A-D, respectively, p=0.029) with 18 (37%) developing empyema, 11 (22%) requiring surgery and 3 (6%) deaths. Comorbidities (p=0.1 to 0.9), surgical approach (MIS vs thoracotomy, p=0.75), extent of resection (p=0.577) and antibiotic use (p=0.32) were not associated with risk of readmission. Median chest tube duration was 22 (4-141) days for readmitted vs 16 (1-148) for non-readmitted (p<0.001). Initial duration of chest tube was the only factor associated with development of empyema (p=0.003) with the risk of empyema increasing 3-fold (OR=2.94) with chest tubes in-situ for more than 20 days (Figure 1).

Conclusions: Discharge with chest tube following lung resection is associated with significant adverse events. Given the high risk of empyema development, removal of chest tube should be considered, when appropriate, after 20 days. Our data suggests a potential need for proactive post-discharge outpatient management programs to diminish subsequent morbidity and mortality.

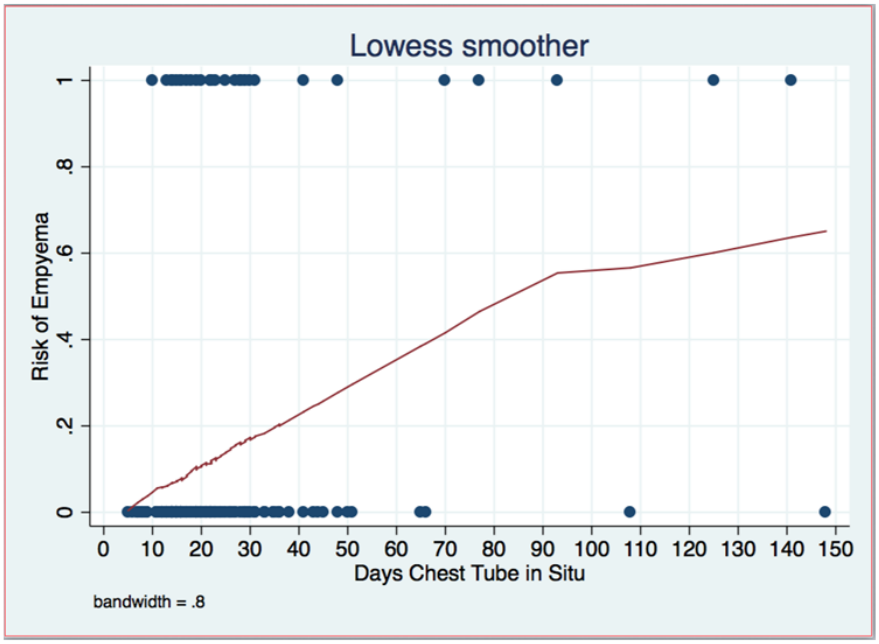


Figure 1: Risk of Empyema development over time for patients with chest tube in-situ (Logistic Regression)

2:45 PM

ABSTRACT: Primary Colorectal Cancer Mutations Predict Survival and Recurrence After Pulmonary Metastasectomy

***E. Corsini**, K. G. Mitchell, R. J. Mehran, D. C. Rice, B. Sepesi, G. L. Walsh, S. G. Swisher, J. A. Roth, W. L. Hofstetter, A. A. Vaporciyan, V. K. Morris, M. B. Antonoff*
The University of Texas MD Anderson Cancer Center, Houston

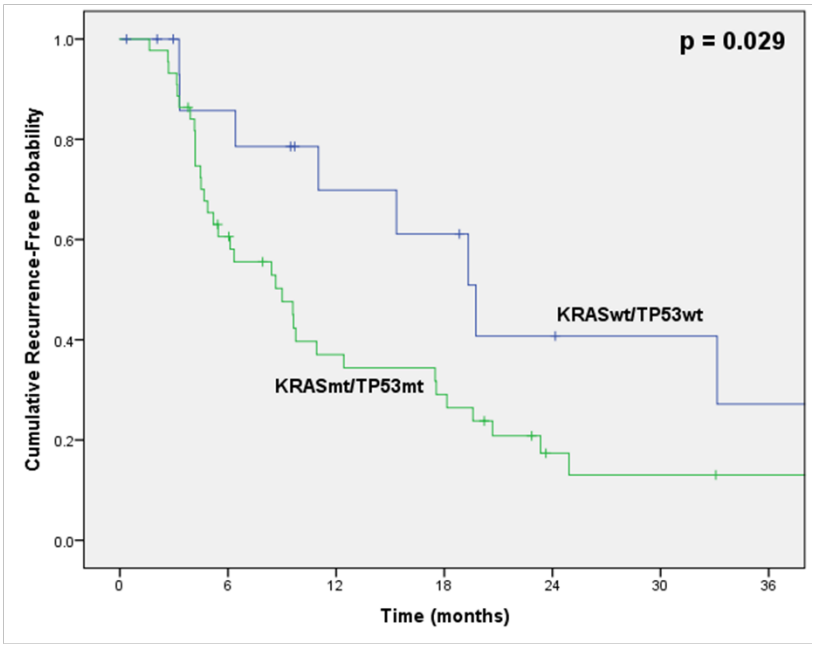
Purpose: While knowledge has grown extensively regarding the impact of mutations on colorectal cancer (CRC) prognosis, the role of mutations in outcome after pulmonary metastasectomy (PM) remains minimally understood. We sought to determine the impact of CRC mutations on survival, disease-free survival (DFS), and lung recurrence after PM.

Methods: Patients with available tumor sequencing profiles who underwent PM for CRC at a single institution from 2011 to 2018 were identified and their charts reviewed. Individuals who underwent initial or subsequent PM at other facilities were excluded. Sex; age; lymphovascular and perineural invasion; CRC stage; 4 of more positive lymph nodes in CRC specimen; disease-free interval prior to first lung occurrence; bilateral pulmonary nodules (PN), 3 or more PN, and size of largest PN in PM; and genetic mutations were tested in univariate and multivariate Cox regression analyses to identify predictors of survival, DFS, and pulmonary disease-free survival (PDFS).

Results: 130 patients met inclusion criteria, among whom 78 (60%) were male and mean age was 57 years. The most prevalent primary location was sigmoid, 50% [64/127]. 70 (54%) presented with a single PM, while 38 (29%) had bilateral PN at initial PM. The median follow-up, survival time, and 5-year survival rate were 33.2 months, 58.2 months, and 47%, respectively. 87 (67%) patients experienced disease recurrence, including 75 (58%) who had at least one lung recurrence after PM. Median time to recurrence was 19.4 months. Upon multivariate analysis, mutations in KRAS, TP53, and APC predicted survival following PM, (Table). KRAS and TP53 mutations predicted DFS, (Figure), while TP53 and APC predicted PDFS in multivariate analyses. No additional factors aside from genetic mutations predicted survival or DFS in univariate analysis. Aside from mutations, age and CRC nodal disease increased hazard of death, and gender predicted PDFS, in univariate analysis.

Conclusions: Following PM for metastatic CRC, mutations play in important role in survival and recurrence. KRAS and TP53 mutations confer increased hazard of death in survival analysis while the APC mutation is protective. KRAS and TP53 predict DFS, and PDFS is predicted by TP53. APC appears protective in analysis of PDFS.

Cumulative recurrence-free probability according to KRAS and TP53 mutations.



KRASwt = KRAS wild type; TP53wt = TP53 wild type; KRASmt = KRAS mutant; TP53mt = TP53 mutant

Prognostic Variables of Colorectal Cancer Metastatic to the Lung Tested in Multivariate Analysis for Survival, Disease-Free Survival, and Pulmonary Disease-Free Survival After Pulmonary Metastasectomy

Variable	HR	95% CI	*p* Value
Overall Survival			
Age (increasing)	1.02	0.99 – 1.05	0.236
At least 4 positive LN in CRC specimen[a]	1.56	0.75 – 3.26	0.236
$KRAS_{mt}$[b]	2.53	1.18 – 5.42	0.017
$TP53_{mt}$[c]	2.47	1.09 – 5.63	0.031
APC_{mt}[d]	0.35	0.16 – 0.78	0.010
Disease-Free Survival			
$KRAS_{mt}$[b]	1.77	1.14 – 2.75	0.011
$TP53_{mt}$[c]	1.73	1.08 – 2.80	0.024
APC_{mt}[d]	0.72	0.47 – 1.11	0.140
Pulmonary Disease-Free Survival			
Male sex	0.75	0.47 – 1.20	0.233
$KRAS_{mt}$[b]	1.50	0.92 – 2.42	0.101
$TP53_{mt}$[c]	2.25	1.32 – 3.84	0.003
APC_{mt}[d]	0.61	0.38 – 0.98	0.041

[a] 9/130 patients were missing pathologic data pertaining to lymph nodes in CRC specimen.
[b] KRAS mutation was present in 57% (74/130) of patients.
[c] TP53 mutation was present in 64% (83/130) patients.
[d] APC mutation was present in 52% (68/130) patients.

HR = hazard ratio; CI = confidence interval; LN = lymph node; $KRAS_{mt}$ = KRAS mutant; $TP53_{mt}$ = TP53 mutant; APC_{mt} = APC mutant

3:00 PM

ABSTRACT: Sublobar Resection of Ground Glass Nodules: Does Margin Matter?

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Purpose: Distance from the resection margin (DM) is an important quality metric predictive of local recurrence (LR) when SLR is performed for pulmonary adenocarcinoma (ADC) presenting as a solid nodule. We hypothesized that when SLR is performed for GGNs, DM is not predictive of LR or survival.

Methods: We performed a retrospective review of our NSCLC database to identify patients with ADC presenting as GGNs and treated by SLR from 2010 to 2017. After re-review of CT scans, patients were divided into 3 groups: pure GGNs (no solid component), part-solid GGNs (solid <50%) and part-solid GGNs >50%. Demographic, clinical, surgical, pathological and outcome variables were collected. Numerical variables were expressed as median [Interquartile range (IQR)] and were compared across the groups using Kruskal Wallis test. Categorical variables were expressed as numbers (percentage), and were compared using Chi square test. Overall survival was estimated using Kaplan Meier method.

Results: 99 patients were identified of whom 36 (35%) had pure GGNs, 32 (33%) had part solid GGNs <50%, and 31 (32%) had part solid GGNs >50%. Demographic, clinical, pathological, and surgical variables in the three groups are shown in Tables 1&2. The majority were white women who were current or former smokers. 47% of patients with pure GGNs had AIS or MIA compared to 9% and 6.5% in the other 2 groups. Nodal metastases were seen in only 2 patients both of whom had part-solid GGNs >50%. Median DM was 1 cm (range:0.1-4.5) and was similar across groups. With a median follow-up of 23 months there were no local or distant recurrences in any patient. 54 patients with a minimum follow-up of 3 years had no recurrence. Subsequent second primary NSCLC occurred in 10 patients (2 within lobe of prior resection). Five-year overall and disease free survival were 93%.

Conclusions: SLR resection for adenocarcinoma presenting as GGN is associated with no local recurrence regardless of distance from the resection margin. Lobar resections should be avoided whenever possible.

Table 1: Demographics and clinical characteristics	Pure GGO (n=36)	Part solid ≤ 50% (n=32)	Part solid > 50% (n=31)	P value
Age	69 (64-75)	72 (65-76)	74 (70-80)	0.077
Gender (female)	24 (67%)	22 (69%)	22 (71%)	0.931
Race (n=65) (White)	19 (83%)	19 (86%)	14 (70%)	0.386
Smoker	31 (86%)	27 (84%)	23 (74%)	0.407
cT size, cm	1.6 (1.2-2)	1.8 (1.4-2.2)	1.50 (1.2-1.8)	0.270
Tumor location				
Upper/middle lobe	22 (61%)	23 (72%)	19 (61%)	0.582
Lower lobe	14 (39%)	9 (28%)	12 (39%)	
Procedure				
Wedge resection	25 (69%)	19 (59%)	15 (48%)	0.216
Segmentectomy	11 (31%)	13 (41%)	16 (52%)	
Number of nodes resected	5 (1-8)	7 (2-9)	6 (3-9)	0.319
Distance from margin (cm)	0.75 (range 0.1–3)	1 (range 0.1–4.5)	(range 0.1–4.4)	0.200

Table 2: Pathological characteristics	Pure GGO (n=36)	Part solid ≤ 50% (n=32)	Part solid > 50% (n=31)	P value
Histology (Minimally invasive / Ais)	17 (47%)	3 (9%)	2 (6.5%)	<0.001
pT size, cm	1.8 (1.0-2.1)	1.7 (1.3-2.2)	1.5 (1.1-1.9)	0.377
pT stage				
Tis / T1a	28 (78%)	22 (69%)	25 (81%)	0.512
T1b/2a	8 (22%)	10 (31%)	6 (19%)	
pN stage				
N0	0	0	0	NA
N1/N2	0	0	2 (6.5%)	
Lymphovascular invasion	0	2 (6%)	2 (6.5%)	
Pleural invasion	0	0	2 (6.5%)	

1:15 PM – 3:15 PM
General Thoracic: Lung Transplantation
Moderators: *Usman Ahmad, Cleveland, OH, and Jasleen Kukreja, San Francisco, CA*

1:15 PM
ABSTRACT: Defining the Optimal Timing of Extracorporeal Membrane Oxygenation as a Bridge to Lung Transplantation
H. Jalal[1]*, M. C. Henn*[1]*, S. Lange*[1]*, M. W. Canter*[1]*, M. S. Damiano*[1]*, T. C. Merritt*[1]*, A. Abarbanell*[1]*, P. Eghtesady*[2]
[1]*Washington University in St Louis, MO,* [2]*St Louis Children's Hospital, MO*

Purpose: There is increasing interest in the role of ECMO as a bridge to lung transplant. Most studies to date, however, have investigated outcomes of patients successfully bridged to transplant, rather than intention to treat. We are interested in determining who is most likely to benefit from this modality of treatment.

Methods: Using the UNOS database, we analyzed 26,416 adults listed for lung transplant since implementation of the Lung Allocation Score (LAS) in 2005. All patients on ECMO at the time of listing for lung transplant were included. Data were collected on patient demographics, characteristics at listing, duration on ECMO after listing, waitlist time, and survival data up to one-year post transplant. The patients were further categorized as successful bridge to transplant, failed bridge to transplant, transplanted off ECMO, or condition improved and removed from waitlist.

Results: At listing, 407/26,416 (2%) of patients were on ECMO. Of these, 244/407 (60%) were male, 106/407 (26%) had history of cigarette use, 23/407 (6%) had prior cardiac surgery (non-transplant), and 46/407 (11%) had prior lung transplant (Table 1). Mean BMI was 25.2±5.4, with mean creatinine of 0.92±0.7 and LAS of 76.0±23.0. A total of 258/407 (63%) were transplanted (20 off ECMO), 141/407 (35%) failed to bridge, and 8/407 (2%) improved and were de-listed. Of the 258 transplanted, only 144/407 (35%) survived to one-year post-transplant. Figure 1 shows cumulative survival of patients as a factor of time on ECMO since listing; for those waiting > 14 days on ECMO, there was less than 40% chance of survival to one-year post-transplant. Older patients, as well as those with diagnosis of pulmonary vascular or restrictive lung disease, or prior history of cardiac surgery appeared to least benefit from ECMO as a bridge to transplant.

Conclusions: ECMO can successfully bridge patients to lung transplant, with one-year post-transplant survival of ~ 50%. A certain subset of patients appear to most benefit from this modality, and optimal chances for being bridged successfully occur within the first two weeks of listing.

Figure 1. Cumulative 1 year post-lung transplant survival versus duration on waitlist for patients successfully bridged on ECMO

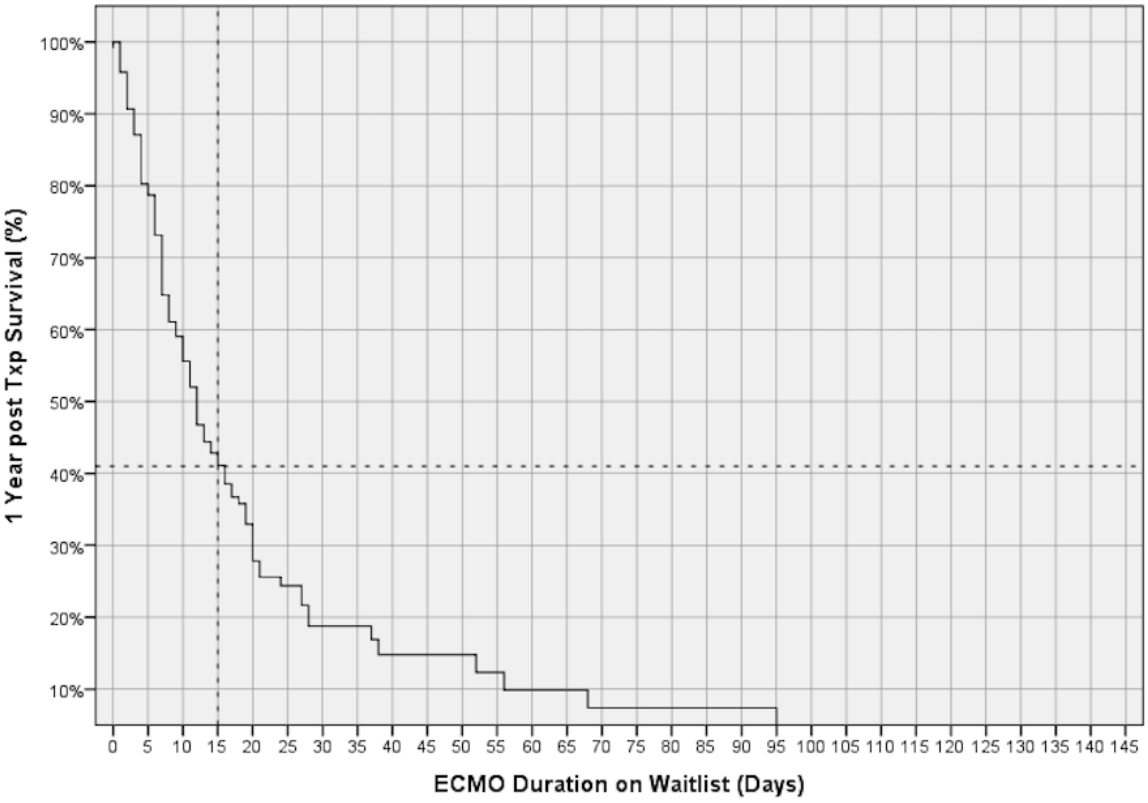

Table 1. Patient Characteristics

Characteristics	1 Year Survival	Non Survivals	P Value
Gender (Male) (n=244)	92 (38%)	152 (62%)	0.92
Age in Years (mean ± StDev)	43 ± 15	46 ± 16	0.08
BMI (mean ± StDev)	24.84 ± 4.99	25.4 ± 5.21	0.45
Diagnosis			0.009
Cystic Fibrosis (n=66)	35 (53%)	31 (47%)	
Obstructive Lung Disease (n=11)	4 (36%)	7 (64%)	
Pulmonary Vasc. Disease (n=22)	6 (27%)	16 (73%)	
Restrictive Lung Disease (n=308)	108 (35%)	200 (65%)	
Prior Cardiac Surgery(n=23)	2 (9%)	21 (91%)	0.92
Prior Transplant (n=46)	22 (48%)	24 (52%)	0.27
Cigarette Use (n=106)	53 (38%)	53 (36%)	0.69
Mechanical Ventilation (n=268)	104 (39%)	164 (61%)	0.4
LAS (mean ± StDev)	75.73 ± 23.88	72.07 ± 25.33	0.72
Creatinine (mean ± StDev)	0.84 ± 0.57	0.88 ± 0.55	0.52

**Categorical variables are presented as N(%) continuous variables are presented as mean ± standard deviation.*

1:30 PM

ABSTRACT: Impact of the Opioid Epidemic on Lung Transplantation: An Analysis of Donor Characteristics, Recipient Outcomes, and Organ Discard

A. F. Ward[1], *K. G. Phillips*[2], *N. K. Ranganath*[2], *J. Malas*[2], *B. E. Lonze*[2], *M. B. Lesko*[2], *N. Moazami*[1], *Z. N. Kon*[2]
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Purpose: The national opioid epidemic has expanded the donor pool for lung transplantation but concerns remain regarding infectious risks and allograft function. We compared donor/recipient characteristics, outcomes, and reasons for organ discard between overdose death donors(ODD) and all other mechanism-of-death donors.

Methods: Data on adult lung transplants from 2000-2017 were provided by the Scientific Registry of Transplant Recipients. Lung allografts used in multiple organ transplantations or from donors after cardiac death were excluded. Information on demographics, pulmonary allograft quality, outcomes, and organ discard were analyzed with regards to ODD since 2010 using parametric and non-parametric tests. Discard analysis was limited to donors who had at least one organ transplanted but their pulmonary allograft discarded, as mechanism-of-death was not provided if all organs were discarded. Kaplan-Meier curves and log-rank tests described overall survival. Statistical analysis was performed using SPSS 25(IBM Corp; Armonk, NY).

Results: From 2010-2017, 7.3%(962/13196) of lung transplantations were from ODD, over a 3-fold increase from the 2.1%(164/7969) in 2000-2007, but still lags behind other solid organ transplants(Figure 1). The highest rates of ODD lung transplantation from 2010-2017 were in Vermont-28.6%(2/7), Delaware-21.5%(14/65), and Massachusetts-16.0%(24/150). Since 2010, drug intoxication is the fourth most common mechanism-of-death in pulmonary allograft donors behind hemorrhage/stroke-36%(4747/13196), blunt injury-23%(3023/13196), and gunshot wound-17%(2288/13196). ODD were younger(median 29 vs 36 years, p<0.001), more likely to have a history of cigarette use (11.6% vs 8.3%, p=0.001), more likely to have hepatitis C(0.8% vs 0.1%, p<0.001), and more frequently had an abnormal pre-transplant bronchoscopy finding(35.7% vs 28.0%, p<0.001)(Table 1). Overall survival was not different between the groups(p=0.174). Discarded ODD allografts were from younger donors and were more likely to be hepatitis C positive(30.8% vs 5.3%, p<0.001), but were less likely to have a history of cigarette use(23.6% vs 29.1%, p<0.001).

Conclusions: While the opioid epidemic in the United States has contributed significantly to the donor pool, the increase has been less dramatic in pulmonary allografts. Further studies are needed to review whether current discard practices regarding ODD lungs are appropriate or whether further expansion of the donor pool is warranted.

Figure 1. Number of Overdose-Death Donors(ODD) from 2000-2016 by Organ Type.

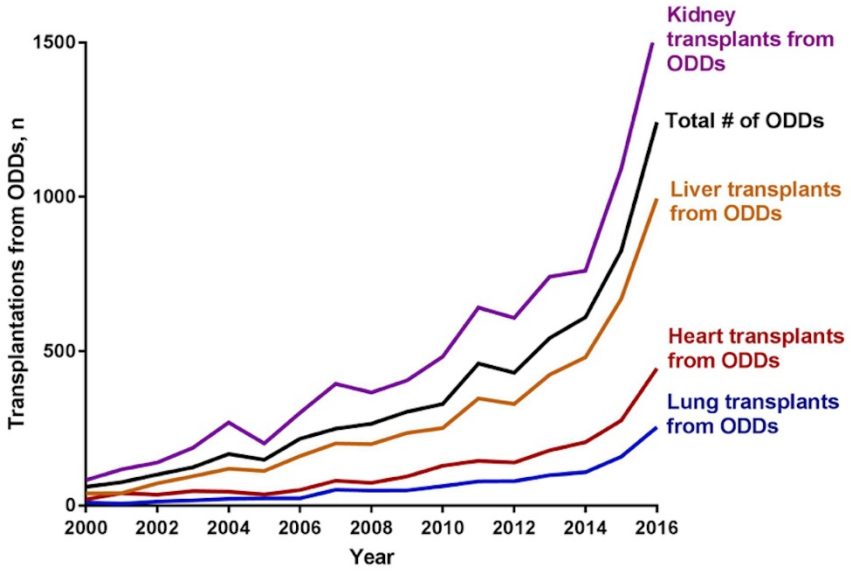

Table 1. Comparison of overdose-death donor (ODD) and non-ODD characteristics, lung allograft quality indices, and discarded allografts by univariate analysis

Donor characteristics	ODD (n=962, 7.3%)	Non-ODD (n=12234,92.7%)	p-value
Donor characteristics [n(%)]			
Age < 40, 13196 (100%)	813 (84.5%)	7070 (57.8%)	<0.001
Male Gender, 13196 (100%)	516 (53.6%)	7314 (59.8%)	<0.001
Caucasian, 13196 (100%)	872 (90.6%)	9175 (75.0%)	<0.001
Hispanic, 13196 (100%)	70 (7.3%)	2038 (16.7%)	<0.001
BMI > 30 kg/m^2, 13196 (100%)	185 (19.2%)	2597 (21.2%)	0.152
Creatinine > 1.5 mg/dl, 13195 (100%)	305 (31.7%)	2519 (19.1%)	<0.001
HCV positive, 13196 (100%)	8 (0.8%)	9 (0.1%)	<0.001
History of cigarette use (>20 pack-yr), 15462 (97.2%)	110 (11.6%)	1006 (8.3%)	0.001
History cocaine use, 12851 (97.4%)	375 (40.5%)	1463 (12.3%)	<0.001
Diabetes, 13131 (99.5%)	26 (2.7%)	990 (8.1%)	<0.001
Hypertension, 13128 (99.5%)	127 (13.3%)	3331 (27.4%)	<0.001
History of malignancy, 13196 (100%)	11 (1.1%)	263 (2.1%)	0.040
Pulmonary allograft quality indices [n(%)] or [median(IQR)]			
Donor inotropic support, 13058 (99.0%)	403 (42.4%)	6012 (49.7%)	<0.001
Cardiac arrest, 12919 (97.9%)	130 (14.0%)	671 (5.6%)	<0.001
Cold Ischemia Time (min), 12845 (97.3%)	311 (245, 379)	300 (239, 368)	0.05
Abnormal bronchoscopy[a], 11635 (88.2%)	302 (35.7%)	3025 (28.0%)	<0.001
PaO2 > 350 mmHg on 100% FiO2, 11994 (90.9%)	580 (66.4%)	7296 (65.6%)	0.683
Discarded Pulmonary Allografts	ODD (4161, 9.0%)	Non-ODD (42120, 91.0%)	
Age, 46281 (100%)	32 [26, 41]	48 [35, 57]	<0.001
HCV Positive, 46267 (100%)	1040 (25.0%)	2193 (5.2%)	<0.001
History of cigarettes > 20 pack year, 45379 (98.1%)	964 (23.6%)	12031 (29.1%)	<0.001
PHS increased risk, 46248 (99.9%)	2596 (62.4%)	5955 (14.1%)	<0.001

[a]Abnormal result includes purulent secretions, aspiration of a foreign body, blood, or anatomy.

1:45 PM

ABSTRACT: Single and Double Lung Transplantation Have Equivalent Survival in Idiopathic Pulmonary Fibrosis Patients

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Purpose: Several studies have described better survival with double-lung transplantation(DLT) compared to single-lung transplantation(SLT) in pulmonary fibrosis. However, those results may reflect selection bias by including patients exclusively listed for SLT or DLT. To avoid that innate bias, this study analyzed those deemed appropriate for either procedure at time of listing.

Methods: All consecutive adult lung transplants for idiopathic pulmonary fibrosis (IPF) provided by the Scientific Registry of Transplant Recipients were retrospectively reviewed (2007-2017). Isolated lobar transplants (N=4), or patients listed only for SLT (N=1834) or DLT (N=2372) were excluded. Group stratification was based on the ultimate procedure (SLT vs DLT). Group propensity matching was performed based on 24 recipient/donor characteristics. Parametric and non-parametric statistical tests were used to compare recipient/donor demographics and outcomes between groups. Kaplan-Meier curves and log-rank tests described overall survival from time of listing and separately from time of transplant.

Results: During the study period, 45%(974/2179) and 55%(1205/2179) of patients that were listed for both procedures ultimately received SLT and DLT, respectively. After propensity matching, 466 matched patients remained in each group. Donor and recipient characteristics were similar between groups(Table). SLT patients were less likely to require prolonged(>48 hours) ventilator support than DLT patients, 31.6%(147/465) vs 42.0%(194/462)(p=0.001). There was also a trend towards SLT patients having reduced rates of post-transplant renal failure requiring dialysis, 2.6%(12/464) vs 5.0%(23/463)(p=0.060), and decreased post-transplant hospital length of stay(median 14 vs 16 days, p=0.084). Overall patient survival since time of listing was 88.3% vs 88.2% at 1 year, 57.4% vs 61.3% at 5 years, and 28.1% vs 24.4% at 10 years for SLT and DLT, respectively. Whether analyzed by time of listing(p=0.711) or time of transplant(p=0.417), overall patient survival curves were not significantly different between groups(Figure).

Conclusions: In this cohort of lung transplant recipients listed for both SLT and DLT, overall survival is similar regardless of ultimately undergoing SLT or DLT. This data suggests that the previously purported survival advantage may purely represent selection bias, and should not preclude the use of SLT in appropriately-selected IPF patients.

Figure. Patient Survival Since Time of Listing (A) and Time of Transplant (B)

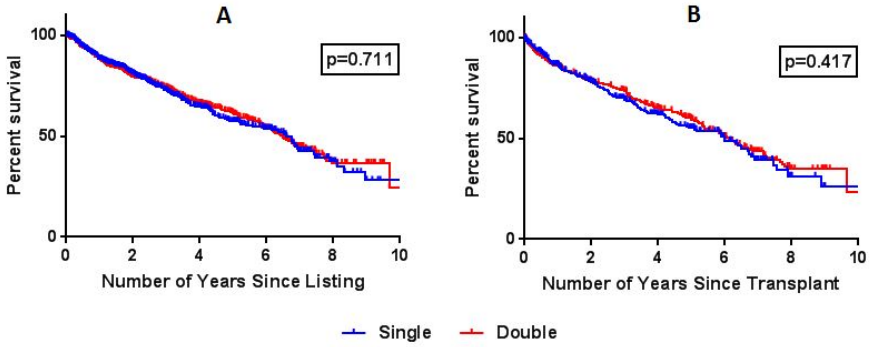

Table. Propensity-matched recipient and donor characteristics in patients listed for both single-lung transplantation (SLT) and double-lung transplantation (DLT)

	SLT (n=466)	DLT (n=466)	p-value
Recipient Demographics			
Age ≥ 70 years	52 (11.2%)	45 (9.7%)	0.520
Male gender	337 (72.3%)	335 (71.9%)	0.942
BMI≥30	113 (24.2%)	121 (26.0%)	0.597
Diabetes	85 (18.2%)	91 (19.5%)	0.676
Creatinine ≥ 1.5	9 (1.9%)	10 (2.1%)	1.000
Prior Lung Surgery	46 (9.9%)	52 (11.2%)	0.594
Days on waitlist ≥ 150 days	131 (28.1%)	131 (28.1%)	1.000
Chronic steroid use	216 (46.4%)	229 (49.1%)	0.431
Medical condition at transplant			
ICU	41 (8.8%)	52 (11.2%)	0.104
Non-ICU	54 (11.6%)	37 (7.9%)	
Non-hospitalized	371 (79.6%)	377 (80.9%)	
Support at time of transplant			
Mechanical Ventilation	20 (4.3%)	27 (5.8%)	0.369
ECMO	11 (2.4%)	7 (1.5%)	0.476
mPAP (mmHg)			
≤ 25mmHg	272 (58.4%)	274 (58.8%)	
25-35mmHg	161 (34.5%)	146 (31.3%)	0.386
35-45mmHg	25 (5.4%)	33 (7.1%)	
≥ 45mmHg	8 (1.7%)	13 (2.8%)	
LAS			
< 45	230 (49.4%)	210 (45.2%)	
≥ 45	120 (25.8%)	127 (27.3%)	0.526
≥ 60	42 (9.0%)	52 (11.2%)	
≥ 75	74 (15.9%)	77 (16.5%)	
Donor Demographics			
Age ≥ 50	82 (17.6%)	85 (18.2%)	0.864
Male Gender	279 (59.9%)	263 (56.4%)	0.319
BMI ≥ 30	78 (16.7%)	73 (15.7%)	0.722
Smoking > 20 pack-years	41 (8.8%)	42 (9.0%)	1.000
Hypertension	103 (22.1%)	100 (21.5%)	0.874
Creatinine ≥ 1.5	95 (20.4%)	85 (18.2%)	0.455
Diabetes	34 (7.3%)	32 (6.9%)	0.899
PaO2/FiO2 < 300	139 (29.6%)	140 (30.0%)	0.943
Ischemic time			
< 2 hours	5 (1.1%)	4 (0.9%)	
2-4 hours	113 (24.2%)	128 (27.5%)	0.624
4-6 hours	279 (59.9%)	261 (56.0%)	
≥ 6 hours	69 (14.8%)	73 (15.7%)	
Increased infectious risk	57 (12.2%)	40 (8.6%)	0.086
Donor after circulatory death	30 (6.4%)	22 (4.7%)	0.318

2:00 PM

ABSTRACT: Extracorporeal Membrane Oxygenation as a Bridge to Redo Lung Transplantation: A Contemporary Analysis of National Data

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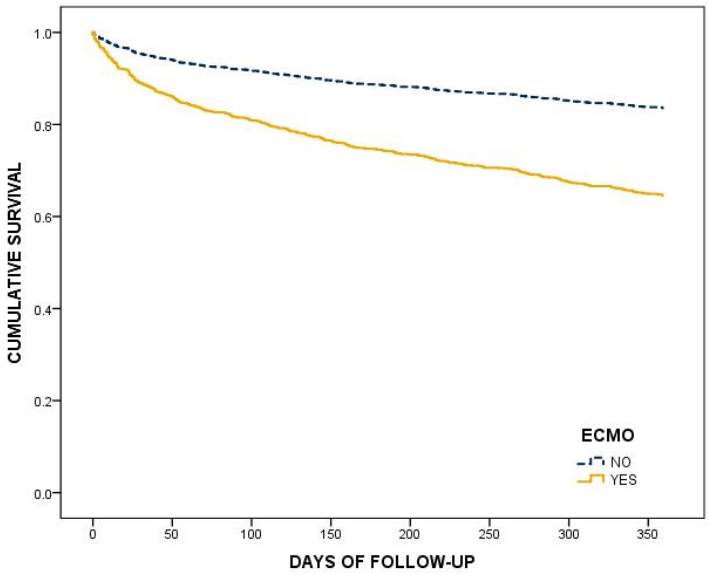
Purpose: The purpose of this study was to examine the influence of extracorporeal membrane oxygenation (ECMO) as a bridge to a redo lung transplantation (LT) on outcomes and survival.

Methods: Data analyzed were from the United Network for Organ Sharing (UNOS) Organ Procurement and Transplantation Network (OPTN) Database pertaining to LT recipients transplanted a second time between 2005 and 2017. A total of 1,960 recipients were categorized according to need for ECMO as a bridge to redo LT: No (*n* = 1,861) and Yes (*n* = 99).

Results: The mean age was 50±14 years and 47% were females. The ECMO group was younger (45 vs 50 years, *P* = 0.001). In both univariate and multivariable analyses (adjusting for age and gender), the ECMO group had greater incidence of prolonged ventilation >48 hours (83% vs 40%, *P* < 0.001) and in-hospital dialysis (27% vs 7%, *P* < 0.001). There were no differences in incidence of acute rejection (15% vs 11%, *P* = 0.205), airway dehiscence (4% vs 2%, *P* = 0.083), stroke (3% vs 2%, *P* = 0.731), or reintubation (20% vs 20%, *P* = 0.998). Kaplan-Meier survival analysis showed that the ECMO group had reduced 1-year survival (66.6% vs 83.0%, *P* < 0.001). After adjusting for age and gender, patients who required ECMO as a bridge to redo LT had more than 2 times greater risk for 1-year mortality (HR = 2.44, *P* < 0.001; FIGURE).

Conclusions: The cumulative 1-year survival of patients bridged to redo LT has improved considerably over the past decade.



2:15 PM

ABSTRACT: Outcomes of Declined Donors in Lung Transplant Recipients in the Current Era

A. L. Axtell*, P. Moonsamy, S. Melnitchouk, G. Tolis, D. D'Alessandro, M. A. Villavicenci*
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Purpose: Donor sequence number (DSN) represents the number of recipients to whom an organ has been offered. The impact of seeing numerous prior refusals may potentially influence a center's decision to accept an organ. We therefore sought to determine if DSN was associated with inferior post-transplant outcomes.

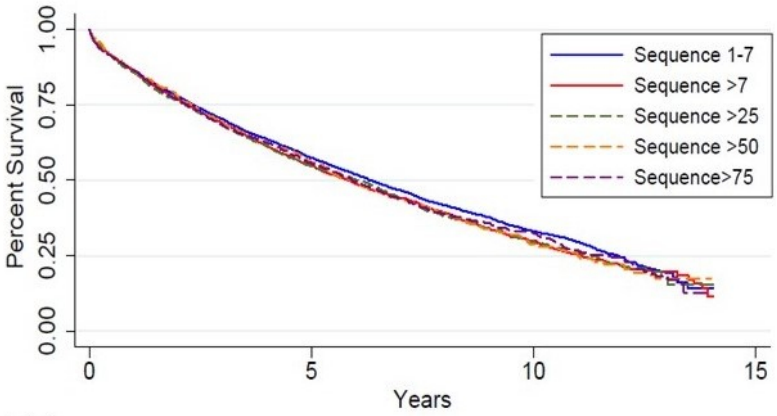
Methods: Using the UNOS database, a retrospective cohort analysis was performed on 22,930 adult patients who received a first-time lung transplant in the US between 2005-2018. Patients were grouped into those with a low DSN (1-7, n=11,690) and those with a high DSN (>7, n=11,240) with additional sensitivity analyses performed for donors with a DSN greater than 25, 50, and 75. Baseline characteristics and post-transplant outcomes including graft failure and re-transplantation were compared between groups and cumulative survival analyzed using a Cox proportional hazards regression model.

Results: For all recipients, the DSN ranged from 1-1735 (median 7, IQR 1-24). A total of 18,975 recipients received an organ with at least one prior refusal and 79% of all prior refusals were for donor organ quality (56% donor age, 27% size, 4% social history, 1% organ preservation or anatomic damage, and 12% other). Recipients of donors with a higher DSN were older (57 vs 54 years, p<0.01) and had longer mean waitlist times (7.1 vs 6.7 months, p=0.02). On adjusted analysis, a high DSN was not associated with an increased

risk for mortality (HR 1.01, 95% CI: 0.96-1.05, p=0.77). Similarly, there was no difference between groups in the incidence of graft failure (p=0.51) or re-transplantation (p=0.42). Recipient subgroups who received donors with an increasing DSN (>25, >50, >75) also demonstrated no increased risk for mortality when compared to recipients in the low DSN group (p=0.43, p=0.46, and p=0.59, respectively).

Conclusions: When controlled for appropriate risk factors, DSN is not associated with increased post-transplant mortality, graft failure, or re-transplantation in patients undergoing lung transplantation. The number of prior refusals should not negatively influence a center's decision to accept a lung for transplant.

Figure 1: Cumulative Post-transplant Survival Stratified by Donor Sequence Number



Number at risk				
Sequence 1-7	11652	3150	551	0
Sequence >7	5565	1547	319	0
Sequence >25	2576	724	159	0
Sequence >50	1105	319	79	0
Sequence>75	1965	579	164	0

2:30 PM

ABSTRACT: Failure to Rescue Is a Significant Contributor to Center-Level Differences in Mortality Following Lung Transplantation

A. A. Osho[1], *M. M. Bishawi*[2], *M. S. Mulvihill*[3], *A. L. Axtell*[5], *S. A. Hirji*[4], *P. J. Spencer*[5], *D. D'Alessandro*[5], *S. Melnitchouk*[5], *M. G. Hartwig*[3], *M. A. Villavicencio*[5]

[1]*Harvard Medical School, Boston, MA,* [2]*Duke University, Durham, NC,* [3]*Duke University Medical Center, Durham, NC,* [4]*Brigham and Women's Hospital, Boston, MA,* [5]*Massachusetts General Hospital, Boston*

Purpose: Complications are not uncommon following lung transplantation (LTx) and the clinical response to these adverse events may contribute to mortality differences between transplant centers. This ability to avoid mortality following a post-operative complication – Failure to Rescue (FTR) – may be an effective quality metric in thoracic organ transplantation.

Methods: The United Network for Organ Sharing (UNOS) database was queried for adult, first-time, lung-only transplantations performed between 05/2005 and 03/2016. Transplantation centers were stratified into equal-sized terciles based on observed mortality rates. Major post-operative complications were identified including stroke, acute rejection, acute kidney injury requiring hemodialysis, airway dehiscence and extra-corporeal membrane oxygenation (ECMO) 72 hours after surgery. Rates of failure to rescue were calculated as proportions, with the denominator being all patients suffering a given postoperative complication, and the numerator consisting of peri-operative mortalities (within 30 days of transplantation and/or prior to discharge) following the occurrence of that complication.

Results: 16,411 lung transplantations performed at 69 transplant centers were included in the analysis. LTx centers were stratified into terciles with average peri-operative mortality of 4.1% for low-mortality centers (N=23), 6.9% for medium-mortality centers (N=23) and 12.4% for high-mortality centers (N=23). Low-mortality centers had slightly lower complication rates (Low-15.0% vs. Medium-17.1% vs. High-19.1%, P<0.001). Differences in failure to rescue were significantly more pronounced, with overall FTR rates of 14.9% in low-mortality centers vs. 23.9% and 34.2% in medium and high-mortality centers respectively (P<0.001). These trends are mirrored in the stratified analysis of FTR rates for individual complications as shown in Figure 1. Multivariable logistic regression models adjusting for age, race, gender, type of transplantation, functional status and lung allocation score suggest that there is an independent relationship between high FTR rates and high mortality in lung transplantation (p<0.001).

Conclusions: Differences in rates of Failure to Rescue (FTR) contribute significantly to per-center variability in mortality following lung transplantation. FTR can serve as a quality metric for both individual programs and regulatory bodies to identify opportunities for improvement as they relate to managing perioperative adverse events.

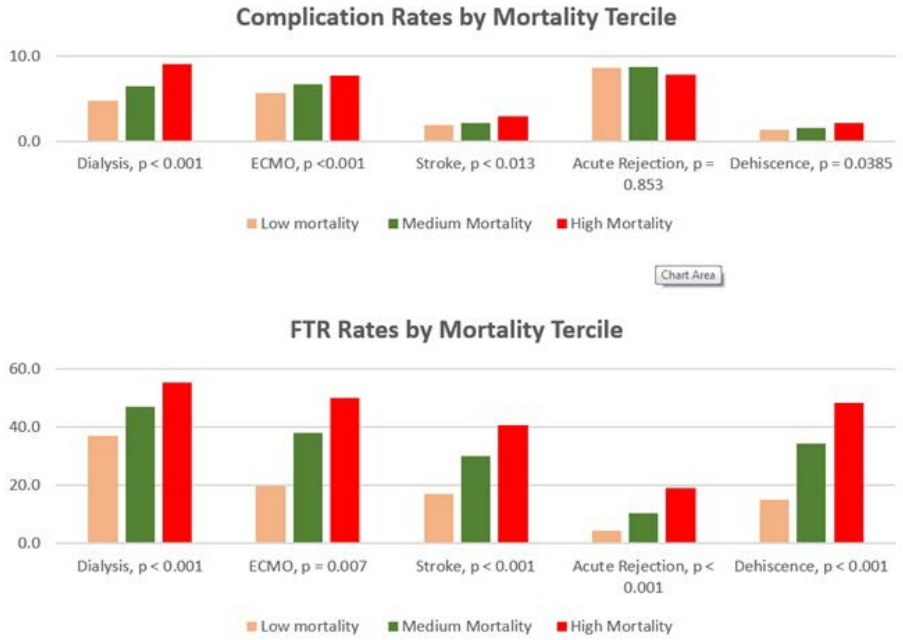


Figure 1: Complication and FTR Rates Stratified by Mortality Terciles

2:45 PM

ABSTRACT: Can Lungs From Donors With Low PaO_2/FiO_2 Ratio and High Body Mass Index Be Utilized for Transplantation With or Without Ex-Vivo Lung Perfusion?

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Cleveland Clinic, OH

Purpose: Our group has demonstrated that donors with high body mass index (BMI) are significantly associated with greater atelectasis and lower PaO_2/FiO_2 (P/F) ratio than those with normal BMI. The purpose of this study was to evaluate the outcome of this new approach in our clinical program.

Methods: Three hundred five lung donors were utilized in 310 lung transplants from Feb 2016 to Aug 2018. Sixty six lung donors (21.6%) met our new marginal criteria (P/F ratio < 300 mmHg or abnormal CXR/CT showing significant infiltrates or massive pleural effusion and BMI > 25) at the time of lung offer. In the donor hospital, surgical inspection, blood gas analysis and lung weight measurement (double lung weight < 1300 grams) following lung recruitment were utilized to make a final decision regarding suitability for EVLP or direct transplantation. Post-operative outcomes were evaluated.

Results: Marginal cases (n = 66) had significantly higher BMI, lower P/F ratio, larger atelectasis area and greater lung weight than standard cases (n = 239). In the donor hospital, 9 donors were declined because of severe pulmonary edema and P/F ratio < 300 mmHg. Thirty two cases (48% of marginal cases) were converted to straight lung transplantation without EVLP, whereas 25 cases (38%) were perfused in EVLP. Following EVLP, 16 cases were utilized for transplantation. Marginal donors demonstrated a significant improvement of arterial P/F ratio after intra-chest recruitment compared with P/F ratio at lung offer (389.2 ± 22.3 vs. 263.2 ± 16.5 mmHg, $p < 0.001$). There was no significant difference in PGD grade 3 at 72 hours, ICU stay, hospital stay and 30 day survival between marginal cases (n = 48) and standard lung transplant controls (n = 262).

Conclusions: These data suggest that atelectasis in high BMI donors contributes to P/F ratios less than 300 mmHg and that intra-operative lung recruitment and/or EVLP can allow utilization of lungs from these donors with good outcomes. These results might increase the number of transplantable lungs.

Table. Marginal cases vs. Standard cases

Groups	Marginal	Standard	P value
Donor demographics			
Age	35.0 ± 5.2	39.8 ± 1.6	0.890
BMI	30.5 ± 1.5	26.8 ± 0.5	0.008
P/F ratio at challenge, mmHg	263.2 ± 16.5	408.2 ± 10.3	< 0.001
Chest findings in procurement			
Lower lobe atelectasis area, %	34.8 ± 5.3	16.8 ± 1.6	< 0.001
Lung weight, gram	933.5 ± 48.5	751.4 ± 34.4	0.010
Arterial P/F ratio, mmHg	389.2 ± 22.3	428.9 ± 15.1	0.134
Outcomes			
ICU stay, days	7.6 ± 1.5	9.5 ± 2.4	0.607
Time to extubation, days	2.7 ± 0.6	2.6 ± 0.4	0.950
Hospital stay, days	19.2 ± 2.2	30.7 ± 3.4	0.199

BMI, Body mass index; P/F ratio, PaO_2/FiO_2; ICU, Intensive care unit.

3:00 PM
Role of Extracorporeal Membrane Oxygenation in Lung Transplantation
Mani A. Daneshmand, Durham, NC

1:15 PM – 3:15 PM
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 pathologies that previously were purely in the domain of cardiac surgeons. This session will offer topics relevant to both fields and provide the perspective of each.

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 massive and sub-massive pulmonary embolism
- Describe the current state of non-femoral access options for delivery of large endovascular devices

Moderators: *Keith B. Allen, Kansas City, MO*, *and Ali Azizzadeh, Los Angeles, CA*

1:15 PM **Alternate Non-Femoral Vascular Access for Large Endovascular Devices**
Keith B. Allen, Kansas City, MO

1:30 PM **Managing Vascular Access Complications**
Ross Millner, Chicago, IL

1:45 PM **Discussion**

1:55 PM **Innovative Devices: The Cardiac Surgeon's Perspective**
Grayson H. Wheatley, Nashville, TN

2:10 PM **Innovative Devices: The Vascular Surgeon's Perspective**
Ali Azizzadeh, Los Angeles, CA

2:25 PM **Discussion**

2:35 PM **The Pulmonary Embolism Team: The Cardiac Surgeon's Perspective**
Lishan Aklog, Purchase, NY

2:50 PM **The Pulmonary Embolism Team: The Vascular Surgeon's Perspective**
Rabih Chaer, Pittsburgh, PA

3:05 PM **Discussion**

1:15 PM – 5:00 PM

Clinical Scenarios: The Heart Team

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 adult cardiac disease processes, speakers will discuss the multidisciplinary approach to aortic valve disease, mitral valve disease, and coronary artery disease. 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 among 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

1:15 PM **Introduction**
Vinod H. Thourani, Washington, DC

Mitral Valve Disease

Moderators: *Vinay Badhwar, Morgantown, WV, Michael J. Mack, Dallas, TX, and Patrick T. O'Gara, Boston, MA*
Panelists: *Ted Feldman, Evanston, IL, Raj Makkar, Los Angeles, CA, Robert L. Smith, Dallas, TX, Vinod H. Thourani, Washington, DC, and Y. Joseph Woo, Stanford, CA*

1:16 PM **Heart Team Discussion With Case Presentations: Patient With Low Ejection Fraction and Functional Mitral Regurgitation**
Y. Joseph Woo, Stanford, CA

1:34 PM **Heart Team Discussion With Case Presentations: Patient With Severe Mitral Annular Calcification**
Raj Makkar, Los Angeles, CA

1:52 PM **Treatment of Functional Mitral Regurgitation: How Do the COAPT Trial Results Change Our Management?**
Michael J. Mack, Dallas, TX

2:02 PM **Update on Surgical and Transcatheter Trials for Mitral Regurgitation**
Vinod H. Thourani, Washington, DC

2:14 PM **Heart Team Discussion With Case Presentations: How I Decide Between Transcatheter or Surgical Repair of Primary Degenerative Mitral Valve Repair**
Gorav Ailawadi, Charlottesville, VA

2:32 PM **Panel Discussion**

Aortic Valve and Aortic Disease

Moderators: *Joseph E. Bavaria, Philadelphia, PA, and Raj Makkar, Los Angeles, CA*
Panelists: *Tirone David, Toronto, Canada, Patrick T. O'Gara, Boston, MA, William M. Suh, Los Angeles, CA, Wilson Y. Szeto, Philadelphia, PA, and Vinod H. Thourani, Washington, DC*

2:42 PM **Heart Team Discussion With Case Presentations: Rationale for Transcatheter or Surgical Aortic Valve Replacementas the Initial Management for Aortic Stenosis in Patients Younger Than 60 Years of Age**
Wilson Y. Szeto, Philadelphia, PA

3:02 PM **Mechanical vs Bioprosthetic Aortic Valve Replacement in Patients Younger Than 60 Years of Age: Recommendations From a Cardiologist**
Patrick T. O'Gara, Boston, MA

3:12 PM **Is the Availability of New Aortic Devices Going to Change Our Index Operation for Type A Dissection?**
Joseph E. Bavaria, Philadelphia, PA

3:22 PM **Case Examples: Treatment of the Moderately Dilated Aortic Root in Tricuspid and Bicuspid Aortic Valve Stenosis—When to Replace the Root vs Just the Aortic Valve**
Eric E. Roselli, Cleveland, OH

3:32 PM **Heart Team Discussion With Case Presentations: Anatomical Considerations for Transcatheter and Surgical Aortic Valve Replacement in Low-Risk Patients**
Vinod H. Thourani, Washington, DC

3:50 PM **Discussion and Case Wrap-Up**

Coronary Artery Disease

Moderators: *John D. Puskas, New York, NY, and Morton J. Kern, Long Beach, CA*
Panelists: *Husam H. Balkhy, Chicago, IL, Ezequiel J. Molina, Chevy Chase, MD, Patrick T. O'Gara, Boston, MA, and William M. Suh, Los Angeles, CA*

4:00 PM **Update on ACC/AHA Guidelines for Coronary Artery Bypass Grafting (CABG): Essentials for the Practicing Cardiac Surgeon**
Patrick T. O'Gara, Boston, MA

4:10 PM **Indications and Techniques for Left Internal Mammary Artery to Diagonal to Left Anterior Descending Bridge Anastomoses**
John D. Puskas, New York, NY

4:20 PM **Heart Team Discussion With Case Presentations: Non-Diabetic Patient With Multivessel Coronary Artery Disease—When to Offer Hybrid Revascularization vs Percutaneous Coronary Intervention (PCI)**
Husam H. Balkhy, Chicago, IL

4:38 PM **Heart Team Discussion With Case Presentations: Deciding Between PCI or CABG in Patients With an Ejection Fraction Less Than 25%**
Ezequiel J. Molina, Chevy Chase, MD

5:56 PM **Discussion**

3:15 PM – 4:00 PM
BREAK—Visit Exhibits and Scientific Posters

4:00 PM – 5:00 PM
Adult Cardiac: Arrhythmia/Atrial Fibrillation
Moderators: *Ralph J. Damiano, St Louis, MO, and Patrick M. McCarthy, Chicago, IL*

4:00 PM
ABSTRACT: Greater Number of New-Onset Atrial Fibrillation Events After Coronary Artery Bypass Grafting Increases Long-Term Mortality Independent of Total Event Duration
*G. Filardo[1], B. D. Pollock[1], B. M. da Graca[1], T. Phan[2], G. Ailawadi[2], V. H. Thourani[3], **J. R. Edgerton**[4]*
[1]Baylor Scott & White Health, Dallas, TX, [2]University of Virginia, Charlottesville, [3]MedStar Heart and Vascular Institute, Washington, DC, [4]Dallas, TX

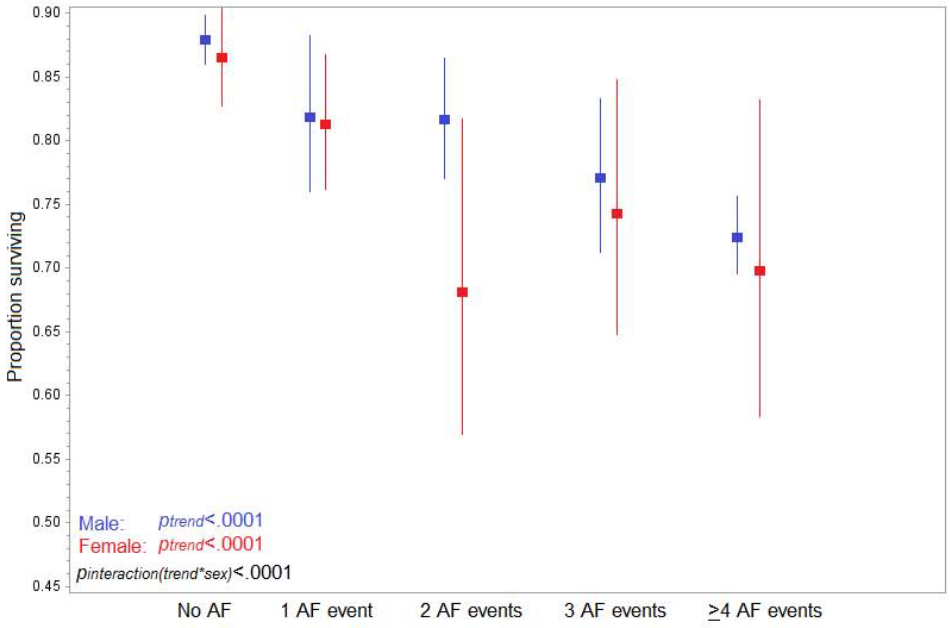
Purpose: New-onset atrial fibrillation (AF) following coronary artery bypass graft surgery (CABG) is associated with poor outcomes, but the effects of its characteristics have not been investigated. We examined the effect the number of distinct AF events has on patients' risk for long-term mortality.

Methods: In this multicenter observational study, routinely-collected Society of Thoracic Surgeons (STS) data were supplemented with detailed data on new-onset post-CABG AF (detected in-hospital via continuous ECG/telemetry monitoring) and long-term survival for 9,203 consecutive isolated-CABG patients (2002-2010). Using Cox regression, we determined the propensity-adjusted (by recognized STS risk factors) effect of number of AF events (0, 1, 2, 3, ?4) on survival, testing for effect modification by sex and controlling for AF total duration.

Results: AF occurred in 739 (29.4%) women and 2,157 (32.3%) men (p<0.001). Following adjustment, women with 2 new-onset AF episodes had the greatest increased risk of 5-year mortality (hazard ratio [HR]; 95% confidence interval [CI]: 2.98; 1.43-4.83, compared to women without AF), followed by women and men with 4+ AF events (HR; 95%CI: 2.76; 1.27-4.55 and 2.73; 2.30-3.19 respectively). Overall, the increased risk of 5-year mortality associated with post-CABG AF was significantly higher among women (p-value interaction AF and sex = 0.001) (**Figure**).

Conclusions: Men and women who experienced 2+ post-CABG AF episodes were at increased risk of mortality within 5 years. While men's risk increased with each additional AF episode, women's peaked at 2 episodes. Future research should investigate whether this is due to sex-based differences in treatment/management or underlying biological differences.

Figure 1. Adjusted† five-year survival (and 95% confidence intervals) by new-onset in-hospital post-CABG atrial fibrillation (AF) events and sex



*†Adjusted for total AF duration, sex*total AF duration interaction, and a propensity-score of 22 STS recognized risk factors*

4:15 PM

ABSTRACT: Impact of New-Onset Postoperative Atrial Fibrillation on 5-Year Clinical Outcomes and Cost

H. Almassi[1], *R. B. Hawkins*[11], *A. W. Shroyer*[2], *B. Hattler*[3], *J. A. Quin*[4], *J. F. Collins*[5], *M. M. Bishawi*[6], *F. Bakaeen*[7], *R. Ebrahimi*[8], *F. L. Grover*[9], *T. H. Wagner*[10]

[1]*Medical College of Wisconsin, Milwaukee,* [2]*Stony Brook University School of Medicine, NY,* [3]*Rocky Mountain Regional VA Medical Center, Denver, CO,* [4]*VA Boston Healthcare System, West Roxbury, MA,* [5]*Cooperative Studies Program Coordinating Center, Perry Point, MD,* [6]*Duke University, Durham, NC,* [7]*Cleveland Clinic, OH,* [8]*University of California, Los Angeles and VA Greater Los Angeles Health Care System,* [9]*University of Colorado School of Medicine, Aurora,* [10]*VA Palo Alto, Menlo Park, CA,* [11]*University of Virginia, Charlottesville*

Purpose: The impact of new-onset postoperative atrial fibrillation (POAF) following coronary artery bypass graft (CABG) surgery on longer-term clinical outcomes and costs is not known. This Veterans Affairs "Randomized On/Off Bypass" Follow-up sub-analysis compared five-year outcomes and costs between patients with and without POAF.

Methods: Patients with pre-CABG atrial fibrillation were excluded (n = 100, 4.8%). New-onset POAF (n = 551) and non-POAF patients (n = 1552) were then compared for five-year clinical outcomes including mortality, major adverse cardiovascular events (i.e., mortality, repeat revascularization and myocardial infarction; including sub-components), stroke, and costs. Risk-adjusted multivariate models for outcome comparisons used patients' baseline characteristics with propensity matching.

Results: Compared to non-POAF patients, POAF patients were older with more complex comorbidities. POAF patients experienced higher unadjusted five-year mortality (16.3% versus 11.9%, $p < 0.001$) and reduced survival ($p = 0.006$). However, there were no significant differences ($p \leq 0.01$) in risk-adjusted five-year outcomes including mortality (odds ratio = 1.19; 99% confidence interval = 0.89 -1.60), cardiac mortality (odds ratio = 1.51; 99% confidence interval = 1.00 – 2.29), major adverse cardiovascular events (odds ratio = 1.06; 99% confidence interval = 0.86 - 1.32), or stroke (odds ratio = 0.83; 99% confidence interval = 0.57 - 1.22). First year post-CABG costs were ~$16,000 higher for POAF patients, but two through five-year costs were not significantly different.

Conclusions: No five-year risk-adjusted outcome differences were found between patients with POAF and without POAF. Although first-year POAF costs were higher, this difference did not persist in subsequent years

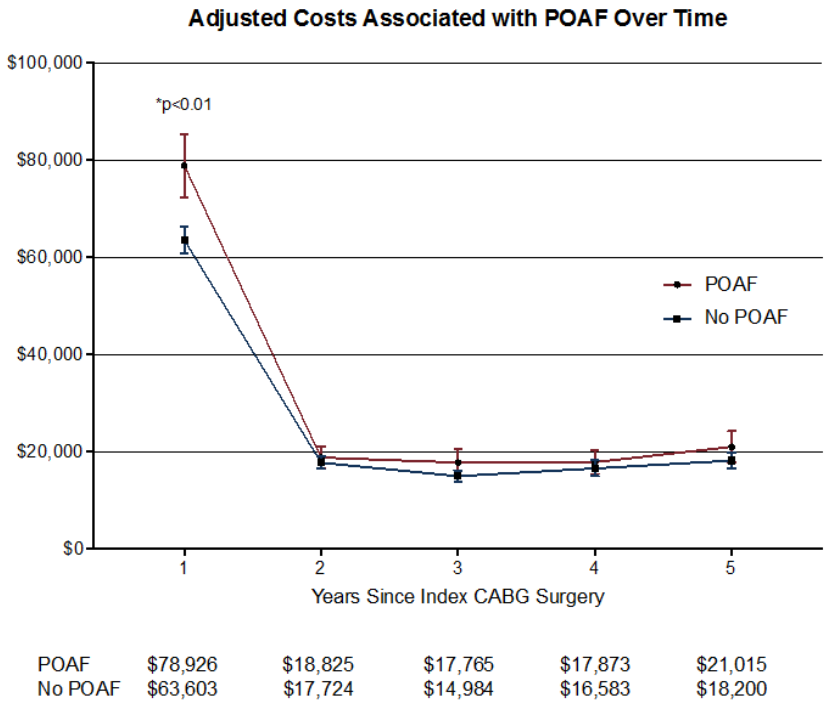


Table: Five-Year Risk-Adjusted Clinical Outcomes

	Risk-Adjusted Results		
	Odds Ratio	99% Confidence Interval	p-value
All Cause Death	1.19	0.89 to 1.60	0.244
Cardiac-related death	1.51	1.00 to 2.29	0.049
Major Adverse Cardiovascular Event	1.06	0.86 to 1.32	0.575
Acute Myocardial Infarction	1.11	0.80 to 1.52	0.538
Repeat Revascularization Procedures	1.03	0.76 to 1.40	0.831
Percutaneous Coronary Intervention	1.03	0.75 to 1.42	0.834
Coronary Artery Bypass Graft	1.12	0.40 to 3.14	0.829
Stroke	0.83	0.57 to 1.22	0.341

4:30 PM
Prophylactic Maze and Left Atrial Appendage Ligation in Patients at High Risk for Atrial Fibrillation
TBD

4:45 PM
Panel Discussion

4:00 PM – 5:00 PM
Adult Cardiac: Contemporary Practices in Surgical Therapy for Advanced Heart Failure
Moderators: *Robert S. D. Higgins, Baltimore, MD, and John M. Stulak, Rochester, MN*

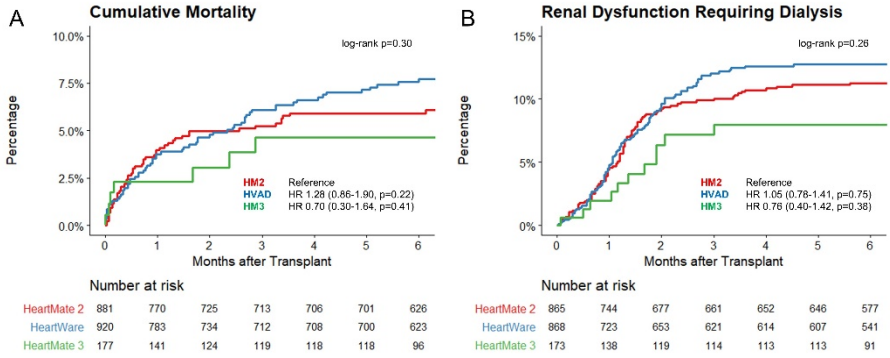
4:00 PM
ABSTRACT: Early Outcomes Following HeartMate 3 Left Ventricular Assist Device as a Bridge to Transplantation: An Observational, Open Cohort Study
A. Suarez-Pierre[1], *C. Lui*[1], *X. Zhou, T. C. Crawford*[2], *C. D. Fraser*[1], *K. Giuliano*[1], *S. Hsu*[1], *R. S. Higgins*[1], *G. J. Whitman*[2], *C. W. Choi*[2], *A. Kilic*[2]
[1]*Johns Hopkins University, Baltimore, MD,* [2]*The Johns Hopkins Hospital, Baltimore, MD*

Purpose: Continuous-flow left ventricular assist devices (CF-LVAD) are being increasingly used as a bridge-to-transplantation (BTT). The HeartMate 3 (HM3) is the newest device to receive FDA-approval as BTT (August 2017). This study examines early outcomes following HM3 as BTT in comparison to the HeartMate 2 (HM2) and HeartWare (HVAD) devices.

Methods: Utilizing the OPTN database, we identified all adult patients who had BTT with a CF-LVAD (HM2, HVAD, or HM3) implanted between April 2015 and May 2018 (inclusive). The primary endpoint was all-cause mortality 6-months after transplantation. Waitlist-specific secondary outcomes were rates of VAD exchange, pump thrombosis, device malfunction, device infection, and degree humoral sensitization. Post-transplantation secondary outcomes were graft rejection requiring treatment and renal dysfunction requiring dialysis at 6-months. The independent influence of bridging device on risk-adjusted outcomes was determined using Cox proportional hazard models.

Results: 1,978 patients were bridged to transplantation with either a HM2 (n=881), HVAD (n=920), or HM3 device (n=177). Six-month mortality rates were similar across these devices (HM2=5.9%, HVAD=7.7%, HM3=4.7%, log-rank p=0.30). On average, HM2 patients were on an LVAD for 2 months longer (HM2=11.0, HVAD=9.1, HM3=9.3, p<0.01). HVAD had the lowest rate of device exchange prior to transplant (HM2=8.2%, HVAD=4.8%, HM3=6.2%, p=0.01). HM3 had no events of pump thrombosis (HM2=7.8%, HVAD=7.3%, HM3=0%, p<0.01). HVAD patients had the lowest rate of device malfunction prior to transplant (HM2=5.4%, HVAD=1.8%, HM3=4.5%, p<0.01). The rate of device infection was similar across all devices (HM2=15.0%, HVAD=12.2%, HM3=11.9%, p=0.41). Panel reactive antibodies (PRA) at the time of transplantation (HM2=11.6%, HVAD=13.3%, HM3=6.6%, p<0.01) were lower for HM3 patients; however, rates of graft rejection at 6-months were not different (HM2=23.3%, HVAD=21.4%, HM3=26.4%, log-rank p=0.25). Rates of renal dysfunction at 6-months were similar across devices (HM2=11.3%, HVAD=12.7%, HM3=8.0%, log-rank p=0.26).

Conclusions: The HeartMate 3 device provides excellent early outcomes as a bridge to heart transplantation and may be associated with a reduction in comorbidities after transplantation. Longer follow-up is needed to better define differences between durable assist devices.



4:15 PM
ABSTRACT: A New Paradigm in Temporary Mechanical Circulatory Support: 100-Patient Experience With a Novel, Minimally Invasive, Temporary Left Ventricular Assist Device
J. S. Chung, D. Emerson, A. Akhmerov, D. Megna, M. V. Aguillon, C. Runyan, R. Cole, J. Moriguchi, ***D. Ramzy***
Cedars-Sinai Medical Center, Los Angeles, CA

Purpose: Acutely decompensated heart failure presents a complicated challenge for modern cardiac surgeons[1]. Established temporary support measures present multiple problems[2]. A novel minimally invasive temporary left ventricular assist device has been developed to support these patients. Here we present outcomes with the first 100 patients at a single, high volume center.

Methods: Patients presenting from 2014-2018 with acutely decompensated advanced heart failure who failed medical management and required additional support using a temporary left ventricular assist device (LVAD) were evaluated in a retrospective manner using a prospectively maintained database. Patients were bridged using the device to a)recovery, b)durable LVAD, or c)heart transplant. All

devices were placed using a subclavian artery approach. Demographics and outcomes were evaluated for each group and compared between groups.

Results: In total, 103 patients underwent insertion of an axillary minimally invasive temporary LVAD. Patients had an average age of 57, were predominantly male (83%), had severely depressed LVEF (average 19%), and were classed at an average INTERMACS score of 1.5 (median 1). Duration of the axillary temporary LVAD use was on average 19 days, with a maximum of 110 days. When divided into groups, there was no difference in age or INTERMACS score, but a statistical difference was noted in baseline LVEF (25%, 16%, 17%), creatinine (1.7, 2.6, 2.0), and baseline mean PA pressure (26, 37, 37), in bridge to recovery, device, or transplant, respectively, with a trend towards improved baseline characteristics among bridge to recovery patients. Survival was 71% overall, and 64%, 58%, and 83% for bridge to recovery, device, and heart transplant, respectively (p=0.05). Survival improved during this experience, and was 90% overall in the most recent 30 patients.

Conclusions: This minimally invasive LVAD system is an attractive strategy to support patients with acute decompensated heart failure to recovery, durable LVAD, or heart transplant. Our use of this device demonstrates excellent and reproducible results, potentially representing a shift in the standard of care in the management of these complicated patients.

4:30 PM

ABSTRACT: Heart Transplant Waiting List Implications of Increased Ventricular Assist Device Use as a Bridge to Transplantation: A National Analysis

***J. J. Han**, H. S. Elzayn, M. Helmers, A. M. Acker, W. L. Patrick, A. Iyengar, E. Y. Birati, P. Atluri*
University of Pennsylvania, Philadelphia

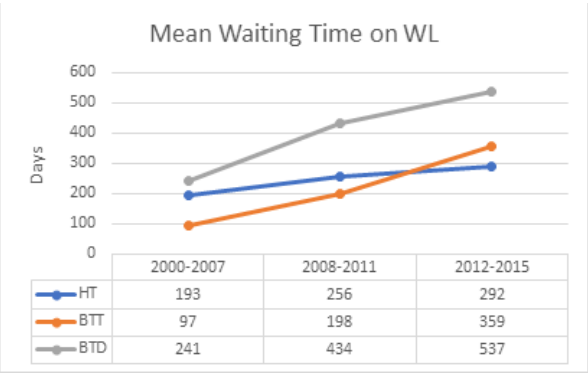
Purpose: The use of ventricular assist devices (VAD) as a bridge to heart transplant (HT) is increasing while the HT volume remains stagnant, which may portend a more challenging and stringent environment for patients on the waiting list (WL).

Methods: A retrospective analysis of patients who received HT in the United Network for Organ Sharing (UNOS) database from 2000 to 2015 were analyzed. Patients were stratified by their transplant strategy into three groups: those who were directly transplanted (direct HT), those who received VADs prior to listing (BTD) and those who received VADs after listing (BTT). Mean waiting time (WT), HT reception rate (%HT), death rate (%death) and removal rate from waitlist for reasons other than HT and death (%removal) were analyzed across first (2000 to 2007), second (2008 to 2011) and third eras (2012 to 2015).

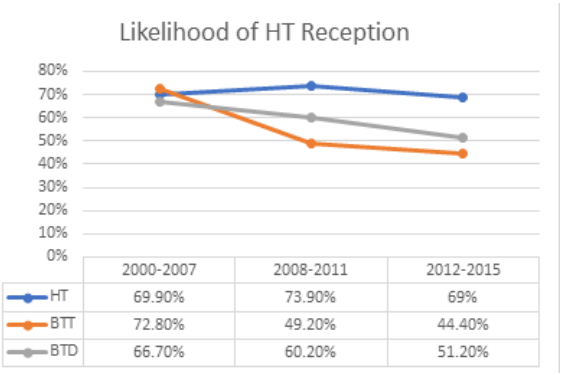
Results: During the study period, 30,623 patients received HT. Of these, 27,324 (89.2%) were direct HT, 1,596 (5.2%) were BTD and 1,703 (5.6%) were BTT. The size of the WL grew across the eras (9,054pts, 10,304pts, 12,296pts, p<0.05). Proportion of VAD patients was stable (12.3%, 7.3%, 10.5%). Across all groups, WT increased over time (190 days, 260, 307, p<.01). This trend held for individual groups: direct HT (193, 256, 292, p<.01), BTT (97, 198, 359, p<.01), and BTD (241, 434, 537, p<.01).

HT reception rate was stable in the direct HT group (69.9%, 73.9%, 69.0%); however, it significantly decreased in the BTD (66.7%, 60.2%, 51.2%, p<.01) and BTT groups (72.8%, 49.2%, 44.4%, p<.01). %Removal was stable in the direct HT group, but increased significantly in the BTD (6.7%, 14.3%, 22.1%, p<.01) and BTT (3.3%, 17.1%, 21.4%, p<.01) groups. Despite these trends, likelihood of death on the waiting list decreased over time across all groups (18.3%, 15.8%, 13.8%, p<.01).

Conclusions: Overall, WT for HT increased from 2000 to 2015. Among patients with VADs as a part of a bridge strategy, decreased %HT and increased %removal were also observed, signifying a growing proportion of patients who may de facto be considered as destination therapy as the volume of VAD implantation continues to grow.



	2000-2007	2008-2011	2012-2015
HT	193	256	292
BTT	97	198	359
BTD	241	434	537



	2000-2007	2008-2011	2012-2015
HT	69.90%	73.90%	69%
BTT	72.80%	49.20%	44.40%
BTD	66.70%	60.20%	51.20%

4:45 PM

Intermacs and the STS National Database: Latest Updates

Robert L. Kormos, Pittsburgh, PA, and Francis D. Pagani, Ann Arbor, MI

4:00 PM – 5:00 PM
Cardiothoracic Surgery Education
Moderators: *Erin A. Gillaspie, Nashville, TN, and Rishindra M. Reddy, Ann Arbor, MI*

4:00 PM
ABSTRACT: The American Board of Thoracic Surgery 10-Year Maintenance of Certification Exam Improves and Validates Knowledge Acquisition
Y. L. Colson[1], *J. B. Putnam*[2], *S. C. Yang*[3], *J. I. Fann*[4], *A. A. Vaporciyan*[5], *J. A. Dearani*[6], *D. R. Jones*[7], *M. S. Allen*[6], *B. F. Meyers*[8], *C. D. Wright*[9], *R. J. Shemin*[10], *W. A. Baumgartner*[11], *D. A. Fullerton*[12]
[1]*Brigham and Women's Hospital, Boston, MA,* [2]*Baptist MD Anderson Cancer Center, Jacksonville, FL,* [3]*Johns Hopkins University School of Medicine, Baltimore, MD,* [4]*Stanford University Medical Center, CA,* [5]*The University of Texas MD Anderson Cancer Center, Houston,* [6]*Mayo Clinic, Rochester, MN,* [7]*Memorial Sloan Kettering Cancer Center, New York, NY,* [8]*Washington University in St Louis, MO,* [9]*Massachusetts General Hospital, Boston,* [10]*University of California, Los Angeles,* [11]*Johns Hopkins University, Baltimore, MD,* [12]*University of Colorado School of Medicine, Aurora*

Purpose: Demonstration of effective knowledge acquisition through MOC is elusive. Previous “high-stakes” examinations required remote testing, were not tailored to individual practices and were non-educational. Given the ABTS mission of public safety and diplomate education, the ABTS-MOC examination was revised in 2015 to improve the educational experience and validate knowledge acquired.

Methods: Using questions based on specific clinical scenarios, the ABTS-MOC Committee developed a web-based, secure examination tailored to the specialty-specific practice profile (cardiac, general thoracic, cardiothoracic, congenital) of the individual surgeon. After an initial answer to each question, the examinee reviewed a detailed, educational critique with pertinent references before returning to the initial question and logging a second (final) response. Intra-exam learning was assessed comparing scores before and after reading the critique, with the final response used to calculate passing metrics. Diplomate feedback was utilized to assess convenience, clinical relevance and educational value via a post-exam survey.

Results: A total of 938 Diplomates completed the 10-year MOC examination between 2015 and 2017. Substantive learning occurred during the exam with average improvements of 20%, 17%, 21% and 6% in the cardiac, general thoracic, cardiothoracic and congenital final scores, respectively (Table). This improvement was most notable among Diplomates with the lowest initial scores, gaining 33%, 43%, 32%, and 16% (respectively) after reviewing the critiques. Compared with prior high-stakes MOC exams from 2010-2014, fewer diplomates failed the new exam (<1% vs 2.3%) and over 95% of diplomates answered all questions correctly for their final score (vs < 50% of Diplomates on the high-stakes exam). Diplomate survey results markedly improved in clinical relevance (35% vs 78%), convenience (37% vs 78%), and learning (15% vs 45%). Over 80% of examinees stated that the exam provided educational value and 97% preferred the new format vs. the prior exam.

Conclusions: The new MOC process demonstrates increased knowledge acquisition through a convenient, secure, web-based practice-focused examination. It eliminates the high-stakes, limited feedback format of prior exams, identifies baseline knowledge gaps for individual diplomates, and validates new knowledge attained.

	Composite data for 2015-2017 MOC 10-year exam			
Subspecialty Exam	CARDIAC	THORACIC	CARDIOTHORACIC	CONGENITAL
n (total = 938)	264	206	408	98
	Average % correct answers			
Initial Answers	75%	78%	74%	93%
Final Score	95%	95%	95%	99%
Substantive Learning	20%	17%	21%	6%

4:12 PM
ABSTRACT: Debunking the July Effect in Cardiac Surgery: A National Analysis of More Than 430,000 Procedures
R. Shah, *S. A. Hirji, S. Goel, S. H. Kiehm, F. Yazdchi, T. K. Kaneko*
Brigham and Women’s Hospital, Boston, MA

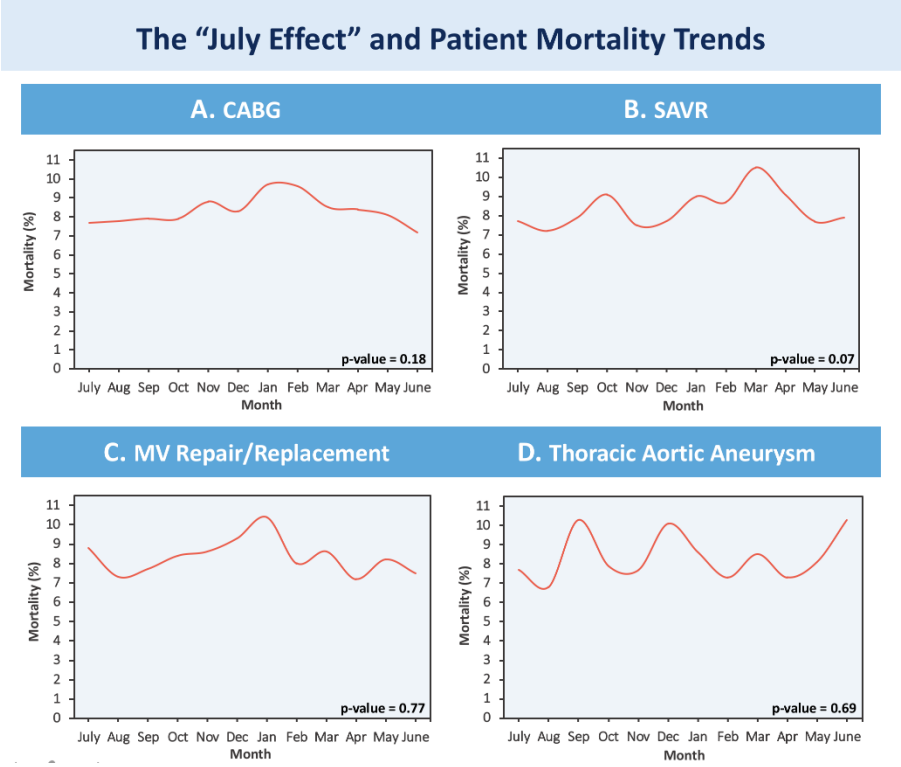
Purpose: Recent studies in non-cardiac surgery have described worse outcomes in the first month of training. However, the ‘July effect’ in the context ofcardiac surgical outcomes is not well understood. We aimed to examine whether patient outcomes following cardiac surgery were affected by procedure month or academic year quartile.

Methods: The National Inpatient Sample was utilized to isolate all coronary artery bypass grafting (CABG), surgical aortic valve replacement (AVR), mitral valve repair or replacement (MVR) and isolated thoracic aortic aneurysm (TAA) replacement procedures between 2012-2014. Overall trends in in-hospital mortality and hospital complications were compared by procedure month and academic year quartiles (i.e. between 1stacademic year quartile (Q1) versus 4thquartile (Q4). Outcomes between teaching and non-

teach hospitals were also compared. Logistic regression models were used to independent predictors for in-hospital mortality. Post-estimation analyses were used to obtain risk-adjusted mortality rates for each surgery.

Results: During the study period, 301,105 CABG, 111,260 SAVR, 54,985 MVR and 2,655 TAA procedures were performed. In-hospital mortality for each procedure did not vary by procedure month (**Figure**). Even after adjusting for patient-level characteristics (such as age, race, gender and insurance status) and hospital-level characteristics (such as size, location, teaching status, admission acuity), Q1 admission did not predict in-hospital mortality for CABG (OR 1.0, 95%CI: 0.9-1.2), SAVR (OR 1.0, 95% CI: 0.8-1.3), MVR (OR 1.0, 95% CI: 0.8-1.3) and isolated TAA replacement (OR 1.1, 95% CI 0.1-37.3, all p>0.05). Teaching vs. non-teaching status did not influence risk-adjusted mortality for CABG and isolated TAA replacement (both P>0.05). However, teaching hospitals had significantly lower mortality than non-teaching hospitals for SAVR (3.17% vs. 3.97% for Q1, 3.12% vs. 3.92% for Q4) and MVR (4.40% vs. 5.78% for Q1, 4.24% vs. 5.58% for Q4, all p<0.01).

Conclusions: The "July Effect" is not evident for cardiac surgery despite pre-existing notions. Teaching hospitals performed at least equivalent, if not better, for major cardiac surgery procedures. Earlier resident teaching and autonomy may be appropriate, whenever possible, in an era when cardiac surgery programs are balancing graduate medical education with outcomes.



4:24 PM

ABSTRACT: Social Media Engagement Improves Dissemination of Cardiothoracic Surgery Scholarship: A Prospective Study

J. G. Luc[10], *M. A. Archer*[1], *R. C. Arora*[2], *E. M. Bender*[3], *A. Blitz*[4], *D. T. Cooke*[5], *T. Nihici*[6], *B. Kidane*[2], *M. Ouzounian*[7], *T. K. Varghese*[8], *M. B. Antonoff*[9]

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Purpose: The Thoracic Surgery Social Media Network (TSSMN) represents a collaborative effort of leading journals in cardiothoracic surgery highlighting publications via social media, specifically Twitter. We sought to determine the impact of TSSMN activity on scientific article views by prospectively studying the effect of scheduled tweeting on non-traditional bibliometrics of dissemination.

Methods: Fifty-six representative original articles (2017-2018) were randomly selected, with 28 (50%) from the *Annals of Thoracic Surgery* and 28 (50%) from *The Journal of Thoracic and Cardiovascular Surgery*. Four articles per day were tweeted by TSSMN delegates for 14 days. Altmetrics (an objective quantification of attention received by scientific publications on online platforms), Mendeley reads, and Twitter analytics were compared immediately prior to tweet and seven days post-tweet for each article. Impressions are the number of times article tweets were viewed by unique individuals, while engagements are the events in which individuals interacted with a tweet (re-tweets, link clicks, etc.)

Results: Seven days post-tweet, the featured articles each achieved an average of 2295 impressions and 68 engagements (13 retweets, 10 likes, and 13 link clicks to the respective journal website to view the full text). Tweeting via TSSMN significantly improved article Altmetric scores (Pre-tweet mean 0 vs. Post-tweet 8, p<0.001), Mendeley reads (Pre-tweet mean 1 vs. Post-tweet 3, p<0.001) and Twitter impressions (Pre-tweet 2715 vs. Post-tweet 4808, p<0.001) (Figure). Incorporating photos into the tweets and tweeting at various times throughout the day (9am EST, 1pm EST, 5pm EST, 9pm EST) were not associated with change in social media impact. In comparing amongst article categories tweeted (n=14 per category), articles published in adult cardiac surgery achieved the highest change in Altmetric score (p=0.028), were more likely to be retweeted (p=0.042) and have more Mendeley reads (p=0.028) compared to those published in the categories of education, general thoracic surgery and congenital surgery (Table).

Conclusions: Dissemination of scholarly literature via TSSMN Twitter activity improves article Altmetric scores, Mendeley reads, and Twitter analytics, with greater audience exposure and access of publications after social media highlights. Future analyses will determine if wider social media engagement affects the citation impact of the scholarly work and author *h*-index.

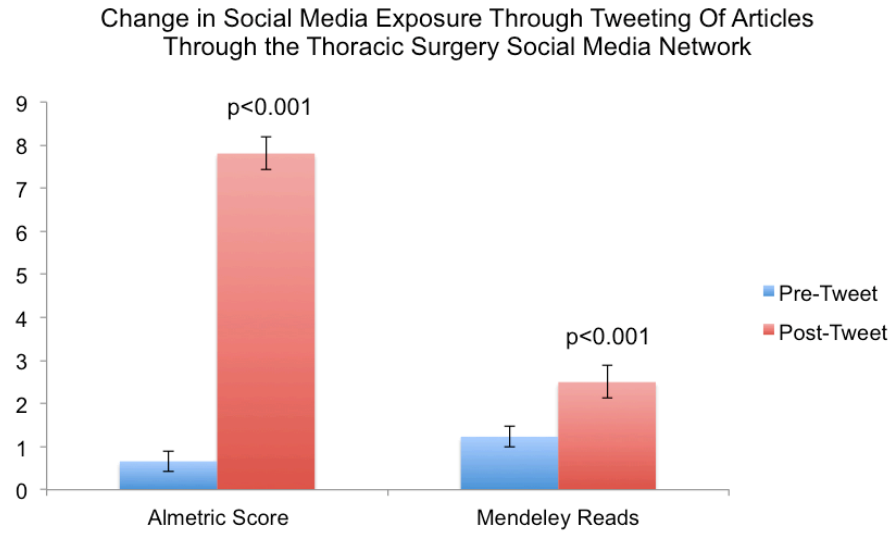

Table: Change in Altmetrics and Twitter Analytics By Article Category

		Education	General Thoracic	Adult Cardiac	Congenital	P-Value
Change in Altmetric	Score	7.43	6.79	8.57	5.79	0.028
	Tweet	13.79	13.79	16.21	12.00	0.042
	Mendeley	0.50	0.50	2.50	1.57	0.028
	Twitter Followers	47136.07	36798.28	37645.93	31232.00	0.717
Change in Twitter Analytics	Impressions	927.50	620.79	667.43	569.43	0.289
	Total Engagements	13.36	6.79	11.43	7.86	0.553
	Retweets	13.43	12.71	12.71	11.57	0.284
	Likes	1.21	0.71	1.07	0.57	0.704
	URL Clicks	3.50	0.79	1.50	1.57	0.151
	Hashtag Clicks	0.21	0.00	0.07	0.21	0.360
	Detail Expand	2.71	1.21	2.71	1.36	0.441
	Media Views	7.29	3.50	3.71	3.00	0.518
	Media Engagements	2.43	1.36	3.71	1.43	0.761

4:36 PM

ABSTRACT: Female Representation Among STS Authorship Positions Over Time: Has Academic Achievement Paralleled Changes in the Workforce?

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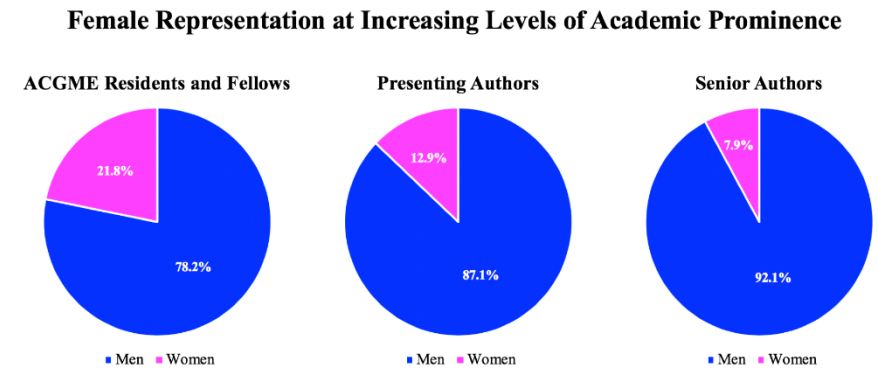
Purpose: Recent years have shown a promising increase in women comprising the cardiothoracic (CT) surgery workforce and training positions. It remains unclear whether such change has been accompanied by parallel increases in academic achievement. We examined female representation over time among the authors of Society of Thoracic Surgeons (STS) presentations.

Methods: STS Annual Meeting online archives from 2015 and 2018 were reviewed for male and female representation among oral presentation authors, with attention paid to first and senior author positions. In addition, *Annals of Thoracic Surgery* (*ATS*) editorial board and STS nominated leadership positions (councils, annual meeting task forces, and workforces) were assessed for female

representation. Differences between male and female representation, as well as changes over time, were assessed with chi-square and t-tests.

Results: In 2015, among 336 presenting and senior author positions, 36 (10.7%) were filled by women, vs 300 (89.3%) by men, p<0.001. Of the women, 22 (13.1%) were presenting authors and 14 (8.3%) were senior authors (p<0.001 vs men for both). Between 2015 and 2018, no increase was observed in female authorship, with 29/278 (10.4%) authorship positions filled by women, vs 249/278 (89.6%) by men, p<0.001. In 2018, women comprised 18 (12.9%) presenting and 11 (7.9%) senior authors (Figure). This lack of change in representation over time held true in the cardiac, congenital, thoracic, education, and quality improvement subspecialties, for both presenting and senior authors. However, there were significantly more female *ATS* editorial board members in 2018 than in 2015 (14 [15.7%] vs 4 [5.4%], p=0.029). Similarly, there was a trend toward women more often occupying nominated STS leadership positions in 2018 than in 2015 (82 [12.8%] vs 44 [8.6%], p=0.077).

Conclusions: Despite increased representation in the CT surgical workforce, societal membership, and leadership positions, women remain stagnant in their underrepresentation in academic authorship, particularly at the senior level. There remains ample room for improvement, further validating the STS's recent emphasis on diversity and inclusion.



4:48 PM

ABSTRACT: Relationship Between Personality Factors and Match to Cardiothoracic Residency Training

F. Manetta[1], *A. J. Kent*[2], *P. Yu*[1], *J. S. Kent*[1]
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Purpose: Training in cardiothoracic surgery is challenging. Residency directors recognize that factors beyond traditional criteria must be considered to accurately predict an applicant's proclivity for success in residency training. This research identified personality traits training directors look for in applicants and then measured how closely they select candidates with those traits.

Methods: Attending physicians in cardiothoracic surgery were administered a Modified TIPI (measures of "BIG-5" Personality traits). Applicants seeking acceptance I6 cardiothoracic surgery residency were separately administered the NEO-PI-3 Personality inventory. Statistical analysis was done to identify trainer's ideal resident's personality; quantify normative personality traits among applicants to cardiothoracic surgery residency programs; determine what if any personality factors predicted match to residency training, and determine how closely were residency directors able to select candidates with the personality profile matching their ideal candidate.

Results: Trainers in cardiothoracic surgery rated high levels of conscientiousness as the most important personality factor for a successful applicant, followed closely by low levels of emotional instability, and then high level of interpersonal functioning. Compared to the general population, applicants in cardiothoracic surgery on average, score significantly higher in conscientiousness, and openness to experience, and significantly lower in the area of emotional instability. There was no difference between applicants and the general population in extroversion and agreeableness. No broad personality trait predicted match in cardiothoracic surgery, However, higher rates of anxiety (a subfactor of emotional instability) among applicants was positively correlated with matching into residency training in cardiothoracic surgery.

Conclusions: Cardiothoracic surgery naturally attracts applicants with personalities training directors seek. However, current methods for applicant screening struggle to assess the variability of personality within this subpopulation. The use of standardized personality testing as part of the candidate screening process, may provide incremental utility in selecting the most optimal candidates.

4:00 PM – 5:00 PM
Congenital: Adult Congenital
Moderators: *Charles B. Huddleston, St Louis, MO, and Ram Kumar Subramanyan, Los Angeles, CA*

4:00 PM

ABSTRACT: Adult Congenital Heart Disease: Current Early Expectations for Cardiac Transplantation

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Purpose: Adult congenital heart disease (ACHD) patients have unique characteristics making them more challenging to transplant than non-ACHD patients. This has been shown in the past to lead to higher early mortality, yet long-term survival is consistently comparable. We sought to compare current 1-year survival of ACHD versus non-ACHD transplant recipients.

Methods: All heart transplant recipients ?18-year old were identified from the UNOS database from 2000 to 2017. Patients with ACHD were compared to non-ACHD patients. Patient characteristics and preoperative variables between the two groups were compared, including renal and liver function, degree of sensitization based on PRA, body-mass index (BMI) (kg/m^2), and transplant era (2000-2008 vs 2009-2017). Data is reported as median or percent and compared using non-parametric tests of independence or chi-square or Fischer's exact test when appropriate. One-year post-transplant survival was compared between subsets of the ACHD and non-ACHD population.

Results: 1079 ACHD recipients and 33,448 non-ACHD recipients were identified. ACHD patients were younger (35 vs 56 years), more female (38.5% vs 24.5%), lower BMI (23.6 vs 26.6), more normal renal function (77.2% vs 71.6%), more impaired liver function (32.8% vs 27.6%) more sensitization (30.6% vs 23.1%), fewer VADs (8.7% vs 32.9%) and received more induction therapy (81% vs 77%), all $p<0.001$. Compared to early era, late era ACHD patients had better one year survival (85.7% vs 77.8%) despite higher BMI (24.1 vs 23.0), being older (37 vs 32 years), with more VADs (10% vs 5%), longer waitlist times (149 vs 95 days), more status 1 listing (47% vs 38%), and more sensitization (15% vs 10%), all $p<0.005$ (Table 1). In the recent era (2009-2017), ACHD patients with either normal/low BMI, normal liver function, VAD at listing or transplant, or non-sensitization have comparable 1-year survival to non-ACHD patients, all $p>0.05$.

Conclusions: ACHD patients' survival has significantly improved. Early survival is now equivalent to non-ACHD patients in many ACHD cohorts. Since 2009, non-overweight ACHD patients, those with normal hepatic function, those with VAD at transplant, or PRA <50%, all have survival similar to non-ACHD patients, > 87% one-year survival.

Characteristics of Adult Congenital Heart Disease Populations

Recipient Variable [IQR], (%)	2000-2008 n=495	2009-2017 n=584	*p* -value
Ageat Trasnplant, years	32 [23-44]	37 [26-48]	<0.001
Gender, female	189 (38%)	226 (39%)	0.862
Ethnicity			0.488
White	412 (83%)	476 (82%)	
Black	35 (7%)	54 (9%)	
Hispanic	33 (7%)	32 (6%)	
Other	15 (3%)	22 (4%)	
Weight, kg	67 [57-79]	70 [59-83]	0.002
Overweight/Obese	180 (37%)	266 (46%)	0.003
GFR (mL/min/1.73)			0.961
<60	108 (23%)	133 (23%)	
60-90	142 (30%)	168 (29%)	
>90	228 (48%)	280 (48%)	
Total Bilirubin at Transplant ≥ 1.2 mg/dL	175 (38%)	165 (29%)	0.002
Listing Status IA	59 (12%)	82 (14%)	0.347
Listing Status IA or IB	189 (38%)	277 (47%)	0.002
Intra-aortic Balloon Pump	15 (3%)	17 (3%)	0.908
ECMO	8 (2%)	8 (1%)	0.739
VAD at Transplant	27 (5%)	67 (11%)	<0.001
Time on Waitlist	95 [31-307]	149 [46-401]	0.001
Ischemic Time	3.5 [2.8-4.2]	3.5 [2.7-4.1]	0.744
PRA Sensitivity ≥ 10%	104 (23%)	158 (39%)	<0.001
PRA Sensitivity ≥ 50%	48 (10%)	87 (15%)	<0.001

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ABSTRACT: Transconal Unroofing of a Septal Course of Anomalous Aortic Origin of a Left Coronary Artery With Posterior Elongation of the Right Ventricular Outflow Tract

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Cleveland Clinic, OH

Purpose: Anomalous origin of left coronary artery from aorta (AAOLCA) which arises from the right sinus and traverses the interventricular septum causes ischemia during exertion. Coronary artery bypass grafts fail due to competitive flow. We devised a technique of coronary artery unroofing with right ventricular outflow tract elongation.

Methods: This video illustrates the surgical technique of anomalous left coronary artery unroofing with posterior elongation of the right ventricular outflow tract. The patient is a 45-year-old woman who presented with angina, ischemia on stress echocardiography, and no coronary artery stenoses on angiography. She was found to have an anomalous left main coronary artery arising from the right coronary artery, diving down into the interventricular septum, and emerging laterally to bifurcate into the LAD and circumflex arteries. Traditional coronary artery bypass grafting was a poor treatment option due to the lack of fixed coronary artery stenosis.

Results: Following initiation of cardiopulmonary bypass with ascending aortic and bicaval cannulation, with the heart beating, the single coronary artery ostium is isolated and its branches are carefully dissected. The anomalous left main coronary artery is followed until it is seen entering the interventricular septum. At this point, the aortic cross clamp is applied and cardioplegic arrest established for accuracy. The anterior right ventricular outflow tract (RVOT) infundibulum is divided below the pulmonary valve. As the incision in the RVOT is extended rightward, the unroofing begins. Crossing muscle fibers and fibrous tissue are carefully dissected off the left main coronary artery along its entire course until it emerges to the left of the RVOT, thereby dividing the RVOT. A rectangular patch of autologous pericardium is then sutured along the posterior three-quarters of the right ventricular outflow tract to elongate the infundibulum posteriorly and prevent compression of the anomalous coronary artery.

Conclusions: When an anomalous left main coronary artery arises from the right and traverses the interventricular septum, coronary artery unroofing with posterior elongation of the right ventricular outflow tract can effectively relieve compression-induced ischemia and lacks the pitfall of coronary artery bypass graft failure.

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ABSTRACT: Repair of Variant Unicuspid Aortic Valve Defect Using Geometric Ring Annuloplasty

***M. Si**[1], R. D. Hobbs[1], J. S. Rankin[2], V. Badhwar[2], J. C. Romano[3], R. G. Ohye[1]*
[1]University of Michigan, Ann Arbor, [2]West Virginia University, Morgantown, [3]Michigan Congenital Heart Center, Ann Arbor

Purpose: Sievers type 2 or unicuspid valves have two fused commissures, with major fusion of the right/left commissure and minor fusion of the right/non-coronary in virtually 100%. A rare unicuspid valve was encountered, with a major right/non-coronary fusion and minor right/left fusion. This video illustrates successful repair using geometric ring annuloplasty.

Methods: With bicuspid ring annuloplasty, major remodeling of the annulus is an advantage, allowing a 2-cusp repair tailored to the size of the non-fused leaflet. The need for pericardium is minimized, and native leaflet tissue is utilized primarily. A 23-year-old female with heart failure, severe aortic insufficiency, and a 4.6 cm aortic aneurysm had a unicuspid valve, with major right/non-coronary fusion, minor right/left fusion, and an annular diameter of 25 mm. The non-fused left cusp free-edge length sized to a 21-mm bicuspid ring. A left/right commissurotomy was performed, and the two 180° sub-commissural ring posts were sutured into the sub-commissural triangles.

Results: Three annular sutures were placed in the non-fused left sinus, and four in the fused sinus, each looping the sub-annular ring. Right cusp commissural tissue was deficient and partially disconnected, so the commissure was reconstructed with double pericardial strips, sandwiching the leaflet between the strips and attaching to the lateral aorta. The non-fused left cusp was plicated to a reference effective height of 1 cm. The right/non-coronary cleft then was closed, raising the fused leaflet to a coaptation height equivalent to the non-fused cusp. Left cusp mobility was limited by calcium at the hinge point, which was debrided with an ultrasonic device. At the end, the two leaflets had equivalent lengths and effective heights, and moved well. The ascending aorta was replaced with a polyethylene terephthalate (Dacron) tube graft. Post-bypass echo showed the leaflets opened well, no insufficiency, and a mean gradient of 21 mmHg, which normally falls over time.

Conclusions: Major remodeling afforded by bicuspid ring annuloplasty permits 2-lealfet repair of even unusually complex unicuspid valves. Addition of pericardial substitutes is minimized with optimal utilization of native leaflet tissue. This technique could facilitate and standardize repair of unicuspid valve defects, even with complex variant anatomy.

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Natural History of Coronary Anomalies

Anusha Jegatheeswaran, Toronto, Canada

4:00 PM – 5:00 PM
Critical Care Research
Moderators: *Thomas E. MacGillivray, Houston, TX, and Nathalie Roy, Boston, MA*

4:00 PM

ABSTRACT: Cardiac Intensive Care Unit Staffing Models: Open, Closed, Intensivists, Offsite Surgeons—Here Is the Lay of the Land

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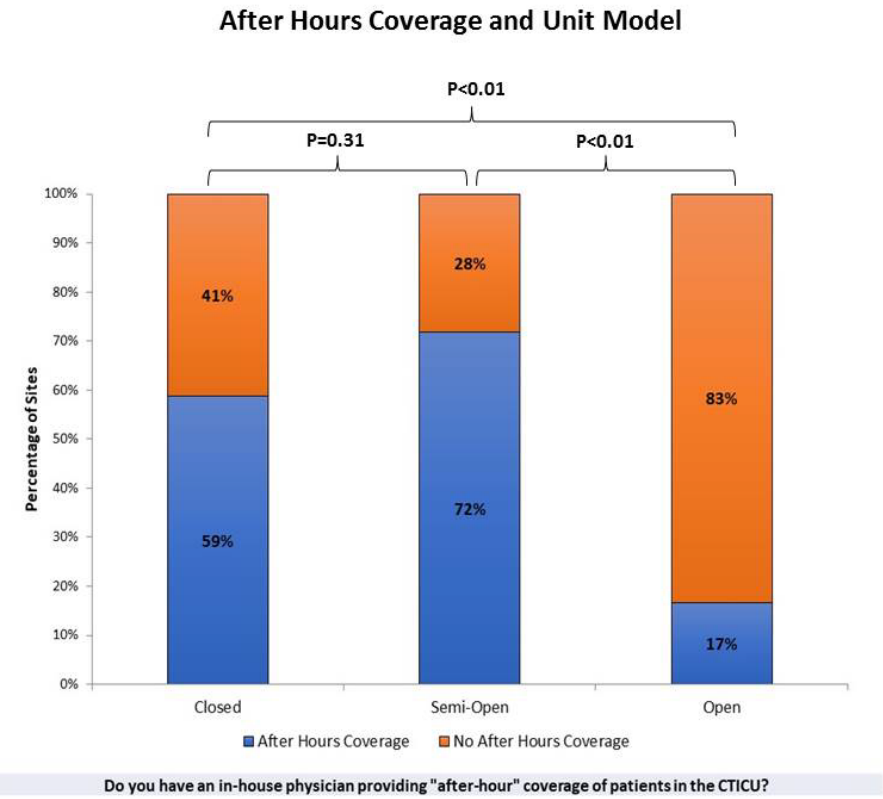
Purpose: ICU structure and physician staffing (ISPS) models may be an important modifier of outcomes following cardiac surgery. Given the limited information on staffing in the CVICU, the STS Workforce on Critical Care (WFCC) undertook a survey to determine current ISPS models. We hypothesized that variability would exist throughout the US. Submitted on behalf of the STS Workforce on Critical Care (WFCC).

Methods: Approved by STS staff leaders, a 27-question survey developed by the WFCC assessed case volume, ICU census, procedure profiles, and base specialties of consultants. The ISPS management model was determined, defined as “open” (managed by cardiac surgeons not dedicated full time to the CTICU), closed (all decisions made by dedicated intensivists 7 days a week.) or semi-open (intensivist attends 5-7 days a week and shares daily management with the surgeon), as was intensivist specialty, experience level of bedside healthcare providers, and night-time in-house healthcare provider coverage.

Results: STS Adult Cardiac Surgery Database centers (n=965) were contacted of which 148 (15.3%) completed surveys. Approximately 41% of reporting centres describe having a dedicated CVICU environment (as opposed to mixed ICU or a surgical ICU with both cardiac and non-cardiac patients) for immediate postoperative management. The most commonly reported ISPS model was open (47%), followed by semi-open (41%) and closed (12%). The base specialties of intensivists varied widely, with pulmonary medicine/critical care being predominant (67%). A physician assistant was the most common healthcare professional providing after-hours coverage (44%). Regardless of case complexity, e.g. ECMO, VAD, and transplants, more than one-third described having only bedside RN nighttime in-house coverage, particularly in open units (83% versus 28% and 41% in semi-open and closed units respectively; see Figure).

Conclusions: In responding STS centres, ISPS models vary widely, almost half being open. In-house nighttime coverage was a) not driven by case complexity, and b) most commonly provided by a PA. Almost half of responding CVICUs with open models employed RN nighttime coverage. Outcomes associated with different ISPS models requires further evaluation.



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ABSTRACT: Association of Overnight Extubation With Outcomes for Post-Cardiac Surgery Patients in the Intensive Care Unit

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Purpose: Overnight extubation (OE) for non-cardiac surgery patients has been found to be associated with higher rates of reintubation and mortality. Early extubation is favored following adult cardiac surgery, but the frequency and safety of OE in this population is unknown.

Methods: We performed a retrospective cohort study using STS data (July, 2014 – June, 2017). Our primary cohort included adults in the ICU following elective CABG; we evaluated 3 secondary cohorts: non-elective CABG; elective aortic valve replacement (AVR); and elective CABG+AVR. We defined overnight as 7:00pm – 6:59am. We assessed OE frequency and used multilevel multivariable regression modelling to identify factors associated with OE. Within mechanical ventilation (MV) duration strata defined by 3-hour groupings, we used propensity-score matching to evaluate associations of OE with reintubations (primary outcome), mortality, and complications.

Results: Among 142,225 elective CABG patients, 42.2% had an OE (Figure). After adjustment, factors most strongly associated with OE were MV duration, cardiopulmonary bypass time, distal anastomosis number, and hospital of admission (median Odds Ratio (OR) (95% CI): 1.82 (1.76-1.89)). After propensity matching, OE was associated with increased reintubation for patients with MV duration 6-8h (2.2% vs 1.7%, OR (95% CI): 1.27 (1.04,1.56)), decreased reintubation for patients with MV duration 15-17h (3.0% vs 4.2%, OR 0.70 (0.50,0.97)) and 18-20h (2.3% vs 5.7%, OR 0.39 (0.21,0.72)), and no association with reintubation for other MV duration groups (Table) ; OE was associated with increased ICU length of stay for patients with 6-8h of MV, but reduced ICU length of stay for patients with 9-20 h of MV. OE was not associated with increased mortality (hospital, 30-day). Other cardiac surgery groups had similar OE rates (non-elective CABGs, 47.6%; elective AVR, 36.0%; elective CABG+AVRs, 51.0%).

Conclusions: OE is prevalent following cardiac surgery. Overall, this practice appears to be associated with little risk and reduces ICU length of stay for those requiring mechanical ventilation for more than 8 hours.

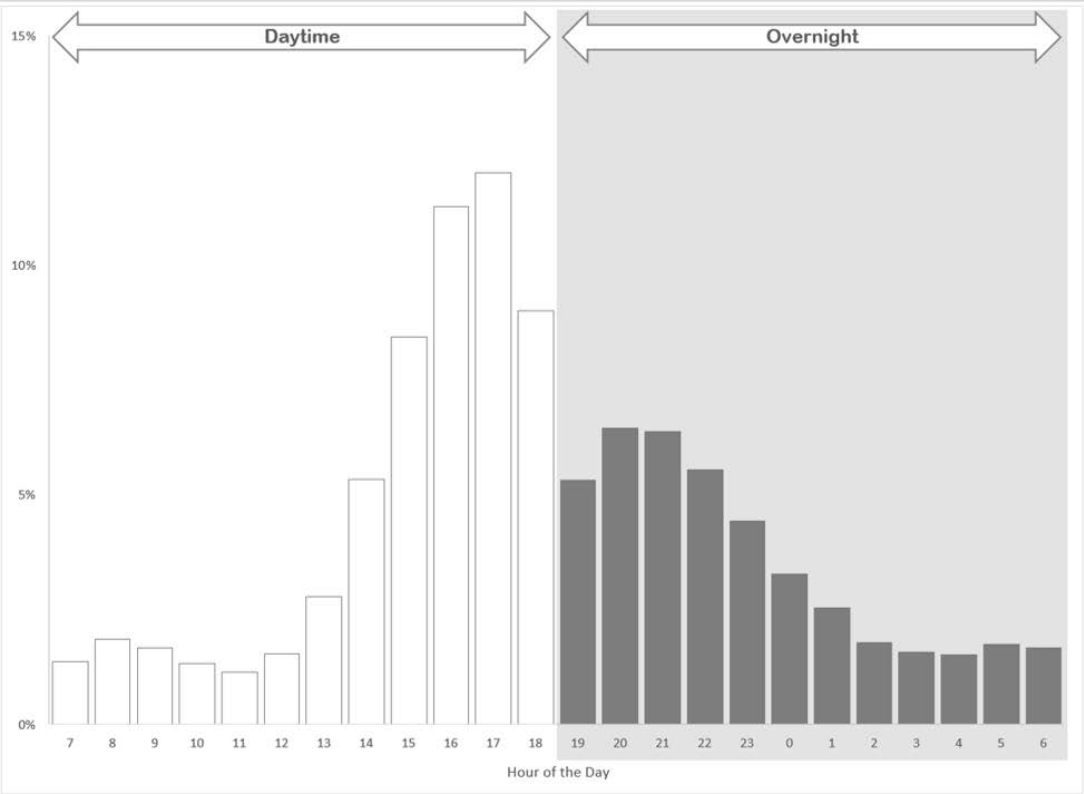

Table. Association of Overnight Extubation with Reintubation for Propensity Matched Pairs of Elective CABG Patients.				
		Reintubation		OR (95% CI) for Reintubation
MV Duration	# Pairs	Daytime Extubation	Overnight Extubation	(Overnight vs Daytime Extub)
0-2 h	813	2.0%	3.0%	1.52 (0.80,2.87)
3-5 h	12,578	2.0%	2.2%	1.10 (0.92,1.30)
6-8 h	9,728	1.7%	2.2%	1.27 (1.04,1.56)
9-11 h	339	2.7%	1.8%	0.66 (0.23,1.88)
12-14 h	1,225	3.9%	4.3%	1.11 (0.74,1.65)
15-17 h	2,093	4.2%	3.0%	0.70 (0.50,0.97)
18-20 h	612	5.7%	2.3%	0.39 (0.21,0.72)
21-23 h	24	4.2%	12.5%	3.29 (0.32,34.08)
24+ h	62	12.9%	3.2%	0.23 (0.05,1.11)

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ABSTRACT: Not Anticoagulating Patients Supported With Venoarterial Extracorporeal Membrane Oxygenation Decreases Complications, Blood Transfusions, and Heparin-Induced Thrombocytopenia

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Purpose: Systemic anticoagulation is the standard of care for adult patients supported on venoarterial extracorporeal membrane oxygenation (VA ECMO). There is limited evidence in the literature regarding the outcomes for managing VA ECMO without anticoagulation. We hypothesized that not anticoagulating VA ECMO patients will decrease complications.

Methods: We retrospectively reviewed all patients who were supported on VA ECMO at our institution from May 2011 to January 2018 (n=247). Beginning in 2015, we routinely have used VA ECMO without anticoagulation. Patients were stratified based on whether they received anticoagulation while on ECMO. Baseline patient characteristics, comorbidities, and indication for ECMO were compared between the groups. Outcomes were similarly compared, specifically focusing on in-hospital mortality and complication rates related to hemorrhagic and thrombotic events. Secondary outcomes included the development of heparin induced thrombocytopenia and renal failure requiring dialysis.

Results: Of the 247 patients reviewed, 44 were excluded due to evidence of hemorrhage at initial presentation making them ineligible for anticoagulation consideration. Of the 203 patients remaining, 72 (29%) were not anticoagulated while on VA ECMO. Baseline patient characteristics were similar between groups. Overall complication rates were significantly lower for patients that were not anticoagulated compared with those who received systemic anticoagulation (57% vs 76%, p = 0.007). This includes a trend towards fewer hemorrhagic complications for those not anticoagulated (53% vs 63%, p = 0.178) without any indication of increased risk for thrombosis (13% vs 21%, p = 0.147). The anticoagulated group required more transfusions of red blood cells (12.8 vs 1.09, p=0.002) and platelets (3.0 vs 1.3, p = 0.009). They similarly showed a higher incidence of HITT (8% vs 0%, p=0.015) without a difference in overall mortality (62% vs 72%, p = 0.165).

Conclusions: Not anticoagulating patients who are supported with VA ECMO decreases complications, blood transfusions and heparin induced thrombocytopenia. Not anticoagulating patients does not increase thrombotic complications including embolic strokes or limb ischemia. VA ECMO patients without other reasons for anticoagulation should be treated without heparin during their VA ECMO course.

	Anticoagulated (N=131)	Not Anticoagulated (N=72)	p-Value
Inhospital Mortality (%)	81 (62%)	52 (72%)	0.165
Successful Weaning (%)	75 (57%)	27 (38%)	**0.008**
Time on ECMO (hr)	201.4 ± 14.6	139.5 ± 23.2	**0.019**
ICU LOS (days)	20.9 ± 3.7	11.1 ± 1.9	0.060
Overall Complication (%)	99 (76%)	41 (57%)	**0.007**
Hemorrhagic (%)	83 (63%)	38 (53%)	0.178
Cardiac (%)	12 (9%)	5 (7%)	0.792
Gastrointestinal (%)	19 (15%)	6 (8%)	0.266
Surgical site (%)	11 (8%)	4 (6%)	0.581
Cerebral (%)	5 (4%)	2 (3%)	1.000
Pulmonary (%)	8 (6%)	3 (4%)	0.750
4+ units PRBC in 24h (%)	31 (24%)	15 (21%)	0.727
Other (%)	3 (2%)	1 (1%)	1.000
Thrombotic (%)	28 (21%)	9 (13%)	0.132
Circuit Clots (%)	2 (2%)	0 (0%)	0.540
Stroke (%)	4 (3%)	5 (7%)	0.285
Limb (%)	16 (12%)	4 (6%)	0.147
Pulmonary Embolism (%)	3 (2%)	0 (0%)	0.554
Intracardiac (%)	7 (5%)	1 (1%)	0.264
Other (%)	1 (1%)	1 (1%)	1.000
Other			
Seizure (%)	4 (3%)	4 (6%)	0.458
Dialysis (%)	40 (31%)	14 (19%)	0.099
HIT (%)	10 (8%)	0 (0%)	**0.015**
Infection (%)	21 (16%)	7 (10%)	0.288
Transfusions (avg while on ECMO)			
PRBC (units)	12.8 ± 1.6	5.4 ± 1.1	**0.002**
Platelets (units)	3.0 ± 0.5	1.3 ± 0.3	**0.009**
Plasma (units)	0.7 ± 0.2	0.5 ± 0.2	0.569
Cryoprecipitate (units)	0.5 ± 0.1	0.3 ± 0.1	0.099

ICU = intensive care unit; HIT = heparin induced thrombocytopenia; PRBC = packed red blood cells

4:45 PM

ABSTRACT: Mitigating the Risk: Transfusion or Reoperation for Bleeding After Cardiac Surgery

C. Pasrija[1], *M. Ghoreishi*[1], *G. J. Whitman*[2], *N. Ad*[3], *D. E. Alejo*[2], *S. D. Holmes*[3], *S. Schena*[2], *R. Salenger*[1], *M. Mazzeffi*[4], *C. E. Fonner*[5], *B. S. Taylor*[4]

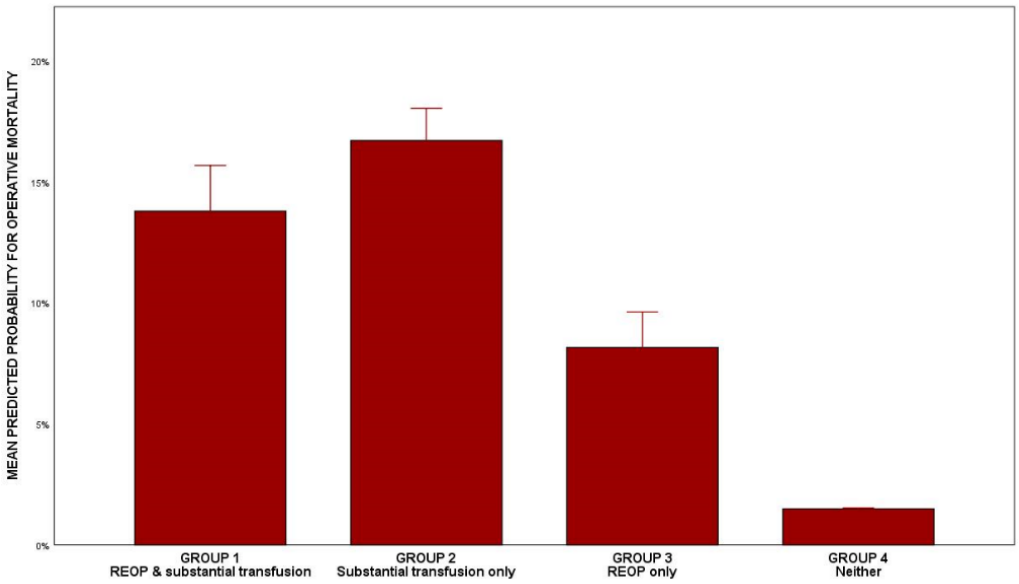
[1]*University of Maryland, Baltimore,* [2]*The Johns Hopkins Hospital, Baltimore, MD,* [3]*West Virginia University Heart and Vascular Institute, Morgantown,* [4] *University of Maryland Medical Center, Baltimore,* [5]*Virginia Cardiac Services Quality Initiative, Virginia Beach*

Purpose: Several studies have established morbidity associated with bleeding after cardiac surgery. While reoperation has been implicated as the marker for this morbidity, there remains limited understanding regarding impact of substantial blood transfusion in this patient population. We sought to determine relative morbidities of reoperation and substantial transfusion after cardiac surgery.

Methods: The Society of Thoracic Surgeons Maryland statewide database was reviewed for patients who underwent adult cardiac surgery (7/2011-3/2018). There were 17,602 eligible patients (REOP, *n*=408). Substantial transfusion was defined as requiring greater than the REOP group median red blood cell (RBC; 4 units) and non-RBC (3 units). Patients were stratified into 4 subgroups: Group 1 had REOP with substantial transfusion (*n*=177); Group 2 had no REOP with substantial transfusion (*n*=488); Group 3 had REOP without substantial transfusion (*n*=231); and Group 4 had no REOP without substantial transfusion (*n*=16,698). Operative morbidity and mortality were compared using multivariable logistic regressions.

Results: REOP patients were older (68 [60-75] vs. 65 [57-73] years, *P*<0.001), more likely to be in congestive heart failure (30% vs. 25%, *P*=0.021), and dialysis-dependent (5% vs. 3%, *P*=0.038). Multivariable analysis demonstrated that REOP was associated with increased odds of operative mortality (OR=3.78, *P*<0.001), renal failure (OR=3.35, *P*<0.001), and stroke (OR=2.42, *P*=0.003). Among subgroups, the odds of operative mortality were 6.54 times greater in Group 1 than Group 4 (*P*<0.001; FIGURE). Within patients who required REOP, substantial transfusion did not significantly impact odds of mortality, renal failure, or stroke. However, Group 2 had greater odds of renal failure than Group 3 (OR=2.29, *P*=0.009; TABLE). REOP <24 hours after initial operation was associated with reduced operative mortality (9% vs. 19%, *P*=0.040) and renal failure (7% vs. 22%, *P*=0.003) compared to REOP >24 hours.

Conclusions: Reoperation for bleeding is associated with morbidity and mortality after cardiac surgery. However, better timing for reoperation and guided transfusion approaches may mitigate morbidity and provide benefit compared to substantial transfusions without REOP. Studies standardizing timing and indications for reoperation are needed to optimize outcomes for patients with postoperative bleeding.



	Operative Mortality	Renal Failure	Stroke
Group 1 versus:			
Group 2	0.97 (0.55–1.70)	0.67 (0.37–1.22)	2.24 (0.89–5.64)
Group 3	1.66 (0.78–3.51)	1.53 (0.71–3.31)	1.70 (0.56–5.13)
Group 4	**6.52 (3.89–10.93)**	**5.82 (3.36–10.07)**	**3.23 (1.54–6.78)**
Group 2 versus:			
Group 3	1.72 (0.92–3.22)	**2.29 (1.23–4.27)**	0.76 (0.28–2.09)
Group 4	**6.76 (4.92–9.28)**	**8.63 (6.37–11.70)**	1.45 (0.78–2.68)
Group 3 versus:			
Group 4	**3.93 (2.19–7.04)**	**3.81 (2.13–6.82)**	1.90 (0.81–4.49)

Data presented as OR (95% CI) from multivariable logistic regression analyses with significant results bolded
Group 1 = Both REOP & substantial transfusion; Group 2 = Substantial transfusion only; Group 3 = REOP only; Group 4 = neither

4:00 PM – 5:00 PM
Next-Generation General Thoracic Surgery
Moderators: *Lisa M. Brown, Sacramento, CA, and Michael J. Weyant, Aurora, CO*

4:00 PM **CAR-T Cell Therapy in Thoracic Malignancies**
Prasad S. Adusumilli, New York, NY

4:15 PM **Intraoperative Localization Techniques**
Sunil Singhal, Philadelphia, PA

4:30 PM **Nanotechnology in Thoracic Surgery**
Gaetano Rocco, New York, NY

4:45 PM **Immunotherapy and Lung Cancer Surgery**
Boris Sepesi, Houston, TX

4:00 PM – 5:00 PM
Quality Improvement in Cardiothoracic Surgery
Moderators: *Shanda H. Blackmon, Rochester, MN, and Carsten Schroeder, Augusta, GA*

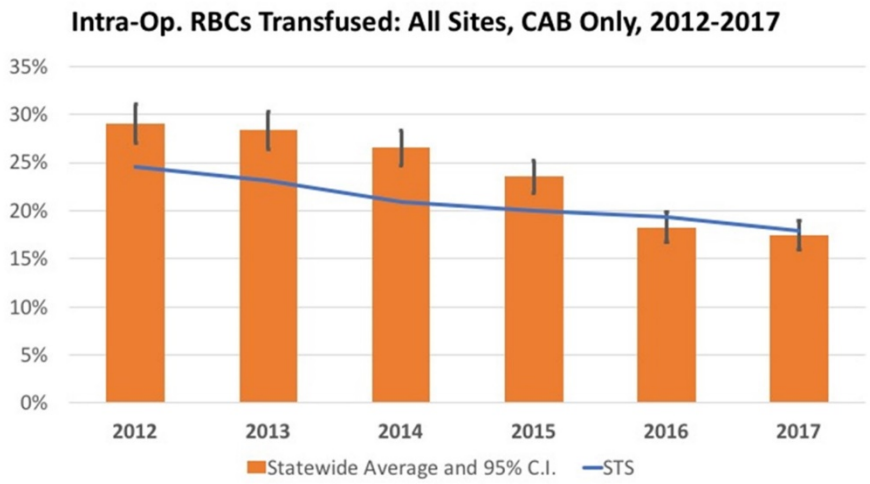
4:00 PM
ABSTRACT: Blood Utilization: A Tale of Two Metrics—Improvement and Variability
X. Zhou[3], *C. E. Fonner*[1], *A. Suarez-Pierre*[3], *C. Lui*[2], *D. E. Alejo*[3], *G. J. Whitman*[3], *B. S. Taylor*[4], *N. Ad*[5], *R. Salenger*[6]
[1]*Virginia Cardiac Services Quality Initiative, Virginia Beach,* [2]*Johns Hopkins University School of Medicine, Baltimore, MD,* [3]*The Johns Hopkins Hospital, Baltimore, MD,* [4]*University of Maryland Medical Center, Baltimore,* [5]*West Virginia University Heart and Vascular Institute, Morgantown,* [6]*University of Maryland, Baltimore*

Purpose: Eliminating unnecessary packed red blood cell (PRBC) transfusion is an important quality metric in cardiac surgery. We describe a regional quality initiative to reduce perioperative PRBC utilization. In addition to characterizing improvements in transfusion rates and cost-savings, we hope to identify institutional factors associated with transfusion practice variability.

Methods: In a statewide collaborative of 10 cardiac surgery centers, intraoperative and postoperative PRBC utilization for isolated coronary artery bypass surgery (CAB) were retrospectively analyzed for each institution in a blinded fashion and shared with all participating centers. Through focused discussions involving surgeons, anesthesiologists, perfusionists, and data coordinators, high performing institutions shared best practices regarding blood conservation. Spearman's rank correlation test and multivariate linear regression were used to analyze predictors of institutional blood utilization and improvement. Variables studied included hospital size, volume, and academic status. Patients requiring re-operation for bleeding were excluded.

Results: From 2012-2017, statewide intraoperative PRBC transfusion rates fell from 29% to 17% ($p<0.0001$), and postoperative PRBC transfusion rates decreased from 34% to 29% ($p=0.00012$), comparing favorably with reported benchmark data from the STS and resulting in $5.34 million of savings over five years in direct transfusion costs (Table 1). Despite the significant decrease in the overall statewide PRBC transfusion, significant variation between centers was noted. Intraoperative and postoperative PRBC transfusion rates at our best performing institution were 7% and 14% versus 37% and 56% at our lowest performing hospital. When controlling for preoperative hemoglobin and risk stratification, centers with residency programs transfused an additional 0.67 units on average intraoperatively (0.52-0.75 units, $p<0.0001$) and 0.62 units on average postoperatively (0.44-0.90 units, $p<0.0001$). Residency programs were also associated with a smaller decrease in transfusion rate over time ($p=0.03$).

Conclusions: Multi-institutional regional collaboration has the potential to lead to improved care and reduced costs. Wide institutional variability in performance exists and represents additional opportunities to improve care. Our data suggest that specifically targeting residency programs and empowering trainees to champion blood conservation efforts may lead to further performance improvement.



Estimated Cost Savings From Reduced PRBC Utilization by Year

Year	CAB Procedure Volume	Average PRBC Units / Patient	Total PRBC Units Transfused	Savings
2012	1,898	1.85	3,517	N/A
2013	2,071	1.67	3,457	$363,855
2014	2,228	1.49	3,327	$764,955
2015	2,424	1.56	3,781	$679,005
2016	2,324	0.99	2,294	$1,921,460
2017	2,459	1.17	2,869	$1,612,040
TOTAL	**13,404**	**1.44**	**19,245**	**$5,341,315**

4:12 PM

ABSTRACT: Using Application-Based Technology to Improve Patient Engagement and Collect Patient-Reported Outcomes for Cardiac Surgery

Y. Lamarche, P. Demers, C. Migneault, D. Bouchard, M. Carrier, R. D. Cartier, I. El-Hamamsy, M. Pellerin, ***L. P. Perrault***
Montreal Heart Institute, Canada

Purpose: Application-based technology has been studied for patient engagement and collecting Patient Reported Outcomes (PROs) in several surgical specialties (orthopedics, colorectal), with limited research in cardiac surgery. Our cardiac center evaluated an App-based technology to determine its effectiveness for collecting PROs, improving the patient experience and reducing health services utilization.

Methods: Patients accessed an interactive application ("App") via smartphone, tablet or computer. Patients were guided from 4 weeks pre-op to 4 weeks post-op via reminders, tasks, PRO surveys and evidence-based education. In the post-operative period, patients were engaged with daily health surveys to track warning signs and recovery milestones, and based on a patient's signs or symptoms, the App escalated lower-risk issues to self-care education or higher-risk issues to the care team (e.g. phone call to a nurse). Patient-generated data collected by the App was accessible via dashboards and was exported to spreadsheets for additional analysis.

Results: Sixty-four percent (64%) (489/759) of patients activated their App account. A total of 3,970 post-operative health surveys were completed by 489 patients. Of the health surveys which triggered self-care education on the App, the most common issues were low pain, diet issues and sleep issues. Of the health surveys which triggered a phone call to the care team, the most common issues were low heart rate, trouble breathing and high blood pressure. Seventy-one (71) patients completed an end-of-program feedback survey, with 94% (67/71) recommending the App to family or friends, 83% (59/71) feeling more prepared for surgery and 97% (69/71) finding the application helpful in recovery. Patients also reported using the App to avoid unnecessary health services utilization, with 74% (53/71) using the App to avoid at least 1 phone call and 42% (30/71) using the App to avoid at least 1 hospital visit.

Conclusions: App-based technology for patient engagement is an effective modality to enhance the patient experience, better understand the trajectory of recovery and reduce unnecessary health services utilization. Future opportunities include leveraging the data collected to build predictive models and more accurately predict patients at-risk of adverse outcomes.

4:24 PM

ABSTRACT: Impact of Perioperative Prescriptions, Race, Sex, and Postoperative Complications on New Persistent Opioid Usage Among Medicare Beneficiaries After Cardiothoracic Surgery

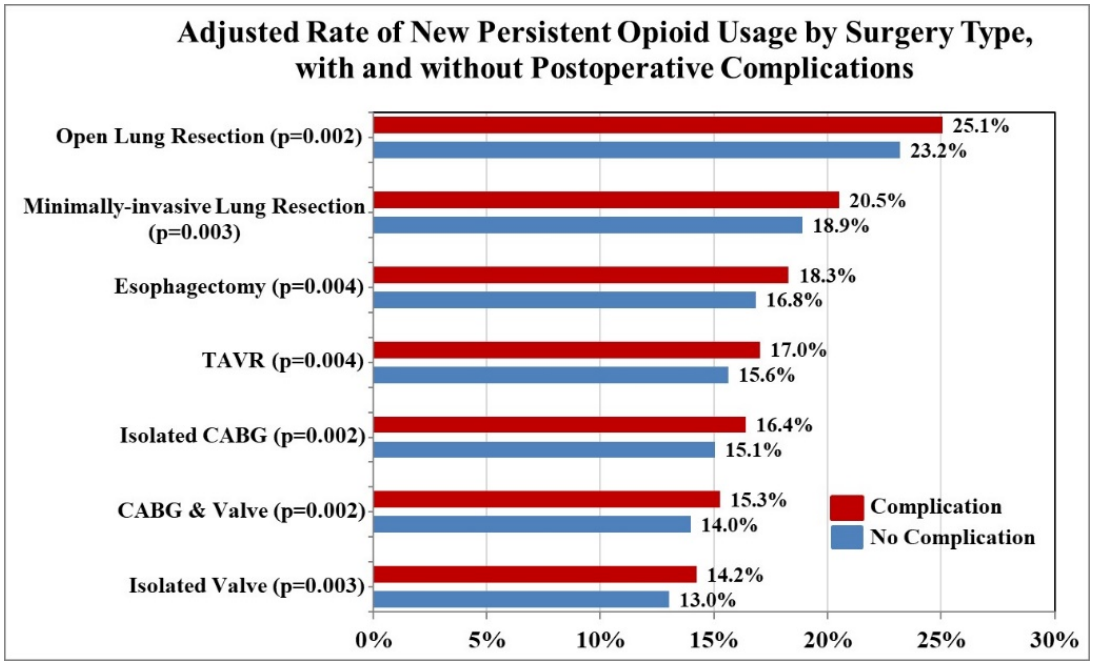
A. A. Brescia[1]*, P. A. Lagisetty*[1]*, H. Hu*[1]*, M. J. Englesbe*[2]*, C. M. Brummett*[1]*, J. F. Waljee*[1]*, K. H. Lagisetty*[2]
[1]*University of Michigan, Ann Arbor,* [2]*Michigan Medicine, Ann Arbor*

Purpose: New persistent opioid usage 3-6 months after surgery has been reported in 3-14% of patients after elective operations. The association between postoperative complications and new persistent opioid usage has not been well-described. We evaluated postoperative complications and other possible risk factors for new persistent usage after cardiothoracic surgery.

Methods: Opioid-naïve Medicare patients undergoing cardiothoracic operations from January 2009 through June 2015 were identified. Patients who filled an opioid prescription between 30 days before and 14 days after surgery and with continuous Medicare enrollment 12 months before and 6 months after surgery were selected (n=30,086). New persistent opioid usage was defined as continued opioid prescription fills 90-180 days after surgery. ICD-9 codes for thirty-nine 30-day complications were evaluated. Variables with $p<0.20$ by univariate analysis chi-squared testing were selected for inclusion in a multivariable regression performed for risk adjustment, and results were reported with odds ratio (OR) and confidence interval (CI).

Results: Among 30,086 patients, 14560 (48%) underwent isolated CABG, 4731 (16%) isolated valve, 3824 (13%) combined CABG/valve, 3437 (11%) minimally-invasive lung resection, 3003 (10%) open lung resection, 314 (1%) esophagectomy, and 217 (1%) transcatheter aortic valve replacement (TAVR). Age was 71±8 years, 11207 (37%) were female, and 27149 (90%) were white. Rate of new persistent opioid usage was 16.4% (4919/30086), with adjusted rates decreasing yearly from 20.3% in 2009 to 12.6% in 2015 (p<0.001). At least one postoperative complication was experienced by 33.8% (10178/30086) of patients, most commonly atrial fibrillation (n=4271/30086, 14.2%) and postoperative blood transfusion (n=3525/30086, 11.7%). Multivariable regression demonstrated increased odds of new persistent opioid usage among black patients (OR 1.63 [CI 1.44-1.85], p<0.001), females (1.15 [1.08-1.23], p<0.001), and those with a postoperative complication (1.11 [1.04-1.19], p=0.002) [Table]. Patients experiencing complications also had higher rates of new persistent usage when stratified by procedure, highest after open lung resection (Figure).

Conclusions: New persistent opioid usage in the Medicare population after cardiothoracic surgery is higher than previously published rates. Despite an overall yearly decrease in new persistent usage, initial opioid prescription dose and timing, sex, race, procedure type, and postoperative complications confer an increased risk for developing new persistent opioid usage.



Independent Risk Factors for New Persistent Opioid Usage through Multivariable Regression Analysis			
Variable	**Odds Ratio**	**95% Confidence Interval**	**P-value**
Complication (Ref: No complication)	1.11	1.04 - 1.19	0.002
Procedure type (Ref: Isolated CABG)			
Isolated valve	0.86	0.78 - 0.95	0.002
Open lung resection	1.19	1.07 - 1.32	0.001
Initial perioperative opioid Rx filled preoperatively instead of postoperatively	2.05	1.85 - 2.26	<0.001
Dose of initial perioperative Rx 450 mg OME or greater (≥75th percentile)	1.41	1.32 - 1.51	<0.001
Female sex	1.15	1.08 - 1.23	<0.001
Black (Ref: white)	1.63	1.44 - 1.85	<0.001
Geographic division (Ref: East North Central)			
South Atlantic	1.19	1.06 - 1.34	0.004
West South Central	1.15	1.00 - 1.33	0.043
CCI (Charlson Comorbidity Index)	1.07	1.06 - 1.08	<0.001
Tobacco use	1.18	1.10 - 1.26	<0.001
Mood disorder	1.15	1.04 - 1.28	0.005
Back pain disorder	1.24	1.15 - 1.33	<0.001
Year (beginning 2009)	0.90	0.89 - 0.92	<0.001

4:36 PM

ABSTRACT: Pain Management Strategies and Opioid Use by US Cardiothoracic Surgeons: Survey Results From the STS Task Force on the Opioid Crisis Intervention in Cardiothoracic Surgery

S. C. Yang[1], *P. Atluri*[2], *N. J. Boden*[3], *J. S. Donington*[4], *J. S. Ikonomidis*[5], *K. H. Lagisetty*[6], *D. C. Rice*[7], *D. E. Sengewald*[3], *E. E. Tseng*[8], *M. J. Weyant*[9], *C. Yohe Savage*[10]

[1]*Johns Hopkins University School of Medicine, Baltimore, MD,* [2]*University of Pennsylvania, Philadelphia,* [3]*The Society of Thoracic Surgeons, Chicago, IL,* [4]*The University of Chicago, IL,* [5]*The University of North Carolina at Chapel Hill,* [6]*Michigan Medicine, Ann Arbor,* [7]*The University of Texas MD Anderson Cancer Center, Houston,* [8]*University of California, San Francisco Medical Center and San Francisco VA Medical Center,* [9]*University of Colorado School of Medicine, Aurora,* [10]*The Society of Thoracic Surgeons, Washington, DC*

Purpose: With the growing opioid epidemic in the US, no guidelines or data exist on the beliefs, knowledge, or prescribing patterns regarding opioid use in cardiothoracic surgical procedures. A survey tool was developed to gain a better understanding of the current perioperative pain management strategies by CTS in the US.

Methods: The STS Opioid Taskforce developed a 30-question online survey, which was sent to members of both the STS in the US and the General Thoracic Surgical Club (GTSC) who were active clinically and prescribed opioids, and open for six weeks starting on 2/22/18. Eligible respondents selected their primary subspecialty and recorded general demographics. Questions focused on perioperative and post-discharge pain management strategies, and opioid regimens commonly prescribed. Respondents reflected on statements regarding the opioid crisis, and provided open comments. Based on the STS US list-serve of 4,751, an 11% (534) survey response would be needed for a 95±4% confidence level.

Results: There were 517 eligible respondents (11%): 49% (250) and 42% (217) were adult cardiac and general thoracic surgeons, respectively, and 50% were in practice >20 years. Collectively, 76% have standard pain protocols, 95% use multi-modality pain strategies, and 69% use regional analgesia postoperatively; 76% do NOT routinely prescribe preventive analgesia prior to surgery. Opioid prescribing was based upon both approach and procedure type in 49%, with 19% using patient self-reported needs. Pain management strategies used pre- and post-discharge are outlined in Table 1. After discharge, 86% prescribe short-acting opioids, but 57%% provide refills only with a clinic visit; 94% do NOT prescribe long-acting opioids. At 4 weeks, 39% will refer to specialty clinics for chronic pain. There was no consensus on the type or dose of opioids most often prescribed. Regarding the opioid crisis, 53% agreed about opioid overuse, while 34% prescribe opioids to optimize patient satisfaction scores.

Conclusions: A slight majority of responding CTS believe opioid overuse exists, evident by a wide variability of prescribing patterns. Most surgeons incorporate multimodality pain management strategies, and hardly use long-acting opioids. However, survey comments reflect a need for more education and guideline development to help curtail the use of perioperative opioids.

Table 1: Percent use of analgesic medication categories pre- and postoperatively by survey respondents (n=517)

	Preoperative Preventive Analgesics (n = 121 respondents who use)	*Prior to Discharge (n = 499)*	*At Time of Discharge (n = 497)*
Acetaminophen	72%	83%	53%
COX-2 Inhibitors	13%	8%	3%
NSAIDS	23%	76%	52%
Steroids	7%	3%	0%
Neuropraxic	59%	30%	18%
Strong opioid agonists	3%	37%	11%
Mild/Moderate opioid agonist	3%	87%	87%
Mixed opioid agonist	6%	39%	26%
IV Opioids	6%	79%	0%
Patches	1%	14%	4%

4:48 PM

ABSTRACT: What Drives Opioid Prescriptions Following Cardiac Surgery: Practice or Patient?

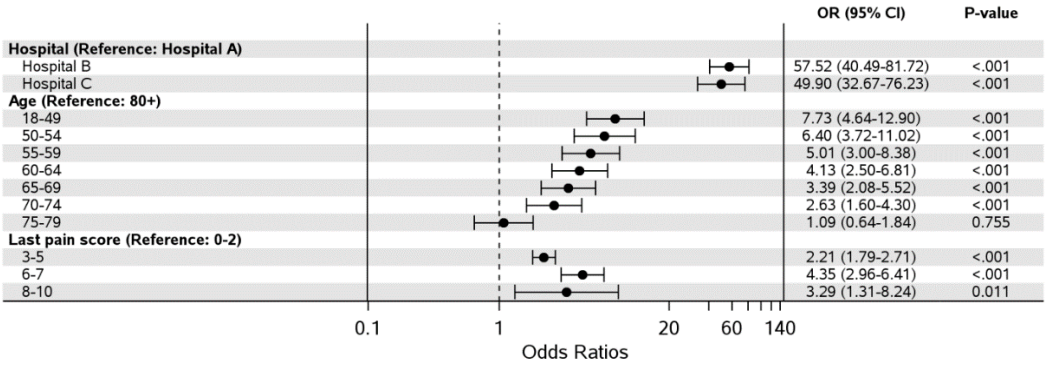
K. A. Holst[1], *J. A. Dearani*[1], *H. V. Schaff*[1], *K. T. Hanson*[1], *C. A. Thiels*[1], *S. Pham*[2], *K. P. Landolfo*[2], *O. E. Pajaro*[3], *E. B. Habermann*[1]
[1]*Mayo Clinic, Rochester, MN,* [2]*Mayo Clinic, Jacksonville, FL,* [3]*Mayo Clinic, Phoenix, AZ*

Purpose: Postoperative opioid prescribing practices are largely unknown and lack standardization. The objective of this study was to describe opioid use following hospitalization for elective cardiac surgery, to identify factors associated with increased opioid prescriptions, and to develop procedure-specific opioid prescribing guidelines.

Methods: We analysed data from all adults (?18 yr) undergoing elective cardiac surgery for acquired heart disease from 7/2014 to 3/2017 at 3 hospitals. Patients having cardiac transplant and/or ventricular assist device implantation were excluded. Clinical and opioid prescription data were abstracted and converted to morphine milligram equivalents (MME). Kruskal-Wallis, chi-square, and Fisher's exact tests assessed patient and operative factors, and comparisons were made between patients with a top-quartile (Q4) prescription compared to the remainder of patients (Q1-Q3). Multivariable logistic regression was performed with the outcome of top-quartile prescriptions.

Results: There were 4,140 study patients following exclusion of preoperative opioid users (10.4%). Mean patient age was 63.9±13.2 years, and 68.4% (2,832) were male. The operation was the first in 87.3% (3,612); the most common operative approach was sternotomy in 91.1% (3,773), followed by robotic in 4.6% (192). The majority of patients, 72.7%, received an opioid prescription at hospital dismissal with median opioid prescription of 200 MME (interquartile range 0 to 361 MME; range 0 to 6400 MME). This varied by hospital, with medians of 150, 450, and 650 MME. On multivariable analysis, the factor with greatest effect on risk of top-quartile opioid prescription was hospital (OR 57.5 highest vs lowest, CI 40.5-81.7; p<0.001); see Figure for additional variables. Opioid prescribing guidelines were subsequently created and implemented.

Conclusions: Significant variation in opioid prescribing practices following cardiac surgery was observed; the primary driver was hospital-centric as opposed to patient-specific factors. Opioid prescribing guidelines were established to standardize post-hospital pain management with tailored prescribing to patient need.



5:15 PM – 6:15 PM
Business Meeting (STS Members Only)

6:30 PM – 7:30 PM
STS-PAC Reception
Open to 2019 STS-PAC contributors

Tuesday, January 29

6:30 AM – 1:00 PM
Registration

9:00 AM – 1:30 PM
Exhibit Hall

7:00 AM – 9:00 AM
Adult Cardiac: General
Moderators: *Faisal Bakaeen, Cleveland, OH, and T. Sloane Guy, New York, NY*

7:00 AM
ABSTRACT: Effects of Frailty on Outcomes and 30-Day Readmissions Following Surgical Mitral Valve Replacement
A. Iyengar[1], *N. J. Goel*[1], *J. J. Kelly*[2], *J. J. Han*[2], *C. Brown*[2], *F. N. Khurshan*[2], *Z. Chen*[3], *N. Desai*[2]
[1]*Hospital of the University of Pennsylvania, Philadelphia,* [2]*University of Pennsylvania, Philadelphia,* [3]*University Heart Center Freiburg, Germany*

Purpose: Frailty is increasingly recognized as an important prognostic marker in surgical populations[1]. Given the inherent complexity of patients requiring mitral valve replacement (MVR), the effects of frailty on outcomes in this population is less clear. We sought to evaluate the impact of frailty on outcomes and readmission rates after MVR.

Methods: Adult patients undergoing isolated MVR were queried from the National Readmissions Database from 2010 to 2014. Patients with a history of previous valve surgery were excluded. Frailty was defined using the Johns Hopkins ACG frailty-defining diagnoses indicator, a validated instrument developed for use in health administrative data[2]. Estimates of hospital cost were made by converting individual hospital charge data and adjusting to 2014 consumer price indices. A composite, previously validated variable of postoperative complications including cardiovascular, pulmonary and infectious complications was defined, and data was collected on the prevalence and indications for readmission within 30 days.

Results: Among 50,410 patients identified who underwent MVR, 7.9% met frailty criteria. Frail patients were older, had more non-private insurance, index admissions from the emergency department, and teaching hospital care (all $p<0.001$). As expected, frail patients also had more postoperative complications (77% vs. 47%, $p<0.001$), more facility discharges (50% vs. 21%, $p<0.001$), and higher in-hospital mortality (12% vs. 4%, $p<0.001$). Index hospital costs were almost doubled in frail patients ($91,000 vs. $48,000), and 30-day readmissions were more frequent (28% vs. 20%, $p<0.001$). Frailty independently increased risks of index hospitalization composite complications (AOR 2.93[2.54-3.37]), in-hospital mortality (AOR 2.35[1.90-2.92]), and 30-day readmissions. Frailty was a stronger predictor of index length of stay and costs than age. Associated median costs of readmission were greater in frail patients ($13,200 vs. $8,900). The most common reasons for readmission were cardiac (45.2%), followed by pulmonary (14.9%) and infectious (11.7%) diagnoses, without significant differences between frail and non-frail patients.

Conclusions: Frailty remains an independent predictor of morbidity, mortality, and increased costs after MVR, and appears to have a stronger impact than age alone. Frail patients have increased readmissions after MVR, although reasons for readmission do not differ. Careful patient selection prior to MVR may improve outcomes and reduce readmission rates.

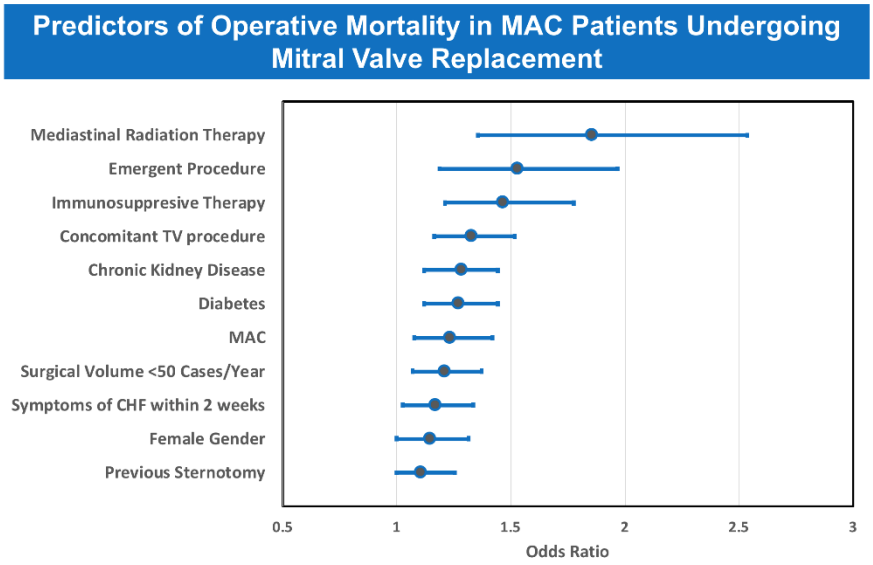
7:15 AM
ABSTRACT: Characterizing Risks Associated With Mitral Annular Calcification in Mitral Valve Replacement: An Analysis Utilizing the STS Adult Cardiac Surgery Database
T. K. Kaneko[1], *S. A. Hirji*[1], *S. F. Aranki*[1], *S. McGurk*[1], *S. Body*[2], *M. Heydarpour*[1], *H. R. Mallidi*[1], *S. K. Singh*[1], *J. Rawn*[1], *M. P. Pelletier*[1], *P. S. Shekar*[1]
[1]*Brigham and Women's Hospital, Boston, MA,* [2]*Beth Israel Deaconess Medical Center, Boston, MA*

Purpose: Mitral annular calcification (MAC) increases technical complexity for surgeons during mitral valve procedures. This study assesses the additional operative risks conferred by the presence of MAC in patients undergoing planned mitral valve replacement (MVR) using the STS Adult Cardiac Surgery Database (STS ACSD).

Methods: A total of 197,737 unique MV procedures were performed at 1,158 institutions between 2011 and June 2017. Outcomes of interest included operative mortality, postoperative complications, and contribution of hospital MV procedure volume to risk in MAC patients. Hospital MV volume categories were created based on average total number of MV procedure/year during the study period. Outcomes in MAC patients were compared to a cohort derived using de-confounding techniques; Subjects with concomitant procedures or from institutions that did not report at least 1 MAC case per year were also excluded. Operative mortality risk was assessed by multivariable logistic regression.

Results: Of the 53,261 qualifying isolated MVR cases, 9,626 were classified as MAC (18%); Centers with >200 MV procedures/year had a higher relative proportion of MAC cases (13% vs 8% for non-MAC, P<.001). MAC patients were older (mostly ?85 years), and had higher rates of metabolic diseases, peripheral vascular disease and atrial fibrillation (all P<.001). STS PROM was higher in the MAC group (6.24±6.5 vs 5.19±6.3;P<.001). Observed operative mortality was 5.8% for MAC and 4.4% for non-MAC patients (OR 1.28, 95% CI: 1.19–1.38). While postoperative stroke and reoperation rates were similar, MAC was associated with increased risk of acute kidney injury (OR 1.15) and reintubation (OR 1.26, all P<.001). When controlling for confounders and baseline differences, MAC remained a risk factor for operative mortality (OR 1.24, 95% CI:1.08-1.42). Additionally, Centers with <50 MV procedures/year were associated with increased operative mortality due to MAC (OR 1.21, 95% CI 1.08-1.37).

Conclusions: MAC was associated with increased mortality even after adjusting for attendant cardiovascular and metabolic comorbidities. Lower hospital MV volume was also associated with increased operative mortality in MAC patients. These findings may suggest referring these high-risk patients to high-volume MV centers.



7:30 AM

ABSTRACT: Ultrasound-Guided Septal Myectomy Using High-Resolution Intracardiac Probe and Mitral Leaflet Height Reduction for Systolic Anterior Motion in Hypertrophic Obstructive Cardiomyopathy

***H. Arai**, K. Oishi, K. Oi, T. Mizuno, M. Yashima, H. Kuroki, T. Fujiwara, M. Takeshita, T. Kubo, Y. Okumura, J. Nabeshima*
Tokyo Medical and Dental University, Japan

Purpose: Extended septal myectomy for hypertrophic cardiomyopathy (HOCM) is still a challenging procedure regarding safe and effective resection range and prevention of systolic anterior motion (SAM). In this report, we describe an ultrasound-guided septal myectomy using intra-cardiac high-resolution ultrasonography and a mitral valve repair without ring annuloplasty.

Methods: A 46-year-old male was diagnosed with HOCM on the echocardiogram. His dyspnea was gradually progressing, and the pressure gradient of the left ventricular outflow tract developed at a maximum of 69 mmHg. Moderate mitral regurgitation was also observed with SAM. Cardiologists performed two series of percutaneous transluminal septal myocardial ablation. However, the patient's symptoms did not improve. The patient was referred to our hospital for septal myectomy and mitral valve repair.

Results: Extended septal myectomy was performed in a transaortic approach. Intra-cardiac high resolution ultrasonic probe was inserted into the left ventricle, and the thickness of the left ventricular wall was measured to determine the depth and the length of myectomy. Resection was performed until the anterior leaflet of mitral valve became sufficiently visible?without causing septal perforation. Preoperative echocardiography revealed the elongation of mitral valve leaflets and systolic anterior motion. Therefore, We performed bi-leaflet height reduction by placing a mattress suture near the annulus, and ring annuloplasty was not done because it could trigger SAM. This procedure reduced the coaptation zone and moved coaptation line posteriority. Postoperative echocardiography showed that mitral regurgitation was trivial and the SAM was disappeared. Moreover, Left ventricular outflow tract obstruction was reduced and maximum pressure gradient was reduced from 69 mmHg to 8 mmHg.

Conclusions: Safe and effective myocardial resection was performed with the guidance of intra-cardiac high resolution ultrasonography. Height reduction of the redundant mitral leaflets in combination of myectomy was effective to resolve MR due to SAM. No use of annuloplasty ring might be helpful to avoid recurrence of SAM.

7:45 AM

ABSTRACT: Five-Year Outcomes of Patients Treated With a Novel Thoracic Endograft for Blunt Thoracic Aortic Injury: The RESCUE Pivotal Trial

H. J. Patel[1], *A. Azizzadeh*[2], *A. H. Matsumoto*[3], *O. C. Velazquez*[4], *J. Rovin*[5], *J. V. Lombardi*[6], *A. Khoynezhad*[7], *Y. Dai*[8], *R. A. White*[9]
[1]*University of Michigan Medical Center, Ann Arbor,* [2]*Cedars-Sinai Medical Center, Los Angeles, CA,* [3]*University of Virginia Health System, Charlottesville,* [4]*University of Miami Jackson Memorial Hospital, FL,* [5]*Morton Plant Hospital, Clearwater, FL,* [6]*Cooper Medical School of Rowan University, Camden, NJ,* [7]*MemorialCare Long Beach Medical Center, CA,* [8]*Medtronic, Santa Rosa, CA,* [9]*MemorialCare Heart and Vascular Institute, Long Beach, CA*

Purpose: The RESCUE study, a prospective non-randomized North American multicenter clinical trial evaluating thoracic endovascular repair (TEVAR) using a novel stent graft for treatment of blunt thoracic aortic injury (BTAI) reported promising 30-day outcomes. We now describe long term follow up of this cohort.

Methods: 50 patients (mean age 40.7±17.4 years, 76.0% (38/50) male, mean injury severity score=38.4±14.4) were treated for BTAI with TEVAR between 2010 and 2012 using this endograft. 70.0% (35/50) of BTAI extent was grade III or higher, including one free rupture. The extent of arch repair required full (40.0%, 20/50) or partial (18.0%. 9/50) left subclavian artery coverage. At 5 years, clinical and imaging compliance was 90.3% (28/31) and 67.7% (21/31) respectively. Reported long term outcome include 5-year mortality, rates of endoleaks, adverse events, and secondary interventions. Stent graft integrity was also assessed.

Results: 30-day mortality was previously reported in four patients. Three additional patients expired of non-device related causes (respiratory failure, infection, seizure) resulting in an all-cause mortality of 14.0% (7/50) through 5 years. No stroke nor spinal cord ischemia was observed at 5 years. While 2 patients had type II endoleaks at 30 days, both resolved spontaneously and no additional endoleaks were described in the study cohort at 5 years. Major adverse events are presented in Table 1. No secondary endovascular procedures or conversion to open surgery were reported through 5 years. Four subjects underwent left subclavian revascularization for symptomatic indications, including one preoperatively and three on postoperative days 8, 36, and 103. Finally, complete exclusion of the traumatic injury was maintained with no incidences of stent graft kinking, fracture, loss of patency, or migration through 5 years in all patients.

Conclusions: This multicenter clinical trial describes excellent five-year outcomes and durable exclusion of blunt thoracic aortic injury using a novel stent graft system. TEVAR with this endograft appears to be a safe and effective treatment option for patients with BTAI.

	31-365 days % (m/n)	366-731 days % (m/n)	732-1096 days % (m/n)	1097-1461 days % (m/n)	1462-1826 days % (m/n)
Device Related AEs[1]	0.0% (0/46)	0.0% (0/39)	0.0% (0/36)	0.0% (0/32)	0.0% (0/31)
Total Serious AEs	6.5% (3/46)	0.0% (0/39)	5.6% (2/36)	0.0% (0/32)	3.2% (1/31)
Myocardial Infarction	0.0% (0/46)	0.0% (0/39)	0.0% (0/36)	0.0% (0/32)	3.2% (1/31)
Infection	2.2% (1/46)	0.0% (0/39)	0.0% (0/36)	0.0% (0/32)	0.0% (0/31)
Peripheral Ischemia	2.2% (1/46)	0.0% (0/39)	0.0% (0/36)	0.0% (0/32)	0.0% (0/31)
Pain In Extremity[2]	2.2% (1/46)	0.0% (0/39)	0.0% (0/36)	0.0% (0/32)	0.0% (0/31)
Peritoneal Hemorrhage	0.0% (0/46)	0.0% (0/39)	2.8% (1/36)	0.0% (0/32)	0.0% (0/31)
Convulsion	0.0% (0/46)	0.0% (0/39)	2.8% (1/36)	0.0% (0/32)	0.0% (0/31)

AEs in days 0-30 were previously reported J Vasc Surg. 2013;57(4):899-905. m=number of subjects with an event in the category, n=number of subjects followed at the beginning of the time period interval. [1]Device related AEs included SAEs. [2]right calf pain reported Apr2013.

8:00 AM

Surgical Video: Pulmonary Embolectomy With Retrograde Pulmonary Perfusion for Saddle Pulmonary Embolus

Erik Beyer, Fort Lauderdale, FL

Purpose: This video demonstrates the technique for retrograde pulmonary perfusion as an adjunct to pulmonary embolectomy. Thrombus in the distal pulmonary vascular bed is difficult to extract manually. This technique allows for a more thorough embolectomy.

Methods: The raw footage for this video was obtained using a standard 45 degree thorascope.

Results: The patient presented did well and was discharged home on postoperative day ten.

Conclusions: This video demonstrates the standard techniques for pulmonary ermbolectomy and for retrograde pulmonary perfusion. For cases involving acute massive pulmonary embolus this has become our routine to clear both large and small emboli in the pulmonary arterial vasculature.

8:15 AM

ABSTRACT: Early Experience in Preclinical Orthotopic Cardiac Xenotransplantation

L. DiChiacchio[1], *K. B. Deatrick*[1], *Z. N. Kon*[2], *D. J. Kaczorowski*[4], *D. Ayares*[3], *J. Bromberg*[4], *B. P. Griffith*[1], *S. T. Bartlett*[4], *M. M. Mohiuddin*[1]

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Purpose: Interest in the development of a preclinical orthotopic cardiac xenotransplantation model has been increasing, with the goal of implementing clinical xenotransplant trials as a way of alleviating the shortage of donor hearts. We describe our early experience developing this model.

Methods: Specific pathogen free baboons were transplanted with hearts from alpha-Gal-knockout, human transgenic pigs in the orthotopic position. Three training experiments and six long-term survival experiments were undertaken. The team was comprised of cardiac transplant and congenital cardiac surgeons, perfusionists, cardiac anesthesiologists, residents, and veterinary staff. The procedure and peri-operative care were optimized to mimic clinical heart transplantation.

Results: All recipient baboons were transplanted and weaned off of cardiopulmonary bypass with life sustaining cardiac function. Low dose inotropic and vasopressor support was continued in all cases. Recipients were monitored using femoral arterial lines, transesophageal echocardiogram, external EKG, continuous pulse oximetry, and serial bloodwork including ABG, CBC, BMP, and ACT. Central venous access with multiple lumens was critical to post-operative care. Invasive hemodynamic monitoring, pretreatment with anti-arrhythmics, and availability of cardioversion for the donor pig allowed rapid reversal of fibrillation episodes during procurement. Survival to 26 hours without mechanical circulatory support and 48 hours with central venoarterial extracorporeal membrane oxygenation were achieved.

Conclusions: Cardiac xenotransplantation is a potential solution to the paucity of human heart donors. Development of a life-sustaining preclinical large animal model is a prerequisite to implementing clinical trials. Here we detail our early experience developing this model in non-human primates.

8:30 AM

ABSTRACT: Perioperative Pain Management and Opioid Use Patterns by US Adult Cardiac Surgeons: Survey Results From the STS Task Force on the Opioid Crisis Intervention in Cardiothoracic Surgery

S. C. Yang[1], *P. Atluri*[2], *N. J. Boden*[3], *J. S. Donington*[4], *J. S. Ikonomidis*[5], *D. C. Rice*[6], *D. E. Sengewald*[3], *E. E. Tseng*[7], *M. J. Weyant*[8], *C. Yohe Savage*[9]

[1]*The Johns Hopkins School of Medicine, Baltimore, MD,* [2]*University of Pennsylvania, Philadelphia,* [3]*The Society of Thoracic Surgeons, Chicago, IL,* [4]*The University of Chicago, IL,* [5]*The University of North Carolina at Chapel Hill,* [6]*The University of Texas MD Anderson Cancer Center, Houston,* [7]*University of California, San Francisco Medical Center and San Francisco VA Medical Center,* [8]*University of Colorado School of Medicine, Aurora,* [9]*The Society of Thoracic Surgeons, Washington, DC*

Purpose: Despite the opioid epidemic in the US, no guidelines or data exist on the beliefs, knowledge, or prescribing patterns regarding opioid use in cardiothoracic surgical procedures. A survey tool was developed to better understand the current perioperative pain management strategies used by ACS in the US.

Methods: An online survey was developed by the STS Opioid Taskforce consisting of 30 questions. This was sent to members of the STS in the US who were in active clinical practice and prescribed opioids. Respondents were asked to select their primary subspecialty and of general demographics. Questions focused on perioperative and post-discharge pain management strategies, and the types of opioids commonly prescribed. Respondents were asked to reflect on statements regarding the opioid crisis, and allowed to provide open comments.

Results: Of the total 505 surgeon respondents, 49% (250) were ACS; most (83%) were in practice >11 yrs, have standard pain protocols (73%), and use multi-modality pain strategies (93%). Only 49% use regional analgesia: 77% intercostal blocks, 47% epidurals, 41% local anesthetics, and 23% tunneled catheters. Opioid prescribing was based upon approach (e.g. sternotomy) and procedure type (e.g. CABG) in 53%, with 23% using patient self-reported needs. The oral pain management strategies used pre- and post-discharge are outlined in Table 1. After discharge, 87% prescribe short-acting opioids, but 52% provide refills only with a clinic visit; 92% do NOT prescribe any long-acting opioid. 43% refer to pain management clinics 4-5 weeks of chronic pain. There was no consensus on the specific types of opioids most often prescribed. Regarding opinions on the opioid crisis, 50% agreed about the overuse of opioids, while 34% prescribe opioids to attain good patient satisfaction scores.

Conclusions: It is not clear by this survey whether there is opioid overuse by ACS, and the prescribing patterns are quite variable. Most ACS are practicing multimodality pain management strategies. However, there remains ample opportunity to develop education and guidelines for all surgeons in curtailing the use of perioperative opioid use.

Table 1: Percent use of analgesic medication categories pre- and postoperatively by adult cardiac surgeons (n=250)

	Preoperative Preventive Analgesics n = 47 (19%)	*Prior to Discharge n=244*	*At Time of Discharge n=243*
Acetaminophen	72%	83%	51%
COX-2 Inhibitors	4%	8%	2%
NSAIDS	24%	65%	36%
Steroids	4%	5%	0%
Neuropraxic	44%	21%	8%
Strong opioid agonists	2%	42%	11%
Mild/Moderate opioid agonist	0%	91%	88%
Mixed opioid agonist	2%	47%	30%
IV opioids	7%	86%	0%
Patches	2%	17%	3%

8:45 AM

ABSTRACT: Effect of the Time Interval Between Coronary Angiography and Coronary Artery Bypass Grafting Surgery on Postoperative Acute Kidney Injury: Analysis of the STS Adult Cardiac Surgery Database

*A. C. Guercio[1], **M. P. Macris**[1], S. Hebert[2], C. S. Bell[3], C. C. Miller[3], D. Molony[3]*
[1]Memorial Hermann, Houston, TX, [2]Houston Methodist Hospital, TX, [3]McGovern Medical School at UT Health, Houston, TX

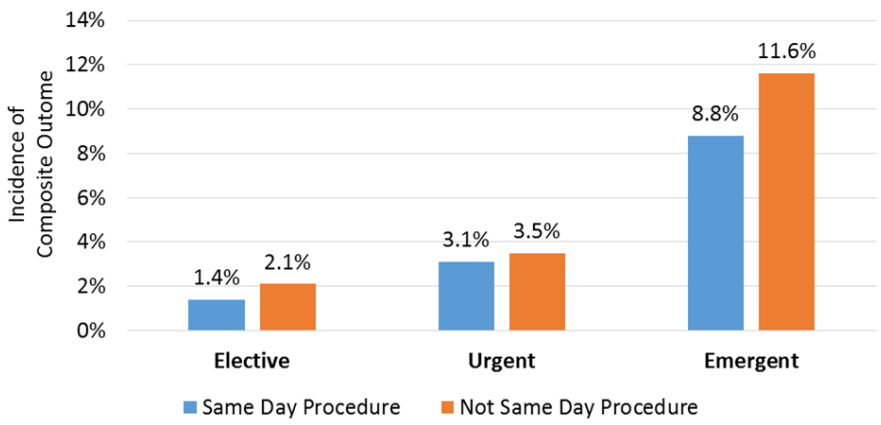
Purpose: Coronary artery bypass grafting (CABG) within one day of angiography has been discordantly associated with an increased risk of post-procedural renal injury. We hypothesize that after controlling for confounding factors, same day angiography and surgery procedure is associated with an increased risk of postoperative death and renal injury.

Methods: We retrospectively analyzed 433,362 patients from the Society of Thoracic Surgeons Adult Cardiac database over three years (July1, 2014 - June 30, 2017). Primary outcome was composite of either operative death (OpDeath) or renal failure (RF) as defined by RIFLE criteria. Effect of same day procedures on composite outcomes was compared across urgency strata. Propensity scores from 38 preoperative factors were designed to predict likelihood of same day procedures. Logistic regression models evaluated the time interval impact on the outcomes with the log odds from the propensity score model used as continuous covariate for risk adjustment.

Results: The composite outcome was higher in all patients having same day procedures compared to one or more days apart: 6.5% (3.6% RF, 4.3% OpDeath) vs. 3.1% (2.0% RF, 1.6% OpDeath), p<0.001). Conversely, once stratified by urgency status, the composite outcome was lower in case of same-day versus non same-day procdures: Urgent status (3.1% v 3.5%, p<0.001) and Emergent status (8.8% vs. 11.6%, p<0.001) when stratified by triage status in those with both procedures performed on same day. However, in multivariable analysis, same day procedures showed no significant increase or decrease in the probablity of composite outcome overall or within urgency status group. Risk factors most associated with the composite outcome in multivariate analysis were cardiogenic shock at procedure, morbid obesity, elevated creatinine, and emergent satus. Similiar conclusions were found in the non-composite outcomes of death and stage 1 AKI.

Conclusions: Same day angiography and surgery is not associated with increased post-operative incidence of death or renal failure and may be continued in clinical practice. Accurate risk assessment related to time interval between angiography and cardiac surgery requires simultaneous control for pre-operative risk factors, particulary surgical urgency status.

Figure. Unadjusted incidence proportion of composite outcome (operative death or renal failure) across urgency strata



7:00 AM – 9:00 AM

Adult Cardiac: Mitral and Tricuspid Valves

Moderators: *Richard Lee, Augusta, GA, and Tom C. Nguyen, Houston, TX*

7:00 AM

ABSTRACT: Impact of Tricuspid Regurgitation With and Without Intervention During Surgical Aortic Valve Replacement

W. Z. Chancellor[1]*, J. H. Mehaffey*[1]*, J. P. Beller*[1]*, R. B. Hawkins*[1]*, A. M. Speir*[2]*, L. T. Yarboro*[1]*, N. R. Teman*[1]*, G. Ailawadi*[1]
[1]*University of Virginia, Charlottesville,* [2]*Cardiac, Vascular & Thoracic Surgery Associates, Falls Church, VA*

Purpose: Long-term outcomes of surgical aortic valve replacement (AVR) are worse in patients with tricuspid regurgitation (TR) but the impact of concomitant tricuspid valve intervention remains unknown. The purpose of this study was to determine the risk associated with tricuspid intervention in patients undergoing AVR stratified by severity of TR.

Methods: All patients undergoing AVR for aortic stenosis (AS) with or without coronary artery bypass graft surgery in a regional Society of Thoracic Surgeons database (2001-2017) were stratified by severity of TR and whether or not they underwent concurrent tricuspid intervention. Patients with missing TR data were excluded. Primary outcomes of interest included surgical morbidity and mortality, which were compared using univariate analysis. A subgroup analysis was performed using propensity score matched patients to assess the impact of tricuspid intervention on morbidity and mortality.

Results: Of 17,749 patients undergoing AVR for AS, a tricuspid intervention was performed in 111 (0.6%), including 0.3% of patients with mild, 3% with moderate, and 31% with severe TR. Patients undergoing tricuspid intervention were more likely to be female (54% vs 39%, p=0.001) and had higher rates of heart failure (68% vs 44%, p<0.0001) and previous cardiac intervention (56% vs 32%, p<0.0001). As expected, severity of TR was associated with worse composite morbidity (none 17.2%, mild 16.3%, moderate 19.8%, severe 33.3%, p=0.0001) and operative mortality (none 3.2%, mild 3.9%, moderate 6.3% severe 13.9%, p<0.0001). However, tricuspid intervention did not offset the risk (Figure). After 1:1 propensity-matching (n=55 per group), operative mortality was twice as high in the tricuspid intervention group (18% vs 9%, p=0.2) and composite major morbidity was significantly worse (51% vs 26%, p=0.01).

Conclusions: Increasing severity of TR is associated with worse outcomes after AVR, yet few patients undergo concomitant tricuspid surgery. Those who do undergo tricuspid intervention have worse surgical morbidity. Consideration should be given to whether the long-term benefit of repairing TR at the time of AVR is worth the elevated risk.

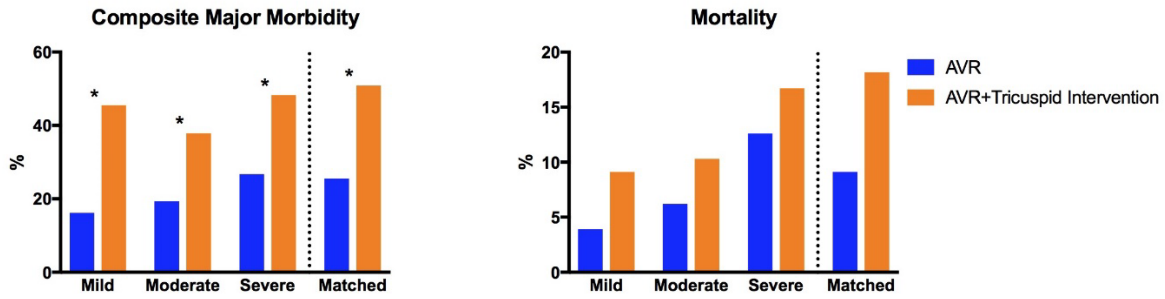


Figure: Surgical major morbidity and mortality after aortic valve replacement in patients with tricuspid regurgitation with and without concomitant tricuspid intervention (* indicates $p<0.05$).

7:15 AM

ABSTRACT: Evolution of Tricuspid Regurgitation After Repair of Degenerative Mitral Regurgitation

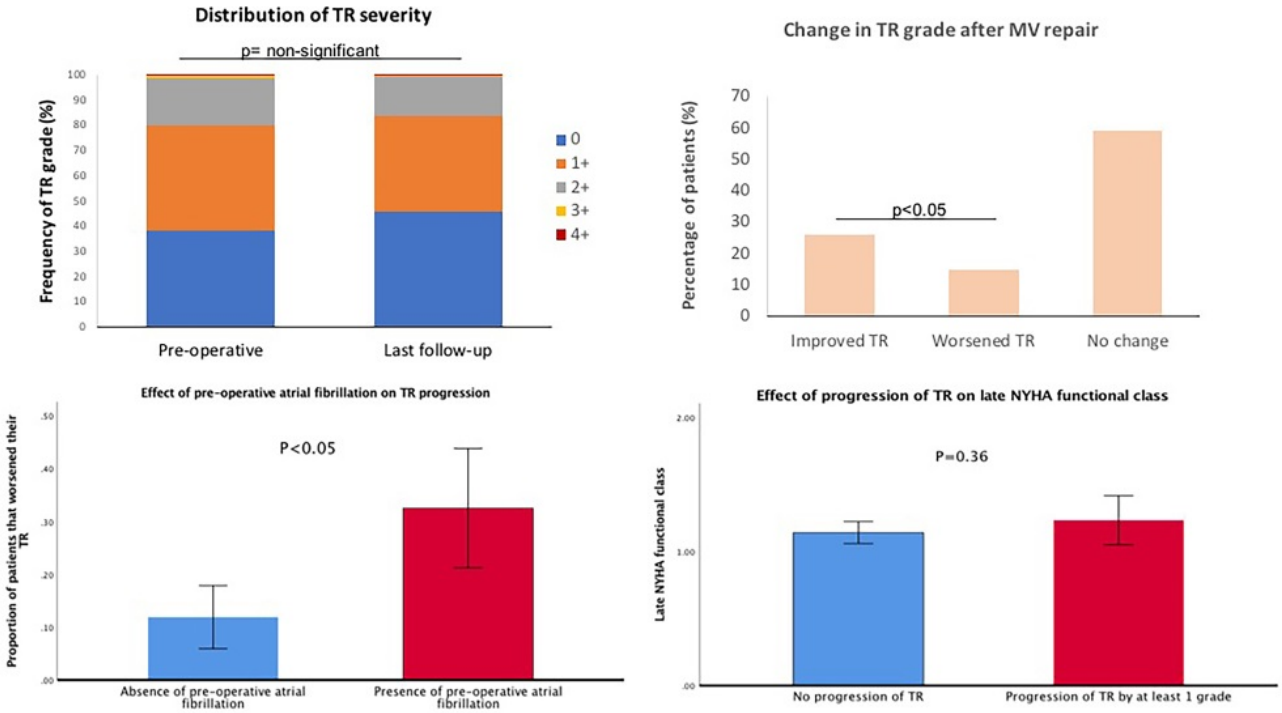
A. Hage[1], *F. Hage*[1], *N. Tzemos*[2], *M. W. Chu*[2]
[1]*Western University, London, Canada,* [2]*London Health Sciences Center, Canada*

Purpose: The fate of unrepaired tricuspid regurgitation (TR) after mitral valve repair (MVr) for degenerative mitral regurgitation (MR) remains poorly defined. The objective of this study was to examine the progress of unrepaired TR after MVr for degenerative MR.

Methods: 183 patients (age: 60.6 ± 13.9 years) with severe MR underwent MVr, without TR repair, for degenerative MR, and were prospectively followed up for a maximal duration of 9 years. 146 patients (80%) had less than moderate TR, and 20.2% (n=37) had = or > moderate TR. Mean pre-operative right ventricle systolic pressure was 27.6 ± 8.8 mmHg. The rate of pre-operative atrial fibrillation (AF) was 21.86% (n=40).

Results: At follow-up, the distribution of TR severity remained similar to pre-operatively (prevalence of = or > moderate TR: 16.4% (n=30) at follow-up vs. 20.2% (n=37) pre-operatively, P=0.42). Despite similar distribution of TR severity at follow-up, more patients (53 patients) had improved their TR severity by at least 1 grade, as compared to those (30 patients) that had worsened it (P<0.05). Echocardiographic worsening of TR (by = or > 1 grade) was not associated with an increase in NYHA class (P=0.36). Multivariate analysis identified pre-operative AF (OR 7.6, P<0.05) and pre-operative elevated RVSP (OR 1.2, P<0.05) as independent predictors for TR progression (worsening of TR by = or > 1 grade). In contrast, the severity of pre-operative TR had no impact on its progression (P=1.0 between different groups of TR severity).

Conclusions: After MVr, a significant proportion of patients improved their TR, regardless of the pre-operative TR severity. Patients with AF or elevated RVSP at baseline had progression of TR albeit without functional impact calling into question the need for an aggressive approach of TR repair in patients with < moderate TR.



7:30 AM

ABSTRACT: Comparison of Mid-Term Survival and Recurrence of Tricuspid Regurgitation Following Tricuspid Valve Repair Ring Annuloplasty vs Suture Bicuspidization Annuloplasty: Implications on Transcatheter Technologies

S. A. Hirji*, S. H. Kiehm, S. M. Landino, F. Yazdchi, S. McGurk, S. K. Singh, H. R. Mallidi, M. P. Pelletier, S. F. Aranki, P. S. Shekar, T. K. Kaneko*

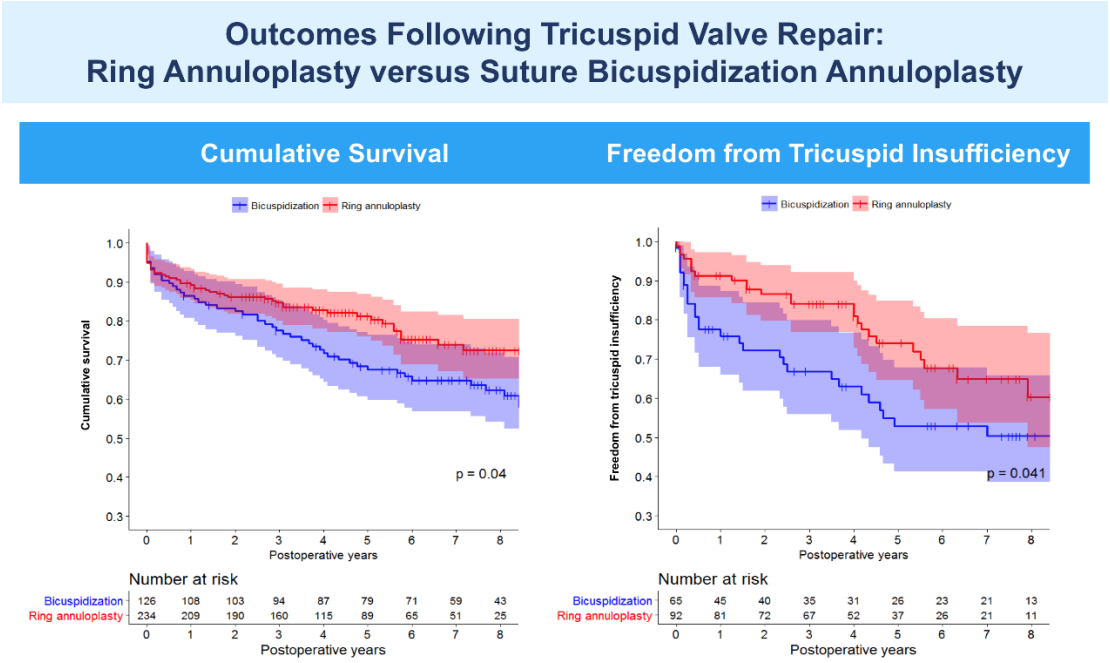
Brigham and Women's Hospital, Boston, MA

Purpose: Suture biscupidization annuloplasty (SB) and ring annuloplasty (RA) are two commonly utilized techniques for tricuspid valve (TV) repair. With emergence of transcatheter approaches for TV intervention, and initial studies demonstrating the utility of transcatheter bicuspidization repair, we sought to compare mid-term outcomes and longitudinal echocardiographic profiles between the two approaches.

Methods: We retrospectively reviewed all patients who underwent either a RA or SB repair technique during TV repair from January 2012 to December 2016. Patients undergoing concomitant mitral valve (MV) or CABG procedures were included. Patients undergoing TV replacement, concomitant aortic valve or aortic procedures, and elective VAD placement were excluded. Primary endpoints were cumulative survival and freedom from recurrent tricuspid regurgitation (defined as more than moderate TR), and both were determined using Kaplan-Meier analysis. Longitudinal survival and echocardiographic follow-up were available in 99% and 44% of patients, respectively.

Results: In our review of 360 patients, RA and SB repair was performed in 234 (65%) patients and 126 (35%) patients, respectively. Both cohorts were similar in terms of age, gender, and baseline characteristics including the proportion of concomitant CABG and MV procedures (all P>0.05). While perfusion times and cross-clamp times were significantly longer among RA patients, rates of reoperation for bleeding, stroke and new onset renal insufficiency were not statistically different when compared to SB patients (all P>0.05). Operative mortality (5.6% vs 6.3%;P=0.82) and postoperative LOS (9 vs 9 days;P=0.70) were also similar between RA and SB patients, respectively. However, SB was associated with significantly lower unadjusted cumulative survival and freedom from tricuspid regurgitation at 1, 5 and 8 years compared to RA patients (both P<0.05; **Figure**).

Conclusions: Our study demonstrate a superiority of ring annuloplasty over suture bicuspidization annuloplasty for TV repair in terms of mid-term survival and subsequent risk of clinically significant tricuspid regurgitation. These findings raise concern in the context of emerging transcatheter technologies which utilize the bicuspidization approach.



7:45 AM

What to Do With Tricuspid Regurgitation? Repair, Replace, or Leave Alone

Vinay Badhwar, Morgantown, WV

8:00 AM

ABSTRACT: Surgical Management and Outcomes of Infective Endocarditis Over 15 Years in a Single Institution

A. R. Stram[1]*, M. Kasten*[1]*, L. R. Timsina*[1]*, P. Hess*[2]*, J. Everett*[2]
[1]*Indiana University School of Medicine, Indianapolis,* [2]*Indiana University Health, Indianapolis*

Purpose: The incidence of infective endocarditis (IE) requiring hospitalization and surgery is increasing. Intravenous drug use (IDU) is a risk factor for IE that has become an important public health problem in recent years, and may be contributing to a change in the epidemiology and surgical management of this disease.

Methods: Our aim was to investigate the temporal trends in surgical care of IE in our institution over the last fifteen years. We looked for identifiable factors associated with increased risk of mortality or postoperative adverse events, including history of IDU. We performed a retrospective examination using the STS database to identify all patients who underwent surgery for IE between July 2003 and February 2017. There were 693 surgeries for IE (men = 427, women = 266, age = 48.9 years). Procedures included single valve (195 aortic, 197 mitral, 102 tricuspid, 9 pulmonic), multiple valves (139), and “other” cardiac procedures (51).

Results: At least one complication, including new-onset atrial fibrillation, occurred in 312 cases (45.0%). Thirty-day mortality was 7.07% (n=49). Patients with at least one complication were more likely to die within 30 days of surgery (36/276, 13.0%) compared to no complications (13/368, 3.5%)($p<0.001$). Specific complications that increased risk of death were neurological event (n=19, $p=0.032$), cardiac arrest (n=20, $p<0.001$), re-intubation (n=72, $p<0.001$), pneumonia (n=70, $p<001$), and prolonged ventilator time (>24 hours) (n=194, $p<0.001$). Procedure type did not affect risk of complications or mortality. There was a significant increase in the number of tricuspid valve (TV) procedures over this time period ($p<0.001$). From 2011-2017, 72.3% of TV procedures, either alone or in combination with other valves, were performed on patients with a documented history of IDU. The average age of patients decreased significantly over time ($p<0.001$), with the youngest patients undergoing tricuspid and pulmonic valve procedures.

Conclusions: Postoperative complications and mortality rates are high after valve surgery for IE. We found a significant increase in the number of TV operations over time, with a majority in individuals having a history of IDU. These results may help direct decisions regarding surgical care of IE in the United States.

8:15 AM

ABSTRACT: Degenerative Mitral Valve Repair Simplified: An Evolution to Universal Artificial Chordal Repair

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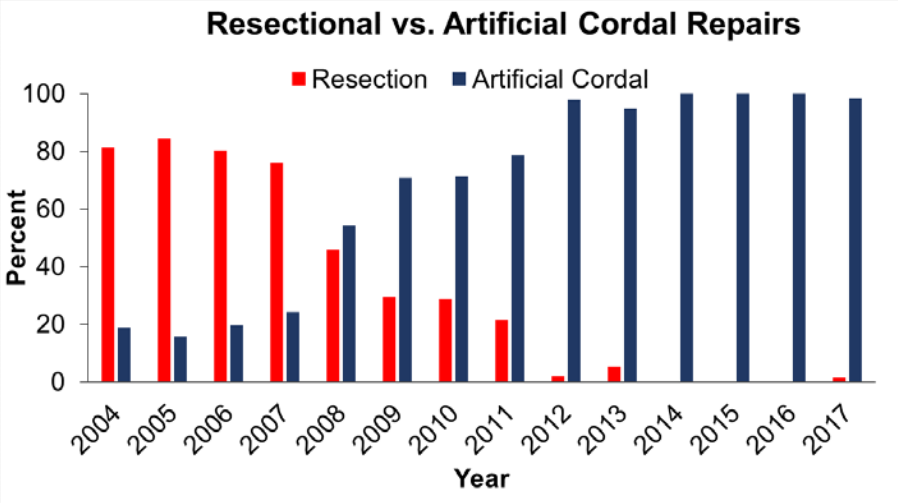
University of Maryland School of Medicine, Baltimore

Purpose: Resectional and artificial cordal repair(ACR) techniques are effective strategies for degenerative mitral valve (MV) repair. However, resectional repair requires a tailored approach using various techniques, while ACR offers a simpler, easily-reproducible repair. Our approach has evolved from resectional to ACR over time, and we compared outcomes between the two eras.

Methods: All consecutive MV repairs for degenerative mitral regurgitation (MR) from 2004-2017 were retrospectively reviewed. Clinical and echocardiographic late follow-up was complete in 79% (667/848) of patients with mean follow-up of 4.8±2.9 years (range: 0-14 years). Pre-discharge echocardiography was performed in 91% (774/848) of patients. Patients were stratified by era. From 1/2004-6/2011 (Era-1, n=411), resectional techniques were utilized in 56% and ACR in 44% (FIGURE). From 7/2011-7/2017 (Era-2, n=437), ACR techniques were utilized in 98.4% of patients. The primary outcome was repair failure, defined as greater than moderate MR or MV reoperation.

Results: Of 852 patients with degenerative disease, successful repair was achieved in 848 patients (99.5% repair rate). Leaflet prolapse was posterior in 66%, anterior in 10%, and bileaflet in 24% (TABLE). Cardiopulmonary bypass (CPB) time and cross-clamp (XC) times were shorter in Era-2 (CPB: 113±32 vs. 101±29minutes, $p<0.001$, XC: 92±28 vs. 82±5minutes, $p<0.001$). Overall, pre-discharge echocardiography demonstrated none/trace MR in 95%, mild in 4.8%, and moderate in 0.3% of patients. Operative mortality was similar in the two eras (Era-1: 0.7%, Era-2: 0.7%, $p=0.94$). After risk adjustment, Era-1 was not a risk-factor for late mortality (HR: 1.973 (0.92-4.3), $p=0.08$). Repair failure developed in 31/667 patients: 24 required reoperation and 7 had >moderate MR. At 6-years, the probability of repair failure (Era-1: 5%, Era-2: 5%, HR: 1.38 (0.59-3.23), $p=0.456$), stroke (Era-1: 3.4%, Era-2: 5%, $p=0.433$), and endocarditis (Era-1: 0.8%, Era-2: 0.3%, $p=0.635$) were similar.

Conclusions: ACR techniques for all patients with degenerative MV disease simplifies MV repair and is more efficient than a resectional approach. Moreover, ACR techniques yield equivalent and excellent late outcomes compared to more complex resectional techniques. Degenerative MV repair can almost exclusively be performed with ACR.



	Overall *N=848*	Era-1 (n=411)	Era-2 (n=437)	*p-value*
Preoperative Characteristics				
Age (years)	61 ±13	59 ±13	62±12	<0.001
Male	64%	69%	62%	0.034
Atrial Fibrillation	28%	28%	28%	0.805
LVEF				<0.001
Normal (>=60%)	64%	56%	72%	
Reduced (<60%)	36%	44%	28%	
Systolic PA Pressures				0.005
Normal (<40 mmHg)	69%	64%	75%	
Elevated (>40 mmHg)	31%	36%	25%	
Operative Characteristics				
Mitral Pathology				
Isolated Posterior	66%	65%	67%	0.975
Isolated Anterior	10%	11%	10%	0.082
Bileaflet	24%	24%	23%	
Artificial Cordal Repair	72%	44%	98%	<0.001
Number of Cords	3.2±1.5	2.5±1.3	3.8±-1.3	<0.001
Resectional Technique	28%	56%	2%	<0.001
Concomitant Procedures	37%	36%	38%	0.682
CryoMaze	24%	25%	24%	0.771
CABG	12%	15%	11%	0.0964
TV Repair	10%	6%	14%	<0.001
Systolic Anterior Motion req intraop intervention	2%	2%	2%	0.318
In-Hospital Outcomes				
Mitral Regurgitation				0.278
None/Trace	94.9%	94.2%	95.7%	
Mild	4.8%	5.3%	4.3%	
Moderate	0.2%	0.5%	0%	
Severe	0%	0%	0%	
Mean Gradient (mmHg)	4±2	5±2	4±2	0.318
Stroke	0.7%	0.5%	0.9%	0.687
Survival	99.3%	99.3%	99.3%	0.940
Probability at 6-years				
Endocarditis	0.5%	0.8%	0.3%	0.635
Stroke	4%	3.4%	5%	0.433
Repair Failure	5%	5%	5%	0.426
Long-term Outcomes				
Change in sPAP (mmHg)	5±21	7±21	2±19	0.035
NYHA Class				0.068
1	86%	83%	88%	
2	11%	11%	10%	
3	3%	4%	2%	
4	1%	2%	1%	
Mean Gradient (mmHg)	4±2	4±2	4±2	0.178

8:30 AM

DEBATE: Respect, Not Resect, in Mitral Valve Repair

Con: *Patrick M. McCarthy, Chicago, IL*

Pro: *James S. Gammie, Stevenson, MD*

7:00 AM – 9:00 AM
Congenital: Pediatric Congenital III
Moderators: *James J. Gangemi, Charlottesville, VA, and James S. Tweddell, Cincinnati, OH*

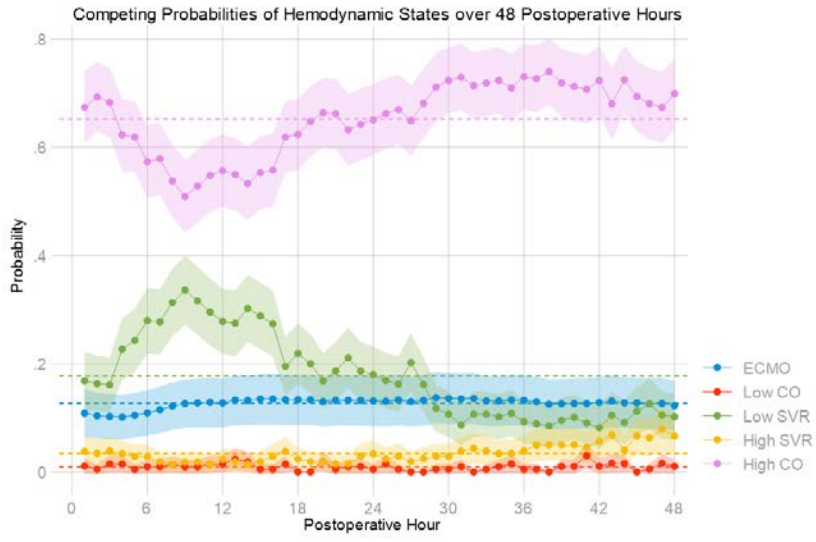
7:00 AM
ABSTRACT: Identification of Time-Dependent Risks of Hemodynamic States Following Stage 1 Norwood Palliation
G. M. Hoffman[1], *J. P. Scott*[1], *N. S. Ghanayem*[2], *E. E. Stuth*[1], *M. E. Mitchell*[1], *R. K. Woods*[1], *V. Hraska*[1], *R. A. Niebler*[1], *R. Bertrandt*[1], *K. A. Mussatto*[1], *J. S. Tweddell*[3]
[1]*Children's Hospital and Medical College of Wisconsin, Milwaukee,* [2]*Baylor College of Medicine/Texas Children's Hospital, Houston,* [3]*Cincinnati Children's Hospital Medical Center, OH*

Purpose: Morbidity and mortality following stage one Norwood palliation (S1P) of hypoplastic left heart syndrome (HLHS) remains significant despite improved outcomes[1]. Hemodynamic vulnerability can be partitioned into states of high and low cardiac output (CO) and systemic vascular resistance (SVR)[2]. We sought to identify time-dependent changes in postoperative hemodynamic states.

Methods: Perioperative data on neonates undergoing S1P were prospectively collected in an IRB approved database. Eligibility included use of deep hypothermic cardiopulmonary bypass, circulatory arrest, and/or selective antegrade cerebral perfusion with perioperative cerebral and somatic NIRS monitoring. Hemodynamic state was classified by domains of high/adequate CO, high SVR, low SVR, and low CO using two-parameter analysis of mean arterial pressure (MAP, cutpoint 48 mmHg) and somatic-renal regional saturation (rSO2R, cutpoint 70%), and ECMO. State classifications over the first 48 postoperative hours were modelled using generalized ordered logistic regression with time and patient variance components, and transitional probabilities were calculated.

Results: Data from 9800 hours in 219 patients from 2002 to 2013 were available for analysis. Hospital survival was 90.2%. The predominant state was high CO (65% of time), which decreased to 55% during hours 6-16. The overall hourly transition probability (entry to and exit from) high CO was 10.5%. Exit from high CO increased to 15.4% during hours 1-12, mainly to the low SVR state, with re-entry during hours 12-16 mainly from high SVR. Incidence of low SVR was increased from hours 4-15. ECMO was employed to treat low CO during 12.4% of time in 25 patients. The risk of ECMO slightly increased from hours 6-12. The risk of low CO without ECMO was 0.93% overall, and 1.24% during hours 1-16 (see figure). The overall hourly probability of transition onto ECMO was 0.5%, and 4.9% during hours 6-12, mainly from the high SVR state.

Conclusions: Early postoperative hemodynamic vulnerability persists with current perioperative support techniques[3,4]. High SVR state was unstable, and associated with transitions both onto ECMO and into high CO, while transitions off ECMO were into low SVR or high CO states. Strategies to maintain CO and control SVR remain relevant.



7:15 AM
ABSTRACT: Unplanned Interstage Interventions Between Norwood Palliation and Superior Cavopulmonary Anastomosis: A Report From the National Pediatric Cardiology Quality Improvement Collaborative
D. A. Castellanos[1], *E. C. Ocampo*[1], *A. Gooden*[2], *C. M. Mery*[3], *A. M. Qureshi*[2], *J. S. Heinle*[2], *Y. Wang*[2], *G. D. Hill*[4], *N. S. Ghanayem*[1]
[1]*Baylor College of Medicine/Texas Children's Hospital, Houston,* [2]*Texas Children's Hospital, Houston,* [3]*The University of Texas Dell Medical School/Dell Children's Hospital, Austin,* [4]*Cincinnati Children's Hospital Medical Center, OH*

Purpose: Some interstage mortality following Norwood stage 1 palliation (S1P) for single ventricle heart disease is attributed to residual or recurrent anatomic lesions. Reports on interstage interventions after S1P discharge are limited. This study sought to describe the scope and associated risk factors for surgical and catheter-based interstage interventions.

Methods: The National Pediatric Cardiology Quality Improvement Collaborative registry was queried for patients born between 2008-2016 and discharged from the hospital after S1P. Hybrid palliation was excluded. Interstage period was defined as time from S1P hospital discharge to superior cavopulmonary anastomosis stage 2 palliation (S2P). Individual characteristics, details from S1P and S2P hospitalizations, and interstage readmissions were examined. Multivariable logistic regression including all variables with $p < 0.3$ on univariable analysis was used to compare those who had an unplanned surgical or catheter-based interstage intervention (Intervention Group, IG) to those who did not (No Intervention Group, NIG).

Results: The study included 2,002 participants from 60 cardiac programs; 352 (17.6%) had 555 unplanned interstage interventions (148 surgical and 407 catheter-based). Aortic valve dilation prior to S1P, longer cardiopulmonary bypass time at S1P, neoaortic arch obstruction on S1P pre-discharge echocardiogram, and lower weight at S1P discharge were significantly and independently associated with receiving an unplanned interstage intervention (**Table 1**). Interstage mortality between groups was similar at 6%, as was median interstage duration [107 (IQR 84-134) days for IG vs 109 (IQR 85-137) days for NIG, p= 0.550]. Patients in the IG were more likely to undergo heart transplant prior to S2P or deemed to be unsuitable for S2P (7.4% vs 2.6%, p=<0.001).

Conclusions: The need for unplanned interstage interventions does not seem to increase interstage mortality. However, it is associated with lower likelihood of progressing to S2P. Neoaortic arch obstruction is the only anatomic finding associated with unplanned interstage interventions. Further study of this population may inform S1P perioperative and interstage surveillance practices.

Table 1: Multivariable Logistic Regression Model for Outcome of any Interstage Surgery or Unplanned Interventional Catheterization

Variable	Odds Ratio (95% CI)	P-value
S1P CPB Time	1.006 (1.002, 1.009)	0.006
Weight at S1P Discharge	0.598 (0.426, 0.840)	0.003
Prenatal Diagnosis	1.873 (0.969, 3.619)	0.062
S1P Discharge Echocardiogram Demonstrating Moderate/Severe Tricuspid Valve Regurgitation	1.571 (0.943, 2.616)	0.082
S1P Discharge Echocardiogram Demonstrating neoaortic Arch Obstruction	2.336 (1.416, 3.855)	<0.001
Route of nutrition at S1P Discharge		
Oral only	Ref	Ref
NG/NJ/G-tube	1.667 (0.945, 2.942)	0.078
Oral and NG/NJ/G-tube	1.527 (0.897, 2.599)	0.119
Oxygen Therapy at S1P Discharge	1.838 (0.998, 3.385)	0.051
Aortic valve dilation prior to S1P	6.352 (1.580, 25.53)	0.009

7:30 AM

ABSTRACT: Pulmonary Atresia With Intact Ventricular Septum and Right Ventricle Dependent Coronary Circulation: Location of Coronary Obstruction Impacts Survival

Z. A. Spigel[1]*, A. M. Qureshi*[2]*, S. A. Morris*[2]*, C. M. Mery*[3]*, S. Sexson-Tejtel*[2]*, R. Zea-Vera*[1]*, Z. M. Binsalamah*[1]*, M. Imamura*[1]*, J. S. Heinle*[2]*, I. Adachi*[2]

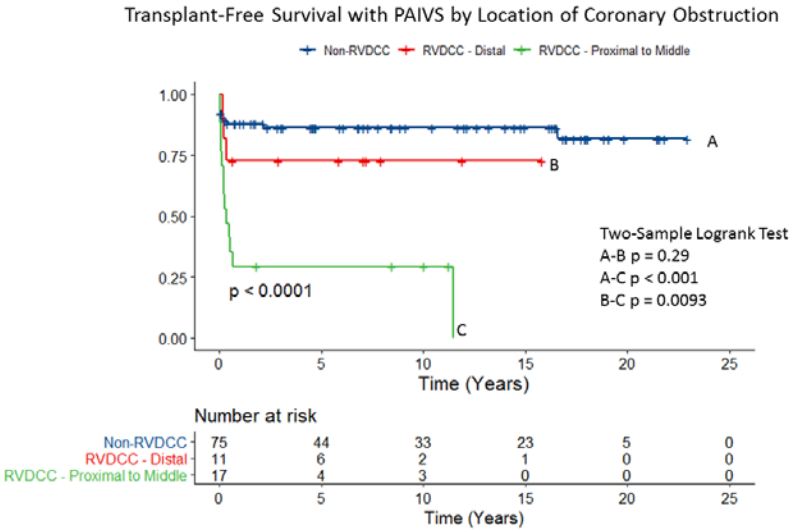
[1]Baylor College of Medicine, Houston, TX, [2]Texas Children's Hospital, Houston, [3]The University of Texas Dell Medical School/Dell Children's Hospital, Austin

Purpose: Pulmonary atresia with intact ventricular septum (PAIVS) is a heterogeneous congenital heart defect with a range of palliation strategies[1]. We aim to review a modern, single-center experience with PAIVS with a focus on patients with right ventricle dependent coronary circulation (RVDCC), a lesion with a reported 50% ten-year mortality[2-3].

Methods: We reviewed all neonates with PAIVS at our center between January 1995 and December 2017. RVDCC was defined as right ventricle to coronary artery fistula with stenosis or atresia of a coronary artery, confirmed by coronary angiography. Location of coronary obstruction was categorized as either proximal to middle (including ostium atresia) or distal segments. Using Kaplan-Meir analysis and univariate Cox regression, we first compared patients with and without RVDCC, with the outcome of cardiac death (orthotopic heart transplant [OHT] or patient death). Then, within the group of patients with RVDCC, we evaluated variables associated with cardiac death.

Results: Of 103 patients with PAIVS, 28 (27%) had RVDCC. Median age at last follow-up for all patients was 6.1 years (IQR 0.6-14.6). RVDCC was associated with increased cardiac death compared to patients without RVDCC (57% vs 15%; HR 5.3, 95% CI 2.4-11.8, p<0.0001). Of patients with RVDCC, 26 underwent primary surgical or catheter-based palliation (Blalock-Taussig shunt n= 23, 82%, ductal stent n= 3, 11%) and 1 (3.6%) underwent primary OHT. Five patients (18%) underwent OHT after initial palliation. Proximal to middle coronary artery obstruction had increased cardiac death relative to isolated distal obstruction, regardless of the number of arteries involved (76% vs 27%, HR 4.11, 95%CI 1.16–14.54, p=0.028). Patients with distal obstruction had similar transplant-free survival compared to the cohort without RVDCC (logrank test p=0.29; Figure). Sensitivity and specificity for transplant-free survival with proximal versus distal obstruction were 67% and 81%, respectively.

Conclusions: PAIVS with RVDCC continues to be a challenging condition with suboptimal long-term survival. In this cohort, the location of coronary artery obstruction was associated with cardiac death and may represent a potential branch point in the management of these patients. Long-term follow-up of a larger cohort is warranted.



7:45 AM

ABSTRACT: Impact of Bilateral, Bidirectional Cavopulmonary Shunt on Outcomes Following Staged, Single Ventricle Palliation

***M. Ono**, M. Burri, B. Mayr, E. Beran, J. Cleuziou, A. Hager, R. Lange*
German Heart Center Munich

Purpose: The presence of bilateral superior vena cavae (SVC) poses unique flow characteristics following bilateral bidirectional cavopulmonary shunt (BCPS). A recent study demonstrated that bilateral SVC is a significant risk for mortality after BCPS. This study was performed to evaluate outcomes of these patients before and after total cavopulmonary connection (TCPC).

Methods: Among 405 patients who underwent staged surgical palliation for single-ventricle physiology (both BCPS and TCPC) between May 1997 and December 2017, 40 patients (9.9%) underwent bilateral BCPS and the remaining 365 patients (90.1%) underwent unilateral BCPS. Patients´ diagnosis, morphological characteristics, palliative surgeries, pre-TCPC hemodynamics, systemic ventricular function, atrioventricular valve function, and outcomes following TCPC were compared between the groups. The time to discharge from intensive care unit (ICU) and estimated overall survival following TCPC was compared between groups, using Kaplan-Meier method and long-rank test.

Results: Patients with bilateral BCPS had a higher rate of dextrocardia (33 vs. 6%, p<0.001), heterotaxy (40 vs. 4%, p<0.001), anomalous pulmonary venous drainage (20 vs. 5%, p<0.001), common atrioventricular valve (43 vs. 6%, p<0.001), dominant right ventricle (88 vs. 55%, p<0.001), and extra-cardiac anomaly (23 vs. 10%, p=0.013), as compared with those with unilateral BCPS. Median age at BCPS (0.6 [0.4-1.5] vs. 0.4 [0.3-0.8] years, p=0.156) and median age at TCPC (2.6 [2.2-3.1] vs. 2.0 [2.2-3.1] years, p=0.089) were similar between groups. Pre-TCPC hemoglobin level (16.8±2.5 vs. 16.0±1.7 g/dl, p=0.010), mean pulmonary artery pressure (10.2±3.6 vs. 9.1±2.7 mmHg, p=0.017), and mean left atrial pressure (6.6±3.1 vs. 5.3±2.3 mmHg, p=0.001) were higher in patients with bilateral BCPS. Following TCPC, the probability of ICU discharge (45.0% vs. 61.9% at 7 days, p=0.024) and the estimated overall survival (83.9 vs. 96.1% at 15 years, p=0.004) were significantly lower in patients with bilateral BCPS.

Conclusions: Although the timing of BCPS and TCPC were similar, pulmonary artery pressure at TCPC was higher, post-TCPC ICU stay was longer, and survival following TCPC was worse in patients with bilateral BCPS. Unique flow characteristic after bilateral BCPS and associated morphologic anomalies might contribute to the worse outcomes following TCPC.

8:00 AM

ABSTRACT: Long-Term Surgical Prognosis of Primary Supravalvular Aortic Stenosis Repair

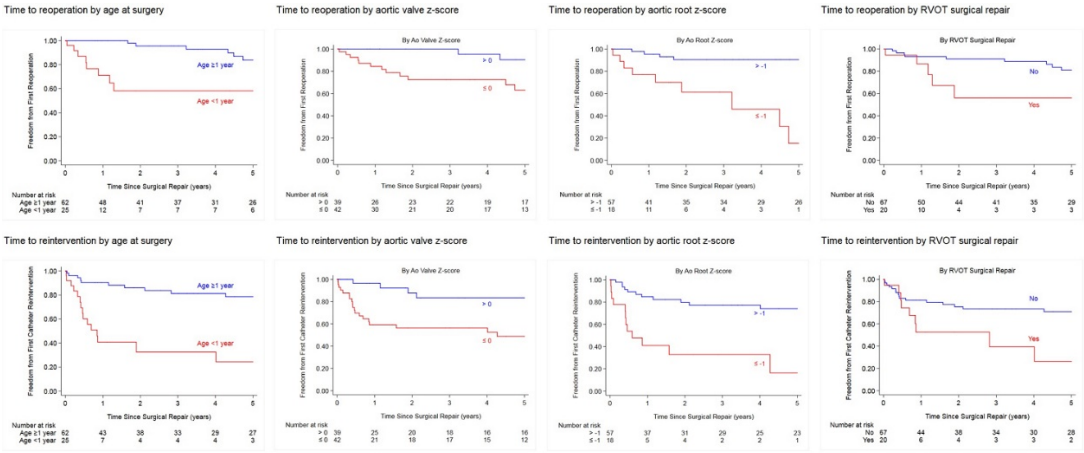
***F. Wu**[1], A. Mondal[2], P. J. del Nido[2], K. Gauvreau[2], S. M. Emani[2], C. W. Baird[2], A. K. Kaza[2]*
[1]Taipei Veteran General Hospital, Taiwan, [2]Boston Children's Hospital, MA

Purpose: Supravalvular aortic stenosis (SVAS) represents a heterogeneous group, including Williams syndrome, familial elastin arteriopathy, sporadic cases and others. In this study, we sought to evaluate long-term outcomes of SVAS repair.

Methods: A total of 87 patients underwent surgical repair of congenital SVAS at our institution between 1997 and 2017. 41 patients had Williams syndrome. Among the 46 non-Williams syndrome patients, 23 had sporadic SVAS and 13 had familial elastin arteriopathy. Demographic data and outcomes were reviewed and analyzed from medical records.

Results: The median age at operation was 2.9 years. Mean z-score of sinotubular junction (STJ) was -3.29 ± 1.42 and aortic root was -0.09 ± 1.19. 26.3% (n=22) patients had coronary ostium stenosis and 41% (n=9) of them required patch plasty. 5-year, 10-year and 20-year survival rates were all 94.3%. Freedom from left ventricular outflow tract (LVOT) reoperation at 5 years, 10 years and 20 years was 78.5%, 70.3%, 70.3%, respectively. Freedom from aortic arch reintervention at 5 years, 10 years and 20 years was 98.6%, 94.3%, 89.3%, respectively. In risk factors analysis, age < 1 year, z-scores of aortic valve, aortic root and concomitant right ventricular outflow tract (RVOT) surgical repair were predictive of the need for reoperation and reintervention for LVOTO/RVOTO.

Conclusions: Excellent long-term survival rates can be achieved with surgical repair of SVAS. Age < 1 year, small aortic valve, aortic root z-scores and concomitant RVOT surgical repair were predictors of reoperation and reintervention.



	Reoperation		Reintervention	
	Hazard Ratio	P Value	Hazard Ratio	P Value
Williams syndrome	0.9 (0.3, 2.4)	0.86	1.9 (0.9, 4.1)	0.09
Age <1 yr at surgery	3.7 (1.4, 9.8)	0.008	6.0 (2.6, 13.6)	<0.001
Weight ↓ 5 kg	1.2 (0.9, 1.5)	0.1	1.3 (1.1, 1.7)	0.01
RVOT surgical repair	2.6 (0.9, 7.6)	0.07	2.6 (1.1, 5.9)	0.02
Ao valve z-score ≤ 0	4.4 (1.2, 15.5)	0.02	5.5 (1.9, 16.1)	0.002
Ao root z-score ≤ -1	9.2 (2.9, 29.1)	<0.001	5.9 (2.6, 13.5)	<0.001
Asc ao z-score ↓ 1	1.2 (0.9, 1.6)	0.28	1.6 (1.2, 2.2)	0.004

Cox regression for time from surgical repair to outcome or last follow-up Hazard ratios (95% CI) and p values are shown

8:15 AM

ABSTRACT: Williams Syndrome: A 24-Year, Single-Institution Evaluation of Outcomes and Risk of Long-Term Reintervention

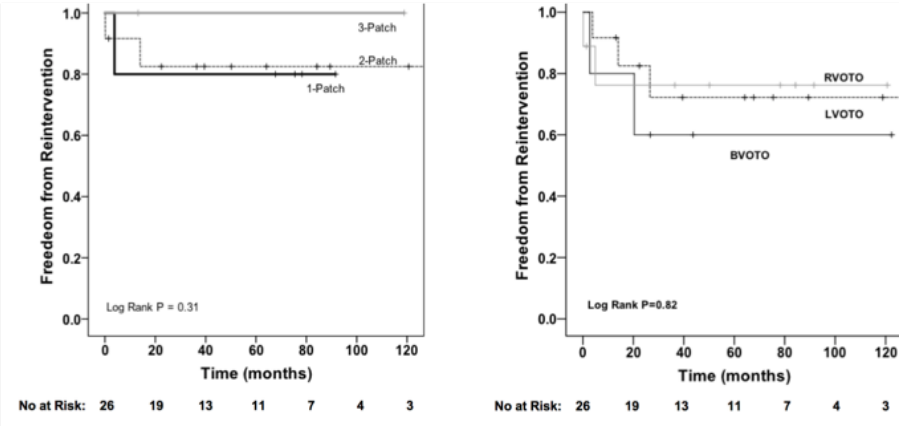
A. L. Zenilman[1]*, D. Blitzer*[1]*, B. R. Anderson*[2]*, D. M. Kalfa*[2]*, P. J. Chai*[1]*, E. A. Bacha*[1]*, D. J. LaPar*[2]
[1]NewYork-Presbyterian/Columbia University Medical Center, NY, [2]NewYork-Presbyterian/Morgan Stanley Children's Hospital, Columbia University Medical Center, NY

Purpose: William's syndrome (WS) confers increased surgical risk for correction of cardiac defects. While perioperative outcomes following surgical correction is reported, long-term risk remains poorly characterized. The purpose of this study was to evaluate factors influencing operative and long-term outcomes and the likelihood of reintervention following cardiac surgery for WS patients.

Methods: A total of 26 WS patients (1995-2018) undergoing cardiac surgical repair were evaluated at a single institution. Patients were characterized according to anatomic substrate as Right (RVOTO), Left (LVOTO) or Bi-ventricular Outflow Tract Obstruction (BVOTO) as well as by surgical approach (1-patch, 2-patch, or 3-patch repair of supravalvular aortic stenosis [SVAS]). Patient factors, operative features, and outcomes were evaluated by univariate analysis. Kaplan Meier estimates were utilized to examine long-term freedom from reintervention following surgical repair.

Results: Median patient age was 5.4 years (range 5d-10yr) and median weight at time of operation was 26.3 kg (range 2.5-50kg). The prevalence of RVOTO was 19%, LVOTO 46%, and BVOTO 35%. The majority (65%) of patients underwent a 2-patch repair of SVAS. The incidence of major adverse cardiac events (MACE) was 23%, hospital mortality was 3.8%, and reintervention within 30 days was 15%. With a median follow-up of 2.3 years, the overall incidence of long-term reintervention was 27%. Importantly, Kaplan Meier overall freedom from reintervention was 84%, 84% and 71% at 1, 3, and 5 years. When characterized by anatomic substrate and SVAS surgical repair type, surgical repair for isolated RVOTO and a 3 patch SVAS repair trended toward higher freedom from long-term surgical and/or catheter-based reintervention (Figure 1).

Conclusions: Williams syndrome patients remain a high-risk cardiac surgical cohort with ~30% requiring future surgical and/or catheter-based reinterventions. Complex LVOTO or BVOTO raises concern for increased risk of reintervention. These data highlight the need for careful attention and consistent follow-up in the postoperative period to reduce long-term morbidity and mortality.



8:30 AM

ABSTRACT: Staging of Surgical Repairs in Children With Comorbid Long Segment Congenital Tracheal Stenosis and Congenital Cardiovascular Abnormalities

***M. Ramaswamy**, R. Varman, O. Fedevych, D. McIntyre, N. McIntosh, D. Roebuck, R. Hewitt, N. Muthialu*
Great Ormond Street Hospital, London, United Kingdom

Purpose: Co-existent long segment congenital tracheal stenosis (LSCTS) and congenital cardiovascular (CVS) abnormalities in children pose challenges in offering simultaneous or staged surgical repairs. The aim of this study is to explore the possibility of arriving at clinical decisions for this combination of congenital abnormalities to be repaired simultaneously or in stages.

Methods: All children who underwent both tracheal and cardiac surgeries either simultaneously (SR1) or in stages (SR2) in a single institution from January 1995 to June 2018 were included retrospectively. Variables analysed included age, gender, weight, pre-operative cardiorespiratory support, preoperative malacia and cardiopulmonary bypass time (CPB). In SR2, CPB is cumulative of tracheal and cardiac surgeries performed separately. RACHS-1 (Risk Adjustment for Congenital Heart Surgery-1) categorisation was also considered. Primary outcome is mortality and secondary outcomes are ventilation days, intensive care unit (ICU) days, haemorrhage, mediastinitis and re-operation. Continuous and categorical variables are analysed respectively by t-test and chi-square test.

Results: 113 children were eligible (SR1 = 81, SR2 = 52). No significant differences were seen between baseline characteristics of SR1 and SR2 for mean age (12.3 & 12.2 months, p = 0.99), proportion of females (40.7% & 50%, p = 0.37), mean weight (6.6 & 5.8 kilograms, p = 0.43), pre-operative respiratory support (61.7% & 46.9%, p = 0.15), pre-operative extracorporeal support (8.6% & 6.3%, p = 0.67) and pre-operative malacia (19.8% & 25%, p = 0.53). Unsurprisingly, mean CPB is lower in SR1 than SR2 (120.2 &178.9 minutes, p = 0.001). No significant differences were seen between SR1 and SR2 in mortality (13.6% & 18.8%, p = 0.49) and secondary outcomes of mean ventilation days (19.8 & 16.5, p = 0.54), mean ICU days (24.2 & 27.3, p = 0.61), haemorrhage (2.5% & 3.1%, p = 0.85) and re-operation (9.9% & 15.6%, p = 0.39). Mediastinitis was significantly lower in SR1 (3.7% & 6.2%, p = 0.03).

Conclusions: Although there are no major differences in the outcomes between the two groups, staged repairs are preferable in children with long segment congenital tracheal stenosis when the associated congenital cardiovascular abnormality is categorised higher than three in RACHS-1classification. This is to mitigate morbidities of prolonged cardiopulmonary bypass.

8:45 AM

ABSTRACT: Pediatric Tracheal Surgery: A 25-Year Review

*C. L. Backer, **E. H. Stephens**, O. Eltayeb, M. C. Monge*
Ann & Robert H. Lurie Children's Hospital of Chicago, IL

Purpose: There are a limited number of centers that focus on tracheal surgery in infants and children. The purpose of this study was to assess the outcomes of tracheal surgery at our institution, analyze data for predictors of outcomes, report on changes in our management strategy, and identify areas for improvement.

Methods: Retrospective review of tracheal surgery from 1/1/1993 to 5/1/2018 was performed (see Table). Standard demographic data were collected, as well as operative details, perioperative data, and clinical outcomes. Our management strategy has evolved to less rigid bronchoscopy and more reliance on advanced imaging with perioperative use of inhaled ciprofloxacin/dexamethasone.

Results: There were 44 patients with a median age of 4.08±3.72 months and weight of 4.16±19.2kg. Thirty-six patients (88%) had complete tracheal rings, 11 patients (27%) had a pulmonary artery sling. Lung hypoplasia or agenesis was present in 7 patients (17%). Other cardiovascular anomalies occurred in 21 patients (51%). Eleven patients (27%) were transferred from an outside hospital intubated. Slide tracheoplasty was performed in 27 patients (66%); resection with end-to-end anastomosis in 15 patients (37%). Other cardiac repairs were performed in 14 patients (34%). Complications included reintubation in 3 patients (7%), tracheostomy in 4 patients (10%), and in-hospital mortality in 3 patients (7%). Length-of-stay was 25.0±81.8 days with ventilator duration of 7.0±21.0 days. On multi-variate analysis for death, reintubation, tracheostomy, only length-of-stay was significant (HR: 1.025, 95% CI 1.006-1.054, p=0.015), and the only factor associated with death was an intracardiac anomaly (HR: 15.5, 95% CI 1.37-175.4, p=0.027).

Conclusions: Slide tracheoplasty and tracheal resection are effective operative management strategies for infants and children with tracheal stenosis independent of lung hypoplasia/agenesis or preoperative intubation.

Table: 25 Years of Pediatric Tracheal Surgery at a Single Institution

Demographics	
Male	16 (39%)
Genetic abnormality/syndrome	5 (12%)
Associated Pulmonary/Tracheobronchial Anomalies	
Tracheal RUL	4 (10%)
Hypoplastic right lung	2 (5%)
Absent right or left lung	5 (12%)
Congenital diaphragmatic hernia	2 (5%)
Associated Cardiovascular Anomalies	
DORV / RVOTO	1 (2%)
VSD / PA	1 (2%)
PDA (alone)	6 (15%)
ASD / VSD ± PS	3 (7%)
ASD / VSD / MR / CoA	1 (2%)
ASD	3 (7%)
VSD	1 (2%)
Previous Tracheal Interventions	
Dilations	3 (7%)
Tracheal resection	1 (2%)
Previous Cardiac Surgeries	
VSD	1 (2%)
PDA	2 (5%)
Clinical Status	
Intubated	11 (27%)
Transferred from outside hospital intubated	11 (27%)
Tracheostomy	1 (2%)
Diagnostic	
Bronchoscopy	41 (100%)
CT scan	25 (61%)
Operative Details	
Slide tracheoplasty	27 (66%)
REEA	15 (37%)
Repair Sling	11 (27%)
Other cardiac repairs	14 (34%)
CPB (min)	120.0 ± 56.0
XC (min)	60.5 ± 22.8
Perioperative	
Ventilator time (days)	7.0 ± 21.0
Length-of-stay (days)	25.0 ± 81.8

ASD, atrial septal defect; CoA, coarctaton; CPB, cardiopulmonary bypass; CT, computed tomography; DORV, double outlet right ventricle; PA, pulmonary atresia; PDA, patent ductus arteriosus; PS, pulmonary stenosis; REEA, resection with end-to-end anastomosis; RUL, right upper lobe; RVOTO, right ventricular outflow tract obstruction; VSD, ventricular septal defect; XC, cross-clamp

7:00 AM – 9:00 AM
General Thoracic: Lung Cancer II
Moderators: *Natalie S. Lui, Stanford, CA, and Robert A. Meguid, Aurora, CO*

7:00 AM

ABSTRACT: Cardiopulmonary Assessment Prior to Lung Resection: What Are Thoracic Surgeons Doing?

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Purpose: Cardiopulmonary assessment for lung resection is important for risk stratification, and the American College of Chest Physicians (ACCP) guidelines are a predominant source for decision support. We aimed to ascertain thoracic surgeons' cardiopulmonary assessment practices and determine whether they vary by demographics and are concordant with ACCP guidelines.

Methods: An anonymous survey was emailed to 846 thoracic surgeons who participate in the Society of Thoracic Surgeons (STS) General Thoracic Surgery Database (GTSD). We analyzed survey responses by practice type (general thoracic [GTS] vs cardiothoracic surgeon [CTS]) and years in practice (0–9, 10–19 and ≥20) using contingency table analysis. We compared survey practice pattern responses to the ACCP guidelines on physiologic evaluation prior to lung cancer resection to determine respondent adherence to individual recommendations within the guidelines, as well as overall guideline adherence.

Results: The response rate was 24.0% (n=203). Most surgeons, n=121 (59.6%), cited a predicted postoperative forced expiratory volume in 1 second (FEV1) or diffusing capacity for carbon monoxide (DLCO) threshold of 40% for further evaluation. CTS had more variability for lung function threshold (Figure 1, p=0.01). Experienced surgeons (≥20 years) were more likely to have a threshold that varies by surgical approach (31.3% vs 23.5% 10–19 and 15.9% 0–9 years, p=0.007) and were less likely to order DLCO (73.1% vs 88.2% 10–19 and 93.7% 0–9 years, p=0.048). Overall, 52.2% refer patients with cardiovascular risk factors to cardiology, 42.9% refer patients with abnormal stress testing; only 7.4% calculate the Thoracic Revised Cardiac Risk Index. CTS were more likely to refer all patients to cardiology than GTS (17.6% vs 2.4%, p<0.001). No respondent was 100% adherent to ACCP guidelines, and 6% and 53% were 75% and 50% adherent, respectively.

Conclusions: There is variation in preoperative cardiopulmonary assessment practices by thoracic surgeons, with differences by practice type and years in practice, and marked discordance with the ACCP guidelines. Such low guideline adherence among STS GTSD surgeons with reported excellent outcomes identifies a potential need for guideline improvement.

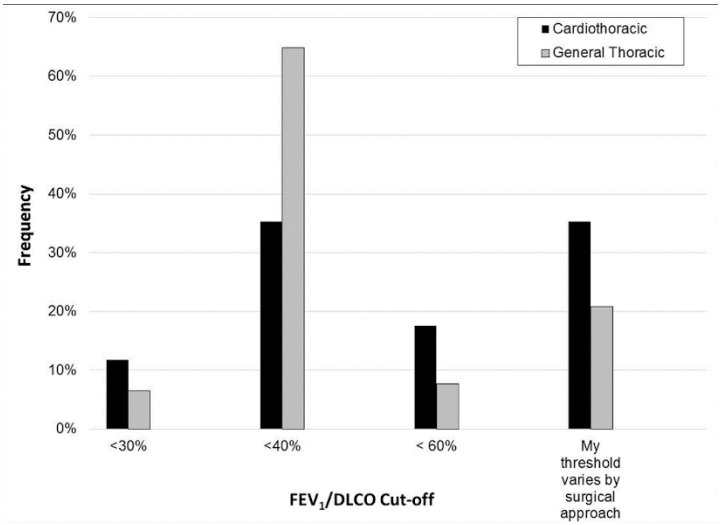

Table 1: Adherence of survey respondents to ACCP physiologic evaluation for lung cancer resection guidelines.

Guideline Component	Adherence
Order spirometry	98%
Assess for cardiac risk factors / inquire about functional status / calculate ThRCRI composite	98%
Refer patients with cardiovascular risk factors to a cardiologist	52%
Order DLCO testing	84%
Calculate ppoFEV$_1$%	76%
Calculate ppoDLCO%	57%
If the ppoFEV1% and/or ppoDLCO% is <30%, the patient is further evaluated via cardiopulmonary exercise testing (CPET)	40%
If the ppoFEV1% and/or ppoDLCO% is <60%, the patient is further evaluated via either 6 minute walk test, stair climbing test, or shuttle walk test	30%
Refer patients with borderline lung function to pulmonary rehabilitation	21%

ppoFEV$_1$% (ppoDLCO%): predicted postoperative FEV$_1$ (DLCO) as percentage of normal
ThRCRI: Thoracic Revised Cardiac Risk Index

7:15 AM

ABSTRACT: Richard E. Clark Memorial Paper for General Thoracic Surgery: Equivalent Survival Between Lobectomy and Segmentectomy for Lung Cancer: An Analysis of Elderly Clinical Stage IA Patients in the STS General Thoracic Surgery Database

M. Onaitis[1], *A. P. Furnary*[2], *A. S. Kosinski*[3], *L. Feng*[4], *D. J. Boffa*[5], *B. C. Tong*[6], *P. A. Cowper*[4], *J. P. Jacobs*[7], *C. D. Wright*[8], *R. H. Habib*[9], *J. B. Putnam*[10], *F. G. Fernandez*[11]
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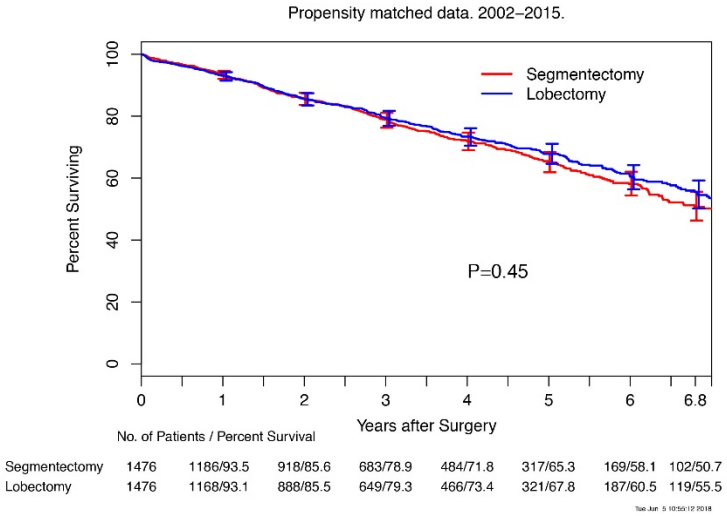
DISCUSSANT: *Mark F. Berry, Stanford, CA*

Purpose: The oncologic efficacy of segmentectomy is controversial. We have used STS-Medicare linked data to analyze long-term survival in clinical stage IA (T1N0) patients undergoing lobectomy and segmentectomy.

Methods: The STS-GTSD was linked to Medicare data in 14,286 lung cancer patients who underwent segmentectomy (n=1654) or lobectomy (n=12,632) for clinical stage IA disease. Cox proportional hazards modeling was used to create a long-term survival model. Lobectomy and segmentectomy patients were then propensity matched on demographic and clinical variables to create 1476 matched pairs. Kaplan-Meier survival analysis was performed on this cohort.

Results: Predictors of survival in Cox modeling of the entire population are listed in the Table. Segmentectomy has survival similar to lobectomy [HR 1.04, 95%CI (0.89,1.20), P=0.64]. Kaplan-Meier analysis of the matched patients also demonstrates no differences in survival (P=0.45). The population was also restricted to the years 2009-15 (n = 11,811), when T1a tumors were specified and PET scan results and mediastinal staging procedures were accurately recorded in the database. In the restricted population, segmentectomy (versus lobectomy) continues to have no effect on survival [HR 1.00, 95% CI (0.87,1.16)].

Conclusions: Lobectomy and segmentectomy for early stage lung cancer have equivalent effects on survival in the Medicare linked subpopulation of the STS-GTSD. STS surgeons appear to be selecting patients appropriately for sublobar procedures.



Characteristic	Univariate HR (95%CI)	P	Multivariable HR (95%CI)	P
ASA group		<.0001		<.0001
I-II	1.00		1.00	
III	1.88 (1.62,2.18)		1.37 (1.18,1.58)	
IV-V	3.11 (2.57,3.75)		1.66 (1.37,2.00)	
Age group		<.0001		<.0001
65-69	1.00		1.00	
70-74	1.24 (1.12,1.37)		1.18 (1.05,1.32)	
75-79	1.45 (1.30,1.62)		1.44 (1.27,1.62)	
80+	1.95 (1.74,2.20)		2.07 (1.79,2.40)	
Gender		<.0001		<.0001
Male	1.00		1.00	
Female	0.61 (0.57,0.66)		0.65 (0.60,0.72)	
BMI group		<.0001		<.0001
18.5-25	1.00		1.00	
<18.5	1.57 (1.20,2.05)		1.71 (1.27,2.31)	
25-30	0.87 (0.79,0.96)		0.79 (0.72,0.88)	
30-35	0.85 (0.76,0.95)		0.82 (0.73,0.93)	
>35	0.90 (0.76,1.05)		0.81 (0.69,0.95)	
Zubrod		<.0001		<.0001
0	1.00		1.00	
1	1.38 (1.26,1.52)		1.22 (1.13,1.32)	
2-5	2.28 (1.98,2.64)		1.83 (1.46,1.94)	
CAD	1.52 (1.42,1.62)	<.0001	1.08 (0.99,1.18)	0.0725
CVD	1.50 (1.35,1.66)	<.0001	1.16 (1.04,1.30)	<.0001
CHF	1.97 (1.69,2.29)	<.0001	1.51 (1.28,1.79)	<.0001
DM	1.26 (1.18,1.36)	<.0001	1.11 (1.03,1.19)	0.0042
Steroids	1.61 (1.38,1.88)	<.0001	1.49 (1.27,1.76)	<.0001
Htn	1.20 (1.12,1.30)	<.0001	1.04 (0.95,1.13)	0.3988
PVD	1.77 (1.62,1.92)	<.0001	1.28 (1.17,1.41)	<.0001
CKD	2.29 (1.86,2.81)	<.0001	1.54 (1.27,1.86)	<.0001
% FEV1 Predicted		<.0001		<.0001
>80				
60-80	1.00		1.00	
40-60	1.41 (1.30,1.53)		1.24 (1.15,1.34)	
<40	1.70 (1.55,1.85)		1.41 (1.27,1.56)	
	1.73 (1.43,2.09)		1.42 (1.17,1.72)	
Smoking		<.0001		<.0001
Never	1.00		1.00	
Past	1.79 (1.59,2.01)		1.54 (1.35,1.75)	
Current	2.18 (1.92,2.47)		1.95 (1.68,2.26)	
Race		0.2271		0.4221
White	1.00		1.00	
Black	1.13 (0.98,1.30)		1.10 (0.95,1.26)	
Other	1.16 (0.74,1.83)		1.07 (0.64,1.76)	
Procedure		0.2361		0.6374
Lobectomy	1.00		1.00	
Segmentectomy	1.10 (0.94,1.28)		1.04 (0.89,1.20)	
Approach				
Open	1.00		1.00	
VATS	0.77 (0.71,0.83)	<.0001	0.86 (0.80,0.94)	0.0006

7:30 AM

ABSTRACT: Persistent Opioid Use Among the Elderly After Lung Resection: A SEER-Medicare Study

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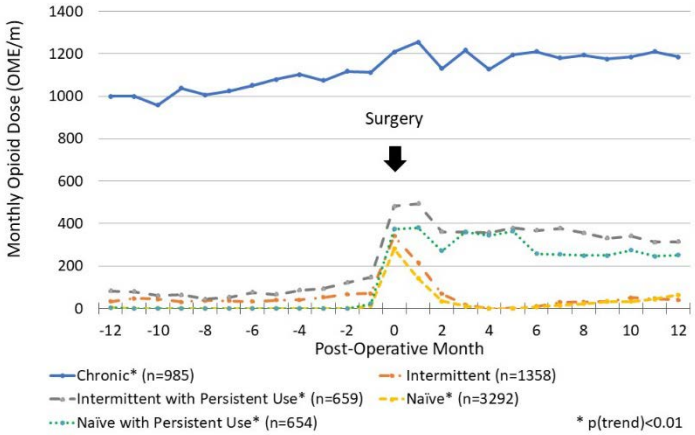
Purpose: Opioids remain the mainstay for postsurgical pain but have adverse effects contributing to postoperative morbidity. Additionally, dependency may occur and misuse of prescribed opioids is fueling the current opioid crisis. The aim of the study was to determine the incidence of chronic opioid use among opioid-naïve patients following lung surgery.

Methods: Patients who underwent lung resection from 2008-2013 for non-small cell lung cancer were identified in the SEER-Medicare database. Patients were categorized as being chronic, intermittent, or naïve pre-operative opioid users using information obtained from Part D records. Multivariable logistic regression using sociodemographic, tumor, and treatment related variables was used to determine factors associated with persistent opioid use. Persistent opioid use was defined as having a filled opioid prescription between 3-6 months after lung resection. Monthly opioid utilization was expressed as oral morphine equivalents (OME), which were calculated from dosages obtained from filled opioid prescriptions.

Results: 6,948 patients were identified, among whom 3,946 (56.8%) were opioid-naïve, 2017 (29.0%) were intermittent opioid users, and 985 (14.2%) were chronic opioid users preoperatively. Persistent opioid use (3 – 6 months) after lung resection was high (31%), even among opioid naïve patients (17%). Among those who were previously opioid naïve, independent predictors of persistent opioid use were receipt of adjuvant radiation (OR 1.36, 95% CI 1.06-1.74) or chemotherapy (OR 1.87, 95% CI 1.49-2.33), age less than 70 (OR 1.55, 95% CI 1.16-2.06), Charlson 1 (OR 1.35, 95% CI 1.10-1.64) or 2 (OR 1.27, 95% CI 1.00-1.60), and residence in zip codes associated with lower education (OR 1.86, 95% CI 1.32-2.61). Conversely, patients who underwent minimally invasive surgery (MIS) were less likely to have persistent opioid use (OR 0.75, 95% CI 0.62-0.90). Race, urban environment, poverty level, stage, extent of resection, and tumor grade were significant factors on univariable only.

Conclusions: Opioid dependence in the over 65-year old population after lung resection is high but was significantly lower among those who received minimally invasive surgery. Additional independent risk factors included age < 70 years, adjuvant treatment, comorbidities and residence in zip codes associated with lower education level.



7:45 AM

ABSTRACT: The Oldest Old: A National Analysis of Outcomes for Patients 90 Years or Older With Non–Small-Cell Lung Cancer

C. J. Yang[2], *A. B. Brown*[1], *D. Z. Liou*[2], *N. S. Lui*[2], *L. M. Backhus*[2], *T. A. D'Amico*[3], *J. B. Shrager*[2], *M. F. Berry*[2]
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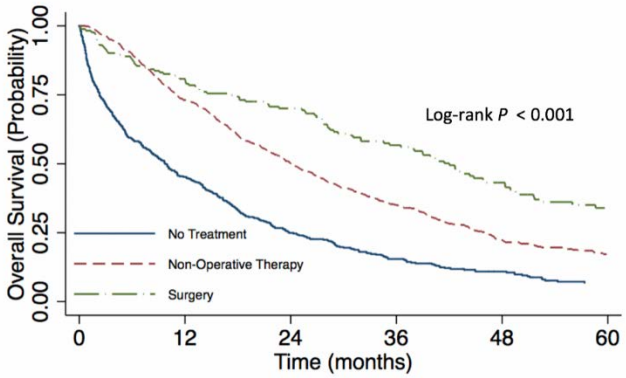
Purpose: Most clinicians will encounter patients 90 years or older with lung cancer but there is currently no available evidence to inform decision-making regarding treatment for this extremely elderly population. The purpose of this study was to evaluate practice patterns and outcomes associated with treatment strategies for this nonagenarian population.

Methods: Of 1,393,073 patients with non-small-cell lung cancer (NSCLC) in the National Cancer Data Base from 2004-2014, 7,756 (0.6%) patients with completed data fields were age 90 years or older. Predictors of practice patterns (use of surgery, chemotherapy, radiation, and no treatment) for these patients were evaluated using multivariable logistic regression. Overall survival associated with different treatment strategies for both the entire cohort and the subset of patients with stage I disease was evaluated using the Kaplan-Meier method and multivariable Cox proportional hazard models.

Results: The majority (N=4495, 58%) of the 7,756 patients 90 years or older with stage I-IV NSCLC did not receive any therapy. For the entire cohort, treatment at an academic center, male sex, lower co-morbidities scores, and lower stage were significantly associated with increased likelihood of receiving treatment (Table). Receiving treatment was associated with significantly better survival (5-year survival 9.7% [95% CI; 8.6-11.0] vs 1.8% [95% CI; 1.3-2.3], Table) when compared with no therapy. Amongst the subset (N=1,556) with stage I disease, only 12% (N=183) had surgery and 34% (N=531) had no therapy. In these stage I patients, surgery was associated with significantly better 5-year and median survival (34%, 42 months) than non-operative therapy (17%, 24 months) and no therapy (7%, 10 months) (Table,Figure). The survival benefit for both surgery (aHR 0.39 [95% CI; 0.32-0.47]) and non-operative treatment (aHR 0.55; $p < 0.001$) over no therapy persisted in multivariable analysis.

Conclusions: Therapy for nonagenarians with NSCLC is associated with a significant survival benefit but is not used in most patients. Treatment should not be withheld for these “oldest old” patients based on their age alone, and evaluation at a specialized center should be considered before deeming patients inappropriate for treatment.

Figure. Overall Survival of Patients 90 years or older with Stage I NSCLC Stratified by Treatment Strategy



No. at Risk						
No Treatment	485	211	111	59	32	16
Non-Op Therapy	728	516	321	183	87	51
Surgery	174	138	113	80	51	31

Table. Practice Patterns, Survival and Predictors of Use of Treatment for Patients 90 years or older with NSCLC from 2004-2014

	Entire Cohort	Stage I
TREATMENT		
No Treatment, no (%)	4,495 (58.0%)	531 (34.1%)
Non-operative therapy, no (%)	3,005 (38.7%)	842 (54.1%)
Chemotherapy, no (%)	470 (15.6%)	29 (3.4%)
Chemoradiotherapy, no (%)	312 (10.4%)	24 (2.9%)
Radiotherapy, no (%)	2,223 (74.0%)	789 (93.7%)
Surgery, no (%)	256 (3.3%)	183 (11.8%)
5-vear survival		
No Treatment, % (95% CI)	1.8% (1.3-2.3)	6.8% (4.4-9.8)
Non-operative therapy, % (95% CI)	6.9% (5.7-8.1)	16.8% (13.6-20.4)
Surgery, % (95% CI)	30.8% (25.5-36.3)	34.0% (26.0-42.1)
Any Treatment (non-operative or surgery), % (95% CI)	9.7% (8.6-11.0)	20.4% (17.3-23.7)
Median Survival		
No Treatment, months (95% CI)	1.97 (1.9-2.1)	9.8 (8.1-11.4)
Non-operative therapy, months (95% CI)	8.7 (8.2-9.3)	24.1 (22.1-26.5)
Surgery, months (95% CI)	37.5 (28.9-41.9)	42.0 (34.6-48.4)
Any Treatment (non-operative or surgery), % (95% CI)	9.8 (9.2-10.6)	26.9 (24.5-28.9)
Relevant Predictors of Use of Treatment from Logistic Regression Analysis		
Male *v* female, OR (95% CI)	0.81 (0.72-0.90)	
Facility type (ref = community), OR (95% CI)		
Academic/research	1.48 (1.23-1.81)	2.13 (1.31-3.48)
CDCC score (ref = 0), OR (95% CI)		
1	0.72 (0.63-0.82)	
2	0.52 (0.42-0.63)	0.49 (0.32-0.74)
3+	0.47 (0.35-0.66)	
Stage (ref = 1), OR (95% CI)		
2	0.68 (0.55-0.86)	
3	0.42 (0.36-0.50)	
4	0.27 (0.24-0.32)	
Clinical T2 status (ref = T1), OR (95% CI)		0.69 (0.54-0.89)

8:00 AM

ABSTRACT: Open, Video-Assisted Thoracoscopic Surgery and Robotic-Assisted Lobectomy: An Analysis of Longitudinal Trends, Clinical Outcomes, and Cost

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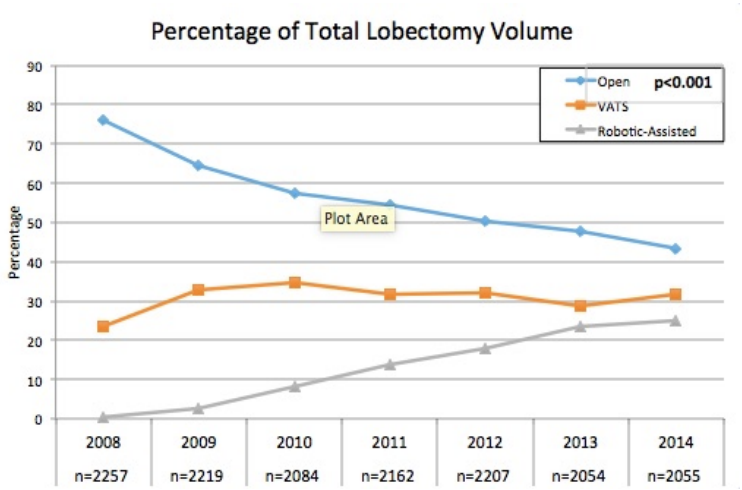
Purpose: Minimally invasive lobectomy is associated with decreased morbidity and length-of-stay. However, few published analyses have used large, longitudinal databases to compare clinical outcomes and cost by approach, inclusive of robotic-assisted procedures. We compared utilization trends, 30-day outcomes, and costs in patients undergoing open, video-assisted thoracoscopic surgery (VATS), and robotic-assisted lobectomy.

Methods: We identified patients who underwent elective open, VATS, and robotic-assisted lobectomy in the Healthcare Cost and Utilization Project Florida State Inpatient Database (2008-2014). We examined volume of procedure by approach and trends in utilization over the study period. We compared postoperative complications, length-of-stay, and 30-day readmissions between cohorts.

Hierarchical logistic regression and linear modeling with clustering at the hospital level were used to model in-hospital mortality and index hospitalization costs.

Results: We identified 15,038 lobectomy patients, of which 8,501 (56.5%), 4,608 (30.6%), and 1,929 (12.8%) underwent open, VATS, and robotic-assisted lobectomy, respectively. Robotic-assisted lobectomies comprised 0.4% of total lobectomy volume in 2008, and increased to 25.0% by 2014 (Figure 1, p<0.001). Length-of-stay was significantly different by approach (open: 7 days (5, 9), VATS: 5 days (4, 8), robotic: 4 days (3, 6); p<0.001). VATS and robotic-assisted lobectomy were associated with decreased risk of in-hospital mortality compared to open lobectomy (VATS: OR: 0.72 (95% CI: 0.53-0.98), Robotic: OR: 0.64 (95% CI: 0.39-1.05), p=0.043). Unadjusted costs were significantly different by approach (open: $21,535.67 ($13,637.61-$22,921.84), VATS: $20,775.48 ($13,997.70-$23,096.91), robotic: $23,838.92 ($16,441.87-$26,271.89), p<0.001). After adjusting for age, gender, comorbidities, and teaching facility status, VATS lobectomy was 2.6% less expensive (p=0.0017) and robotic-assisted lobectomy was 12.6% more expensive (p<0.001) than the open approach.

Conclusions: Utilization of minimally invasive approaches, particularly robotic-assisted procedures, has increased dramatically over the past decade. Both approaches appear to yield improved clinical outcomes compared to open lobectomy. However, only VATS lobectomy is associated with better clinical outcomes at a reduced cost.



8:15 AM

ABSTRACT: Identifying Patients at Increased Risk of Not Receiving Guideline-Concordant Treatment for Pathologic N1 Non–Small-Cell Lung Cancer

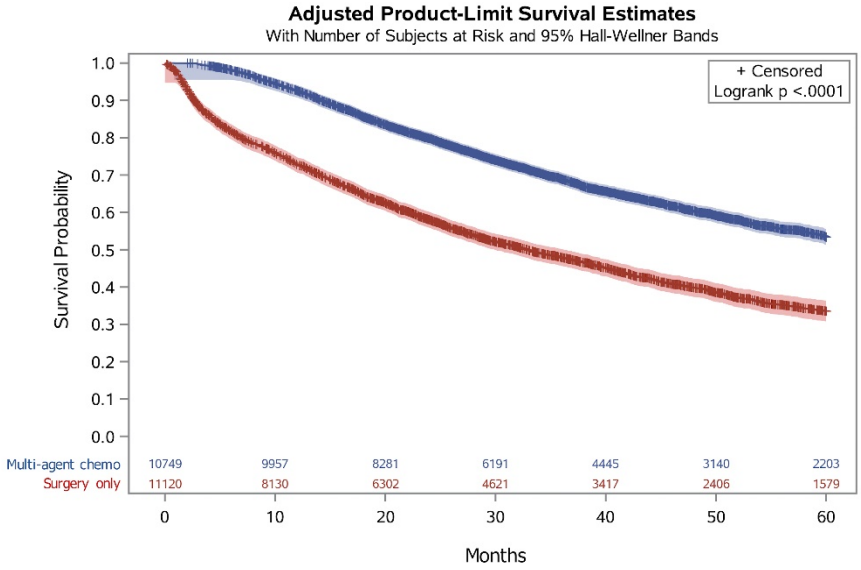
***O. Toubat**, A. W. Kim, S. M. Atay, L. Ding, P. Ebner, P. M. McFadden, E. A. David*
University of Southern California, Los Angeles

Purpose: Socioeconomic status (SES) disparities in the surgical management of non-small lung cancer (NSCLC) are well recognized. However, the impact of patient SES on the receipt of adjuvant chemotherapy is not well defined. We assessed the influence of SES factors on adjuvant chemotherapy use following resection in patients with pN1 NSCLC.

Methods: The National Cancer Database was queried for cN0/N1 NSCLC patients who underwent lobectomy, bilobectomy, or pneumonectomy between 2004 and 2014. From this cohort, those with pN1 disease were selected and dichotomized into two treatment groups based on whether they received adjuvant chemotherapy (multi-agent chemotherapy) or no additional treatment following resection (surgery only). SES variables included race, income, insurance, urban/rural residence, and education. Logistic regression was used to identify factors contributing to treatment group allocation. Kaplan Meier analysis of five-year survival with log-rank test and Cox regression with propensity score-weighting method were used to compare five-year survival between the two groups.

Results: Of the 14,782 patients that underwent curative resection for pN1 disease, 7,990 (54.1%) patients received multi-agent adjuvant chemotherapy. After adjusting for other demographic and clinical characteristics, pN1 patients were less likely to receive adjuvant chemotherapy if they were less educated (OR 1.119, 95% CI 1.039-1.206, p=0.0031), resided in rural areas (OR 1.246, 95% CI 1.123-1.381, p<.0001), or were uninsured or on Medicaid insurance (OR 1.214, 95% CI 1.060-1.391, p=0.0050). Among matched patients, the five-year overall survival was significantly higher for those receiving multi-agent adjuvant chemotherapy compared to surgery only (53.36% vs 33.53%, log-rank p<.0001) (Figure 1). In a propensity score-weighted Cox-proportional hazard model, lower education (HR 1.050, 95% CI 1.008-1.093, p=0.0199) and uninsured or Medicaid insurance (HR 1.222, 95% CI 1.135-1.315, p=0.0043) were independently associated with an increased risk of mortality.

Conclusions: Patients with less education, rural residence, or uninsured/Medicaid insurance are at increased risk of failing to receive guideline-recommended adjuvant chemotherapy for pN1 NSCLC. Given the significant survival benefit of adjuvant chemotherapy in this context, physicians must be mindful of these findings and take steps to mitigate perpetuating these disparities.



8:30 AM

ABSTRACT: Thoracic Surgery Outcomes Research Network Consensus Measures of Lung Cancer Care: Results of a Modified Delphi Study

D. D. Odell[1], *D. T. Cooke*[2], *R. A. Meguid*[3], *L. M. Backhus*[4], *S. B. Krantz*[5], *T. K. Varghese*[6], *K. Y. Bilimoria*[1]

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Purpose: Despite widespread dissemination of guidelines, best practices in lung cancer treatment are frequently not followed. Valid methods to measure quality care are integral to the identification of areas for improvement. We sought to develop meaningful quality measures that can be utilized nationally to assess the quality of lung cancer care.

Methods: Candidate measures were developed from a systematic review of the published literature on lung cancer care and published guidelines to identify essential components of high quality lung cancer care. We engaged members of the Thoracic Surgery Outcomes Research Network (ThORN) to survey thoracic surgeons, medical and radiation oncologists, pulmonologists and pathologists at their respective institutions. In Round 1, these physicians ranked each candidate measure on a 9-point scale (1 “not valid”, 5 “uncertain validity”, 9 “valid”). After the initial round of ranking, a 12-member expert panel met in-person to review rankings, modify and develop a final list of quality measures.

Results: 47 candidate quality measures were identified from review of the literature (40 process and 7 outcome measures). Measures were reviewed by 42 physicians at 12 medical centers. The respondents included Thoracic Surgeons (61%), Medical Oncologists (17%), Radiation Oncologists (11%), Radiologists (5%), Pulmonologists (3%) and Pathologists (3%). Following initial ranking, 37 measures were advanced to the second round for panel discussion. After discussion, the 12-member expert panel endorsed 33 measures in total: 7 measures related to patient evaluation; 11 measures to early stage disease, 5 to advanced disease, 3 to cancer surveillance, 2 to smoking cessation, along with 5 outcome measures. Interestingly a number of common, nationally-reported measures, including Commission on Cancer measures related to surgical lymph node counts and a 6-month timeframe for referral for adjuvant chemotherapy, were not felt to be valid by the panel. Concordance between panel recommendations and outcome measures endorsed by the STS was high.

Conclusions: The Delphi Process is a validated method for achieving consensus recommendations. The application of this methodology to lung cancer quality assessment provides more meaningful measures of quality care that can be used to assess care delivery and guide quality improvement efforts in lung cancer.

Table: Final ThORN lung cancer quality measures developed via a modified Delphi process.

Category	Quality Measure
Patient Evaluation	
	Documentation of clinical AJCC stage prior to initiation of treatment.
	Pre-operative OR intra-operative tissue diagnosis should first be confirmed or reasons for not achieving a diagnosis should be documented for patients undergoing lobectomy (or greater).
	Resection should be performed by a board certified (or eligible) Thoracic Surgeon.
	ALK and EGFR mutation status should be assessed.
	CT of the chest should be performed less than 60 days prior to the initiation of treatment for all patients with NSCLC.
	PET imaging or PET CT should be obtained less than 60 days prior to treatment initiation for all patients with NSCLC.
	IF a patient has NSCLC, THEN performance status (ASA and Zubrod) should be documented at the time of diagnosis.
Early Stage Disease	
	IF a non-anatomic resection is performed, THEN a >=2 cm surgical margin OR if primary smaller than 2 cm then a margin equal to the maximum diameter of the tumor should be obtained
	At least 2 N2 stations and any N1 stations should be sampled or attempted sampling documented.
	IF a patient undergoes surgical resection for stage T1b or greater disease (> 2-cm lesion), THEN an anatomic pulmonary resection (Segment, lobectomy, etc.) should be performed.
	IF surgical resection is performed, THEN an R0 resection should be achieved.
	High risk stage IB-IIA, N0 patients (including all re-resections for margins) should be referred for adjuvant treatment within 60 days of surgery.
	Referral to medical oncology should be made within 60 days of surgery for patients with pathologic stage II or greater NSCLC following resection
	IF a patient undergoes surgical resection for stage T1b or greater disease (> 2-cm lesion), THEN an anatomic pulmonary resection (Segment, lobectomy, etc.) should be performed
	IF a patient is treated non-operatively for stage Ia-IIb disease, THEN consultation with a surgeon or multidisciplinary tumor board should take place before treatment initiation.
	IF a patient receives SBRT, THEN a pathologic diagnosis should be confirmed or attempted prior to treatment.
	IF patients are potential candidates for surgery (Ia-IIb), THEN PFTs should be documented within 365 days preoperatively (FEV1 and DLCO reported as % predicted)
	IF a patient with NSCLC is offered curative ablative therapy (SBRT, RFA, etc.), THEN they should also be evaluated by a thoracic surgeon to assess surgical candidacy (either in person or in a multidisciplinary discussion).
Advanced Disease	
	IF a patient receives neoadjuvant chemotherapy, THEN surgery should be performed within 60 days from the completion of the neoadjuvant chemotherapy.
	IF a patient has clinical N2 disease, THEN surgical resection should not be the initial treatment.
	Referral to a radiation oncologist for consideration of mediastinal radiation treatment (either before or after surgical resection) for patients with documented N2 Disease
	IF a patient has known/suspected IIIa disease, THEN treatment should be determined by a multidisciplinary panel.
	Pathologic mediastinal staging should be performed prior to initial treatment for patients with clinical N2 disease
Smoking Cessation	
	IF a patient has NSCLC AND is actively smoking, THEN smoking cessation counseling and a prescription for pharmacotherapy (i.e. nicotine replacement) should be offered.
	IF a patient has NSCLC, THEN smoking status should be documented.
Surveillance	
	Following treatment, a surveillance chest CT should be performed q6-12mo x2 years then annually.
	Lung cancer surveillance should be managed by a thoracic surgeon, medical oncologist, radiation oncologist or pulmonologist.
	Smoking status should be documented and smoking cessation counseling given at every surveillance visit.
Outcome Measures	
	Overall and Cancer Specific Survival at 30d, 90d, 1 yr., and 5yr from cancer registry
	STS defined combined morbidity
	Reoperation related to index operation within 30 days following resection
	Timing from diagnosis to treatment initiation
	Recurrence-free survival at 90 days, 1 year, 3 years, 5 years

8:45 AM

Cleaning Up the Mess: Salvage Pulmonary Resection After Definitive Therapy

Usman Ahmad, Cleveland, OH

7:00 AM – 9:00 AM
General Thoracic: Mediastinal/Pulmonary
Moderators: *James Huang, New York, NY, and Ikenna Okereke, Galveston, TX*

7:00 AM
ABSTRACT: Post-Intubation Tracheal Stenosis Management and Results
*C. D. Wright[1], H. Ott[1], M. Lanuti[1], H. Gaissert[1], **D. J. Mathisen**[1], S. M. Li[2]*
[1]Massachusetts General Hospital, Boston, [2]First Affiliated Hospital of Guangzhou Medical University, China

Purpose: To evaluate the management, complications of treatment and outcomes of postintubation tracheal stenosis (PITS).

Methods: A retrospective review of all patient records undergoing tracheal resection or laryngotracheal resection from 1993-2017 for PITS from a prospective database was performed. Redo operations following failure of initial resection and reconstruction were included.

Results: There were 392 patients whose ages ranged from 0.25 to over 80. 257 had tracheostomies performed (123 at time of resection), dilations in 202, laser treatment in 82, T tubes in 61 and stents in 44 patients. Median length of resection 3 cm. (>4 cm. adversely affected outcomes). Laryngeal release was required in 15/392 (3.8%). Operative mortality was .8% (3/392) Redo tracheal resections, steroid use, calcified airways, tracheostomy present at resection, requirement for postoperative tracheostomy, complications, and length of resection adversely impacted outcomes. (Table 1) Tracheal resection and reconstruction (301) had good or satisfactory outcomes in 95.7% of patients compared to 84.6% for laryngotracheal resection (91). Complications within 30 days and >30 days occurred in 116 patients and 14 patients respectively (130/392 - 33%). There were 98 anastomotic complications; 71.1% minor, 28.9% major. Necrosis of cartilage occurred in 12 and dehiscence in 17 patients.

Conclusions: Despite advances in care, PITS remains a challenging problem. There are many factors that affect the outcome of surgical resection. Excellent surgical results can be obtained for PITS. Good results require careful evaluation, management of comorbid conditions, meticulous technique, minimizing tension and preservation of blood supply.

Table I.

Outcomes (%)

	N	Good/Satisfactory	Failure	Death
Tracheal/Laryngotracheal stenosis	301 / 91	95.7 / 84.6	3.3 / 15.4	1.0 / 0
Tracheostomy/ No T-Treatment	275 / 107	91.6 / 98.1	8.0 / 0	0.4 / 1.8
Tracheostomy present at R&R	123	86.2	13.0	0.8
Dilation /stent /T tubes	202 / 44 / 61	95.5 / 86.4 / 90.2	4.0 / 13.4 / 9.8	.05 / 0/0
Calcified airway/ Non-calcified	70 / 322	88.6 / 94.1	10.0 / 5.3	1.4 / 0.6
Tracheostomy Postop	51	56.9	39.2	3.9
• In OR	27	74.1	25.9	0
• Postop	24	37.5	54.2	8.3
• Redo TRR	48	89.6	10.4	0

No T-treatment: no prior tracheostomy, T-tube or stent treatment

7:15 AM
ABSTRACT: Newly Identified Lymph Nodes More Than Double the Chance of Recurrence and Death in Patients With Malignant Pleural Mesothelioma
***J. Friedberg**[1], C. B. Simone[1], M. Culligan[1], A. Barsky[2], M. E. Putt[2], K. Cengel[2]*
[1]University of Maryland, Baltimore, [2]University of Pennsylvania, Philadelphia

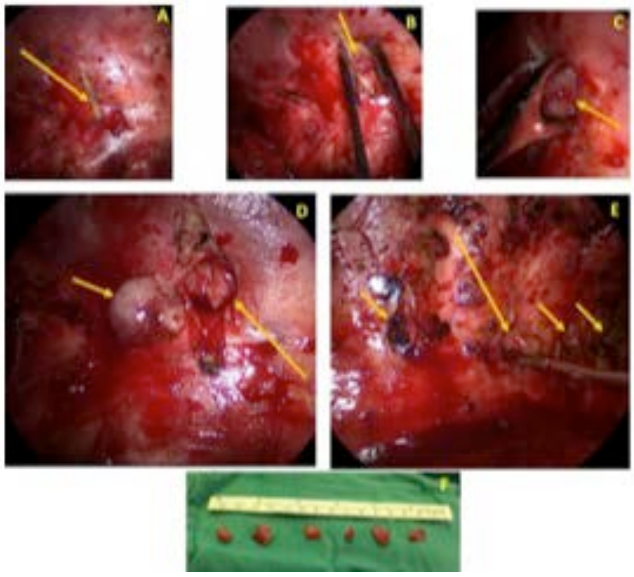
Purpose: Posterior intercostal lymph nodes, previously undescribed for cancer staging and discovered incidentally by this group, are part of the lymphatic drainage of the pleural space. The purpose of this study was to assess the impact of these nodes on survival in patients undergoing surgery for malignant pleural mesothelioma.

Methods: As part of the thoracic lymphadenectomy in patients undergoing pleurectomy for mesothelioma posterior intercostal lymph nodes, which lie in the intercostal spaces outside of the pleural cavity, were accessed by incising the endothoracic fascia at the level of

the rib heads. These nodes were systematically harvested in 56 consecutive patients undergoing extended pleurectomy decortication in a clinical trial. The impact of these nodes on both progression free and overall survival was then analyzed by multiple statistical methods, accounting for the other risk factors and viewing them as an independent variable as well as within the context of other nodal stations.

Results: The cohort represents 56 patients with epithelial histology, 78.6% male, median age 64.7 years and 62.5% N2 disease. Median PFS/OS for the whole cohort were 11.6/25.5 months, respectively. In 6/56 (11%) the intercostal nodes were the only positive nodes and, overall, 48.2% had intercostal nodal metastases. Patients with traditionally defined N2 disease had significantly poorer prognosis if the intercostal nodes were involved: PFS (7.3 vs 14.9 months, p=0.002) and OS (14.4 vs 26.1 months, p = 0.028). Nodal stage was associated with progression (p=0.006) and death (p=0.046), but even after adjusting for nodal stage, positive intercostal nodes conferred a 2.1 fold increased risk of progression (p=0.001) and 1.9 fold increased risk of death (p=0.016). In the multivariable models, after adjustment for nodal stage and other prognostic factors, intercostal nodes remained associated with a 2.5 fold elevated risk of progression (p<0.001) and 2.3 fold elevated risk of death (p<0.001).

Conclusions: This first reported series of posterior intercostal lymph nodes revealed they independently more than doubled the risk of progression and death and in 11% of the patients were the only metastatic nodes. These nodes warrant further investigation, including nonoperative techniques to identify them and factor them into treatment decision making.



7:30 AM

ABSTRACT: Repeated Surgery for Multiple Recurrences of Thymoma: Is It Really the Best Treatment?

M. Chiappetta[1], *E. Zanfrini*[1], *M. Mastromarino*[1], *D. Nachira*[2], *M. Congedo*[2], *P. Filosso*[3], *F. Guerrera*[3], *M. Lucchi*[4], *G. Di Tanna*[5], *V. Aprile*[4], *E. Meacci*[2], *S. Margaritora*[2]

[1]*Universita Cattolica del Sacro Cuore, Rome, Italy,* [2]*Fondazione Policlinico Universitario A.Gemelli IRCCS, Rome, Italy,* [3]*University of Torino, Italy,* [4]*University of Pisa, Italy,* [5]*University of Barcelona, Spain*

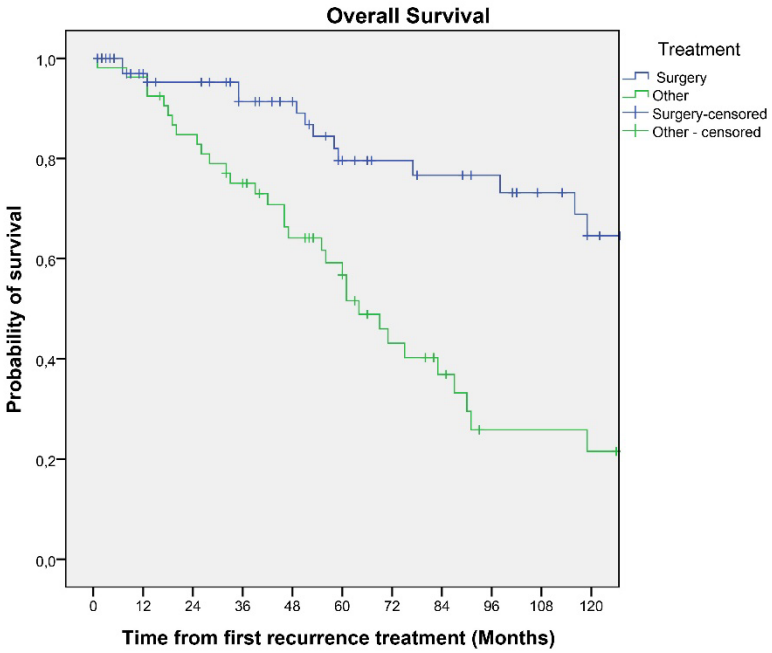
Purpose: Thymomas are rare neoplasm characterized by a low recurrence rate and surgery is the favourite option in case of recurrence, but its effective role in multiple recurrences has not been well investigated yet[1-3]. Aim of this study is to analyse the survival outcome in patients treated for multiple recurrences.

Methods: Data of 128 patients from 3 different centres affected by recurrence after complete resection of thymoma were retrospectively reviewed. All patients underwent surgery for recurrence from 01/01/1990 to 1/12/2015. Clinical and pathological data, associated with the pattern of recurrence(localization, number, histology,timing)(table1) and the type of treatment administered (surgery or chemotherapy, radiotherapy or both(CT/RT) were correlated to Overall Survival(OS) by using the Multivariable Cox Regression model. Survival curves were calculated by the Kaplan–Meier method and the log-rank test was used to assess differences between subgroups. Significance was defined at the p?0.05 level.

Results: Surgery was performed in 109(85%) patients, with 92(84%)complete resections. Fourty-nine(53%) patients experienced a second recurrence, surgically treated in 26(55%). Finally,of the 18(69%) patients with complete resection, 11(61%) experienced more relapses(range1to5), surgically treated in 9(85%)cases. The overall 5and 10years survival resulted of 70%and43.7% respectively, with a mean OS of 135±13months. Patients treated with repeated surgery for every recurrence had significantly better outcome than patients treated with CT/RT(5and 10years survival of 79.6%and64.6% vs 56.7%and21.5% respectively,p<0.001,figure1). The 5and the 10years survival of surgically treated patients compared to chemotherapy or radiotherapy resulted of 72.3%and48.5% vs 63%and14%(p=0.073) in patients with one recurrence, of 82.9%and70% vs 59.7%and 27.4%(p=0.003) in patients with two recurrences and of 90% and90% vs 67%and18% in patients with three or more recurrences(p=0.011). No differences in survival on the

basis of the number of recurrences(p=0.126). At multivariable analysis, Myasthenia Gravis(p=0.010), single localization(p=0.04), radicality in multiple recurrences(p=0.03)and surgical treatment(p<0.001) resulted independent favorable prognostic factors.

Conclusions: Our study confirms the excellent survival outcome in patients surgically treated for recurrence of thymoma, with a significant better survival rate compared to chemo/radiotherapy. Repeated surgery, with the aim to achieve complete resection, may be taken in account whenever is technically feasible independently by the number of recurrences.



	I Recurrence	*II Recurrence*	*III Recurrence*
Number of Patients	128	49	20
Pattern of recurrence			
Local	20 (15.7%)	4 (8%)	-
Regional	89 (70%)	33 (65%)	14 (70%)
Distant	18 (14.3%)	12 (27%)	4 (30%)
Single	41 (31.5%)	19 (39%)	6 (35%)
Multiple	87 (68.5%)	27 (55%)	12 (65%)
Missing data		3(6%)	
Site of recurrence			
Pleura	59 (46.5%)	24 (49%)	9 (50%)
Parenchyma	6 (4.7%)	7 (14%)	2 (10%)
Both	19 (14.9%)	5 (10%)	1 (5%)
Other	44 (33.9%)	13 (27%)	6 (35%)
Treatment of recurrence			
Complete resection	92 (72.4%)	18 (37%)	9 (45%)
Incomplete resection	18 (13.4%)	8 (16%)	2 (5%)
CT/RT	18 (14.2%)	23 (48%)	9 (50%)
Preoperatory CT/RT	61 (48%)	38 (57%)	9 (45%)
Myasthenia Gravis	85 (66.9%)	45 (68%)	15 (75%)
WHO upgrading	17 (13.4%)	8 (12.1%)	2 (10%)
Disease Free Interval (months)	70.8 (±54)	51 (±43)	33.7 (±23.3)
Overall Survival (months)	123 (±83.7)	118(±89.8)	156 (±74)
Age at surgery (years)	44 (±16.3)	42 (±19)	42 (±13)

7:45 AM

ABSTRACT: Thymic Neuroendocrine Tumors vs Thymic Carcinoma: Demographics, Treatment, and Survival

A. Salami[1], *C. T. Bakhos*[2], *L. R. Kaiser*[2], *R. V. Petrov*[2], *A. E. Abbas*[2]
[1]*Albert Einstein Healthcare Network, Philadelphia, PA,* [2]*Lewis Katz School of Medicine at Temple University, Philadelphia, PA*

Purpose: Although rare, thymic neuroendocrine tumors (TNET) and thymic carcinoma (TC) are the most common thymic non-thymomatous malignancies. Survival outcomes of TNET and TC have not been thoroughly compared. We analyzed the clinical, treatment, and survival characteristics of TNET and TC.

Methods: This retrospective cohort study was conducted using the national cancer database. We identified all patients with a histologic diagnosis of TNET & TC between 2004 and 2015. Exclusion criteria were age<18 years and unstaged tumors. Descriptive statistics, survival analysis, and multivariable Cox regression analyses were used in elucidating associations. A p<0.05 was deemed statistically significant.

Results: 1,489 patients were included (TNET: 19.8%). Patients with TNET were significantly younger (57 vs. 62.5 years), more likely to be male (70.5 vs. 60.0%) and have localized tumors (45.4 vs. 32.3%). Patients with TC more frequently underwent chemotherapy (56.1 vs. 34.9%), radiation therapy (56.9 vs. 39.3%), definitive chemoradiation (15.6 vs. 10.2%), and trimodality therapy (21.3 vs. 11.5%). Resection rates were similar (55.3 vs. 58.3%). Following multivariable adjustment for treatment, comorbidity and stage, survival outcomes of TC were similar to TNET [Table 1]. For the subset treated with adjuvant radiation (ART) after surgery [n=778 (TNET: 21%)], ART conferred a survival benefit for TC with regional extension (5-year survival:73 vs. 53%; log-rank<0.001); this trend was not observed for TNET across all stages. Patients with positive margins treated with ART showed improved survival irrespective of histology. ART was also an independent predictor of survival on sub-analysis (HR: 0.56, CI: 0.44 – 0.71; p<0.001).

Conclusions: Adjusted for treatment modality, comorbidity and stage, survival from TNET and TC are similar. ART is associated with improved survival for regional and margin positive TC and may be beneficial for margin positive TNET. Prospective studies are warranted to better clarify the role of ART for TC and TNET.

Variable	Hazard Ratio	Confidence Interval	*p*-value
Histology (TNET)	Ref		
TC	1.09	0.96 – 1.22	0.093
Age in years	1.01	1.001 – 1.014	0.022
Charlson-Deyo Score >0	1.26	1.06 – 1.50	0.009
Tumor Stage (Localized)	Ref		
Regional	1.47	1.22 – 1.76	<0.001
Distant	2.10	1.62 – 2.74	<0.001
Definitive chemoradiation	1.25	1.02 – 1.55	0.036
Surgery only	0.75	0.59 – 0.94	0.015
Trimodality therapy	0.51	0.40 – 0.64	<0.001

8:00 AM

ABSTRACT: A Prospective Study of Postoperative Pain and Quality of Life Between Subxiphoid and Intercostal Video-Assisted Thoracoscopic Surgery: Midterm Results of NCT03331588

J. Chen
Shanghai Jiao Tong University, China

Purpose: Uniportal video-assisted thorascopic surgery (VATS) emerged as a promising approach for minimally invasive thoracic surgery. However, chest wall trauma still exist via the intercostal route. Here, the investigators undertook a novel uniportal VATS technique involving a subxiphoid approach. However, these two methods had never been compared in a randomized trial.

Methods: we launched the first randomized controlled trial on clinicalTrials.gov(NCT 03331588). The investigators randomized patients between subxiphoid and Intercostal VATS in a double blinded design. The clinical information, hospitalization expenses, pathology, perioperative complications, postoperative pain and life quality were investigated. Postoperative pain was measured with a numeric rating scale (NRS) 24, 48 hours after surgery, day of tube off, 2 weeks and 2 months after discharge. Quality of life was assessed with the EuroQol 5 dimensions (EQ5D) 2 month after discharge. The primary outcomes were the proportion of patients with clinically relevant pain and mean quality of life scores.

Results: Since November 2017, 83 cases of subxiphoid and 80 cases of intercostal VATS were successfully enrolled in our surgery group. There was no difference of age, sex, BMI, smoking history, pulmonary function, discharge time, nodule size, surgery type, operation time, first day drainage, hospitalization expenses, and pathology results (P>0.05). Besides, perioperative surgical complications were similar between the two groups, consisting of reoperation for bleeding, atelectasis, arrhythmia, air leakage or infection. The average pain scores during the first 24h after surgery was similar, but was significantly lower at 48h after surgery, day of tube off, 2 weeks and 2 months after discharge in subxiphoid VATS than intercostal VATS (P<0.05). what's more, Quality of life according to EQ5D was significantly better after Subxiphoid VATS (P<0.05).

Conclusions: Subxiphoid VATS is safe and reliable, which was associated with less postoperative pain and better quality of life than is intercostal VATS, suggesting that subxiphoid VATS should be the preferred surgical approach for thoracic surgery.

8:15 AM

ABSTRACT: Acute Pain Management Following Thoracic Surgical Procedures: Results From the STS Task Force on the Opioid Crisis Intervention in Cardiothoracic Surgery

K. H. Lagisetty[1], *P. Atluri*[2], *N. J. Boden*[3], *J. S. Donington*[4], *J. S. Ikonomidis*[5], *D. C. Rice*[6], *D. E. Sengewald*[3], *E. E. Tseng*[7], *M. J. Weyant*[8], *C. Yohe Savage*[9], *S. C. Yang*[10]

[1]University of Michigan, Ann Arbor, [2]University of Pennsylvania, Philadelphia, [3]The Society of Thoracic Surgeons, Chicago, IL, [4]The University of Chicago, IL, [5]The University of North Carolina at Chapel Hill, [6]The University of Texas MD Anderson Cancer Center, Houston, [7]University of California, San Francisco Medical Center and San Francisco VA Medical Center, [8]University of Colorado School of Medicine, Aurora, [9]The Society of Thoracic Surgeons, Washington, DC, [10]The Johns Hopkins School of Medicine, Baltimore, MD

Purpose: Opioid abuse is a rising national problem, partially attributed to current postoperative prescribing practices. In order to better understand acute pain management and opioid-prescribing practices as they relate to thoracic surgery, The Society of Thoracic Surgeons (STS) created a Task Force on the Opioid Crisis Intervention in CT Surgery.

Methods: An online 30-question survey was sent to US members of STS and the General Thoracic Surgical Club in active clinical practice. Data regarding type, dose, and duration of in-patient and outpatient postoperative pain medications were collected. Descriptive analysis, such as distributions and proportions were applied to a quantitative dataset.

Results: There were 505 respondents and 217 (43%) were primary general thoracic surgeons. Respondents were academic (52%), hospital employed (33%), and private practice (11%) surgeons. 70% of providers had 10+ years of experience and 7% were residents or non-physician providers. 93% surveyed reported using regional anesthesia, most commonly intercostal nerve blocks (87%), epidurals (51%), local anesthesia (30.5%), and paravertebral blocks (27%). Commonly utilized oral analgesics included: NSAIDS (88%), acetaminophen (86%), mild/moderate opioids (86%), and neuropraxic agents (43%). Patient-controlled analgesia (PCA) was the primary in-patient medication in 20% surveyed, 25% used PCAs when epidural was unavailable, and 39% when other forms of pain control failed. At discharge, 87% surveyed prescribed short-acting opioids, with 77% recommending acetaminophen and 76% ibuprofen. Upon follow-up, 25% of prescribers provided refills without requiring a visit, 64% required a visit, and 10% did not provide refills. 70% surveyed managed postoperative pain 4-11 weeks prior to pain specialist referral.

Conclusions: Although there are similarities in pain medication practices among general thoracic surgeons, it is highly variable regarding routine use of regional anesthesia and duration of outpatient pain management. These results highlight a need for evidence-based guidelines for acute postoperative pain management in thoracic surgery.

8:30 AM

ABSTRACT: Primary Thoracic Soft Tissue Sarcomas: Impact of Radiation Therapy on Survival Following Surgical Resection in a Large Population Cohort

S. Rehmani[1], *W. Raad*[2], *J. Weber*[3], *S. Lazarev*[4], *F. Bhora*[5]

[1]Mount Sinai St Luke's Hospital, New York, NY, [2]Icahn School of Medicine at Mount Sinai/Mount Sinai Health System, New York, NY, [3]Icahn School of Medicine at Mount Sinai, New York, NY, [4]Mount Sinai Health System, New York, NY, [5]Mount Sinai West, New York, NY

Purpose: The aims of this study were to examine the characteristics of patients with primary thoracic soft tissue sarcoma (STS) who received adjuvant radiation therapy (RT) following surgical resection and investigate the impact of RT on survival outcomes.

Methods: We queried National Cancer Database (NCDB) to identify patients with surgically resected non-metastatic thoracic STS from 2004-2012. To minimize bias in favor of RT, only patients who survived for at least 1 month after surgery were included. Multivariate Binomial Logistic regression analysis was performed to identify factors associated with receiving adjuvant RT. Kaplan-Meier and Cox regression analyses were used to compare overall survival and identify prognostic factors.

Results: Overall 1455 patients with pathologically confirmed thoracic STS met the selection criteria, of whom 624(42.9%) cases received adjuvant RT. On multivariate analysis, higher tumor grade (OR 2.77[95%CI:2.13-3.58]) and tumor size >5cm (OR 1.80[95%CI:1.35-2.341]) were found to be significantly associated with receiving adjuvant RT. Females, patients with higher comorbidity score or treated at academic centers were less likely to receive adjuvant RT. Age, insurance status, histology, tumor grade, and tumor size were identified as strong predictors of survival (Table 1). Mean OS of patients who received adjuvant RT was 89.71 months vs. 88.5 months for patients who did not (p= 0.730). However, when adjusted for all variables, adjuvant RT was found to be associated with improved survival (HR 0.79 [95%CI:0.64-0.97]). Subgroup analysis showed patients with intermediate-high grade tumors derived most benefit from adjuvant RT (Mean OS RT=81 vs No RT=68months, p=0.001).

Conclusions: This population-based analysis is the largest dataset of primary thoracic STS to date and demonstrates significant survival benefit associated with adjuvant RT. The improvement in overall survival was more notable in patients with intermediate to high-grade tumors. Randomized prospective studies are warranted to further understand the benefit of RT in this group.

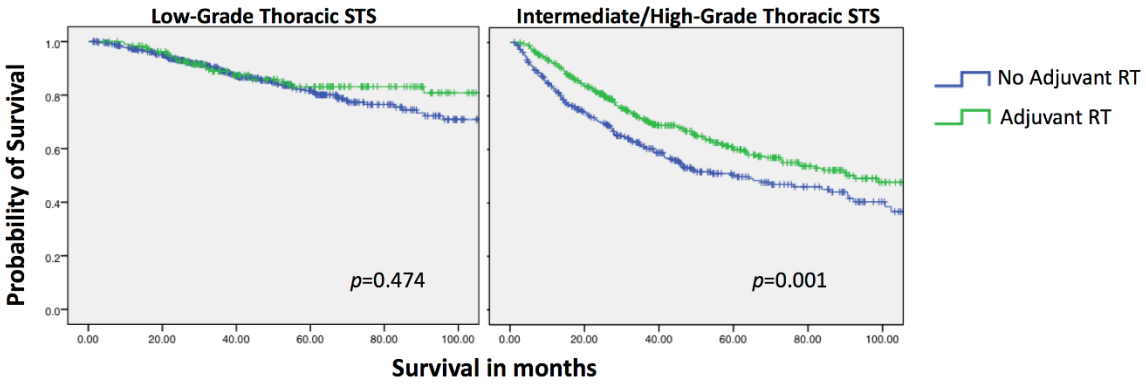


Table: Multivariate analysis of factors associated with receiving Adjuvant RT and Overall Survival for patients with primary thoracic STS

Covariates	Adjuvant RT		Receipt of RT	Hazards of Death
	Yes (n=624)	No (n=831)	OR (95% CI)	HR (95% CI)
Age (mean ± SD)	61(±15)	59(±17)	0.999 (0.989 - 1.01)	**1.042 (1.032 - 1.052)**
Sex (Ref: Male)	402 (64.4%)	474 (57.0%)		
Female	222 (35.6%)	357 (43.0%)	**0.741 (0.582 - 0.943)**	1.098 (0.89 - 1.354)
Race (Ref: White)	529 (84.8%)	710 (85.4%)		
Black	59 (9.5%)	81 (9.7%)	1.111 (0.736 - 1.678)	1.409 (0.973 - 2.041)
Other	36 (5.8%)	40 (4.8%)	1.408 (0.841 - 2.359)	1.221 (0.744 - 2.005)
Insurance (Ref: No insurance/Unknown)	25 (4.0%)	51 (6.1%)		
Private	309 (49.5%)	419 (50.4%)	1.548 (0.858 - 2.792)	**0.543 (0.335 - 0.881)**
Government (Medicare/Medicaid)	290 (46.5%)	361 (43.4%)	1.364 (0.735 - 2.533)	**0.533 (0.322 - 0.882)**
Median Income (Ref: Q1)	88 (14.2%)	136 (16.6%)		
Q2	159 (25.6%)	179 (21.9%)	1.488 (1.014 - 2.183)	1.017 (0.74 - 1.396)
Q3	155 (25.0%)	217 (26.5%)	1.162 (0.794 - 1.701)	0.797 (0.575 - 1.104)
Q4	219 (35.3%)	287 (35.0%)	1.363 (0.943 - 1.971)	0.784 (0.571 - 1.078)
Facility Type (Ref: Community)	288 (46.2%)	325 (39.1%)		
Academic	235 (37.7%)	339 (40.8%)	**0.71 (0.547 - 0.922)**	0.839 (0.675 - 1.043)
Other	101 (16.2%)	167 (20.1%)	0.724 (0.49 - 1.069)	0.937 (0.652 - 1.346)
Charlson-Deyo Score (Ref: 0)	514 (82.4%)	675 (81.2%)		
1	98 (15.7%)	113 (13.6%)	1.08 (0.775 - 1.507)	1.09 (0.841 - 1.412)
2	12 (1.9%)	43 (5.2%)	**0.314 (0.158 - 0.625)**	1.433 (0.943 - 2.176)
Histology (Ref: Sarcoma NOS)	112 (17.9%)	221 (26.6%)		
Liposarcoma	75 (12.0%)	120 (14.4%)	0.787 (0.548 - 1.131)	**0.543 (0.393 - 0.750)**
Leiomyosarcoma	102 (16.3%)	158 (19.0%)	0.992 (0.662 - 1.485)	1.063 (0.756 - 1.493)
Fibro/Myofibroblastic Sarcoma	107 (17.1%)	74 (8.9%)	1.037 (0.718 - 1.497)	**0.554 (0.390- 0.787)**
Undifferentiated pleomorphic sarcoma	44 (7.1%)	42 (5.1%)	1.486 (0.996 - 2.216)	**0.612 (0.449 - 0.833)**
MPNST	15 (2.4%)	24 (2.9%)	1.449 (0.846 - 2.484)	1.351 (0.866 - 2.106)
Synovial Sarcoma	169 (27.1%)	192 (23.1%)	0.622 (0.295 - 1.311)	1.704 (0.964 - 3.012)
Grade (Ref: Low-grade)	193 (30.9%)	473 (56.9%)		
Intermediate/High-grade	431 (69.1%)	358 (43.1%)	**2.765 (2.13 - 3.587)**	**2.413 (1.854 - 3.140)**
Tumor Size (Ref: <5 cm)	188 (31.7%)	296 (39.6%)		
5-10 cm	272 (45.9%)	241 (32.3%)	**1.779 (1.352 - 2.341)**	**1.556 (1.199 - 2.021)**
>10 cm	133 (22.4%)	210 (28.1%)	1.058 (0.768 - 1.458)	**3.126 (2.359 - 4.142)**
Adjuvant RT (Ref: No)	NA		NA	
Yes				**0.791 (0.643 - 0.974)**

8:45 AM
Role of Frailty in Risk Assessment
Mark K. Ferguson, Chicago, IL

7:00 AM – 9:00 AM
Pain Management
Moderator: *Stephen C. Yang, Baltimore, MD*

7:00 AM **STS Survey Review**
Stephen C. Yang, Baltimore, MD

7:20 AM **Government Policy and How It Affects Me**
Stephen J. Lahey, Farmington, CT

7:40 AM **Cardiac Enhanced Recovery After Surgery (ERAS): Best Practice Use of Multimodal Anesthesia**
Daniel T. Engelman, Longmeadow, MA

8:00 AM **Thoracic ERAS**
Linda W. Martin, Charlottesville, VA

8:20 AM **Panel Discussion**

9:00 AM – 9:30 AM
BREAK—Visit Exhibits and Scientific Posters

9:30 AM – 10:45 AM
Plenary Session
Moderators: *Keith S. Naunheim, St Louis, MO, and Joseph F. Sabik III, Cleveland, OH*

9:30 AM — Award Presentations

9:45 AM — **C. Walton Lillehei Lecture:** High-Performance Medicine: The Convergence of Artificial Intelligence and Health Care
Eric Topol, La Jolla, CA

11:00 AM – 12:00 PM
Meet the Experts Sessions

Session 1: What Women Cardiothoracic Surgeons and Trainees Should Know About Fertility
Panelists: *Mara B. Antonoff, Houston, TX, Shanda H. Blackmon, Rochester, MN, Karen M. Kim, Ann Arbor, MI, Nicole Noyes, New York, NY, and Jennifer C. Romano, Ann Arbor, MI*

Session 2: Cardiogenic Shock, Pulmonary Embolism, and Acute Heart Failure: Modern Rescue Therapy With ECMO
Panelists: *Christian A. Bermudez, Philadelphia, PA, Joshua B. Goldberg, White Plains, NY, Jonathan W. Haft, Ann Arbor, MI, Thomas E. MacGillivray, Houston, TX, and Rita C. Milewski, Philadelphia, PA*

Session 3: Surgery and Immunotherapy for Resectable, Unresectable, and Oligometastatic Non–Small-Cell Lung Cancer
Panelists: *Boris Sepesi, Houston, TX*, *and Michael J. Weyant, Aurora, CO*

Session 4: Peroral Endoscopic Myotomy: Growing a Program and Appropriate Use
Panelists: *Matthew G. Hartwig, Durham, NC, Siva Raja, Cleveland, OH, Brian E. Louie, Seattle, WA, and Vickie Lytle, Dallas, TX*

Session 5: Stents in the Right Ventricular Outflow Tract for Tetralogy of Fallot
Panelists: *Christopher A. Caldarone, Houston, TX, and Glen S. Van Arsdell, Los Angeles, CA*

Session 6: Management of the Small Aortic Root
Panelists: *Kevin D. Accola, Orlando, FL, Robert K. Salley, Lexington, KY*, *Paul Stelzer, New York, NY*, *and Vinod H. Thourani, Washington, DC*

Session 7: Functional Mitral Regurgitation in 2019 and Beyond
Panelists: *Michael A. Acker, Philadelphia, PA, Gorav Ailawadi, Charlottesville, VA, Vinay Badhwar, Morgantown, WV, Steven F. Bolling, Ann Arbor, MI*, *James S. Gammie, Stevenson, MD, and Richard Lee, Augusta, GA*

11:00 AM – 12:00 PM
Health Policy Forum: Navigating the Merit-Based Incentive Payment System and Alternative Payment Models in 2019
This session will focus on recent changes to the Merit-Based Incentive Payment System (MIPS), which affects Medicare payments for cardiothoracic surgeons. MIPS assesses physicians in four categories—quality, resource use, participation in clinical practice improvement activities, and use of electronic health records. Attendees will learn what they are required to report and how they can achieve maximum scores in all four categories. In addition, Alternative Payment Models (APMs) and bundled payments for coronary artery bypass grafting (CABG) surgery will be discussed.

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

- Outline the latest updates to MIPS
- Describe Medicare's drive to move physicians into APMs
- Explain the new bundled payment program, which includes CABG procedures
- Discuss the role that the STS National Database plays in these initiatives

Moderator: *Courtney Yohe Savage, Washington, DC*

11:00 AM **Introduction**
Stephen J. Lahey, Farmington, CT

11:05 AM **Cardiothoracic Surgery and Medicare's Push Toward Value-Based Payment**
Robert Jasak, Washington, DC

11:45 AM **Panel Discussion**

12:00 PM – 1:00 PM
BREAK—Visit Exhibits and Scientific Posters

1:00 PM – 3:00 PM
Adult Cardiac: Aorta II
Moderators: *Bradley G. Leshnower, Atlanta, GA, and Himanshu J. Patel, Ann Arbor, MI*

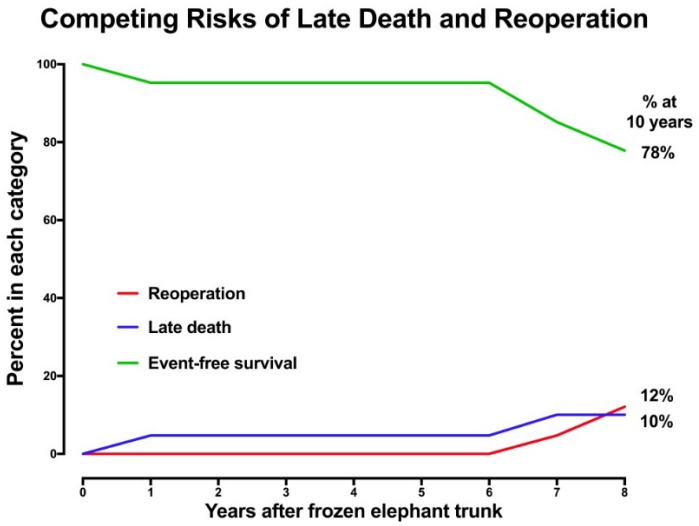
1:00 PM
ABSTRACT: Near "Curative" Impact of Frozen Elephant Trunk on Type I Dissection Confined to the Thoracic Aorta in Marfan Syndrome
*Y. Chen[1], **W. Ma**[1], A. Zhi[2], J. Zheng[3], X. Pan[3], Y. Liu[3], J. Zhu[3], L. Sun[3]*
[1]Beijing Anzhen Hospital, China, [2]Fu Wai Hospital, Beijing, China, [3]Beijing Anzhen Hospital, Capital Medical University, and Beijing Institute of Heart, Lung, and Blood Vessel Diseases, China

Purpose: The use of frozen elephant trunk (FET) technique for DeBakey type I aortic dissection (TIAD) in Marfan syndrome (MFS) is limited because its impact on distal aorta remains largely unknown. We evaluate the long-term outcomes of FET technique in MFS patients with TIAD confined to thoracic aorta over 15 years.

Methods: Between 2006 and 2016, 43 MFS patients (by Ghent criteria) with TIAD confined to thoracic aorta (23 acute, 53.5%) underwent FET. Mean age was 33.6±9.0 years and 65.1% (28/43) were men. Seventeen (39.5%) had positive family history and 6 had prior proximal aortic surgery (14%). Fifteen (34.9%) were hypertensive. Maximal diameter (DMax) of aortic sinuses averaged 66.5±14.4 mm. Entry tear was in ascending aorta in 88.4% and transverse arch in 11.6%. Extent of dissection was to proximal descending aorta in 32 (74%) and above diaphragm in 11 (26%). Risk factors for distal reoperation and dilation were identified with Cox regression.

Results: Operative mortality was 4.7% (2/43). Stroke, acute renal failure, reexploration and distal aortic rupture occurred in 1 each. Follow-up was 100% at 6.3±2.9 years (range 2-13). DMaxs at mid-descending aorta, diaphragm hiatus and abdominal aorta (AA) were 23.0, 21.3 and 20.2 mm preoperatively and 23.5, 22.9 and 22.7 mm on latest CTA. Complete remodeling of distal aorta was observed in 90.0% (37/41) by latest follow-up. There were 1 late death and 3 distal reoperations, including thoracoabdominal aortic repair, abdominal aortic replacement and TEVAR in 1 each. Preoperative AA DMax was predictive of distal reoperation (binary, >= versus < 25 mm) (hazard ratio, HR=12.88, P=0.037) and distal dilatation (in millimeter) (HR=1.93, P=0.007). At 5 and 10 years, survival was 95.4% and 90.1%, freedom from reoperation was 100% and 78.1%, respectively. In competing risks analysis, the rate was 10% for mortality, 12% for reoperation, and 78% were alive without reoperation at 8 years.

Conclusions: FET has a near "curative" impact on type I dissections confined to thoracic aorta in MFS patients. It achieved complete remodeling of the distal aorta and favorable long-term survival and freedom from reoperation in this cohort. Preoperative maximal abdominal aortic size was predictive of distal aortic dilatation and late reoperation.



1:15 PM

ABSTRACT: Extended Stent Graft Coverage Improves Distal Aortic Remodeling and Does Not Increase the Risk of Paralysis in Acute Complicated Type B Aortic Dissection

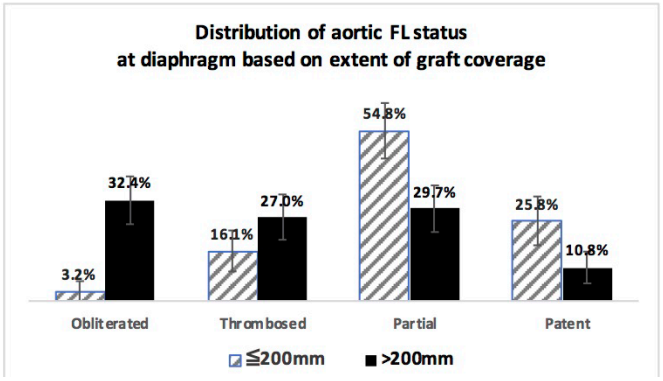
X. Lou*, Y. Duwayri, W. Jordan, E. P. Chen, B. G. Leshnower*
Emory University, Atlanta, GA

Purpose: Thoracic endovascular aortic repair (TEVAR) with endograft coverage from the left subclavian to celiac artery has been theorized to increase the risk of spinal cord ischemia. This study analyzes the impact of extended coverage upon adverse outcomes and aortic remodeling in patients with acute complicated Type B Aortic Dissection (aTBAD).

Methods: From 1/2012 to 7/2018, 87 consecutive patients at a U.S. academic center underwent TEVAR for aTBAD. Median follow-up was 3.0 years (IQR 1.4-4.5) and was complete in 94.3% of patients. The extent of aortic endograft coverage was categorized as Standard (<=200 mm, n=41) or Extended (>200 mm, n=46). Contrast imaging scans were analyzed using aortic centerline analysis to determine length of coverage, maximum aortic diameters, and false lumen (FL) status at time of presentation and at date of last follow-up. Outcomes including mortality, stroke, paraplegia, paraparesis, renal failure, retrograde type A dissection, and need for re-interventions were compared between groups.

Results: The mean age was 53.1±13.6 years, and 67.8% were male. There were no differences in co-morbidities between the cohorts except for a higher incidence of diabetes in the Standard group. The most common indications for intervention were malperfusion (40.9%) and refractory pain (33.0%). Thirteen patients (14.8%) required a lumbar drain (five pre-operatively, eight post-operatively). Median duration between scans was 1.0 year (IQR 0.2-3.1). Length of aortic coverage was significantly longer in the Extended group (Extended 247.7±26.0mm vs Standard 183.2±21.3mm,p<0.001). There were no cases of paraplegia, and three patients in the Extended group had post-operative paraparesis. There was no statistically significant difference in incidence of spinal cord ischemia between groups (Extended 6.5% vs Standard 0%,p=0.244). Morbidity, mortality, and distal aortic re-interventions were equivalent between groups(Table). Following TEVAR, there was a significantly higher incidence of FL obliteration or thrombosis at the diaphragm in the Extended group (Extended 59.4% vs Standard 19.3%,p=0.003)(Figure).

Conclusions: Extended TEVAR improves distal aortic remodeling and does not increase the risk of post-operative spinal cord ischemia in patients with aTBAD. This strategy may eliminate the need for re-interventions on the descending thoracic aorta in the chronic phase of aTBAD.



	Standard (n=41)	Extended (n=46)	*p*-value
Age (yrs)	53.0 ± 14.1	53.2 ± 13.3	0.946
Length of stent graft coverage (mm)	183.2 ± 21.3	247.7 ± 26.0	**<0.001**
Lumbar drain	9.8% (4/41)	19.6% (9/46)	0.240
Post-operative outcomes			
In-hospital mortality	4.9% (2/41)	6.5% (3/46)	1.000
Renal failure requiring dialysis	0.0% (0/41)	0.0% (0/46)	1.000
Stroke	7.3% (3/41)	4.3% (2/46)	0.663
Paralysis	0.0% (0/41)	0.0% (0/46)	1.000
Paraparesis	0.0% (0/41)	6.5% (3/46)	0.244
FL status at level of diaphragm after TEVAR			
Obliterated	3.2% (1/31)	32.4% (12/37)	**0.003**
Thrombosed	16.1% (5/31)	27.0% (10/37)	
Partial	54.8% (17/31)	29.7% (11/37)	
Patent	25.8% (8/31)	10.8% (4/37)	

FL=false lumen
Data represented as mean ± SD or % (number/total).

1:30 PM

ABSTRACT: Impact of Secondary Aortic Interventions After Thoracic Endovascular Aortic Repair on Long-Term Survival

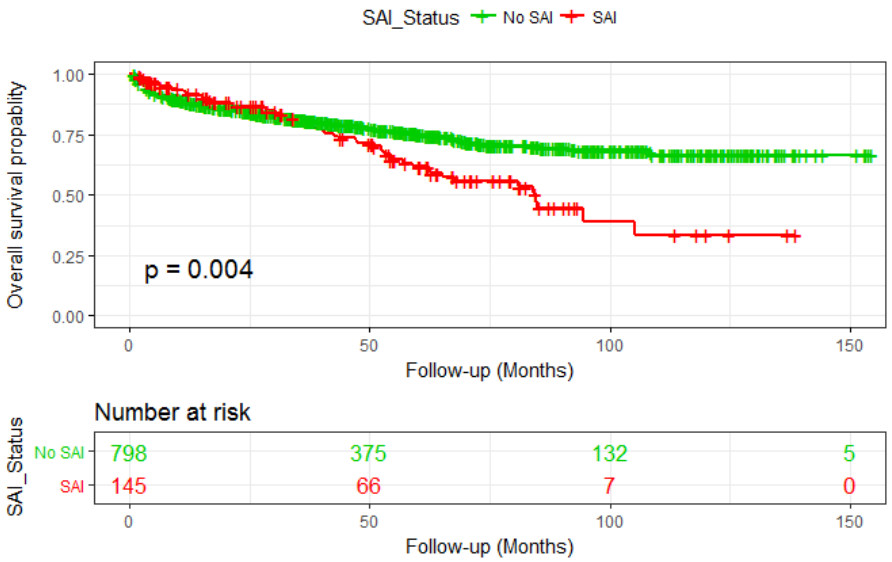
M. Alhussaini, *G. J. Arnaoutakis, S. T. Scali, K. A. Giles, J. Fatima, E. I. Jeng, T. D. Martin, T. M. Beaver*
University of Florida, Gainesville

Purpose: The indications and technology surrounding thoracic endovascular aortic repair (TEVAR) has undergone significant evolution. The more TEVARs done, the more the need of reinterventions. The purpose of this report is to evaluate pathology specific incidence, timing and types of secondary aortic interventions (SAI) after TEVAR and their impacts on survival.

Methods: Single center retrospective review of all TEVARs and SAI performed from 2004-2018. Kaplan-Meier and Cox proportional hazards were used to estimate freedom from SAI, survival, and SAI predictors.

Results: Of 1037 patients (mean age: 65.4±15.1), 153 (14.8%) underwent 212 SAIs [median 5 (interquartile range, 1.5-18) months] with 37 (3.6%) requiring multiple SAI. The primary aortic pathology at index TEVAR significantly affected the incidence of SAI (P = .0001) [chronic dissection (24.5%), post-surgical (19.4%), degenerative aneurysm (15.3%), acute dissection (11.2%), penetrating aortic ulcer (9.1%), traumatic aortic transections (5.4%) and other indications (8.2%)]. Most common indications for SAI were endoleaks (42%), proximal or distal aneurysms (20.8%) and persistent false lumen flow (9.9%). Mean Follow-up was 48.63±39.6 months. Freedom from SAI at 1 and 5 years was estimated to be 90% and 86%, respectively. After exclusion of 30-day mortality events, patients who did not undergo a SAI had better survival vs subjects experiencing SAI [No SAI 1-year, 88.8%; 5-years 78.6%; 10-year 75.4%; and SAI 1-year 92.4%; 5-year 72.4%; 10-year 65.5% (log-rank, P =.004)].

Conclusions: SAI after TEVAR is not uncommon, particularly in chronic dissection pathology. Patients surviving their index hospitalization who experience SAI have worse long-term survival. The varying incidence of SAI by indication identifies the need for pathology specified patient selection and surveillance strategies after TEVAR.



Feature	No SAI (n = 884)	SAI (n =1 53)	P
Age, years	65.5 ± 15.1	64.7 ± 14.8	.8
Sex (female)	291 (32.9)	42 (26.8)	.29
Hypertension	602 (68.1)	117 (76.5)	.038
Dyslipidemia	285 (32.2)	62 (40.5)	0.045
Coronary artery disease	202 (22.9)	27 (17.6)	.15
COPD	147 (16.6)	25 (16.3)	.92
Renal insufficiency	107 (12.1)	29 (19)	.02
Cerebrovascular disease	66 (7.5)	12 (7.8)	.87
Marfan syndrome	0 (0)	8 (5.2)	<.0005
Prior aortic repair	153 (17.6)	43 (28.1)	.002

1:45 PM

DEBATE: Extended Total Arch Reconstruction Is the New Gold Standard for All Type I Dissection

No: *Michael P. Fischbein, Stanford, CA*

Yes: *S. Chris Malaisrie, Chicago, IL*

2:15 PM

ABSTRACT: Impact of Re-Entry Tear on Proximal Descending Aorta After Open Repair of Non-Syndromic Acute Type I Aortic Dissection

J. Kim*, S. Lee, S. Lee, Y. Youn, K. Yoo, H. Joo*

Severance Cardiovascular Hospital, Yonsei University College of Medicine, Seoul, South Korea

Purpose: Patients with reentry tear after proximal repair of aortic dissection have shown unsatisfactory long-term prognosis. However, outcomes according to the location of reentry tear have been poorly understood.

Methods: We analyzed 309 non-syndromic acute type I aortic dissection patients who were repaired to the proximal aorta between 1994 and 2017. The locations of reentry tears were identified with post-operative computed tomography (CT): proximal descending thoracic aorta (DTA) (n=119, 38.5%), distal DTA (n=78, 25.2%) and abdominal aorta (n=129, 41.7%). Patients who had proximal DTA tear were defined as pDTA group (n=119, 38.5%) and did not have proximal DTA tear were defined as non-pDTA group (n=190, 61.5%). Maximum aortic diameter at follow-up CT and aorta-related reintervention rate were compared between the groups. Follow-up CT was performed in 211 (68.3%) patients.

Results: Ascending aorta replacement with hemi-arch (n=215, 69.5%), partial-arch (n=28, 9.1%) and total-arch (n=66, 21.4%) were performed according to the proximal entry tear. The aortic growth rate was 8.0mm/year in pDTA group and 0.2mm/year in non-pDTA group (p<0.001). Aorta-related reintervention rate at 10-years was also significantly higher in pDTA group (43.0±6.2% in pDTA group vs. 8.3±3.7% in non-pDTA group, p<0.001). Multivariate analysis showed that reentry proximal DTA tear was an independent risk factor of significant aortic growth (HR=4.832, 95% CI=2.056-11.356, p<0.001) and aorta-related reintervention (HR=6.748, 95% CI=2.216-20.551, p=0.001).

Conclusions: The reentry tear in proximal DTA is the key risk factor of aorta-related reintervention and significant aortic growth. Complete exclusion of tears located on the proximal DTA in their initial therapy will be an optimal strategy.

2:30 PM

ABSTRACT: Increasing Arch Repairs for Acute Type A Aortic Dissections—Are Outcomes Improving?

M. R. Helder*[1], H. V. Schaff[1], C. N. Day[1], A. Pochettino[1], G. Bagameri[1], K. L. Greason[1], S. L. Lansman[2], L. N. Girardi[3], C. B. Storlie[1], E. B. Habermann[1]*

[1]Mayo Clinic, Rochester, MN, [2]Westchester Medical Center, Valhalla, NY, [3]Weill Cornell Medical Center, New York, NY

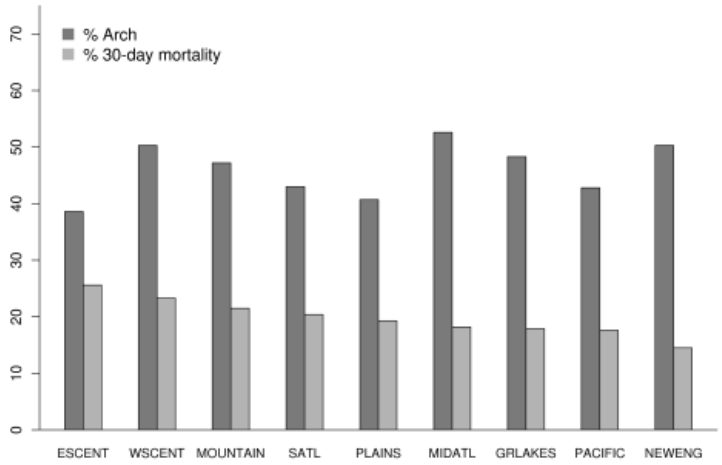
Purpose: Despite increasing interest in addressing the arch during repair of acute type A aortic dissections (AAD), there is little information on the national use of arch operations and potential impact of this strategy on morbidity and mortality.

Methods: We identified 25,462 patients (mean age 59.8±14.2, 66.7% male) with AAD in the Society of Thoracic Surgeons Database between 1/2004-12/2016. Fifty-four percent (n=13,741) of patients had ascending aortic only operations while 46% (n=11,721) had operations involving some part of the arch. Of those patients undergoing ascending only operations, 47.8% (n=6,566) had the aortic valve addressed (any valve procedure) while valve procedures were performed in 56.3% (n=6,598) of patients undergoing arch operations (p<0.001). We examined the relationship between extent of aortic repair and morbidity and mortality. Further, we explored the possible relationship between geographic regions and procedures performed and outcomes.

Results: Perioperative mortality was 19.5% in patients undergoing ascending aortic only operations compared to 20.3% for patients undergoing arch operations (p=0.1337). In multivariable analysis [Table], older age (p<0.001), earlier year of operation (p<0.001), diabetes (p<0.001), severe chronic lung disease (p<0.001), immunosuppression (p=0.044), prior cerebrovascular disease (p<0.001), and longer bypass times (p<0.001) were independently associated with 30-day mortality. Permanent postoperative stroke was

recorded in 12.8% of ascending only patients compared to 13.8% in arch patients (p=0.056). Multivariable analysis revealed that younger age (p=0.002), later year of operation (p=0.026), severe chronic lung disease (p=0.012), prior cerebrovascular disease (p=0.039), and longer bypass times (p<0.001) were independently associated with postoperative stroke. Use of circulatory arrest, in univariate analysis, was statistically significant of increased stroke (p=0.005). Arch repairs varied from 38.6%-52.6% in 9 geographic regions (p<0.0001), and there was regional variation in perioperative mortality (p<.001, Figure) but not in risk of postoperative stroke (p=0.256).

Conclusions: There has been an increasing trend for including arch procedures during repair of AAD. However, mortality and serious morbidity remain high for both procedures in the current era. The demonstrated regional variation on perioperative mortality warrants closer examination and may be a future focus for quality improvement.



	30-day Mortality		Permanent Stroke	
Factor	**OR (95% CI)**	**AOR (95% CI)**	**OR (95% CI)**	**AOR (95% CI)**
Arch operation*	1.06 (0.99, 1.13)	0.95 (0.88, 1.02)	1.10 (1.0, 1.20)	1.04 (0.94, 1.15)
Age, per 10 years	1.25 (1.22, 1.28)	1.26 (1.23, 1.30)	0.95 (0.92, 0.98)	0.94 (0.91, 0.98)
Surgical year, per 1 year	0.99 (0.98, 1.00)	0.97 (0.95, 0.98)	1.03 (1.02, 1.04)	1.02 (1.0, 1.04)
Diabetes	1.43 (1.29, 1.58)	1.24 (1.11, 1.39)	1.00 (0.86, 1.17)	1.03 (0.87, 1.21)
Severe chronic lung disease	1.91 (1.55, 2.35)	1.51 (1.19, 1.92)	0.53 (0.34, 0.81)	0.49 (0.30, 0.79)
Immunosuppression	1.33 (1.12, 1.58)	1.22 (1.01, 1.48)	0.93 (0.71, 1.21)	0.92 (0.69, 1.23)
Cerebrovascular disease	1.53 (1.39, 1.68)	1.34 (1.21, 1.49)	1.15 (1.0, 1.32)	1.17 (1.01, 1.36)
CPB time, per 10 mins	1.07 (1.07, 1.07)	1.11 (1.10, 1.11)	1.01 (1.02, 1.02)	1.02 (1.01, 1.03)
Circulatory arrest#	1.06 (0.96, 1.16)		1.23 (1.06, 1.41)	

Key - OR (95% CI): univariate odds ratio (95% confidence interval); AOR: multivariable, adjusted OR
*as compared to ascending aortic operation only
Circulatory arrest had too many missing variables to include in multivariable analysis

2:45 PM

ABSTRACT: Is Dissection of Arch Branch Vessels Alone an Indication for Aggressive Arch Replacement in Acute Type A Aortic Dissection?

E. L. Norton[1], X. Wu[2], L. Farhat[2], K. M. Kim[3], H. J. Patel[2], G. Deeb[3], ***B. Yang[2]***
[1]Creighton University School of Medicine, Omaha, NE, [2]Michigan Medicine, Ann Arbor, [3]University of Michigan, Ann Arbor

Purpose: To determine if the extension of dissection into the arch branch vessels, including innominate artery, left common carotid artery, should be an indication for aggressive arch replacement in acute type A aortic dissection (ATAAD).

Methods: From 2008 to April 2018, 399 patients underwent open repair for an ATAAD. After excluding patients without arch branch dissection (n=186) or unknown (n=2), or with cerebral/arm malperfusion (n=21), we divided patients (n=190) with innominate and/or LCC artery dissection into two groups: conservative arch: no arch procedure (n=1)/hemiarch replacement (n=109) and aggressive arch: zone 1/2/3 arch replacement (n=80) with replacement of 1-4 arch branch vessels. The data was obtained through chart review, administered surveys and the national death index database. Primary outcomes were postoperative stroke, 30-day mortality, and long-term survival, stroke, and reoperation rate.

Results: The median age was 58-years-old and was similar between two groups. Preoperative comorbidities were similar between groups, including hypertension, diabetes, history of stroke, and history of renal failure, except for conservative group having more coronary artery disease (22% vs. 3%, p=0.0002). Both groups underwent similar aortic root procedures and other concomitant procedures with similar cardiopulmonary bypass and aortic crossclamp times. The aggressive group had longer hypothermic circulatory arrest times with greater use of antegrade cerebral perfusion and higher lowest body temperature achieved (all p<0.05). The perioperative outcomes were similar between two groups (Table), so were the 5-year survival (conservative group: 79% [95% CI: 69%, 87%] vs. 85% [95% CI: 71%, 93%]) and the rates of long-term TIA and stroke. However, the conservative group had more reoperations for aortic arch pathology (3%/year vs. 0.36%/year, p=0.027) with a median 2.3 years, and a trend of increased cumulative incidence of reoperation. (Figure)

Conclusions: In ATAAD with extension into the aortic arch head vessels without cerebral/arm malperfusion, specifically the innominate and LCC arteries, both conservative and aggressive arch replacement are effective operative strategies; however, aggressive management could be considered to prevent future reoperations for pathology of the arch and distal aorta.

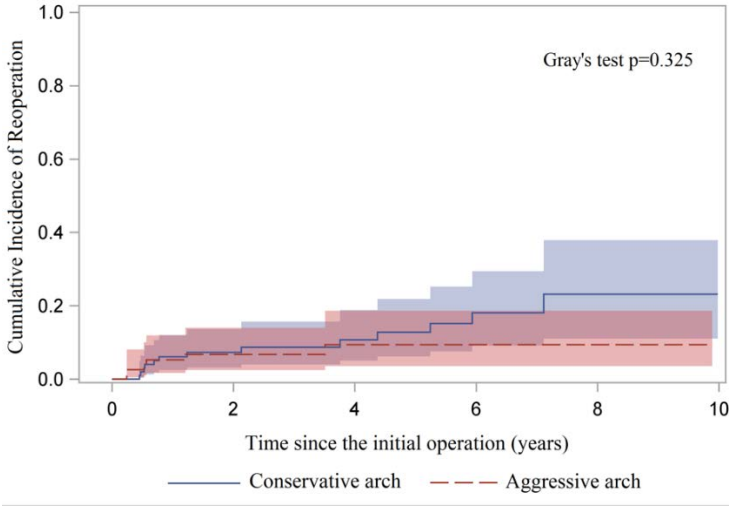


Table: Perioperative outcomes

Variables	Total (n=190)	Conservative arch (n=110)	Aggressive arch (n=80)	p-value
Reoperation for bleeding	14 (7.4)	8 (7.3)	6 (7.6)	0.93
Deep sternal wound infection	0 (0)	0 (0)	0 (0)	-
Sepsis	1 (0.5)	1 (0.9)	0 (0)	1.0
Postoperative MI	3 (1.6)	2 (1.8)	1 (1.25)	1.0
Cerebrovascular accident	20 (11)	12 (11)	8 (10)	0.86
Transient ischemic attack	1 (0.5)	0 (0)	1 (1.25)	0.42
New-onset paraplegia	0 (0)	0 (0)	0 (0)	-
New-onset acute renal failure	18 (9.5)	12 (11)	6 (7.6)	0.44
Requiring dialysis	8 (4.2)	5 (4.5)	3 (3.8)	1.0
Permanent	3 (1.6)	3 (2.7)	0 (0)	0.27
Hours intubated	43 (23, 93)	48 (25, 95)	36 (21, 92)	0.24
Postoperative length of stay (days)	10 (7, 16)	10 (7, 16)	10 (7, 15)	0.99
Intraoperative mortality	1 (0.5)	0 (0)	1 (1.25)	0.42
Mortality at discharge	14 (7.4)	9 (8.2)	5 (6.25)	0.61
30-day mortality	12 (6.3)	8 (7.3)	4 (5.0)	0.53

Data presented as median (25 %, 75 %) for continuous data and n (%) for categorical data.

Abbreviations: MI = myocardial infarction. P-value indicates the difference between the conservative arch and aggressive arch replacement groups.

1:00 PM – 3:00 PM
Adult Cardiac: Aortic Valve/Novel Technologies
Moderators: *Derek R. Brinster, New York, NY, and Ibrahim Sultan, Pittsburgh, PA*

1:00 PM

ABSTRACT: Richard E. Clark Memorial Paper for Adult Cardiac Surgery: Reoperative Surgical Aortic Valve Replacement for Bioprosthetic Failure: Insights From the STS Adult Cardiac Surgery Database

A. Kalra[1], *S. Raza*[1], *M. Hussain*[2], *S. J. Delozier*[1], *S. V. Deo*[1], *S. Khera*[3], *N. S. Kleiman*[4], *M. J. Reardon*[5], *D. Kolte*[6], *T. Gupta*[7], *R. Mustafa*[1], *D. L. Bhatt*[8], *J. F. Sabik*[1]

[1]*University Hospitals Cleveland Medical Center, OH,* [2]*Cleveland Scientific Consulting, OH,* [3]*Columbia University Medical Center, New York, NY,* [4]*Houston Methodist Hospital, TX,* [5]*Houston Methodist DeBakey Heart & Vascular Center, TX,* [6]*Massachusetts General Hospital, Boston,* [7]*Montefiore Medical Center, Bronx, NY,* [8]*Brigham and Women's Hospital, Newton, MA*

DISCUSSANT: *Robert A. Guyton, Atlanta, GA*

Purpose: We hypothesized that with recent approval by FDA in 2015 of valve-in-valve TAVR in patients with degenerated bioprosthesis, there would be a decrease in number of reoperative surgical aortic valve replacements (SAVR). We sought to determine the current nationwide trends in utilization and outcomes of reoperative SAVR for degenerated bioprostheses.

Methods: The study was conducted using the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database. From January 2012 through December 2016, 4,239 patients who underwent isolated reoperative SAVR for degenerated bioprosthesis were included. Patients undergoing other concomitant procedures were excluded. The mean age of included patients was 65.25±13.29 years, 66.1% were males, and 89.5% were white (Table). Trend analyses were conducted to identify changes between 2012-2016. Outcomes studied included stroke, renal failure requiring dialysis, and operative mortality. Multivariable analysis was performed to identify risk factors for worse operative mortality.

Results: Number of patients undergoing reoperative SAVR for degenerated bioprosthesis increased from 782 in 2012 to 844 in 2013 and 900 in 2014 (1.32% increase; p=0.25), and then decreased to 873 in 2015 and 840 in 2016 (6.7% decrease from 2014; p=0.11; Figure). There was small difference in mean ages of patients over this time period—patients were older between 2012-2014 (65.80±13.52 years) compared with 2015-2016 (64.45±12.91 years; p=0.001). Mean STS-predicted mortality was 4.55% between 2012-2014 and decreased to 4.25% for 2015-2016 (p=0.047). There was no difference in post-operative stroke (46/2526 [1.80%] vs. 30/1713 [1.80%]; p=0.96), renal failure requiring dialysis (70/2526 [2.7%] vs. 51/1713 [2.8%]; p= 0.63), or operative-mortality (88/2526 [3.5%] vs. 69/1713 [4.0%]; p= 0.20) in patients undergoing reoperative SAVR between 2012-2014 and 2015-2016, respectively. Risk factors for worse operative-mortality included older age (p= 0.041), male (p= 0.001), use of intra-aortic balloon-pump (p<0.0001), and longer cardiopulmonary-bypass time (p<0.0001).

Conclusions: Our study shows slightly decreasing ages and STS predicted mortality risk scores for patients undergoing reoperative SAVR from 2012-2016. These trends may reflect adoption of valve-in-valve TAVR for older and higher surgical risk patients in the U.S. following FDA approval of the technique in 2015.

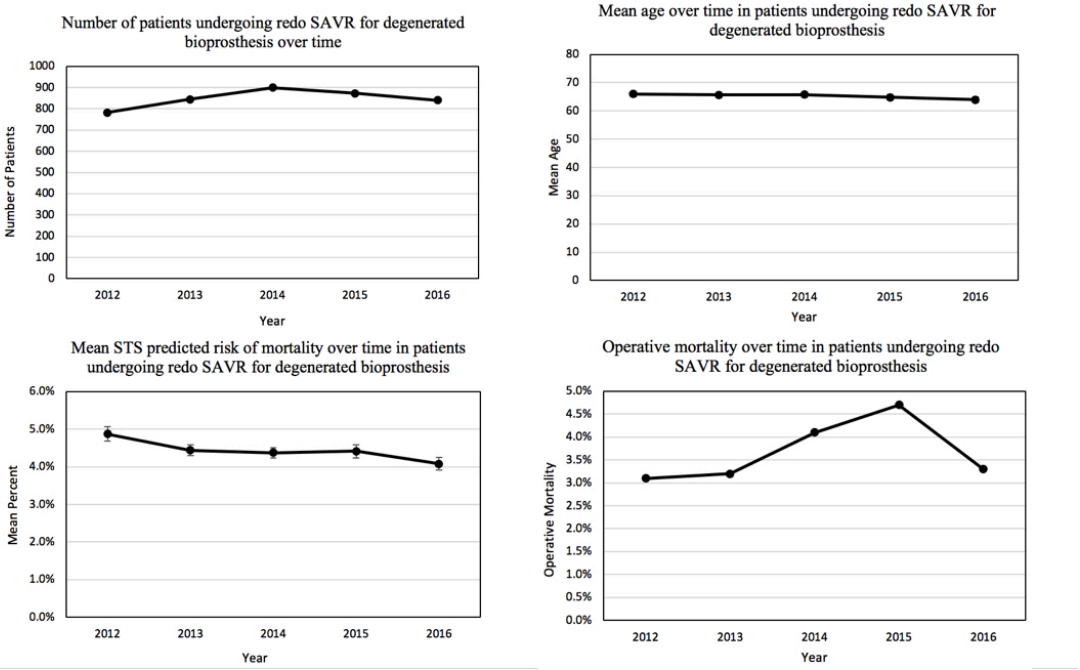


Table: Baseline characteristics of patients who underwent reoperative surgical aortic valve replacement for bioprosthetic failure

		2012-2014 N=2526		2015-2016 N=1713		
		No. (%) or Mean+SD		No. (%) or Mean+SD		*P*-value
Age		65.8	13.5	64.4	12.9	<0.0001
Male		1695	67.1%	1109	64.7%	0.113
Race - White		2244	89.2%	1521	89.8%	0.539
Body Surface Area		2.0	0.3	2.0	0.3	0.6
Diabetes		744	29.5%	472	27.6%	0.189
Dialysis		78	3.1%	38	2.2%	0.103
Chronic Lung Disease	Moderate	160	6.3%	94	5.5%	<0.001
	Severe	155	6.1%	86	5.0%	
Peripheral Arterial Disease		267	10.6%	145	8.5%	0.026
History of Stroke		252	57.7%	186	52.7%	0.172
Last Creatinine Level		1.2	1.1	1.2	1.0	0.365
Prior MI		352	13.9%	252	14.9%	0.42
Congestive Heart Failure		1025	72.1%	663	68.0%	0.032
Cardiogenic Shock		32	1.3%	29	1.7%	0.259
Ejection fraction		54.6	11.9	56.0	11.1	0.001
Status	Urgent	775	30.7%	481	28.1%	0.089
	Emergent	1751	69.3%	1232	71.9%	

1:15 PM

ABSTRACT: Prosthetic Valve Removal Technique Using Ultrasonic Scalpel

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Hokkaido Cardiovascular Hospital, Sapporo, Japan

Purpose: Prosthetic valve removal for reoperative valve replacement is time-consuming and has a risk of damage to the heart during removal due to severe adhesion.The purpose of this surgical video is to show the efficacy of prosthetic valve removal technique using ultrasound scalpel.

Methods: Ultrasonic scalpel (Harmonic scalpel, Ethicon) is a surgical instrument used to simultaneously cut and cauterize tissue by ultrasound vibration in the range of 55,000 Hz. HARMONIC SYNERGY® Blades was used with Ethicon Gen11 Generator at the energy level 5**.** Case 1: A 76-year female implanted tissue valve 7 years ago required redo due to valve deterioration. Case 2:A 76-year male underwent aortic valve replacement (AVR) and mitral valve replacement (MVR) with mechanical valve 7 years ago required re AVR because of valve malfunction. Case 3: A 67-year female received mechanical valve 8 years ago required redo due to paravalvular leakage.

Results: Case 1: Implanted tissue valve was removed in 4 minutes and 46 seconds. Case 2: Implanted mechanical valve sealed with autologous tissue severely was removed in 5 minutes and 51 seconds. Case 3: Implanted mechanical valve cuff was removed in 4 minutes and 10 seconds. All patients had no complications including tissue injuries or atrioventricular block.

Conclusions: Prosthetic valve removal technique using ultrasonic scalpel is quick, easy and safe.Prosthetic valve could be removed in a short time without any complications.

1:30 PM

ABSTRACT: Impact of Aortic Atherosclerosis Burden on Outcomes in Patients Undergoing Surgical Aortic Valve Replacement: Results From the Cardiothoracic Surgical Trials Network Cerebral Embolic Protection Trial

***A. Iribarne**[1], S. Pan[2], J. N. McCullough[1], J. P. Mathew[3], J. Hung[4], P. D. Voisine[5], P. T. O'Gara[6], N. M. Sledz[2], A. Gelijns[2], W. C. Taddei-Peters[7], S. R. Messe[8], A. J. Moskowitz[2], M. A. Groh[9], G. Giustino[2], J. R. Overbey[2], J. DiMaio[10], P. K. Smith[11]*
[1]Dartmouth-Hitchcock Medical Center, Lebanon, NH, [2]Icahn School of Medicine at Mount Sinai, New York, NY, [3]Duke University Medical Center, Durham, NC, [4]Massachusetts General Hospital, Boston, [5]Quebec Heart and Lung Institute, Canada, [6]Brigham and Women's Hospital, Boston, MA, [7]National Heart, Lung, and Blood Institute, Bethesda, MD, [8]Perelman School of Medicine, University of Pennsylvania, Philadelphia, [9]Mission Hospitals, Asheville, NC, [10]Baylor Scott & White Health, Dallas, TX, [11]Duke University, Durham, NC

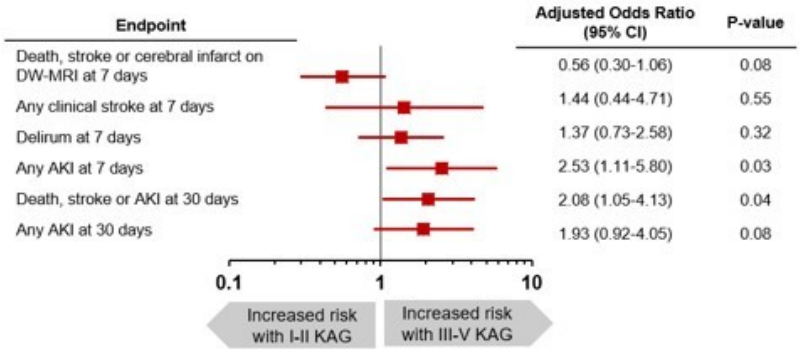
Purpose: Epiaortic ultrasound (EAU) can detect and localize ascending aortic atherosclerosis, but it is unclear whether the aortic atheroma burden is associated with worse outcomes after cardiac surgery. We investigated the association between EAU-based atheroma grade during surgical aortic valve replacement (SAVR) and perioperative adverse outcomes.

Methods: We conducted a trial of patients with calcific aortic stenosis undergoing SAVR randomized to standard-aortic-cannula versus 1 of 2 cerebral embolic protection devices between 3/2015 and 7/2016. Prior to randomization, patients underwent a protocol-defined 5-view EAU read at a core-laboratory. Aortic atherosclerosis was quantified with Katz atheroma grade (KAG) and patients categorized into mild KAG (grade I-II) versus moderate/severe KAG (grade III-V). Patients were assessed for clinical or DW-MRI evidence of stroke at 7 days. Multivariable logistic regression was used to estimate the association between EAU-based KAG and risk of adverse events at 7 and 30 days.

Results: Of the 383 randomized patients, 285 (74.4%) had pre-cannulation EAU data available. Of these, 89 patients (31.2%) had moderate/severe KAG at any segment of the ascending aorta. Baseline characteristics are reported in **Table 1**. Patients with moderate/ severe KAG had greater prevalence of peripheral vascular disease and longer operation time. By multivariable logistic regression analysis **(Figure 1)**, while there were no significant differences in the composite of death, stroke or cerebral infarction on DW-MRI within 7 days, there was a greater risk of acute kidney injury (AKI) at 7 days associated with moderate or severe KAG (adjusted odds ratio [OR]: 2.53; 95% confidence interval [CI]: 1.11-5.80; p=0.03). At 30 days, patients with moderate or severe KAG at baseline had greater risk of the composite of death, stroke or AKI (adjusted OR: 2.08; 95% CI: 1.05-4.13; p=0.04).

Conclusions: In patients undergoing SAVR, the presence of more advanced KAG detected with EAU was associated with greater risk of AKI at 7 days and death, stroke or AKI at 30 days. Larger studies are needed to establish the association between aortic atheroma burden and risk of clinical stroke after SAVR.

Risk of adverse events by 7 and 30 days after surgical aortic valve replacement



Multivariable logistic regression model adjusted for age, sex, history of AF, diabetes, PAD, embolic protection used, cardiopulmonary by-pass time, concomitant CABG, and Log Ratio of White Matter Lesion to Intracranial Volume

Table 1. Baseline characteristics according to the baseline aortic atheroma burden.

	I or II Katz Atheroma Grade (N=196)	III-V Katz Atheroma Grade (N=89)	p-value
Baseline clinical characteristics			
Age (years)*	73.8 ± 6.6	74.8 ± 6.0	0.20
Body mass index	29.6 ± 5.9	30.2 ± 6.1	0.40
Male sex*	121 (61.7)	57 (64)	0.71
White race	184 (93.9)	80 (89.9)	0.45
Severe carotid artery disease (>80% stenosis)	6 (3.1)	2 (2.3)	>0.99
Peripheral vascular disease*	18 (9.2)	22 (24.7)	<0.01
Hypertension	161 (82.1)	74 (83.2)	0.84
Diabetes*	51 (26)	33 (37.1)	0.06
History of atrial fibrillation*	19 (9.7)	15 (16.9)	0.08
History of stroke or TIA	18 (9.2)	7 (7.9)	0.72
White Matter Lesion Volume (mm^3)	5662 (2799, 9230)	4259 (2178, 9135.2)	0.22
White Matter Lesion Volume/Intracranial Volume*	0.004 (0.002, 0.007)	0.003 (0.002, 0.007)	0.22
Procedural characteristics			
Embolic protection device used*	123 (62.8)	60 (67.4)	0.45
Presence of debris$^{\mp}$	93/106 (87.7)	51/57 (89.5)	0.74
Concomitant CABG*	76 (38.8)	36 (40.4)	0.79
Operation Time (min)	307.8 ± 81.1	334.2 ± 97.6	0.03
CPB Time (min)*	103.6 ± 41.0	107.1 ± 42.0	0.51
Cross Clamp Time (min)	78.3 ± 32.0	79.3 ± 32.3	0.81

Continuous measures are reported as mean ± sd or median (IQR) and categorical measures are reported as number (percent) or when the denominator is not equal to the group total, number/number observed (percent).
* Variables included in the multivariable logistic regression models.
$^{\mp}$ Among patients who received an embolic protection device.

1:45 PM

ABSTRACT: Has Market Competition Influenced the Utilization of Transcatheter Aortic Valve Replacement?

R. J. Strobel*, A. A. Brescia, K. M. Kim, S. Fukuhara, X. Wu, D. S. Likosky, H. J. Patel, G. Deeb, M. P. Thompson*
University of Michigan, Ann Arbor

Purpose: The adoption of novel surgical approaches is often influenced by economic competition, over and above patient need. The purpose of this study is to test the association between increased hospital market competition and TAVR utilization.

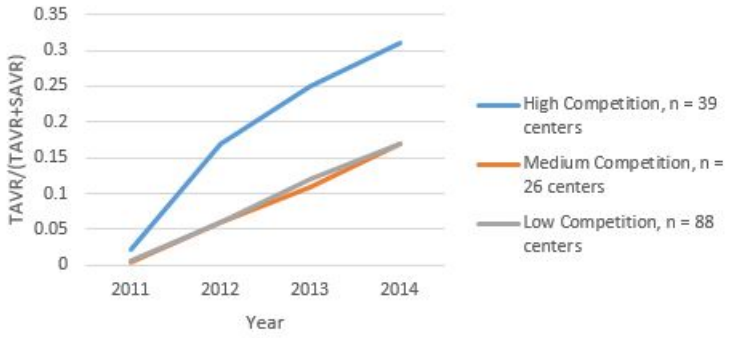
Methods: We used five AHRQ Healthcare Cost and Utilization Project (HCUP) state inpatient databases (AZ, FL, IA, MA, WA) to identify patients undergoing TAVR (n = 5,563) or surgical aortic valve replacement (SAVR; n= 38,540) across 154 centers from 2011-2014. The Herfindahl-Hirschman Index (HHI) was used to assess market competition for each hospital, and hospitals were grouped into

low (HHI > 2500), moderate (HHI 1500-2500), and high competition (HHI <1500) categories based on prior literature. Hierarchical logistic regression identified associations between HHI category and whether a patient received TAVR vs. SAVR, adjusting for patient demographics, comorbidities, calendar year, and center (random effect).

Results: Odds of TAVR utilization increased significantly per year over the study period (OR: 2.28 95% CI: 2.19-2.382). After adjustment for patient characteristics, time, and center, patients who were treated at a high competition center had significantly higher odds of receiving TAVR, relative to patients treated at a low competition center (OR: 14.03 95% CI: 6.27-31.40). Patients at a medium competition center were also observed to have significantly higher odds of receiving TAVR. (OR: 3.53 95% CI: 1.43-8.69). TAVR utilization increased at a faster rate among high competition centers, relative to low competition centers (Figure) as indicated by a significant interaction between calendar year and HHI category (p = 0.014). Trends in TAVR utilization were similar for medium and low competition centers (p=0.852).

Conclusions: TAVR utilization is significantly associated with increased market competition. This work highlights the influence economic factors may have in contributing to the adoption of new surgical approaches. We are currently exploring the patient populations amongst which increased adoption in high competition centers is most pronounced.

Figure. Proportion of patients undergoing TAVR by HHI category, over time



2:00 PM

DEBATE: 60-Year-Old Man With STS PROM 4.5% and Prior 19 mm Bioprosthetic Valve

Redo Aortic Valve/Root Replacement: *Joseph S. Coselli, Houston, TX*
Valve-in-Valve Transcatheter Aortic Valve Replacement: *Keith B. Allen, Kansas City, MO*

2:30 PM

ABSTRACT: Repair of Aortic Valve Insufficiency With Associated Ascending Aortic Aneurysm Using Geometric Ring Annuloplasty

M. W. Gerdisch[1]*, J. S. Rankin*[2]*, S. D. Weaver*[3]*, V. Badhwar*[2]
[1]*Cardiac Surgery Associates, Indianapolis, IN,* [2]*West Virginia University, Morgantown,* [3]*Corazon Medical, Columbus, OH*

Purpose: Outcomes with aortic valve repair for aortic insufficiency (AI) are superior to replacement, but with isolated ascending aortic aneurysms, no approach has been validated. Reimplantation is inappropriate with normal sinuses, and subcommissural annuloplasty is not durable. This video demonstrates a new approach using internal ring annuloplasty during ascending aneurysm replacement.

Methods: Geometric annuloplasty rings have been developed for repair of both tri-leaflet and bicuspid valves. The patient is a 71-year-old male with worsening congestive heart failure, tri-leaflet AI, and a 5.4 cm ascending aneurysm with minimal root involvement. Operative transesophageal echocardiography shows Grade 3 AI, with a central jet and good leaflets. After initiation of bypass and blood cardioplegia, the aortic arch is clamped from the base of the innominate artery to the ligamentum, for a closed hemi-arch replacement. The aortic root is opened with a circular aortotomy, and traction sutures are placed above each commissure for exposure.

Results: On initial testing, the leaflets look good, but the non-coronary leaflet seems slightly low. The annulus is 27 mm. The left and non-coronary leaflets size to a 21 mm ring, but the right leaflet approximates a 23, indicating downsizing to a 21 mm ring. The 3 post sutures are placed low into the subcommissural triangles, and the ring is passed below the valve. Two mattress sutures are placed in each sinus segment, effectively looping the ring (for a total of 9 trans-annular sutures). After suture tying, the non-coronary leaflet still looks a little low. So, a plication suture is placed, correcting the prolapse. A Dacron tube graft, 7 mm larger than the ring (28 mm), is sutured to the supra-coronary aorta and to the distal closed hemi-arch. After repair, the valve leaflets move well, with trivial AI, and a 9 mmHg mean systolic gradient. The patient recovered uneventfully.

Conclusions: Geometric ring annuloplasty is a safe, effective, and standardized method of aortic valve repair during ascending aortic aneurysm surgery. Reconstructive techniques are well validated and allow successful repair in most pathologies. Aortic ring annuloplasty provides a simple option for increasing aortic valve repair rates and improving patient outcomes.

2:45 PM

ABSTRACT: Early vs Delayed Pacemaker Implantation for Heart Block Following Aortic Valve Replacement: A Cost-Effectiveness Analysis

J. P. Beller, *Z. Tyerman, J. H. Mehaffey, R. B. Hawkins, E. J. Charles, L. T. Yarboro, N. R. Teman, N. Mehta, T. N. Wanacheck, G. Ailawadi*
University of Virginia, Charlottesville

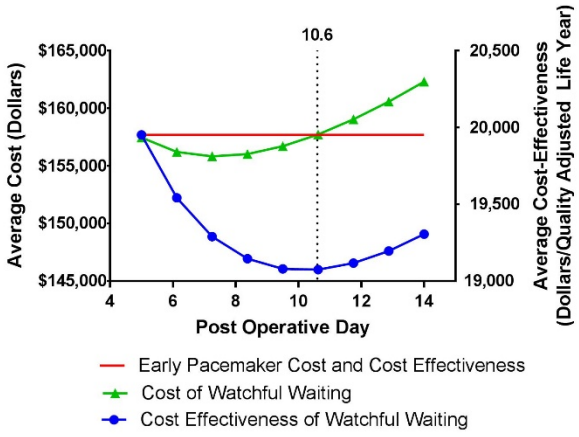
Purpose: The development of atrioventricular (AV) block after surgical aortic valve replacement (SAVR) is well described. However, conduction may recover spontaneously preventing the need for a permenant pacemaker. The purpose of this analysis was to evaluate the cost effectiveness of delaying pacemaker implantation.

Methods: A cost effectiveness model was developed using costs and probabilities of short and long-term complications, pacemaker device implantation, and follow up visits. These were derived from a combination of institutional data and the reported literature. Prospectively collected patient reported outcomes were used to determine risk-adjusted differences in quality of life. The probability of recovery from complete heart block was calculated as a cumulative distribution function (Pr(recovery) = 0.1339*ln(postoperative day) + 0.0349). Primary decision analysis was based on an expected recovery rate of 38% at 14 days with timing of pacemaker placement: early (5 days) vs. watchful waiting for 14 days.

Results: A strategy of delaying pacemaker placement to 14 days while awaiting spontaneous recovery was more costly (Average Cost: $162,303 vs. $157,463 [difference = $4,840]), but more effective than early placement (Quality Adjusted Life Years[QALY]: 8.4 vs. 7.9 years). Cost minimization would occur with a strategy of pacemaker placement at 8.3 days while optimization of average cost effectiveness occurs at 10.6 days (**Figure**). At 10.6 days, the incremental cost-effectiveness ratio was $10,004/QALY. The results are sensitive to rates of recovery of AV node function, with increased costs and decreased efficacy for the delayed strategy at progressively lower recovery rates. A recovery rate of less than 19% at 14 days was found to be the low threshold for cost effectiveness in a delayed strategy.

Conclusions: A watchful waiting strategy until postoperative day 11 is the most cost-effective management of AV block after SAVR. Although a delayed strategy is cost effective for SAVR, provided the recovery rate of intrinsic rhythm is at 20% or greater.

Costs and Cost Effectiveness of Early Pacemaker vs. Watchful Waiting



1:00 PM – 3:00 PM

Advanced Therapies for End-Stage Cardiopulmonary Disease

Cardiothoracic surgeons, cardiologists, intensivists, and allied health professionals who care for patients with advanced heart and lung failure will benefit from this session, which will focus on organ transplantation and donor-related issues. Speakers will discuss the financial considerations in organ procurement, ex-vivo organ preservation, the use of donors from cardiac death and those with hepatitis C, and the recent United Network for Organ Sharing heart allocation model, which was implemented in October 2018.

Learning Objectives

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

- Describe the ideal diagnostic evaluation and optimization of heart donors
- Summarize the role of organ procurement organizations, their financial and organizational infrastructure, and how they impact clinical practice in thoracic organ procurement
- Explain the current and potential future application of ex-vivo organ preservation

- Describe potential future sources of donor thoracic organs such as those with hepatitis C and from donation after cardiac death
- Explain the new heart allocation model and describe the early impact at high- and low-volume centers

Moderators: *Jonathan W. Haft, Ann Arbor, MI, and Jason W. Smith, Seattle, WA*

1:00 PM **Heart Donor Diagnostic Testing and Optimization: Are We All on the Same Page?**
Hannah M. Copeland, Ridgeland, MS

1:15 PM **Discussion**

1:18 PM **Organ Procurement Agencies: Financial and Organizational Structure for Durable Success**
Jeffrey Orlowski, Oklahoma City, OK

1:43 PM **Discussion**

1:48 PM **Ex-Vivo Thoracic Organ Preservation: Current and Future Applications**
Marcelo Cypel, Toronto, Canada

2:03 PM **Discussion**

2:06 PM **Heart Donation After Cardiac Death Clinical Trial**
Jason W. Smith, Seattle, WA

2:21 PM **Discussion**

2:24 PM **Use of Hepatitis C Donors**
Ashish Shah, Nashville, TN

2:39 PM **Discussion**

2:42 PM **New Heart Allocation Model and Its Early Impact**
Jonathan W. Haft, Ann Arbor, MI

2:57 PM **Discussion**

1:00 PM – 3:00 PM
General Thoracic: Esophageal
Moderators: *Daniela Molena, New York, NY, and Katie S. Nason, Springfield, MA*

1:00 PM
ABSTRACT: Do the 2018 Leapfrog Group Minimal Hospital and Surgeon Volume Standards for Esophagectomy Reflect Better Outcomes?
D. T. Cooke[1], *H. Hashimi*[1], *C. L. David*[2], *L. M. Brown*[1], *G. H. Utter*[1], *M. Nuno*[1]
[1]*University of California, Davis Medical Center, Sacramento,* [2]*University of Massachusetts, Amherst*

Purpose: In 2018 the Leapfrog Group released minimal hospital and surgeon volume standards for esophagectomy for cancer that predict reduced mortality (in-hospital and 30-day), length of stay and complications. These new recommendations are especially novel for surgeon specific volume. We sought to evaluate whether these standards are associated with improved outcomes.

Methods: We used the 2007-2013 Healthcare Cost and Utilization Project's State Inpatient Databases. Patient demographics, comorbidity, and hospital characteristics were assessed to examine the relationship between hospital and surgeon esophagectomy volume on in-hospital mortality, prolonged length of stay (PLOS; >/=14 days) and postoperative complications. We used the 2018 Leapfrog Group minimal hospital and surgeon volume standards to define high (HVH) and low volume (LVH) hospitals (HVH >/= 20 esophagectomies per year), and high (HVS) and low (LVS) volume surgeons (HVS >/= 7 esophagectomies per year). We used multivariable analysis to identify independent predictors of in-hospital mortality, PLOS and complications.

Results: Among 6022 esophagectomies, patients undergoing esophagectomy at HVH (compared to LVH, p<0.001) had reduced mortality (2.6% for HVH vs 5.6% for LVH), PLOS (27.4% vs 37.3%), and any complication (57.3% vs 65.6%). When compared to

procedures performed by LVS (p<0.001) patients undergoing esophagectomy by HVS had similar reduction in mortality (3.0% for HVS vs 5.0% for LVS), PLOS (27.1% vs 36.8%) and any complication (56.6% vs 65.8%). Comparing surgeons in similar environments, LVS operating in HVH had no difference in mortality when compared to HVS operating in HVH (2.5% for HVS vs 3.1% for LVS; p=0.36) but increased PLOS (25.8% vs 32.5%; p<0.001) and any complication (56.1% vs 61.2%; p=0.01). In multivariable analysis, increasing patient age and male sex and hospital volume independently predict in-hospital mortality, but surgeon volume did not (Table). Patients treated by HVS, irrespective of hospital volume, experienced a 20% reduction in PLOS and any complication.

Conclusions: LVS not meeting 2018 Leapfrog standards but operating in hospitals meeting standards have similar mortality outcomes as HVS, suggesting hospital volume standards should take priority over surgeon specific volume standards when considering risk of mortality after esophagectomy. A limitation of our study is our methodology does not capture 30-day mortality.

Table 1. Factors Associated with each outcome, Odds Ratio (OR), and 95% confidence intervals (CI).

			Complications					
Variables	Mortality	PLOS**	Any	Pulmonary	Cardiac	Gastrointestinal	Hematologic	Infectious
Age, decade	**1.8 (1.6-2.0)**	**1.1 (1.04-1.2)**	**1.2 (1.1-1.3)**	**1.1 (1.1-1.2)**	**1.4 (1.3-1.5)**	1.0 (0.9-1.1)	**1.2 (1.1-1.2)**	**1.1 (1.04-1.2)**
Race (ref: White)								
Black	0.9 (0.6-1.6)	1.2 (0.9-1.5)	0.8 (0.6-1.0)	**0.6 (0.4-0.7)**	**0.6 (0.4-0.8)**	0.9 (0.6-1.4)	1.3 (1.0-1.8)	0.9 (0.6-1.2)
Hispanic	1.0 (0.7-1.6)	1.1 (0.9-1.3)	0.9 (0.7-1.0)	**0.8 (0.7-0.9)**	**0.7 (0.5-0.8)**	1.2 (0.9-1.6)	**1.5 (1.2-1.8)**	1.1 (0.9-1.3)
Sex (ref: Female)								
Male	**1.4 (1.0-2.1)**	1.1 (0.9-1.2)	1.1 (0.9-1.3)	**1.2 (1.03-1.4)**	**1.5 (0.3-1.8)**	1.1 (0.9-1.4)	**0.8 (0.7-0.9)**	0.9 (0.7-1.0)
Comorbidity Score*	1.7 (1.4-2.0)	1.6 (1.5-1.8)	**1.5 (1.4-1.6)**	**1.5 (1.4-1.6)**	**1.3 (1.2-1.4)**	**1.3 (1.2-1.5)**	**1.5 (1.4-1.6)**	**1.6 (1.4-1.7)**
Hospital Volume+ (ref: Low)								
High	**0.6 (0.4-0.9)**	**0.8 (0.7-0.9)**	0.9 (0.7-1.0)	0.9 (0.8-1.2)	0.9 (0.7-1.1)	1.0 (0.8-1.4)	**0.7 (0.6-0.9)**	0.9 (0.8-1.1)
Surgeon Volume++ (ref: Low)								
High	0.9 (0.6-1.5)	**0.8 (0.7-1.01)**	**0.8 (0.6-0.9)**	**0.8 (0.7-0.9)**	**1.3 (1.03-1.6)**	**0.7 (0.5-0.9)**	0.8 (0.6-1.0)	0.8 (0.7-1.1)

Significant findings are presented in bold text and grey shading.

*Elixhauser comorbidity score, unit increment.

** PLOS (prolonged length of stay); ≥14 days, from admission to discharge. (Comparison: yes versus no).

+Hospital: High-Volume (≥20 esophagectomies annually), Low-Volume (< 20 esophagectomies annually).

++Surgeon: High-Volume (≥7 esophagectomies annually), Low-Volume (<7 esophagectomies annually).

1:15 PM

ABSTRACT: Delaying the Treatment of Achalasia Affects Long-Term Outcomes: Lessons From a Canadian Cohort Study of 1624 Patients

E. Frechette[1], *B. Allen*[2], *K. Bray Jenkyn*[2], *T. Maniere*[1], *R. A. Malthaner*[3], *S. Z. Shariff*[2]

[1]*University of Sherbrooke, Longueuil, Canada,* [2]*Institute for Clinical Evaluative Sciences, London, Canada,* [3]*London Health Sciences Center, Canada*

Purpose: Esophageal achalasia is a rare dysmotility disorder often recognized only lately by physicians. Because of non-specific clinical features, delays in diagnosis and treatment can be seen. This study's objectives were to identify factors related to treatment delays and measure the impact of such delays on late clinical outcomes.

Methods: Population-based administrative databases were pooled to identified patients undergoing treatment for achalasia between April 1, 1997 and March 31, 2010. A lookback period extending to April 1, 1991 was used to rule out previous achalasia treatments and determine the date of initial consultation for related symptoms. Multivariable logistic regression estimated demographic and clinical factors associated to a time-to-treatment (TTT) longer than 3 years. A follow-up period extending to April 1, 2016 and Cox regression models allowed calculation of hazard ratio of additional treatments, end-stage achalasia, esophageal cancer, and death according to TTT duration.

Results: A total of 1624 new cases of achalasia were identified, (incidence: 1.22 per 100,000 population-year). There were 859 patients treated less than 3 years following the time of initial consultation and 765 after more than 3 years. The mean TTT was 33.42 months (+/-17.91). On multivariable logistic regression, female gender was associated with a long TTT (HR 1.29, p=0.01). At follow-up, 486 patients (29.9%) required additional achalasia treatments and 62 (3.8%) patients developed end-stage achalasia. On Cox regressions models, a long TTT was associated with higher risk to require additional treatments (HR 1.46 after 1-10 years, p=0.02, HR 2.49 after >10 years, p=0.03) and to develop end-stage achalasia (HR 2.36 after 1-10 years, p=0.046, HR 3.42 after >10 years, p=0.17). There was however no significant difference in survival between long and short TTT groups. The risk of esophageal cancer was low (less than 0.7% for the entire follow-up period).

Conclusions: Among patients treated for esophageal achalasia, a long delay before proceeding with initial treatment, compared to short delay, was associated with a higher risk to require additional treatments and to develop end-stage achalasia. Efforts to increase physician awareness of the disease should be considered. Early referral for treatment is recommended.

Figure 1. Kaplan-Meier curves for cumulative incidence of late complications following treatment of achalasia in long and short time-to-treatment groups, including: (a.) need for re-intervention, (b.) development of end-stage achalasia, and (c.) death.

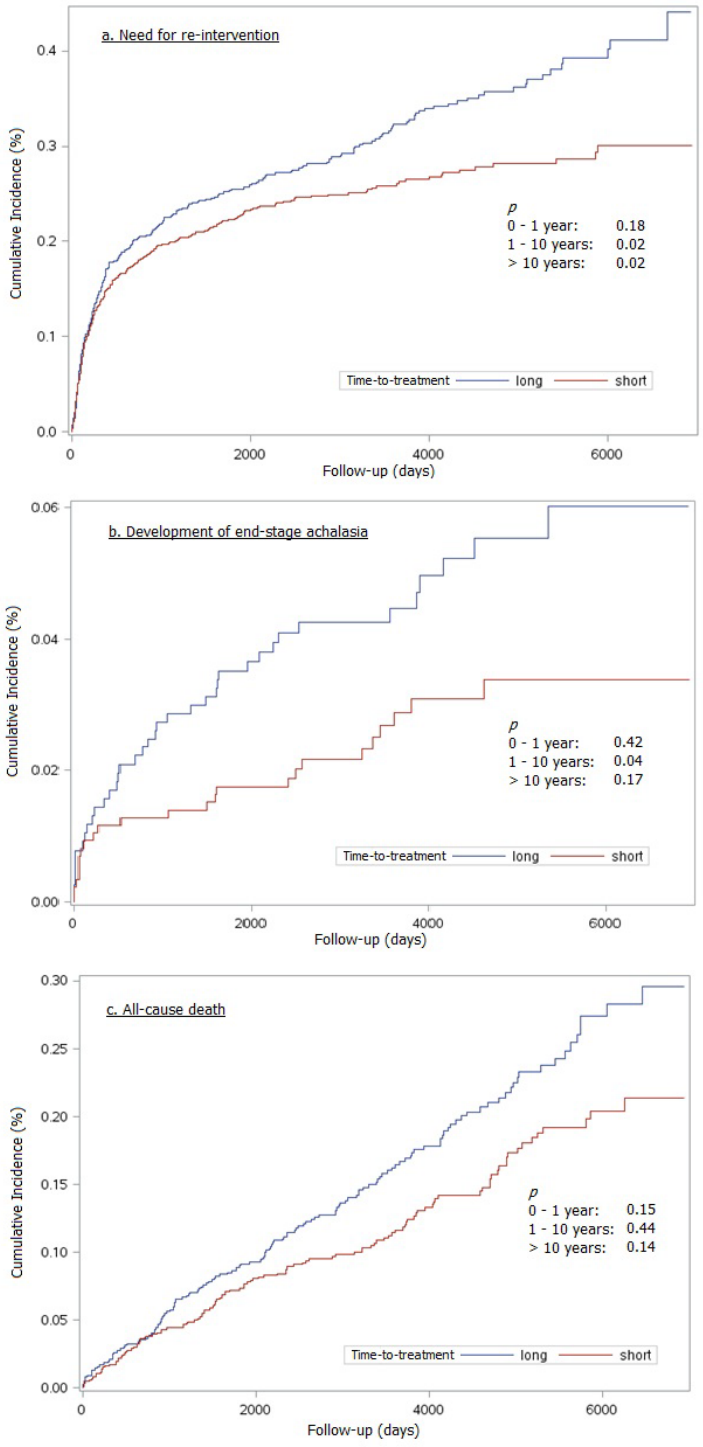


Table 1. Patient Characteristics			
	Short Time-to-treatment (< 36 months)	Long Time-to-treatment (≥ 36 months)	Overall
	N=859	N=765	N=1,624
Time-to-treatment (mean +/- SD):	18.25 ± 8.35	50.45 ± 7.33	33.42 ± 17.91
Age at treatment date (mean +/- SD)	48.86 ± 17.26	53.27 ± 16.80	50.94 ± 17.18
Female n (%)	392 (45.6%)	398 (52.0%)	790 (48.6%)
Era of Treatment:			
1997-1999	172 (20.0%)	133 (17.4%)	305 (18.8%)
2000-2002	150 (17.5%)	151 (19.7%)	301 (18.5%)
2003-2005	181 (21.1%)	166 (21.7%)	347 (21.4%)
2006-2008	211 (24.6%)	179 (23.4%)	390 (24.0%)
2009-2010	145 (16.9%)	136 (17.8%)	281 (17.3%)
Initial treatment			
Myotomy	418 (48.7%)	333 (43.5%)	751 (46.2%)
Pneumatic dilation	441 (51.3%)	432 (56.4%)	873 (53.8%)
Investigation performed:			
Esophagogastroduodenoscopy	775 (90.2%)	724 (94.6%)	1,499 (92.3%)
Barium Swallow	784 (91.3%)	693 (90.6%)	1,477 (90.9%)
Manometry	679 (79.0%)	613 (80.1%)	1,292 (79.6%)
24-hours pH study	79 (9.2%)	83 (10.8%)	162 (10.0%)
Any Specialist Consult	847 (98.6%)	759 (99.2%)	1,606 (98.9%)
GENERAL SURGERY	442 (51.5%)	409 (53.5%)	851 (52.4%)
THORACIC SURGERY	260 (30.3%)	253 (33.1%)	513 (31.6%)
GASTROENTEROLOGY	465 (54.1%)	477 (62.4%)	942 (58.0%)
INTERNAL MEDICINE	536 (62.4%)	535 (69.9%)	1,071 (65.9%)
First Specialist seen:			
Surgical Specialty	212 (24.7%)	205 (26.8%)	417 (25.7%)
Time to first consultation (mean +/- SD)	9.77 ± 7.70	31.67 ± 17.74	20.54 ± 17.45
Medical Specialty	635 (73.9%)	554 (72.4%)	1,189 (73.2%)
Time to first consultation (mean +/- SD)	8.63 ± 7.27	29.29 ± 18.11	18.26 ± 16.95
Income based socioeconomic status:			
Quintile 1	142 (16.5%)	149 (19.5%)	291 (17.9%)
Quintile 2	180 (21.0%)	143 (18.7%)	323 (19.9%)
Quintile 3	165 (19.2%)	170 (22.2%)	335 (20.6%)
Quintile 4	180 (21.0%)	143 (18.7%)	323 (19.9%)
Quintile 5	190 (22.1%)	157 (20.5%)	347 (21.4%)
Rural Location (Y, %)	108 (12.6%)	86 (11.2%)	194 (11.9%)
Charlson Comorbidity Score (N, %)			
0	169 (19.7%)	222 (29.0%)	391 (24.1%)
1	36 (4.2%)	37 (4.8%)	73 (4.5%)
2	21 (2.4%)	22 (2.9%)	43 (2.6%)
>=3	20 (2.3%)	25 (3.3%)	45 (2.8%)
No Hospitalizations	613 (71.4%)	459 (60.0%)	1,072 (66.0%)
At least one hospitalization last 5 years (n, %)	246 (28.6%)	306 (40.0%)	552 (34.0%)
Number of Hospital Admissions last 5 years			
Mean (SD)	0.52 ± 1.21	0.90 ± 1.71	0.70 ± 1.48
Family Physician Vists last 5 years			
Mean (SD)	27.26 ± 28.86	41.98 ± 33.41	34.19 ± 31.94

1:30 PM

ABSTRACT: Understanding Failure-to-Rescue After Esophagectomy in the United States

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Purpose: Data on failure to rescue (FTR) after esophagectomy is sparse. We sought to better understand the patient factors associated with this outcome, and whether there were specific differences associated with this outcome at low- and high-volume hospitals in the United States.

Methods: We identified all patients undergoing esophagectomy between 2010 and 2014 from the Agency for Healthcare Research and Quality's National Readmission Database. We defined FTR as mortality after experiencing a major complication, including: pulmonary failure, pneumonia, myocardial infarction, venous thromboembolism, acute renal failure, post-operative hemorrhage, surgical site infection, and gastrointestinal hemorrhage. We grouped hospitals into quintiles of esophagectomy volume. Multiple logistic regression was used to identify patient factors and hospital-volume associations with FTR.

Results: Of 26,827 patients undergoing an esophagectomy, 7,130 (26.6%) experienced a major complication. Of those, 1,061 did not survive the index hospitalization (FTR rate 14.9%). Risk factors for FTR included: Increasing age (aOR=1.06, p<.001), congestive heart failure (aOR=2.07, p<0.001), bleeding disorders (aOR=2.9, p<.001), liver disease (aOR=2.37, p=0.001), and renal failure (aOR=2.37, p=0.002). At the hospital level, there was wide variation in FTR rates across hospital volume quintiles, with 21.2% of patients suffering a complication not surviving to discharge at low volume hospitals, compared to 13.4% at high volume hospitals (p<0.001). At low volume hospitals, the highest FTR rates were with acute renal failure (35.1%), postoperative hemorrhage (31.9%) and pulmonary failure (28.1%).

Conclusions: One in five esophagectomy patients suffering a complication at low volume hospitals does not survive to discharge. Several patient factors are associated with death after a major complication. Strategies to improve the recognition and management of complications in at-risk patients may be essential to improve outcomes at low-volume hospitals.

1:45 PM

ABSTRACT: Mortality After Esophagectomy: An Analysis of Complications and Their Association With Mortality in the STS National Database

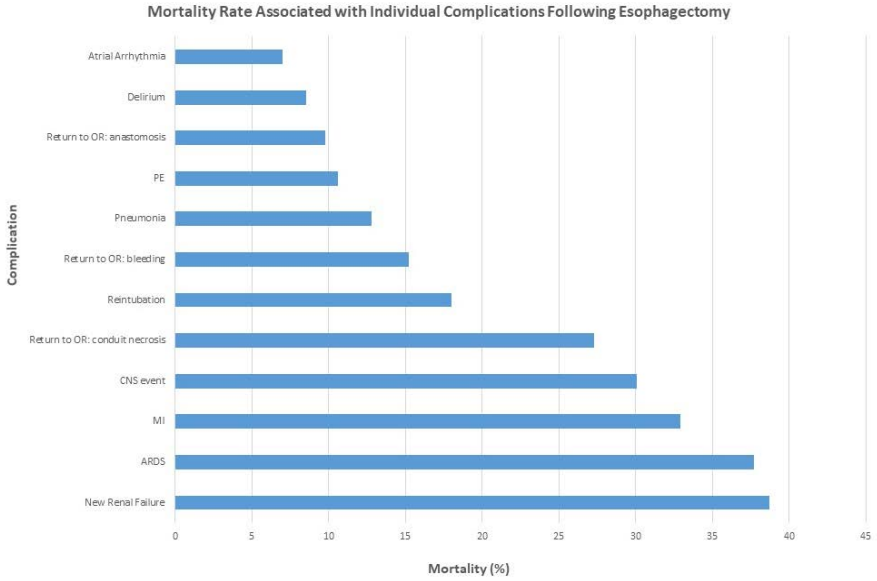
P. A. Linden[1], *C. W. Towe*[1], *T. J. Watson*[2], *D. E. Low*[3], *S. D. Cassivi*[4], *M. V. Grau-Sepulveda*[5], *J. D. Mitchell*[6], *Y. Y. Perry*[1]
[1]*University Hospitals Cleveland Medical Center, OH,* [2]*MedStar Washington, DC,* [3]*Virginia Mason Medical Center, Seattle, WA,* [4]*Mayo Clinic, Rochester, MN,* [5]*Duke Clinical Research Institute, Durham, NC,* [6]*University of Colorado Denver, Aurora*

Purpose: Despite a high complication rate following esophagectomy, the relationship between individual complications and mortality is unclear. The influence of comorbidities on the impact of complications on mortality is also unknown. We sought to assess the impact of individual complications and effect of co-existing comorbidities on mortality following esophagectomy.

Methods: All gastric conduit esophagectomies performed for cancer between 2008-2017 in the National STS Database were identified. Chi square was utilized to identify complications associated with mortality. Multivariable regression analysis was performed, utilizing all complications, to determine the risk-adjusted effect on mortality for each complication (Model 1). To assess the effect of preoperative comorbidities, a second regression analysis was performed, incorporating the STS mortality model, which includes preoperative comorbidities (Model 2). Results are reported as Odds Ratios (95% Confidence Intervals).

Results: Of 11,943 esophagectomy patients, 63.9% suffered complications; perioperative mortality was 3.3%. Both of these figures changed little over the nearly 10 year period. The mortality rate associated with individual postoperative events is listed in Figure 1 and ranged from 6.98% for atrial arrhythmia to 38.7% for new renal failure. In univariate analysis, UTI, recurrent laryngeal nerve injury, and anastomotic leak or chyle leak requiring only medical therapy were not associated with mortality. In multivariate analysis incorporating all postoperative events, the odds ratio for death following each event was: ARDS-7.48, new renal failure-5.97, new CNS event-5.66, return to OR for bleeding-5.12, MI- 4.93, ventricular arrhythmia-4.04, return to OR for Chylothorax-2.53, sepsis-2.41, atrial arrhythmia-1.52, and return to OR for anastomotic leak-1.48 (Table 1). Incorporating preoperative comorbidities into the mortality model did not significantly change the effect of complications on mortality.

Conclusions: 64% of patients suffer complications post esophagectomy. The independent association of certain events with mortality represents an objective means of redefining complications as “major.” Once a complication occurs, preoperative comorbidities have little effect on mortality. Understanding the incidence of complications and their association with mortality is critical to improving outcomes.



Complications	Mortality Risk: Complications Only (Model 1)	P-value	Mortality Risk: Complications and Preoperative Variables (Model 2)	P-value
ARDS	7.48 (5.23,10.7)	<.0001	8.17 (5.61,11.9)	<.0001
Reintubation	6.55 (4.61,9.30)	<.0001	6.39 (4.50,9.06)	<.0001
New cases Renal Failure	5.97 (4.08,8.75)	<.0001	6.18 (4.20,9.09)	<.0001
New Central Neurological Event	5.66 (2.53,12.6)	<.0001	4.79 (2.05,11.2)	0.0003
Return to OR: Bleeding	5.12 (2.48,10.6)	<.0001	4.63 (2.22,9.68)	<.0001
Myocardial Infarction	4.93 (2.34,10.4)	<.0001	4.71 (2.26,9.80)	<.0001
Ventricular Arrhythmia	4.04 (2.26,7.23)	<.0001	4.02 (2.32,6.98)	<.0001
Return to OR: Chylothorax requiring reoperation	2.53 (1.54,4.17)	0.0002	2.55 (1.53,4.23)	0.0003
Sepsis	2.41 (1.69,3.46)	<.0001	2.41 (1.62,3.59)	<.0001
Atrial Arrhythmia	1.52 (1.17,1.98)	0.0017	1.39 (1.06,1.82)	0.0174
Return to OR: Other causes	1.50 (1.04,2.17)	0.0315	1.54 (1.05,2.26)	0.0287
Return to OR: Anastomotic leak	1.48 (1.03,2.14)	0.0355	1.65 (1.15,2.39)	0.0069
Anastomotic Leak: Medical Therapy	0.76 (0.50,1.14)	0.1866	0.80 (0.52,1.22)	0.2959
Recurrent Laryngeal nerve paresis	0.71 (0.30,1.70)	0.4464	0.67 (0.27,1.66)	0.3897
Delirium	0.81 (0.59,1.13)	0.2141	0.77 (0.56,1.06)	0.1086
Chylothorax: Medical Therapy	0.59 (0.30,1.13)	0.1130	0.55 (0.27,1.12)	0.1013
Pneumonia	1.13 (0.79,1.63)	0.5029	1.09 (0.75,1.60)	0.6483
Initial Vent. Support >48 hours	1.26 (0.85,1.87)	0.2448	1.31 (0.84,2.05)	0.2296
Pulmonary Embolus	1.49 (0.72,3.08)	0.2784	1.64 (0.78, 3.42)	0.1895
Deep Venous Thrombosis	0.81 (0.50,1.31)	0.3923	0.83 (0.51,1.34)	0.4384

2:00 PM

ABSTRACT: Impact of Goal-Directed Fluid Therapy on Minimally Invasive Esophagectomy: A Randomized, Controlled Clinical Trial

***X. Chen**, Y. Shen, L. Tan*
Zhongshan Hospital, Shanghai, China

Purpose: No consensus exists regarding the optimal fluid (crystalloid or colloid) or strategy (liberal or restricted) for fluid management in esophagectomy. The effect of goal directed fluid therapy (GDFT) on minimally invasive esophagectomy (MIE) remains unclear. The purpose of this study was to evaluate outcomes following implementation of GDFT in MIE.

Methods: In this randomized controlled trial, patients with esophageal cancer undergoing MIE were prospectively enrolled and randomly assigned to the group with standard fluid therapy (Control Group) or the group with GDFT (GDFT Group) in our high-volume center. The Control Group received a fixed-volume crystalloid regimen supplemented with replacement of blood loss with colloid, while the fluid regimen in the GDFT was shown in Figure 1. Intraoperative hemodynamic changes and postoperative adverse events were collected and compared between groups. The primary outcome was the incidence of major postoperative complications. The Surgical Apgar score (SAS) was generated for risk prediction.

Results: Between March 2015 and January 2016, a total of 110 consecutive patients were randomized, with 54 in the GDFT group and 56 in the control group. Baseline characteristics were comparable between groups. No intraoperative death occurred in either group. Patients in the GDFT group received less intraoperative crystalloid fluid (774.07±71.93 vs 2489.29±110.04, p<0.05) and more intraoperative colloid fluid (432.41±26.54 vs 53.57±20.85, p<0.05) compared to the control group. There were no significant differences in terms of SAS (7.80±0.14 vs 8.07±0.12, p=0.219) and anastomotic leakage (9.3% vs 17.9%, p=0.189) between groups, while a significant decrease in pulmonary morbidity was found in the GDFT group (5.6% vs 17.9%, p=0.046) (Table 1).

Conclusions: Goal directed, individualize intraoperative fluid management is feasible in MIE, associated with similar SAS and a tend towards lower incidence of pulmonary complications. Further studies based on larger population are required to confirm our findings.

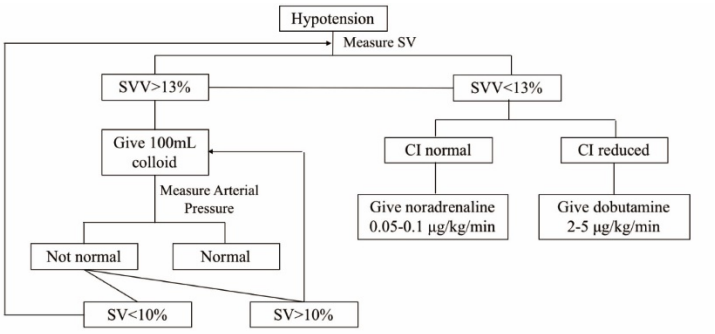


Figure 1 Goal directed fluid therapy
SV, stroke volume; SVV, stroke volume variation; CI, cardiac index.

Table 1 Patient's clinical features and outcomes

Feature	GDFT (n=54)	Control (n=56)	*p* value
Pre-operation			
Age, y	61.5±6.8	63.0±7.4	0.288 †
Male/female ratio	40:14	48:8	0.127 *
BMI	23.37±2.84	23.32±2.93	0.919 †
Albumin, g/L	41.1±2.9	40.5±2.5	0.279 †
ASA(Ⅰ : Ⅱ)	33:21	42:14	0.118 ‡
Stage(Ⅰ : Ⅱ :Ⅲ)	18:25:11	15:31:10	0.726 ‡
Peri-operation			
Crystalloid infusion, mL	774.07±71.93	2489.29±110.04	<0.05 ‡
Colloid infusion, mL	432.41±26.54	53.57±20.85	<0.05 ‡
SAS, points	7.80±0.14	8.07±0.12	0.219 †
Post-operation			
Pulmonary complications	3	10	0.046 *
Anastomotic leakage	5	10	0.189 *

Data are given as mean ± SD unless otherwise indicated.

BMI, body mass index; ASA, American Society of Anesthesiologists; SAS, Surgical Apgar Score.

* By Chi-square test ; † By Student t test ; ‡ By Mann–Whitney test.

2:15 PM

ABSTRACT: Causes, Risk Factors, and Costs Associated With 30-Day Readmissions Following Esophagectomy: An Analysis of the Nationwide Readmission Database

N. J. Goel[1]*, A. Iyengar*[1]*, J. J. Kelly*[2]*, C. D. Mavroudis*[2]*, C. W. Lancaster*[1]*, N. N. Williams*[1]*, D. Dempsey*[1]*, J. C. Kucharczuk*[2]
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Purpose: Postsurgical readmissions are an increasingly scrutinized marker of healthcare quality. Previous reports on readmissions following esophagectomy are limited by databases constrained to index hospital data or Medicare-only populations [1,2]. We sought to estimate the rate, risk factors, and costs associated with readmissions following esophagectomy in a large, nationally-representative cohort.

Methods: We studied adult patients from the Nationwide Readmissions Database undergoing transhiatal and transthoracic esophagectomy from 2010 to 2014. Estimates of hospital cost were made by converting individual hospital charge data and adjusting to 2014 consumer price indices. Data was collected on the prevalence and indications for readmission within 30 days as well as the hospital-, procedure-, and patient-level risk factors as determined by multivariable logistic regression.

Results: Among 16,364 cases, the rate of 30-day readmission was 19.8%, with the most common indications for readmission being pulmonary (20.5%) and gastrointestinal complications (19.6%). Mean cost of readmission was $20,358, and pulmonary complications accounted for 31.0% of all costs. Readmissions to non-index hospitals accounted for 21.5% of all readmissions, and costs of readmission were on average $4,112 less than readmission to an index hospital. Independent risk factors for readmission on multivariable analysis included perioperative blood transfusion (AOR=1.34 [1.11-1.61], p=0.002), length of hospital stay >10 days (AOR=1.47 [1.25-1.73], p<0.001), discharge to a nursing facility (AOR=1.52 [1.21-1.92], p=0.001), high illness severity based on All Patients Refined Diagnosis Related Groups (APRDRG) scoring (AOR=1.59 [1.29-1.96], p<0.001), chronic renal failure (AOR=1.42 [1.06-1.91], p=0.019), and comorbid drug abuse (AOR=1.80 [1.01-3.21], p=0.047). Importantly, operative approach (transhiatal vs. transthoracic), hospital esophagectomy volume, and hospital size/status were not associated with 30-day readmissions.

Conclusions: One in five patients undergoing esophagectomy are readmitted within 30-days of discharge. Readmissions to non-index hospitals account for a significant portion of readmissions, while traditional volume-outcome relationships are not observed. Further characterization of readmissions may help significantly improve the quality of care associated with esophagectomy.

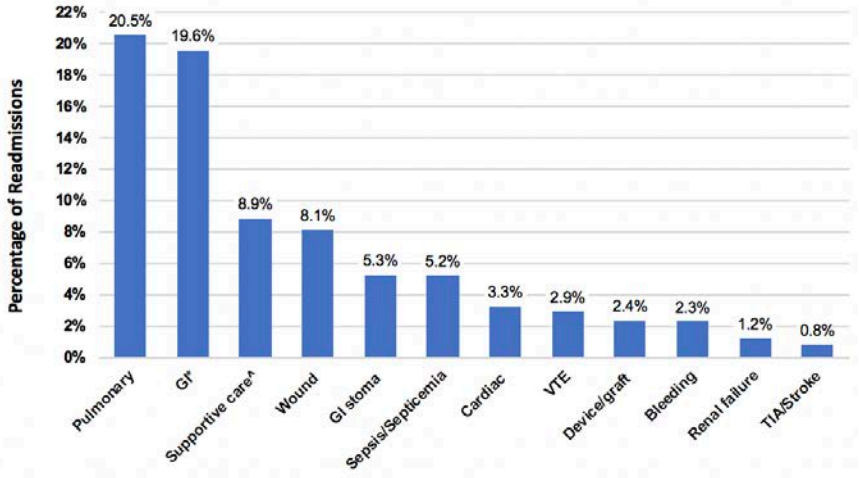


Figure 2. Relative incidence of the causes of 30-day readmission following esophagectomy

*Gastrointestinal tract bleeding is considered a "Bleeding" complication rather than a GI complication
^Supportive care refers to interventions addressing vomiting, dehydration, postoperative pain, poor nutrition, or other non-specific patient complaints

Table 3. Multivariate analysis of factors associated with 30-Day readmission

Variable	OR	95% CI	P-value
Age over 65	1.00	0.80–1.25	0.98
Payer			
Private	Ref.	--	--
Medicare	1.01	0.81–1.26	0.94
Medicaid	1.01	0.76–1.36	0.93
Other	1.02	0.71–1.45	0.92
Disposition			
Home (self-care)	Ref.	--	--
Home with home health care	1.17	0.99–1.40	0.07
Nursing facility	1.52	1.20–1.92	0.001
Short-term hospital	0.90	0.54–1.51	0.70
AMA	3.34	0.99–11.25	0.052
Teaching hospital	1.02	0.85–1.24	0.80
Hospital LOS >10 days	1.47	1.25–1.74	<0.001
Blood transfusion	1.34	1.11–1.61	0.002
Congestive heart failure	0.92	0.68–1.25	0.61
Chronic pulmonary disease	1.01	0.84–1.22	0.89
Coagulopathy	1.15	0.86–1.54	0.34
Drug abuse	1.80	1.01–3.21	0.047
Fluid and electrolyte disorders	0.98	0.83–1.17	0.84
Peripheral vascular disorders	1.27	0.93–1.74	0.13
Chronic renal failure	1.42	1.06–1.91	0.019
Weight loss	0.91	0.76–1.09	0.29
≥3 Elixhauser comorbidities	1.19	0.99–1.44	0.063
APRDRG severity scale			
Minor/Moderate loss of function	Ref.	--	--
Major/Extreme loss of function	1.59	1.29–1.96	< 0.001

2:30 PM
DEBATE: Is Post-Esophagectomy Cancer Survivorship Surveillance Necessary?
Yes: *Wayne L. Hofstetter, Houston, TX*
No: *Andrew C. Chang, Ann Arbor, MI*

1:00 PM – 5:00 PM

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

This session will prepare congenital and pediatric cardiac surgeons to better master challenging operative scenarios such as complex atrioventricular valve disease and complex biventricular repairs. Attendees also will be exposed to emerging technologies and unique approaches to help them better surgically manage heart failure, mechanical support, and cardiac transplantation. Experts will share their experiences as they mastered these complex operative interventions.

Learning Objectives

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

- Detail 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 they may not commonly see in clinical practice

Moderators: *S. Adil Husain, Salt Lake City, UT, and James D. St. Louis, Kansas City, MO*

Session I: Repair of Complete Atrioventricular Septal Defect (ASD)

1:00 PM **Two-Patch Technique**
William I. Douglas, Kansas City, MO

1:10 PM **Modified Single-Patch Technique**
Osama Eltayeb, Chicago, IL

1:20 PM **Repair of ASDs/Tetralogy of Fallot**
Glen S. Van Arsdell, Los Angeles, CA

1:30 PM **Panel Discussion**

Session II: Coronary Implantation Techniques in Complex Congenital Heart Defects

1:50 PM **Anomalous Aortic Origin of the Coronary Artery**
James Jaggers, Aurora, CO

2:00 PM **Anomalous Left Coronary Artery Off the Pulmonary Artery**
Ali Dodge-Khatami, Jackson, MS

2:10 PM **Transposition of Great Vessels With a Single Coronary Artery**
Mark D. Plunkett, Peoria, IL

2:20 PM **Panel Discussion**

2:45 PM **Break**

Session III: Cardiac Transplantation and Mechanical Circulatory Support

3:15 PM **Anticoagulation Strategies in Patients With Ventricular Assist Devices**
Lindsay May, Salt Lake City, UT

3:25 PM **Mechanical Assist Devices in the Functional Single Ventricle Anatomy**
David L. Morales, Cincinnati, OH

3:35 PM **Complex Transplantation in Functional Single Ventricle Anatomy**
Kirk R. Kanter, Atlanta, GA

3:45 PM **Panel Discussion**

Session IV: Complex Neonatal Repair

4:05 PM **Complete Repair of Dextro-Transposition of the Great Arteries With Severe Arch Obstruction and Ventricular Septal Defect**
James S. Tweddell, Cincinnati, OH

4:15 PM **Primary Sutureless Repair of Total Anomalous Pulmonary Venous Connection**
Christopher A. Caldarone, Toronto, Canada

4:25 PM **Technical Variations With the Modified Norwood Procedure**
Jennifer C. Romano, Ann Arbor, MI

4:35 PM **Panel Discussion**

1:00 PM – 5:00 PM

How-To Video Session: General Thoracic

This session will focus on the technical strategies to incorporate minimally invasive techniques such as video-assisted thoracoscopic surgery (VATS) and robotics for the performance of increasingly complicated general thoracic procedures, namely segmentectomy, esophagectomy, and thymectomy. Technical strategies and avoidance of pitfalls will be highlighted.

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

- Explain how to perform a segmentectomy
- Describe the segmental anatomy of the lung
- Describe how to approach thymectomy/thymoma with minimally invasive techniques
- Identify minimally invasive options in the management of large thymomas
- Demonstrate how to perform a minimally invasive/robotic esophagectomy
- Recognize how to avoid pitfalls in esophagectomy

1:00 PM **Introduction**

Esophageal

Moderators: *Virginia R. Litle, Boston, MA, and M. Blair Marshall, Washington, DC*

1:05 PM **Strategies in the Management of Celiac Nodal Disease Following Neoadjuvant Treatment**
Gail E. Darling, Toronto, Canada

1:17 PM **Avoiding Pitfalls During Robotic Esophagostomy**
Kemp H. Kernstine, Dallas, TX

1:29 PM **Creating the Optimal Conduit**
Christopher R. Morse, Boston, MA

1:41 PM **Avoiding Anastomotic Leaks**
M. Blair Marshall, Washington, DC

1:53 PM **Discussion**

Segments

Moderators: *Linda W. Martin, Charlottesville, VA, and Betty C. Tong, Durham, NC*

2:18 PM **Anatomy/Segment Nomenclature (Boyden System)**
Linda W. Martin, Charlottesville, VA

2:30 PM **Tips and Tricks for Identifying Nodules, Bronchial, and Vascular Anatomy During Minimally Invasive Segmentectomy**
Shanda H. Blackmon, Rochester, MN

2:42 PM **When to Abandon the Segment for Lobectomy**
Nirmal K. Veeramachaneni, Kansas City, KS

2:54 PM **Tips and Tricks for the Less Common, More Difficult Segmentectomies—Basilar, Right Upper Lobe, and Lingual-Sparing Left Upper Lobe Segmentectomies (Robotic and/or VATS)**
Betty C. Tong, Durham, NC

3:06 PM **Unusual Anatomy/Anatomic Variants and How to Handle Them During Minimally Invasive Segmentectomy**
Thomas A. D'Amico, Durham, NC

3:18 PM **Discussion**

Mediastinum

Moderators: *James Huang, New York, NY, and Robert E. Merritt, Columbus, OH*

3:43 PM **Thoracoscopic Thymectomy for Non-Thymomatous Myasthenia Gravis**
Joshua R. Sonett, New York, NY

3:55 PM **Robotic-Assisted Thymectomy for Non-Thymomatous Myasthenia Gravis**
Inderpal S. Sarkaria, Pittsburgh, PA

4:07 PM **Thoracoscopic Excision of a Large Thymoma**
Michael J. Weyant, Aurora, CO

4:19 PM **Robotic-Assisted Excision of a Large Thymoma**
Valerie W. Rusch, New York, NY

4:31 PM **Discussion**

1:00 PM – 5:00 PM
"My Tube" Adult Cardiac How-To Video Session

This session will provide technical tips that attendees can immediately implement in their practices. Videos featuring common cases in heart failure surgery, coronary disease, valvular disease, and aortic/great vessel disease will be presented with a focus on new technologies and alternative approaches.

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

- Explain the technical aspects of complex operations commonly performed in adult cardiac surgery, with specific emphasis in the fields of structural heart disease, coronary arterial disease, aortic pathology, and heart failure
- Discuss the pitfalls of critical steps in complex cardiac surgery
- Identify novel tricks to make cardiac operations easier, safer, and more reproducible

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

1:00 PM **MitraClip**
Tsuyoshi K. Kaneko, Boston, MA

1:12 PM **Transapical NeoChord for Mitral Valve Repair**
James S. Gammie, Stevenson, MD

1:24 PM **Transseptal Mitral/Tricuspid Valve Repair With or Without Atrial Fibrillation Surgery**
Richard Lee, St Louis, MO

1:36 PM **Sutureless Aortic Valve Replacement**
Douglas R. Johnston, Cleveland, OH

1:48 PM **Transapical Myectomy**
Hartzell V. Schaff, Rochester, MN

2:00 PM **Aortic Valve Repair for Aortic Insufficiency**
J. Scott Rankin, Morgantown, WV

2:12 PM **Ventricular Septal Defect Repair**
Leora T. Yarboro, Charlottesville, VA

2:24 PM **Total Arterial Revascularization**
Joseph F. Sabik III, Cleveland, OH

2:36 PM **Completely Robotic Coronary Artery Bypass Grafting**
Husam H. Balkhy, Chicago, IL

2:48 PM **Break**

3:00 PM **Emerging Endovascular Approaches for Aortic Arch Repair**
Ali Khoynezhad, Long Beach, CA

3:12 PM **Failed Homograft: Aortic Root Replacement**
Ibrahim Sultan, Pittsburgh, PA

3:24 PM **Managing Descending Thoracic Aneurysm After Previous Dissection**
Joseph S. Coselli, Houston, TX

3:36 PM **Commando/Hemi-Commando for Infective Endocarditis**
Jose L. Navia, Cleveland, OH

3:48 PM **Aortic Root Enlargement**
Juan A. Crestanello, Rochester, MN

4:00 PM **Addressing Malperfusion First in Type A Dissections**
Himanshu J. Patel, Ann Arbor, MI

4:12 PM **Durable Right Ventricular Assist Device Implantation**
Carmelo A. Milano, Durham, NC

4:24 PM **Extracorporeal Membrane Oxygenation With Left Ventricle Venting Strategies**
Bryan A. Whitson, Columbus, OH

4:36 PM **Axillary Intraaortic Balloon Pump**
Val Jeevanandam, Chicago, IL

4:48 PM **Minimally Invasive HeartMate III**
Igor Gosev, Rochester, NY

1:00 PM – 5:00 PM

Patient Safety Symposium: Innovation and Safety in the Digital Era—From EHRs to Cybersecurity

When building a "culture of safety," one often thinks of the leadership and organizational aspects (eg, teamwork training, blame-free environment, medication errors, and root cause analysis). But digital innovations such as electronic health records (EHRs) and cybersecurity are having a growing impact on patient safety. EHRs have generated challenges for providers, specifically in regard to the user interface and availability of performance metrics. Also relevant is hospital cybersecurity as it relates to patient privacy and medical equipment/device security. Cardiothoracic surgeons and all those working in the field need to better understand the current state and future of telehealth in the health care spectrum.

Learning Objectives

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

- Explain the effect of EHRs on patient safety, performance metrics, and health care delivery
- Discuss the current status and future of cybersecurity, patient privacy, and safety in health care
- Describe the effectiveness and limitations of telehealth/telemedicine now and in the future

Moderators: *Steven D. Harrington, Clinton Township, MI, and Garrett L. Walsh, Houston, TX*

1:00 PM	**Introduction**
1:10 PM	**Technological Innovation and Medicine: Where Are We Going?** *Anthony Chang, Orange, CA*
1:45 PM	**Cybersecurity or Cyber-Insecurity** *John Frenzel, Houston, TX*
2:20 PM	**Performance Metrics: Do They Help or Hurt?** *Jeffrey B. Rich, Cleveland, OH*
2:55 PM	**Break**
3:10 PM	**Electronic Health Records: The Good and the Bad** *J. Michael DiMaio, Dallas, TX*
3:45 PM	**Telehealth in Surgery: Now and the Future** *Kevin W. Lobdell, Charlotte, NC*
4:20 PM	**Panel Discussion**

Long-Term Outcomes of Porcine vs Bovine Pericardial Mitral Valve Replacements: 17-Year Follow-Up of 940 Implantations

T. J. Beute[1], *M. R. Goehler*[2], *J. L. Parker*[2], *T. J. Boeve*[2], *J. C. Heiser*[2], *E. T. Murphy*[2], *T. Timek*[2], *C. L. Willekes*[2]
[1]*Michigan State University, Grand Rapids,* [2]*Spectrum Health, Grand Rapids, MI*

Purpose: The object of this study was to compare the long-term outcomes of porcine mitral valves to bovine pericardial mitral valves.

Methods: From 2001 through 2017 at a single institution, 940 patients received a mitral bioprosthesis of which 463 (49.3%) were porcine and 477 (50.7%) were bovine pericardial. Retrospective review of the procedure and post-operative clinical course, including follow-up echocardiography through August 2018 were analyzed. All consecutive mitral valve replacements over the 16 year study period were included. Follow-up was 98.8% (929 patients) complete for a total of 8,543.6 patient years with a mean of 9.1 years.

Results: Operative mortality was 5.54% (n=51) and incidence of postoperative stroke 2.8% (n=20). Overall survival at 10 and 15 years was 50.5% (95%CI: 46.6, 54.3) and 27.6% (22.5, 32.8), respectively. Preoperative characteristics between porcine and pericardial valves were similar including mean age 68 versus 67. Survival at 10 and 15 years was 49.4% (44.1, 54.5) and 28.0% (22.2, 34.0) for porcine valves and 51.3% (45.5, 56.9) and 23.6% (12.2, 37.2) for pericardial valves. Overall freedom from reoperation for structural valve deterioration (SVD) at 10 and 15 years for porcine valves was 97.3% (94.8,98.6) and 90.1% (85.7, 93.2) versus pericardial valves 88.5% (84.1, 91.7) and 81.0% (71.6, 87.5) which was significant (p-value=0.0002). Comparison by age < 65 versus > 65 years demonstrated better freedom from SVD in those > 65 years (Table 1). Overall average time to reoperation for SVD for porcine valves was 119 months versus 83 months for bovine pericardial valves (p-value<0.0001).

Conclusions: In our experience, bovine pericardial mitral valve replacements have significantly earlier structural valve deterioration than porcine mitral valves, especially in younger patients.

Image 1: Overall freedom from reoperation for SVD by valve type.

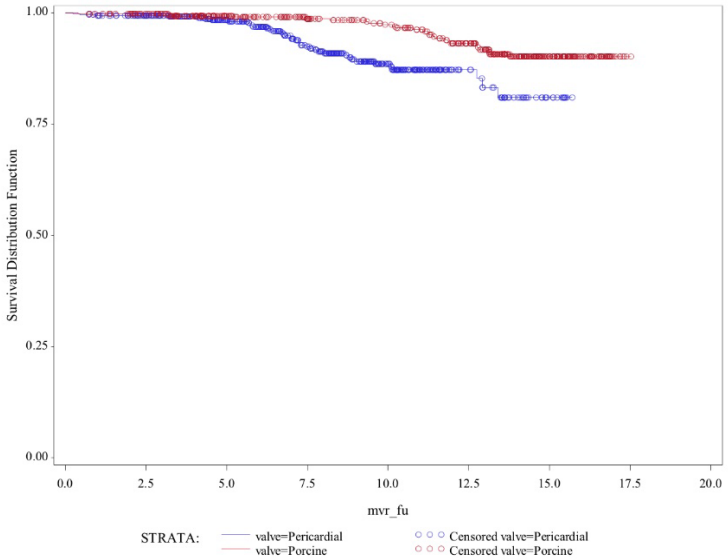


Table 1: Freedom from reoperation for SVD in porcine versus pericardial mitral valves by age <65 versus ≥ 65 years.

	Porcine <65 years	Pericardial <65 years	P-Value
10 Years	92.6 (84.7, 96.5)	76.5 (66.3, 83.9)	0.0034
15 Years	77.3 (65.5, 85.5)	51.9 (29.6, 70.2)	0.0034
	Porcine ≥65 years	Pericardial ≥65 years	P-Value
10 Years	99.2 (96.7, 99.8)	94.4 (91.1, 97.4)	0.0656
15 Years	94.9 (90.3, 97.4)	94.4 (91.1, 97.4)	0.0656

Freedom from reoperation listed as a percentage, with (95% CI). SVD = structural valve deterioration.

Minimally Invasive Bicuspid Aortic Valve Repair Using Geometric Ring Annuloplasty

***V. Badhwar**, T. Murashita, J. S. Rankin, L. Wei*
West Virginia University, Morgantown

Purpose: Minimally invasive incisions for aortic valve procedures are becoming more common, but aortic valve reconstruction requiring root mobilization can be difficult through limited incisions. This video illustrates bicuspid aortic valve (BAV) repair using an internal geometric annuloplasty ring, as a simplification to current techniques.

Methods: The patient is a 51-year-old male with CCS Class II congestive heart failure, a Sievers Type 1 BAV, right-left commissural fusion, severe aortic insufficiency, and deteriorating left ventricular function. Echocardiography shows a Type 1 BAV, with a large non-coronary/non-fused cusp, right-left fusion, minimal coaptation height, and severe posteriorly eccentric AI. Using a third-interspace upper mini-sternotomy and femoral cannulation, a circular aortotomy is made 1 cm above the commissural tops. The annulus sizes to 27 mm, and the non-fused, non-coronary cusp sizes to a 21-mm bicuspid ring, with a large non-coronary cusp and a large dysplastic cleft in the right-left commissure.

Results: A 21-mm bicuspid ring is selected, and the two 180° posts are sutured to the sub-commissural triangles using Cabrol-like horizontal mattress sutures. Three looping annular mattress sutures are placed in the non-fused annulus, and four in the fused annulus (two on either side of the raphe). All nine sutures are tied over small Dacron pledgets, and the knot towers are fixed laterally to prevent leaflet contact. Both leaflets are moved centrally by the annuloplasty ring, but the leaflets still prolapse. Two 6-0 Prolene perinodular plication sutures are placed in the non-coronary leaflet, raising it to a reference effective height of 8-10 mm. Using 5-0 Prolene simple sutures, the fused leaflet cleft is closed from its apex to the leaflet free-edge, raising the fused leaflet to the same effective height and length. Post-repair echo shows good leaflet mobility and opening, no residual leak, and a mean valve gradient of 10 mmHg.

Conclusions: Minimally invasive mini-sternotomy is safe and provides excellent exposure for BAV repair. Aortic ring annuloplasty is simple and facilitates minimally invasive approaches. Converting to minimal access aortic valve repair could reduce morbidity and improve patient satisfaction.

Role of Anti-Inflammatory Medications in Preventing Postoperative Atrial Fibrillation

***T. Watt**[1], A. A. Brescia[1], S. L. Murray[1], K. C. Kleeman[1], A. M. Wisniewski[2], D. A. Burn[3], S. F. Bolling[1]*
[1]University of Michigan Health System, Ann Arbor, [2]University of Toledo, OH, [3]Quinnipiac University, Hamden, CT

Purpose: Postoperative atrial fibrillation (POAF) affects up to 50% of cardiac surgery patients, contributing to cost, morbidity, and mortality. Recent implications of oxidative stress and inflammation in development of POAF substantiate the need to identify protectors against POAF. This study investigates the role of preoperative anti-inflammatory medications in preventing POAF.

Methods: This retrospective study included 2,264 adult patients naïve to atrial fibrillation who underwent elective cardiac surgery between January 2014 and March 2017. Patient preoperative medication regimens, disease physiology, comorbidities, intraoperative factors, and postoperative outcomes were recorded. Patients were categorized into POAF and non-POAF groups. The impact of preoperative medications and disease physiology on development of POAF was evaluated using a Pearson Chi-Squared Goodness-of-Fit analysis for association, comparing the POAF rate with each exposure to the total POAF rate for the entire cohort.

Results: In this patient cohort (mean age 60 years) the overall POAF rate was 30% (669/2264) after cardiac surgery. Notably, patients taking colchicine preoperatively were found to have a significantly lower POAF rate at 9% (2/23, p=0.029). No other preoperative medications, including beta blockers, ACE inhibitors, antiarrhythmics, potassium, calcium, magnesium, montelukast, albuterol, and statins were found to have a significant impact on POAF rate. Importantly, no other anti-inflammatory or antioxidant medications, such as NSAIDs, steroids, fish oil, vitamin C, vitamin E, and coenzyme Q10 prevented POAF. As expected, individual predictors of POAF were congestive heart failure with POAF rate 35% (119/340, p=0.041) and a calcified mitral annulus with POAF rate 36% (82/224, p=0.028). Other comorbidities had no significant impact on development of POAF.

Conclusions: This study found preoperative colchicine to be protective against POAF after cardiac surgery, while other anti-inflammatory and antioxidant medications were not preventative. Colchicine specifically targets nuclear factor-kappa B (NF-kB), a pro-inflammatory transcription factor which is up-regulated in atrial fibrillation. Accordingly, colchicine and other NF-kB-targeted agents warrant further investigation for POAF.

Preoperative Medication	All Patients n=2264	Non-POAF n=1595 (70.5%)	POAF n=669 (29.5%)	p-value$^{\Delta}$
Beta blocker	1235 (54.5%)	854 (69.1%)	381 (30.9%)	0.422
ACE inhibitor	654 (28.9%)	447 (68.3%)	207 (31.7%)	0.302
Antiarrhythmic	120 (5.3%)	82 (68.3%)	38 (31.7%)	0.621
NSAID	1110 (49%)	759 (68.4%)	351 (31.6%)	0.218
Steroid	132 (5.8%)	96 (72.7%)	36 (27.3%)	0.577
Montelukast	56 (2.5%)	35 (62.5%)	21 (37.5%)	0.199
Albuterol	234 (10.3%)	166 (70.9%)	68 (29.1%)	0.876
Colchicine	23 (1.0%)	21 (91.3%)	2 (8.7%)	**0.029***
Statin	1050 (46.4%)	738 (70.3%)	312 (29.7%)	0.923
Fish oil	267 (11.8%)	175 (65.5%)	92 (34.5%)	0.098
Potassium	502 (22.2%)	356 (70.9%)	146 (29.1%)	0.836
Calcium	506 (22.3%)	357 (70.6%)	149 (29.4%)	0.963
Vitamin C	513 (22.7%)	346 (67.4%)	167 (32.6%)	0.180
Vitamin E	355 (15.7%)	240 (67.6%)	115 (32.4%)	0.277
Magnesium	407 (18.0%)	288 (70.8%)	119 (29.2%)	0.899
Coenzyme Q10	109 (4.8%)	68 (62.4%)	41 (37.6%)	0.072

$^{\Delta}$p-values compare POAF rate with each exposure to total POAF rate for the entire cohort

Incidence, Resource Utilization, and Predictors of 30-Day Readmission Following Surgical Aortic Valve Replacement: Insights From the Nationwide Readmission Database 2010-2015

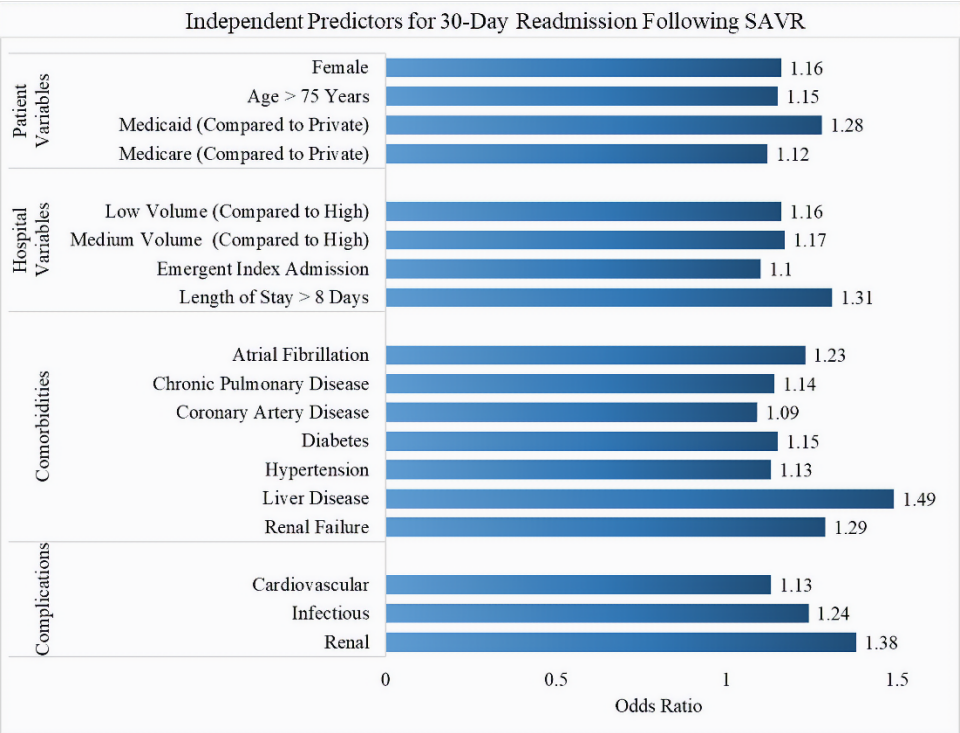
***H. Khoury**, Y. Sanaiha, S. E. Rudasill, A. L. Mardock, H. Xing, R. J. Shemin, P. Benharash*
University of California, Los Angeles

Purpose: Readmission reduction remains a national priority in improving quality of care and reducing healthcare expenditure. Although readmission rates following surgical aortic valve replacement (SAVR) have been previously reported to be frequent, risk factors and resource use related to such rehospitalizations have not been characterized thus far.

Methods: The Nationwide Readmissions Database (NRD) representative of all US hospitalizations, was used to identify all adult patients undergoing SAVR between 2010-2015. Patients with index hospitalization mortality, endocarditis, prior cardiac surgery and concurrent procedures were excluded from the study. Incidence, baseline patient and hospital characteristics, causes, costs, and length of stay were analyzed. Hospitals were stratified based on annual SAVR case volume into low, medium, and high volume tertiles. A multivariable logistic regression was used to identify independent predictors of readmission within 30 days of index hospital discharge.

Results: Of an estimated 136,051 SAVR patients, 18,631 (13.7%) were readmitted to the hospital within 30 days of discharge. Readmitted patients were more commonly female (47.4 vs. 41.6%, P<0.001), older (70.4 vs. 68.3 years, P<0.001), and had a higher Elixhauser comorbidity index (5.4 vs. 4.8, P<0.001), rates of overall postoperative complications (44.0 vs. 37.3%, P<0.001), and longer lengths of index stay (10.9 vs. 8.5 days, P<0.001). The mean cost of readmission was $13,426, accounting for an average annual economic burden of $41,689,968. Female gender, age > 75 years, emergent index admission, length of stay > 8 days, Medicare and Medicaid insurance, and low or medium SAVR hospital volume were identified as independent predictors of readmission (Figure). 49.1% of readmission were related to cardiac causes, of which heart failure (13.2%), and arrhythmias (12.5%) were the single most common causes.

Conclusions: In this national study, 30-day readmission following SAVR was frequent and costly to the healthcare system. Baseline comorbidities, low SAVR hospital volume, and postoperative complications were identified as risk factors for readmission. Enhanced management of modifiable risk factors and optimized discharge follow-up algorithms may decrease readmissions and costs.



Abrupt Increase in Structural Valve Degeneration of a First-Generation Aortic Valve Bioprosthesis

S. Fukuhara[1], *H. J. Patel*[2], *B. Yang*[3], *K. M. Kim*[4], *J. W. Haft*[4], *P. C. Tang*[1], *S. F. Bolling*[2], *F. D. Pagani*[2], *S. Chetcuti*[4], *M. Grossman*[4], *R. L. Prager*[2], *G. Deeb*[4]

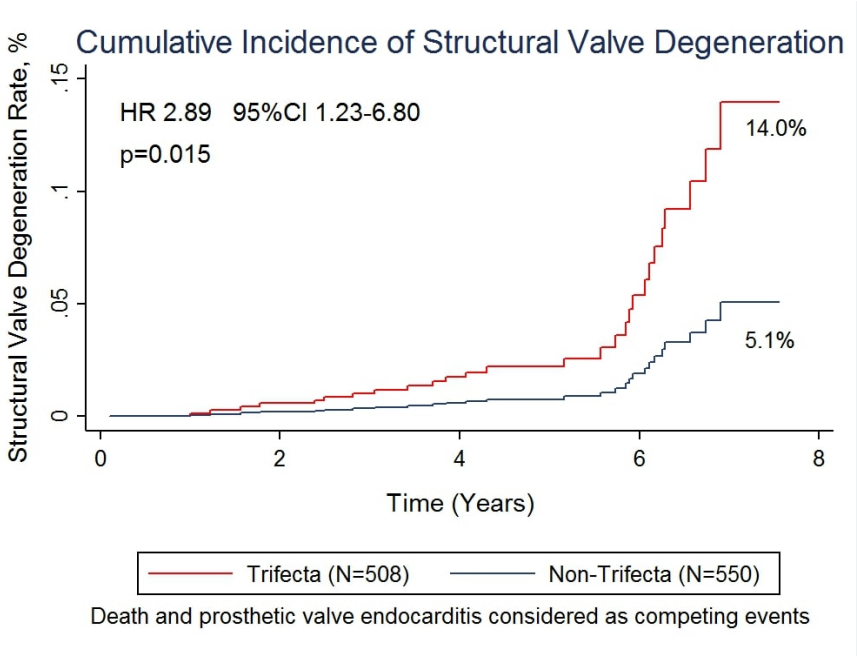
[1]University of Michigan Frankel Cardiovascular Center, Ann Arbor, [2]Michigan Medicine, Ann Arbor, [3]University of Michigan/Michigan Medicine, Ann Arbor, [4]University of Michigan, Ann Arbor

Purpose: Structural valve degeneration (SVD) represents major limitation of use of bioprothesis. We recently observed an apparent increase in the rate of SVD of the Trifecta valve. We investigated the occurrence of SVD in patients who received a stented bioprosthetic aortic valve.

Methods: We retrospectively reviewed 1058 consecutive patients who underwent aortic valve replacement with a stented bioprosthesis between January 2011 and December 2015. A total of eight surgeons performed these procedures. Patients were grouped into Trifecta Group (508 [48.0%]) and non-Trifecta Group (550 [52.0%]).

Results: Patients in the Trifecta group were older (69.7 VS 64.6, p=0.001), were more likely to be male (40.4 VS 28.0%, p=0.001), more often had aortic stenosis (AS) pathology (85.1 VS 77.1%, p=0.001) and received smaller size valve (23.7 VS 24.5 mm, P<0.001) than did patients in the non-Trifecta group. SVD occurred in 28 patients (Trifecta;n=20, Non-Trifecta;n=8) within 7 years. Aortic insufficiency (AI) or mixed AS/AI was observed as the mode of failure in 50% of Trifecta group, whereas only one (12.5%) in non-Trifecta group. The cumulative incidence of SVD was higher in the Trifecta group both in the entire (14.0 VS 5.1%, p=0.015) and the younger cohort (29.0 VS 8.5%, p=0.009) with a notable abrupt increase between 5 and 7 years (Figure 1). Multivariable competing risks regression among the Trifecta patients revealed that younger age (HR:0.94 per 10-point decrease, 95%CI:0.89-0.99, p=0.027) and female (HR1.28, 95% CI:1.05-1.57, p=0.017) to be a contributor to SVD.

Conclusions: We just have noticed the unexpectedly high SVD rate of the Trifecta valve at our center, as compared with other stented bioprosthesis, particularly in female and younger patients. Further investigation with larger sample size may be necessary to assess the longevity of the externally mounted bioprosthesis.



Influence of Age on Longevity of a Stentless Bioprothesis Valve

*A. M. Malik[1], L. Farhat[2], A. Makkinejad[3], E. L. Norton[4], M. Sareini[5], E. C. St. Pierre[3], X. Wu[2], J. W. Haft[3], M. A. Romano[2], R. L. Prager[2], K. M. Kim[3], H. J. Patel[2], G. Deeb[3], **B. Yang**[6]*

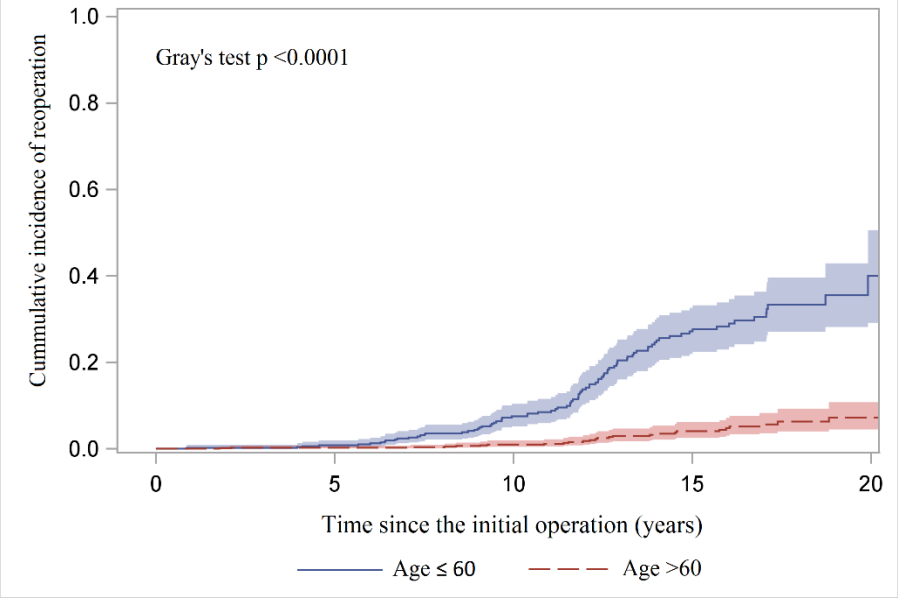
[1]University of Michigan School of Medicine, Ann Arbor, [2]Michigan Medicine, Ann Arbor, [3]University of Michigan, Ann Arbor, [4]Creighton University School of Medicine, Omaha, NE, [5]Wayne State University School of Medicine, Detroit, MI, [6]University of Michigan/Michigan Medicine, Ann Arbor

Purpose: The longevity of a stentless valve in a younger population (< 60 years old) is unknown. We hypothesized that younger age has an adverse effect on the longevity of stentless bioprosthetic valves.

Methods: From 1992-2015, 1947 patients underwent a primary AVR or ARR for aortic stenosis, insufficiency or root aneurysm with a stentless valve as a subcoronary implantation (12, 0.62%), modified inclusion/inclusion (1812, 93%) or total root (60, 3.1%) replacement. Patients with active infective endocarditis were excluded. Age was treated as a dichotomized variable (28 (1.4%) 20-30 years; 90 (4.6%) 31-40 years; 204 (10.5%) 41-50 years; 353 (18.1%) 51-60 years; 574 (29.5%) 61-70 years; 537 (27.6%) 71-80 years; and 161 (8.3%) > 80 years). These data was obtained through chart review, administered surveys and the national death index.

Results: Thirty-day mortality was 2.6%. (Table) During follow up, 815 (42%) of patients died before reoperation, 1019 (52%) were alive without reoperations due to deterioration and 113 patients (5.8%) underwent reoperation for valve deterioration (SAVR and TAVR). After adjusting death as competing risk, the accumulated incidence of reoperation was significantly higher in patients $\leq$ 60 years old compared to patients older than 60 at 10 and 15 years. (7.8% vs. 1.1% and 27.7% vs 4.4%, respectively, p<0.0001) (Figure). Among the patients $\leq$ 60 old, there was no significant difference in reoperation risk by age cohort (20-30 vs. 31-40 vs. 41-50 vs. 51-60). Among patients >60 years old, the risk of reoperation significantly decreased in the older cohort (61-70 vs. >70). The hazard ratio of reoperation for $\leq$ 60 to >60 years was 5.1 (95%CI 3.3, 8.0), P<0.001. The 10- and 15-year survival in the whole cohort was 53% and 29%.

Conclusions: The stentless aortic root provides satisfactory durability as a conduit for aortic valve/root replacement for patients who prefer a bioprosthesis. However, it should be judiciously considered for patients younger than 60 years due to increased incidence of reoperation for structural valve deterioration.



Variable	Freestyle (n=1947)
≤60	675 (34.7)
> 60	1272 (64.3)
Hours to Extubation	10.6 (5.0, 18.8)
Re-operation for Bleeding / Tamponade	77 (3.9)
Blood Transfusion postop units	2.0 (0, 3.0)
MI	8 (0.4)
Stroke	40 (2.0)
Atrial Fibrillation	718 (36.9)
Complete Heart Block or Pacemaker	81 (4.2)
New onset Renal Failure	64 (3.3)
Hospital stay (days)	7.0 (5.0, 12.0)
30-day Mortality	51 (2.6)
In-Hospital Mortality	65 (3.3)

Long-Term Outcomes of Postoperative Renal Failure Following Aortic Valve Surgery in North America

M. Caceres, *D. P. Thibault[1], X. Ying[1], V. Badhwar[2], V. H. Thourani[3], R. J. Shemin[4]*
[1]Duke Clinical Research Institute, Durham, NC, [2]West Virginia University, Morgantown, [3]MedStar Heart and Vascular Institute, Washington, DC, [4]University of California, Los Angeles

Purpose: Postoperative renal failure (RF) carries an increased operative mortality risk in cardiac surgery. In contrast, long-term survival and progression of postoperative RF following aortic valve replacement (AVR) have remained undefined. We sought to define the long-term significance of postoperative RF following AVR.

Methods: From 2008 through 2015, data from the Society of Thoracic Surgeons (STS) database linked to claims Medicare records was extracted for AVR with or without coronary artery bypass grafting (CABG). Postoperative RF (*F* component of the *RIFLE* [**R**isk, **I**njury,**F**ailure, **L**oss of kidney function, and **E**nd-stage kidney disease] criteria) was categorized as without dialysis (RF-no-D) or with dialysis (RF-D). Operative mortality, long-term survival, and readmission for dialysis were modeled with Cox proportional regression. Candidate variables included CABG, glomerular filtration rate (GFR) expressed in mL/min/1.73 m^2, RF-no-D, RF-D, and previously validated predictors from STS risk models.

Results: Of 164727 patients who underwent AVR±CABG, postoperative RF occurred in 3.5% (5733/164727), with dialysis required in 63.3% (3627/5733). Median follow-up was 2.7 years (maximum: 8 years). RF-no-D and RF-D carried a high early (<30 days) mortality risk (hazard ratio [HR]:8.03, p<0.0001 and HR: 11.29, p<0.0001; respectively) as compared to patients without postoperative RF; however, conditional to a 90-day survival, this association largely decreased in the long-term survival analysis (HR:1.69, p<0.0001 and HR:2.42, p<0.0001, respectively). Postoperative mortality of RF-no-D was lower than for RF-D (26.5% vs 46.1%; p<0.001). Once RF developed, paradoxically, a GFR<30 was associated with a lower early (HR:0.48; p<0.0001) but a higher long-term mortality (HR:1.5;p<0.0001) compared to patients with a GFR>60. Figure 1. Table 1. Risk modeling for dialysis-related readmissions restricted to the RF-no-D group shows GFR <30 (HR:13; p<0.0001), GFR 30-60 (HR:2.47; p=0.006), and insulin-dependent diabetes (HR:1.96; p=0.001) as predictors of progression to RF-D.

Conclusions: Postoperative RF following AVR±CABG carries a high early mortality risk, however, much less pronounced in the long-term survival. Once postoperative RF develops, lower preoperative renal function does not increase early mortality, however, predicts long-term survival. Progression of postoperative RF to dialysis is strongly associated with preoperative renal function.

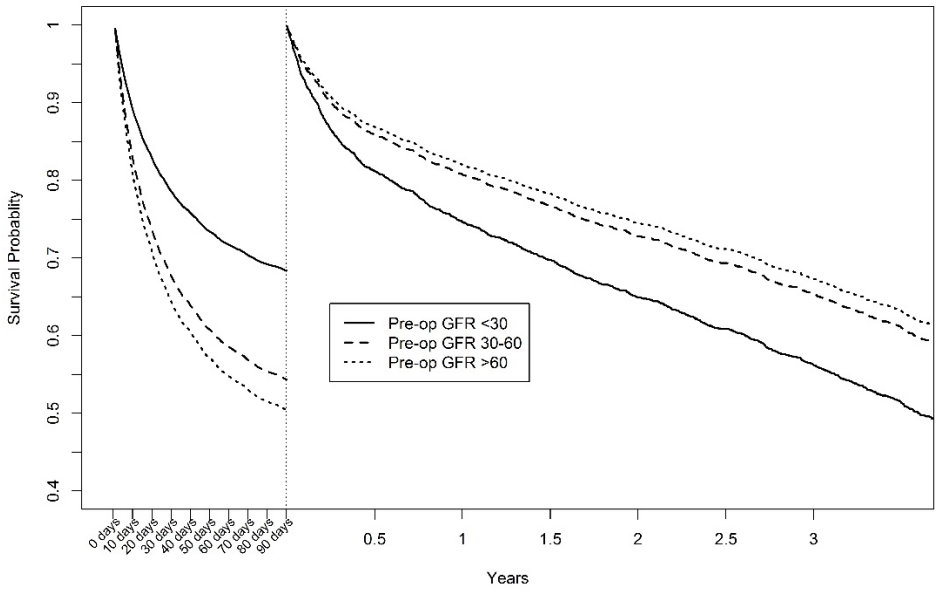


Table 1. Cox Proportional Hazards Model for early and long-term mortality restricted to patients with postoperative renal failure.

	Time Interval: 0-30 days		Time Interval: >90 days	
Variable	**AHR (95% CI)**	**P-value**	**AHR (95% CI)**	**P-value**
Preoperative GFR 30-60	0.85 (0.77-0.95)	0.0037	1.08 (0.94-1.24)	0.2772
Preoperative GFR <30	0.48 (0.41-0.56)	<.0001	1.5 (1.29-1.74)	<.0001
Postoperative dialysis	1.78 (1.58-2.01)	<.0001	1.45 (1.29-1.64)	<.0001
Concomitant CABG	1.12 (1-1.25)	0.0595	1.08 (0.93-1.24)	0.3067
Age (centered at 50)	1.03 (1-1.05)	0.0178	1.01 (0.98-1.03)	0.4906
Age (centered at 75)	0.99 (0.97-1.02)	0.6599	1.05 (1.01-1.08)	0.0084
Female	1.17 (1.02-1.35)	0.0280	1 (0.84-1.19)	0.9958
Chronic lung disease	1.04 (0.99-1.09)	0.1039	1.18 (1.12-1.24)	<.0001
Immunosuppressive treatment	1.11 (0.93, 1.33)	0.2473	1.43 (1.16-1.77)	0.0010
Atrial fibrillation	1.16 (1.03-1.29)	0.0111	1.22 (1.07-1.4)	0.0025
Peripheral vascular disease	1.07 (0.96-1.2)	0.2240	1.31 (1.15-1.49)	<.0001
Diabetes, insulin dependent	0.82 (0.71, 0.94)	0.0051	1.5 (1.27-1.76)	<.0001
Diabetes, noninsulin dependent	0.79 (0.71-0.89)	0.0001	1.18 (1.03-1.35)	0.0161
Reoperation=1	2.14 (1.23-3.73)	0.0070	0.49 (0.24-0.99)	0.0475
Reoperation≥2	2.02 (1.09-3.74)	0.0257	0.55 (0.25-1.24)	0.1500
Endocarditis, active	0.89 (0.63-1.28)	0.5433	0.63 (0.42-0.95)	0.0275
Ejection Fraction	1 (0.99-1)	0.2247	0.99 (0.98-1)	0.0045

AHR=adjusted hazard ration
CI=confidence interval
GFR=glomerular filtration rate
CABG=coronary artery bypass graft

Novel Oral Anticoagulants vs Warfarin Following Bioprosthetic Aortic Valve Replacement

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Purpose: Few studies have evaluated novel oral anticoagulants (NOACs) in patients with bioprosthetic valves, however these medications are increasingly prescribed after bioprosthetic valve replacement. We sought to evaluate the efficacy and safety of NOACs compared to warfarin when prescribed following surgical bioprosthetic aortic valve replacement (AVR).

Methods: All patients undergoing bioprosthetic AVR (2012-2018) from a single quaternary institution receiving postoperative anticoagulation were stratified by anticoagulant type (NOAC vs. warfarin). Patients were propensity matched (n=122) according to 25 preoperative and postoperative variables. The primary outcomes were time to death or thromboembolic event (including stroke, transient ischemic attack, deep venous thrombosis, and myocardial infarction) and time to major bleeding event (as defined by the International Society on Thrombosis and Hemostasis). Time to event analyses were performed with Kaplan-Meier and Cox proportional hazards for both the matched and unmatched groups.

Results: A total of 210 patients were treated with anticoagulation after bioprosthetic AVR, including 90 (42.9%) receiving a NOAC. In the unmatched cohort, warfarin patients exhibited higher STS predicted risk of mortality (3.8% vs. 2.8%, p<0.05) and greater comorbid disease. Both groups had high rates of preoperative atrial fibrillation (56.6% vs. 62.2%, p=0.42), while the NOAC group had a higher rate of postoperative atrial fibrillation (31.7% vs. 52.2%, p<0.05), potentially as the indication for use. In the unmatched cohort, the warfarin group had an increased rate of composite death and thromboembolic events with no difference in bleeding (Table and Figure). Importantly, after propensity matching, there were no differences in death, thromboembolic events, or major bleeding by either Kaplan-Meier or Cox proportional hazards analysis (Table and Figure). Furthermore, Cox regression for the entire group, controlling for propensity score, demonstrated no difference in any outcome by anticoagulant. (all p>0.05).

Conclusions: In this propensity-matched analysis, NOACs provided equivalent protection from death and thromboembolic events compared to warfarin, with no difference in major bleeding events. These data support the safety of NOACs in patients with bioprosthetic valves, while future prospective randomized trials are needed to assess efficacy.

Figure: Incidence of Death or Thromboembolic Events Over Time in Unmatched and Matched Cohorts

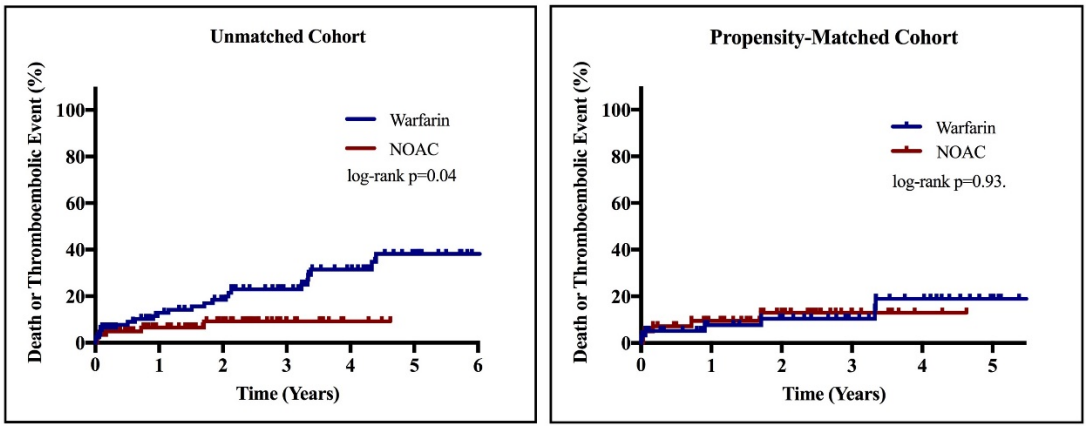

Table: One-Year Kaplan-Meier Estimate for Primary Outcomes in Unmatched and Matched Cohorts (proportion +/- SEM)

Unmatched Cohort

Outcome	Warfarin (n=120)	NOAC (N=90)	p-value (Log-Rank Test)
Death or Thromboembolic Event	12.9 ± 3.5	6.6 ± 2.9	0.0421
Death	6.9 ± 2.7	5.5 ± 2.7	0.0592
Thromboembolic Event	6.2 ± 2.5	2.6 ± 1.9	0.4783
Major Bleeding Event	4.9 ± 2.2	5.7 ± 2.5	0.55

Propensity-Matched Cohort

Outcome	Warfarin (n=61)	NOAC (N=61)	p-value (Log-Rank Test)
Death or Thromboembolic Event	7.6 ± 3.8	9.5 ± 7.1	0.9303
Death	3.5 ± 2.4	7.9 ± 3.8	0.5814
Thromboembolic Event	4.2 ± 3.0	3.9 ± 2.7	0.335
Major Bleeding Event	0 ± 0	6.7 ± 3.2	0.1853

Open Thoracoabdominal Aortic Aneurysm Repair in Patients With Genetically Triggered Aortic Disease: A Report From the GenTAC Registry

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Purpose: Although patients with various types of genetically-triggered aortopathy often require distal aortic repair, data are limited regarding the most extensive operations—open thoracoabdominal aortic aneurysm (TAAA) repairs. The objective of this multicenter registry study was to characterize TAAA repairs in a large cohort of patients with genetically-triggered aortic disease.

Methods: From the 3,671 patients enrolled in the National Heart, Lung, and Blood Institute-funded National Registry of Genetically Triggered Thoracic Aortic Aneurysms and Cardiovascular Conditions (GenTAC), we identified 155 open TAAA repairs in 142 unique patients (mean age, 42.1±13.7 years) enrolled at seven different centers from 2006 to 2014. Of these, 92 repairs (59%) were performed in men and 63 were performed in women. We examined data related to clinical characteristics, indications for operation, surgical techniques, and outcomes.

Results: The primary diagnoses included Marfan syndrome (n=84; 54%), familial thoracic aortic aneurysm and dissections (n=32; 21%), and Loeys-Dietz syndrome (n=10; 7%). Most repairs were performed for aneurysms associated with aortic dissection (n=110; 71%); of these, 73 (66%) were type A dissections and 37 (34%) were type B. Eight operations were performed for failure of previous repair, including six for endoleaks after endovascular procedures. The most common repairs involved the entire descending thoracic aorta with extension into the abdominal segment (21% Crawford Extent I and 36% Extent II). The adjuncts used during repair varied substantially (see Table). The operative mortality rate was 1.3%. Other notable complications included paraplegia (4%), acute renal failure (5%), stroke (2%), and vocal cord paralysis (21%). Reoperation after TAAA repair was required in a subset of cases for early bleeding (n=15; 10%) and late repair failure (n=8; 5%), including three for patch aneurysm and two for pseudoaneurysm.

Conclusions: Open TAAA repairs are necessary in a variety of different forms of genetically-triggered aortopathy. These patients often require extensive surgical repair, and a variety of adjunctive techniques are employed. The need for reoperation is common, and the risk of repair failure supports the need for vigilant long-term surveillance after repair.

Table 1. Adjuncts used during open thoracoabdominal aortic aneurysm repair.

Adjuncts	Number of Cases (n = 155)
Cardiopulmonary bypass	35 (23%)
Hypothermic circulatory arrest	25 (16%)
Left heart bypass	64 (41%)
Cold renal perfusion	70 (45%)
Selective visceral perfusion	38 (25%)
CSF drainage	86 (55%)
Evoked potential monitoring	16 (10%)
Motor	12 (8%)
Somatosensory	13 (8%)

Impact of Concomitant Coronary Artery Bypass Grafting With Aortic Valve Replacement on 30-Day Hospital Readmissions: An Analysis of More Than 114,000 Procedures

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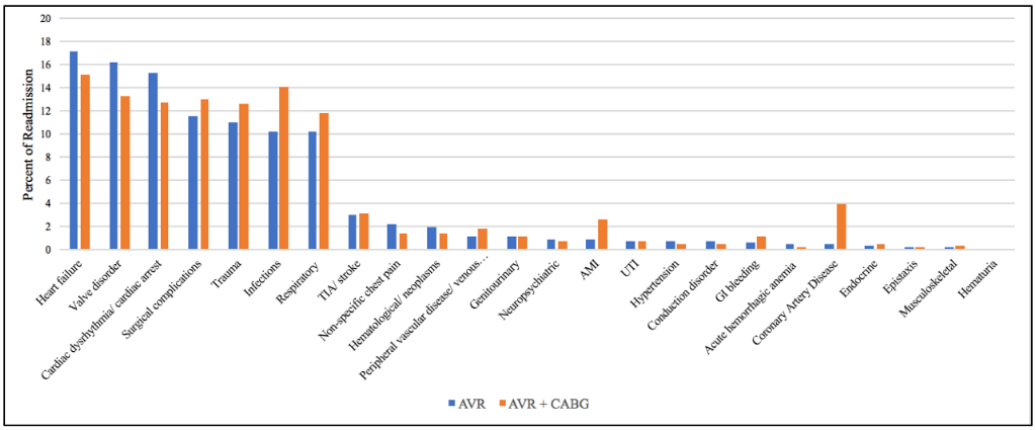
Purpose: Hospital readmission is a widely-accepted quality index for clinical outcomes and reimbursement. The impact of concomitant coronary revascularization with aortic valve replacement (AVR) on hospital readmissions is unclear. We aimed to compare and identify top causes of 30-day hospital readmission following AVR with and without coronary artery bypass grafting (CABG).

Methods: Patients who underwent AVR with and without CABG were queried in the 2013-2014 Nationwide Readmissions Database (NRD). We compared demographics, comorbidities, hospital factors, in-hospital outcomes for index hospitalizations. Readmission rates and causes were determined. A multivariable logistic regression model accounting for the NRD sampling design was employed to determine the effect of AVR with CABG on 30-day readmission following surgery.

Results: We identified 74,957 AVR (13.6% readmitted) and 39,996 AVR with CABG (14.9% readmitted) procedures. Average readmission in-hospital mortality (2.3% vs. 3.1%, p<0.01) and length of stay (6.4 vs. 7.1 days, p<0.01) for AVR vs. AVR with CABG varied whereas readmission costs were similar ($15,081 vs. $15,799, p= 0.29). Cardiac causes accounted for 55% of readmissions for AVR patients: heart failure (17.2%), valve disorder (16.2%), and cardiac dysrhythmia (15.3%) were most common (Figure). Non-cardiac causes included surgical complications (11.6%), trauma (11.1%) and infections (10.3%). Non-cardiac causes accounted for 64% of readmissions for AVR with CABG patients: infections (14.1%), surgical complications (13.1%) and trauma (12.7%) were common causes. Cardiac causes included heart failure (15.2%), valve disorder (13.3%) and cardiac dysrhythmia (12.8%). After adjusting for pre-operative factors, AVR with CABG was not independently associated with increased 30-day readmission compared to isolated AVR (odds ratio 1.03, 95% confidence interval 0.97 to 1.11, p= 0.33).

Conclusions: AVR with concomitant CABG is not associated with higher 30-day readmission compared with AVR without CABG. Clinicians should target more aggressive medical management of heart failure and valve disorders pre-operatively along with minimizing risk for infections, surgical complications and dysrhythmias post-operatively to reduce readmissions in this population.

Figure: Causes of Readmission Stratified by Procedure Type



Direct Intramyocardial Bone Marrow Stromal/Stem Cell Therapy in Patients Undergoing Surgical Revascularization for Ischemic Heart Disease

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Purpose: Bone marrow stromal/stem cells (BMSCs) remain a promising potential therapy for ischemic cardiomyopathy. The primary objective of this study was to evaluate the safety and feasibility of direct intramyocardial injection of autologous BMSCs in patients undergoing transmyocardial revascularization (TMR) or coronary artery bypass graft surgery (CABG).

Methods: A phase I trial was conducted on adult patients suffering from ischemic heart disease with depressed left ventricular ejection fraction who were scheduled to undergo TMR or CABG. Autologous BMSCs were expanded for three weeks prior to scheduled surgery. Following completion of surgical revascularization, BMSCs were directly injected into ischemic myocardium. Safety and feasibility of therapy were assessed. Cardiac functional status and changes in quality of life were evaluated at one year.

Results: Fourteen patients underwent simultaneous BMSC and surgical revascularization therapy (TMR+BMSCs = 10, CABG+BMSCs = 4). BMSCs were successfully expanded and no significant complications occurred as a result of the procedure. Compared to baseline, global LVEF at one-year following surgery was significantly increased (TMR+BMSCs: 42.0% ± 5.1% vs. 46.4% ± 4.3%; P = 0.04. CABG+BMSCs: 36.6% ± 8.1% vs. 44.3% ± 10.7%; P = 0.04). Cardiac magnetic resonance imaging strain tagging studies revealed regional contractility improvement in the cell-treated areas at 12 months (TMR+BMSCs *delta* strain: -4.6% ± 2.1%; P = 0.02. CABG+MSCs *delta* strain: -4.2% ± 6.0%; P = 0.30). Quality of life assessments (SAQ and SF-36) documented significant post-operative enhancement and substantial reduction in angina scores at one year was noted (TMR+BMSCs: 1.3 ± 1.2; P < 0.01, CABG+BMSCs: 1.0 ± 1.4; P < 0.01).

Conclusions: In this phase 1 trial, direct intramyocardial injection of autologous BMSCs in conjunction with TMR or CABG was technically feasible and could be performed safely. Preliminary results demonstrate improved cardiac function and quality of life in patients at one year after treatment.

Constitutive Expression of HIF-1alpha Augments the Therapeutic Potential of Cardiosphere-Derived Cells

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Purpose: Cardiac progenitor cells are derived from the adult myocardium that have limited therapeutic success in cell-based therapies for adult infarcted myocardium in Phase I and II clinical trials. So, we aim to augment the therapeutic potential of adult cardiac progenitor cells by modulating the expression of proangiogenic hypoxia inducible factor-1alpha (HIF-alpha).

Methods: Adult-derived cardiosphere derived cells (aCDC) preparations (aCDCs) were generated and expanded from right atrial appendages of adults who underwent coronary artery bypass grafting. aCDCs were transduced with lentivirus HIF-1alpha and measured by FACS. Neonatal rat cardiomyocytes were cocultured with total conditioned medium (TCM) of transduced aCDCs and rates or cardiomyocyte proliferation were measured. The cell preparation was studied in a well-established in vivo by intramyocardially administering one million cells in a rat model of acute myocardial infarction. Secreted factors within the TCM of each cell preparation were quantified using ELISA.

Results: Transduction efficiency of aCDCs with lentivirus vector was 83.8%. HIF-1alpha overexpressing aCDCs elicited higher rates of cardiomyocyte proliferation (1.5 fold) than controls, and in vivo delivered overexpressing HIF-1alpha aCDCs cells was associated with

significant improvement of left ventricular ejection fraction and fraction shortening at 28-days post infarction/treatment than non-transduced aCDCs. Mechanistically, HIF-1alpha-aCDCs led to enrichment of the secretome in VEGF, ANG2 and SDF which correlated with increased angiogenesis in vivo.

Conclusions: Overexpression of HIF-1alpha in CDCs improves their functional efficacy to induce cardiomyocyte proliferation and preserve myocardial function following infarction. These beneficial effects due to modified CDCs' secretome by enrichment of the factors known to promote favorable myocardial remodeling. These result has important implication for applying modified CDCs in myocardial infarcted patients undergoing coronary artery bypass grafting.

Left Ventricular Remodeling After Mini-Mitral Repair: Does the Complexity of Mitral Disease Matter?

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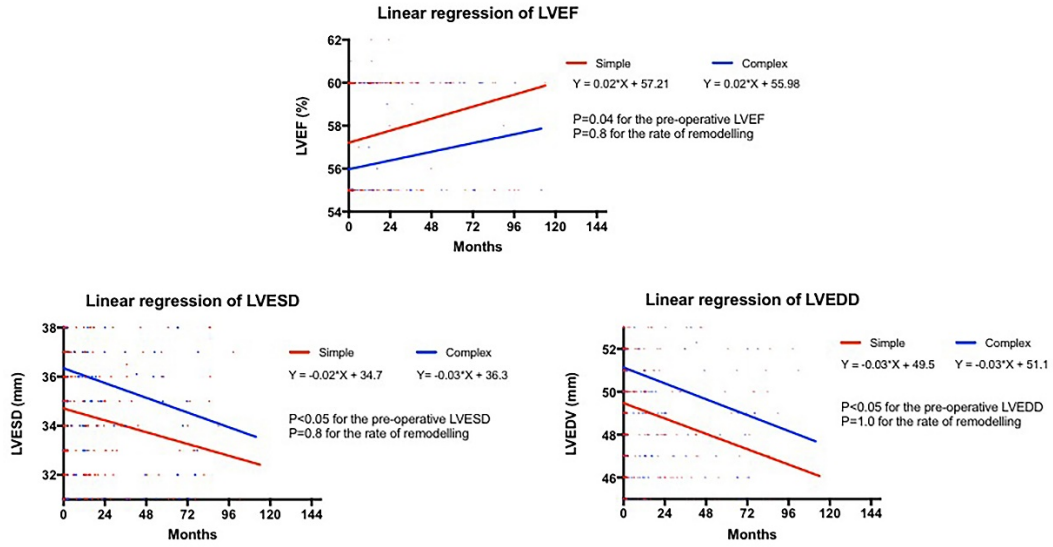
Purpose: Degenerative mitral valve (MV) regurgitation (MR) is associated with left ventricular (LV) dilatation. Surgical treatment of MR has been shown to favorably affect or reverse adverse LV remodelling. We set out to prospectively compare the long-term echocardiographic outcomes on LV remodelling following mini-mitral repair for simple versus complex MV disease.

Methods: We prospectively followed up with serial echocardiography 203 consecutive patients who underwent MV repair for severe degenerative MR over a 10-year period. Simple disease (n=122 patients) defined as MR secondary to posterior MV prolapse was compared to complex disease (n=81 patients) involving anterior or bilateral MV prolapse. Baseline characteristics were similar between groups (age: 62.6 ± 12.8 years for simple, vs. 59.5 ± 15 years for complex, P=0.15; sex: 71.3%, n=87 males, vs. 71.6%, n=58 males, P=0.96; body mass index: 26.8 ± 5 kg/m^2, vs. 25.9 ± 4.6 kg/m^2, P=0.2; pre-operative MR grade >2: 100%, n=122, vs. 98.8%, n=80, P=0.16).

Results: Pre-operative left ventricular ejection fraction (LVEF) was significantly lower in the complex group as compared to the simple group (57.21% for simple vs. 55.98% for complex, P= 0.04). Similarly, pre-operative left ventricular end-systolic diameter (LVESD) and left ventricular end-diastolic diameter (LVEDD) were significantly larger in the complex group as compared to the simple group (LVESD: 34.7 mm for simple vs. 36.3 mm for complex, P<0.05; LVEDD: 49.5 mm for simple vs. 51.1 mm for complex, P<0.05); Despite the very different baseline characteristics of LV function and geometry, both groups had similar remodelling of LV function and dimensions after MV repair (LVEF: +0.02 ± 0.02 mm/month for both groups, P=0.8; LVESD: -0.02 ± 0.01 mm/month for simple vs. -0.03 ± 0.02 mm/month for complex, P=0.8; LVEDD: -0.03 ± 0.02 mm/month for both groups, P=1.0).

Conclusions: Complex MV disease negatively impacts LV function and geometry. Despite having similar remodelling after repair, the lower LVEF, and larger LVESD and LVEDD seen pre-operatively in complex disease continue to be significantly different than in simple disease, suggesting earlier repair of MR in complex disease may better preserve LV function.



Fate of Pericardial Patches in Tricuspid and Bicuspid Aortic Cusp Repair

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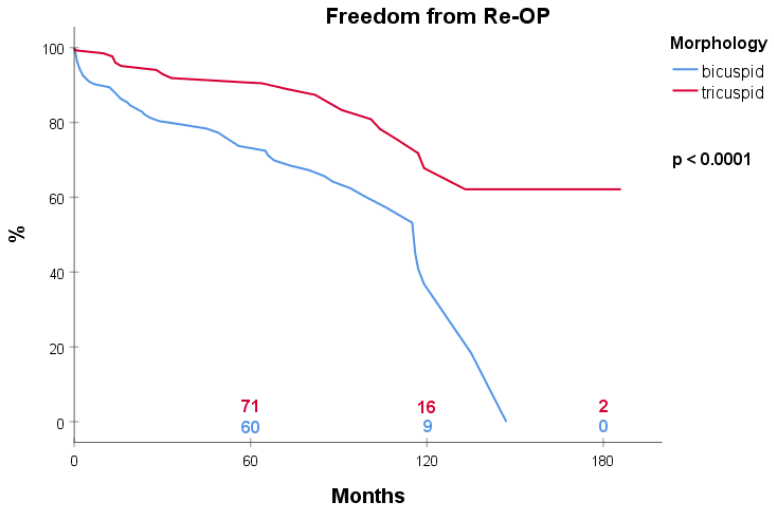
Purpose: The use of pericardium in aortic cusp repair has been associated with decreased valve stability. There is, however, limited data on patch durability in different valve morphologies. We analyzed our long-term results with pericardial patches in aortic repair focusing on valve morphology and different repair techniques.

Methods: From December 2000 to August 2017, 277 patients (mean age 53±14years) underwent aortic valve repair involving pericardial patches. Primary indications for surgery were aortic regurgitation (n=225; 81.2%) or aortic aneurysm (n=34; 12.3%). Tricuspid aortic valve (TAV) morphology was present in 140 patients (50.5%), 137 individuals (49.5%) had a bicuspid aortic valve (BAV). Pericardial patches (autologous n=236, 85.2%; heterologous n=41, 14.8%) were used for either cusp augmentation (n=107, 38.6%) or closure of defects (i. e. perforations/fenestrations, n=152, 54.9%). Commissural reconstruction using pericardium was performed in 18 (6.5%) BAV patients. Follow-up was complete in 96%.

Results: One patient died in hospital, 10-year survival was 84.2%. Freedom from reoperation at 10 years was 52.5%. It was significantly inferior after BAV repair (36.8%) compared to TAV repair (67.8%; p<0.0001). The best valve stability at 10 years was observed after closure of defects (61.1%), it was inferior after cusp augmentation (46.7%) and commissural reconstruction (24.9%; p=0.001). Ten-year freedom from reoperation was comparable for all subgroups in BAV repair (augmentation 43%, closure of defects 29%, commissural reconstruction 25%; p=0.635). In TAV repair, a significantly higher 10-year freedom from reoperation was found after defect closure compared to cusp augmentation (74.7% vs. 51.7%, p=0.009). There was no difference between autologous and heterologous patch material (p=0.875).

Conclusions: The results of aortic cusp repair using pericardium depend on valve morphology and cusp pathology. Mid and long-term durability is reasonable in TAV repair, especially for closure of defects. In BAV repair, valve stability is poor regardless of cusp pathology and repair technique. In those instances replacement should be preferred.



Left Ventricular Pseudoaneurysm of the Heart Base

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Purpose: Cardiac pseudo aneurysms of non-infectious or non-ischemic etiology are rare. We illustrate the surgical management of a patient with a large post-surgical calcified pseudo aneurysm located in the base of the heart disrupting the continuity between the aortic and mitral annulus.

Methods: A 35 year old female with history of mitral and aortic valve endocarditis was treated with mechanical AVR and MVR in 1999 followed by redo MVR three months later. She presented in early 2018 with hemolysis and congestive heart failure symptoms (NYHA class III). Evaluation revealed a 5.0 x 4.5 x 4.0 cm calcified pseudo aneurysm separating the aortic and mitral valve annulus extending behind the aortic annulus and ascending aorta. She also had severe prosthetic aortic valve stenosis and severe mitral paravalvular regurgitation. She had no coronary artery disease and her LVEF was normal.

Results: A third time sternotomy was performed. The aortic and mitral prosthesis were explanted. The aortotomy was extended through the wall of the pseudo aneurysm separating the aorta and the mitral annulus to the mitral annulus. It required the opening of the right atrium wall. This nicely exposed the mitral annulus and the mouth of the pseudo aneurysm in to the LV. The mouth of the pseudo

aneurysm was excluded with a pericardial patch and the mitral valve was replaced through a trans-aortic-LV approach. The aortic valve was replaced. Mechanical valves were used. A double pericardial patch anchored on the mitral annulus was used to reconstruct a) the LVOT, non-coronary portion of the aortic annulus, and ascending aorta and b) the right atrium. Patient was discharged home 19 days after surgery. Hemolysis and heart failure symptoms resolved. Prosthetic valve function and LVEF were normal.

Conclusions: Large calcified pseudoaneurysm of the base of the heart a) cannot be excised and should be excluded using a patch b) compromises the exposure of the mitral valve requiring an alternative approach for valve replacement and c) requires complex patch reconstruction of the LVOT, aortic annulus, ascending aorta, and atrium.

Predictive Utility of a Novel Machine Learning Algorithm in Estimating Operative Mortality After Adult Cardiac Surgery

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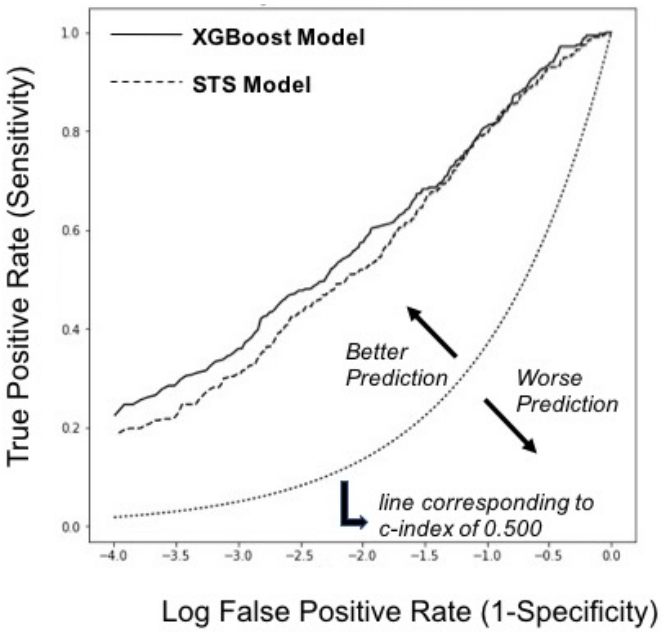
Purpose: Machine learning refers to the ability of systems to learn from data, identify patterns, and automate analytic model building. The purpose of this study was to evaluate the predictive utility of a recently developed machine learning algorithm named Extreme Gradient Boosting (XGBoost) in adult cardiac surgery.

Methods: Index adult cardiac operations (isolated coronary bypass grafting [CABG], isolated valve surgery, and CABG plus valve surgery) performed between 2011 and 2017 at a single institution were included. The primary outcome was operative mortality as defined by the STS. All preoperative variables routinely collected by the STS were evaluated for potential inclusion in the models. The models were evaluated using cross validation and the area under receiver operating characteristic curve, or c-index. Model performance was compared to the STS models for predicting operative mortality (STS-PROM).

Results: A total of 11,191 patients were included (7,049 isolated CABGs, 2,507 isolated valves, and 1,635 CABG plus valves). The STS-PROM for the overall cohort was 3.2% ± 5.0%. Actual operative mortality was 2.9%. The c-index for operative mortality for the STS models in this study cohort was 0.795. The XGBoost model was developed using multiple variables, many of which are included in the STS models (**Table**). The XGBoost model outperformed the STS models in predicting operative mortality in fourfold cross validation with a c-index of 0.812. In particular, the XGBoost model improved sensitivity (or "true positives") at higher specificity (or lower "false positive") thresholds (**Figure**).

Conclusions: XGBoost demonstrates promise in predicting operative mortality in adult cardiac surgery. In addition to outperforming the STS models in the current analysis, the model compares favorably to 2018 STS National Database models where published c-indices were 0.761 to 0.804. Validation of these preliminary results in larger cohorts is therefore warranted.



Risk Factors Included in the XGBoost Model

Demographics	*Comorbidities*	*Acuity and Presentation*
Age	Family History of Coronary Artery Disease	Cardiac Symptoms
Female Sex	Diabetes Mellitus	NYHA Class
Race	Dyslipidemia	Cardiogenic Shock
Height	Dialysis Dependence	Resuscitation
Weight	Hypertension	Inotropes
	Infectious Endocarditis	Number of Diseased Coronary Vessels
	Chronic Lung Disease	Valvular Insufficiency or Stenosis
	Immunosuppression	Urgency of Operation
	Peripheral Arterial Disease	Intra-Aortic Balloon Pump and Timing
	Cerebrovascular Disease	
	Most Recent Serum Creatinine	
	Smoker	
	Prior Myocardial Infarction and Timing	
	Arrhythmia and Type	
	Congestive Heart Failure	
	Prior CABG	
	Prior Valve	
	Prior Other Cardiac Surgery	
	Prior Percutaneous Coronary Intervention	
	Ejection Fraction	

A Century of Heparin

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Purpose: 2018 is the centennial for Emmett Holt and William Howell's naming of heparin. It also marks the 102nd year after Jay McLean worked on an anticoagulant heparphosphatide at Johns Hopkins, prompting Holt and Howell's work. Heparin's utility in medicine is nonpareil. We discuss recently discovered historical artifacts that shed new light on heparin's christening.

Methods: Known historical publications by McLean, Holt, Howell, other contemporary authors, and subsequent medical historians were analyzed. Additional searches were performed at the Alan Mason Chesney Medical Archives of The Johns Hopkins Medical Institutions, the Charles Best papers in the Thomas Fisher Rare Book Library at the University of Toronto, and the Special Collections of the Detroit Public Library, to uncover documents relevant to the discovery of heparin. In addition, present and former staff members at the Department of Pharmacology were interviewed regarding the location of a plaque dedicated to McLean in The Johns Hopkins Medical School.

Results: We discovered an unpublished letter written by Jay McLean in 1950 to the Jam Handy Organization regarding a proposed film on heparin, which was copied to the Director of the Institute of Medical History at The Johns Hopkins. This letter is a significant addition to the materials surrounding the discovery of heparin, since McLean's final 1957 autobiography in *Circulation* on the discovery of heparin was unfinished. This letter represents one of the most complete accounts of heparin's discovery by McLean prior to his death. Furthermore, it was written after Howell's death when McLean was actively claiming, or reclaiming, credit for heparin's discovery, and prior to surviving accounts dated to when Howell was still alive. Meanwhile, we also located the McLean plaque and the circumstances behind its removal from public display at The Johns Hopkins East Baltimore medical campus.

Conclusions: Our intention is to be historical and neutral as to the role of the persons involved in heparin's discovery, and to celebrate its surgical heritage. Indeed, our results on the discovery of the anticoagulant demonstrate how complex a scientific discovery, and the assimilation of that discovery into the corpus of scientific knowledge, can be.

Effect of Preoperative Pulmonary Hypertension on Clinical Outcomes in Patients With Rheumatic Mitral Stenosis After Mitral Valve Replacement

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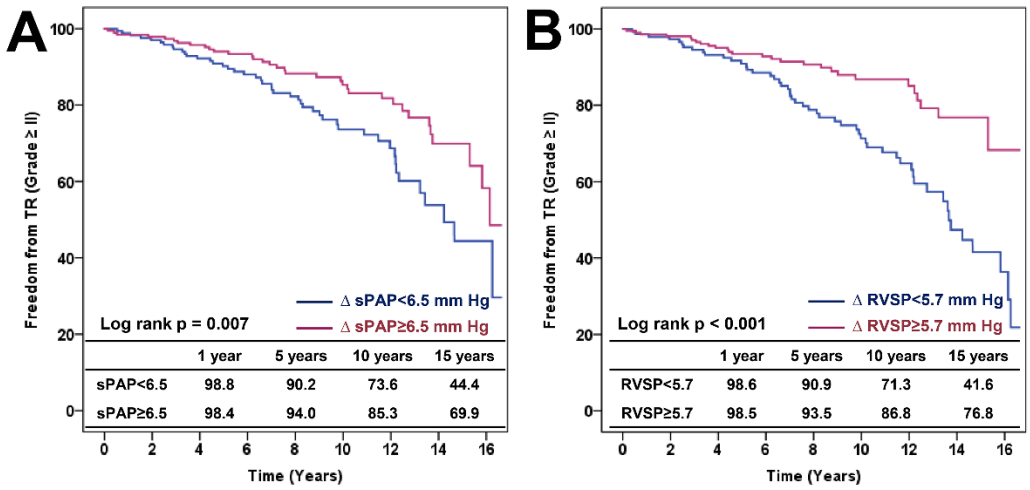
Purpose: Although pulmonary hypertension (PH) was decreased after mitral valve replacement (MVR), significant late-onset tricuspid regurgitation (TR) is commonly developed. The purpose of this study was to evaluate the effect of concomitant PH on clinical outcomes in patients who underwent MVR for rheumatic mitral stenosis (MS).

Methods: We retrospectively reviewed 394 patients who underwent MVR from January 2000 to December 2013. PH defined as systolic pulmonary arterial pressure (sPAP) >50mmHg and patients were classified into 2 groups: those without PH (n=322) and those with PH (n=72). The change from preoperative to postoperative echocardiographic parameters, TR progression (grade >II), and long-term survival were compared between groups.

Results: The 10-year overall survival rate was significantly lower in the PH group (90.7% vs. 79.7%, p=0.04), whereas the rate of freedom from TR progression (grade >II) was similar between the two groups (80.5% vs. 76.9%, p=0.74). Initial high sPAP and right ventricular systolic pressure (RVSP) values did not effect on TR progression, regardless severity of PH. Using a Cox proportional hazards model, postoperative reduction in sPAP (>6.5 mmHg) and RVSP (>5.7 mmHg) was identified as protective factor for TR progression (Hazard ratio [95% Confidence interval]; 0.583 [0.345-0.983], p=0.043 and 0.506 [0.314-0.815], p=0.005, respectively). In patients with a reduction in SPAP >6.5 mmHg and in RVSP >5.7 mmHg, the freedom from TR progression rates at 10 years were significantly superior (sPAP, 85.3% vs. 73.6%, p=0.007; RVSP, 86.8% vs. 71.3%, p<0.001).

Conclusions: Although long-term survival in patients with PH at time of MVR is associated with impaired outcomes, adequate sPAP and RVSP reduction, regardless of the initial high values, can prevent the late-onset progression of TR. Therefore, sPAP and RVSP should be carefully observed after MVR.



Surgical Management of Invasive Double Valve Endocarditis Involving the Intervalvular Fibrous Body

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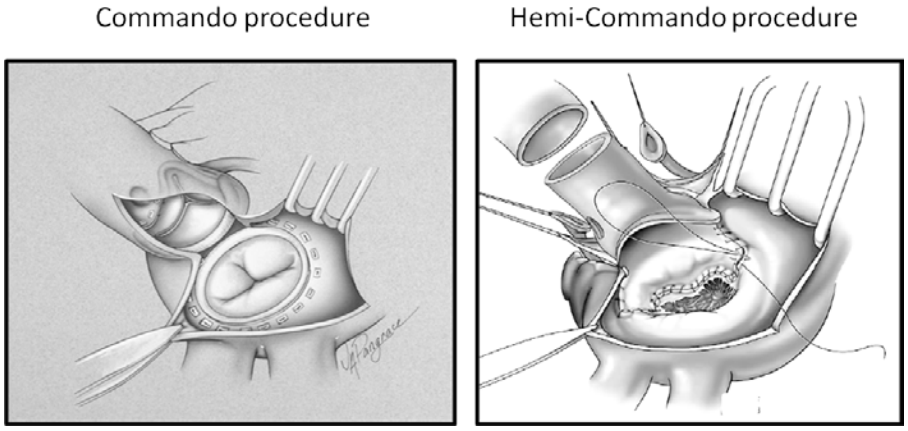
Purpose: Reconstruction of the intervalvular fibrosa (IVF) for invasive double valve endocarditis (IE) is a technically challenging operation in a high risk group of patients. This study presents the long term outcomes of two surgical techniques for reconstruction of the fibrous skeleton.

Methods: From 1988 to 2017, 138 patients with invasive double valve IE underwent surgical reconstruction of the IVF along with either double valve replacement (Commando procedure, n=86) or aortic valve replacement with mitral valve repair (Hemi-Commando procedure, n=52). Pericardial patch was used for IVF reconstruction in 74 patients (54%) and aorto-mitral allograft in 64 patients (46%). Mean follow up is 41.4 ± 5.9 months.

Results: Pre-operative characteristics included 82% reoperations (n=113/138), 34% emergency surgeries (n=47/138), and 48% admission to critical care unit (n=66/138). Important pathological features included 75% prosthetic valve IE (n=104/138), 78% aortic root abscess (n=107/138), 24% mitral annulus abscess (n=33/138), and 12% intra-cardiac fistula (n=16/138). There were 28 hospital deaths (out of 138 patients); 24% in the Commando (n=21/86) and 13.5% in the Hemi-Commando group (n=7/52). Extra-corporeal circulatory

support was required after surgery in 6.5% (n=9/138); 8% Commando (n=7/86) and 4% Hemi-Commando group (n=2/52). Delayed chest closure in 28% (n=38/138); 21% Commando (n=18/86) and 19% Hemi-Commando group (n=10/52). During follow-up, incidence of recurrent IE was 20.5% (n=17/83); 26% Commando (n=13/50) and12% Hemi-Commando group (n=4/33). The overall survival at 1, 5, 12 years was 73, 61, and 51%, respectively. Survival at 1, 3, and 7 years in the Commando was 66, 63, and 52% while 82, 71, and 38% in the Hemi-Commando group.

Conclusions: Despite being technically demanding operation, surgery for invasive IE involving IVF, which provides the only chance for cure, can be performed with reasonable outcomes. In cases of IE invading the IVF and limited to anterior mitral leaflet, avoid replacing the mitral valve through reconstructive repair may improve the early outcomes.



Pulmonary Valve Function Late After Ross Procedure in 443 Adult Patients

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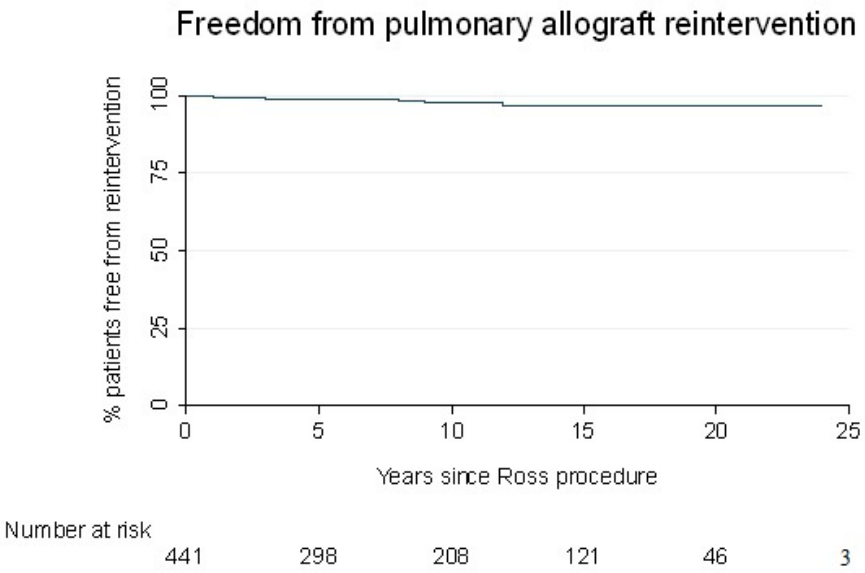
Purpose: Limited data exists on long-term pulmonary valve function after the Ross procedure. Significant late pulmonary allograft dysfunction has been reported (1, 2). We sought to determine the long-term function of the pulmonary valve in 443 consecutive adult patients who underwent a Ross procedure.

Methods: All 443 patients who underwent a Ross procedure between November 1992 and March 2018 were reviewed retrospectively. All underwent pulmonary valve replacement using a cryopreserved pulmonary allograft. Indications for pulmonary valve reintervention included symptoms, mean pulmonary valve gradient exceeding 40mmHg and any evidence of right ventricular enlargement or dysfunction. Freedom from the study's outcomes were calculated using Kaplan Meier survival. All patients underwent second yearly Doppler echocardiography to analyse pulmonary valve function. The following risk factors for valve failure were analysed using Cox regression: donor age and allograft size, patient age, gender and aortic valve lesion and aetiology.

Results: Mean age at time of operation was 39 years (range 15-66 years). There was 1 (0.2%, 1/443) operative mortality. Nine patients required reintervention on the pulmonary allograft at a mean 6.1 years (range 1-12 years) after Ross procedure. Patients required pulmonary allograft reintervention for infective endocarditis (n=4), severe pulmonary stenosis (n=4) or severe pulmonary regurgitation (PR) (n=1). Freedom from pulmonary allograft reintervention was 98.9% (95%CI 97.1-99.6), 97.7% (95%CI 95.1-98.9), 96.6% (95%CI 93.3-98.3) and 96.6% (95%CI 93.3-98.3) at 5, 10, 15 and 20 years (Figure 1). Freedom from pulmonary allograft dysfunction (at least moderate PR and/or mean systolic gradient ? 25mmHg and/or reintervention) was 94.5% (95%CI 91.6-96.4), 88.1% (95%CI 83.6-91.4), 84.9% (95%CI 79.6-88.9) and 78.3% (95%CI 69.5-84.9) at 5, 10, 15 and 20 years. Average mean systolic pulmonary gradient was 11mmHg (range 4-28mmHg) at 20 years. No risk factors were identified to influence pulmonary valve durability.

Conclusions: The pulmonary valve allograft gives excellent long-term function when used in adults undergoing the Ross procedure. Reintervention on the pulmonary valve is rare and significant pulmonary allograft dysfunction is uncommon. No risk factors for structural valve degeneration were identified.



Should Transcatheter Aortic Valve Replacement After Prior Coronary Artery Bypass Grafting Be the New Standard of Care?

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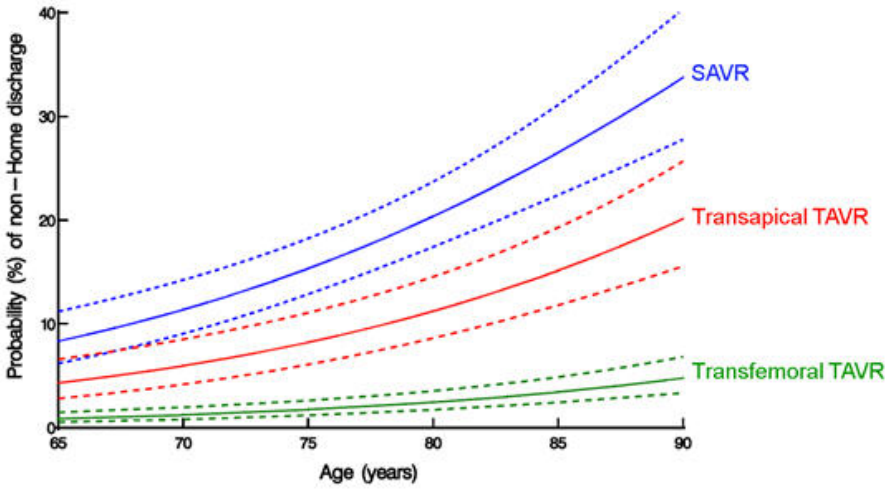
Purpose: Published studies have shown worse long-term outcomes for patients discharged to nursing facilities rather than home following cardiac surgery. The purpose of this study was to investigate differences in discharge to extended-care facilities between transcatheter (TAVR) and surgical aortic valve replacement (SAVR) after prior coronary artery bypass grafting.

Methods: From 2006-2015, 629 patients with a history of CABG underwent TAVR (n=352/56%) or SAVR (n=277/44%) for severe aortic stenosis at a single, tertiary care academic institution. Mean age was 79 years, and 81% were men. TAVR access sites included ileofemoral (n=230, 65%), transapical (n=119, 34%), and other (n=3, 0.9%). Propensity matching was used, resulting in 166 matched pairs (60% of possible matches). The main outcomes were in-hospital morbidity, mortality, length of hospital stay, and discharge location.

Results: Among propensity-matched patients, TAVR was associated with fewer transfusions (n=38 [23%] vs. n=138 [83%]; P<.0001), less new-onset atrial fibrillation (n=10 [6.2%] vs. n=51 [32%]; P<.0001), and less mechanical ventilation >24 hours (n=6 [3.6%] vs. n=31 [19%]; P<.0001). Operative mortality and stroke were similar. Permanent pacemaker insertion was more common after TAVR (n=13 [9.1%] vs. n=5 [3.4%]; P=.045). Minor vascular complications occurred in 9 (5.4%) of TAVR patients. TAVR patients had shorter intensive care unit (27 vs. 49 hours; P=<.0001) and post-procedure lengths of stay (4.6 vs. 7.7 days; P<.0001). Discharge to skilled nursing facilities was less common following TAVR than SAVR (n=14 [8.4%] vs. n=35 [21%]; P=0.001). One (0.6%) TAVR patient and 5 (3%) SAVR patients were discharged to long-term acute care (LTAC) facilities (p=0.12).

Conclusions: For patients developing severe aortic stenosis after CABG, TAVR rather than SAVR should be strongly considered because of less morbidity, shorter length of stay, and increased likelihood of home discharge, with similar occurrence of stroke and mortality.



Outcome	TAVR No. (%) Mean ± SD	SAVR No. (%) Mean ± SD	*P*
Prolonged ventilation (>24 h)	6 (3.6)	31 (19)	<.0001
Blood product transfusion	38 (23)	138 (83)	<.0001
New-onset atrial fibrillation	10 (6.2)	51 (32)	<.0001
Permanent pacemaker	13 (9.1)	5 (3.4)	.045
ICU length of stay (hours)	51 ± 72	82 ± 103	<.0001
Post-procedure length of stay (days)	5.5 ± 7.0	9.2 ± 5.3	<.0001
Discharge to nursing facility	15 (9.0)	40 (24)	.001

Impact of Hospital and Surgeon Procedural Volume on Outcomes After Aortic Root Replacement in the Medicare Population

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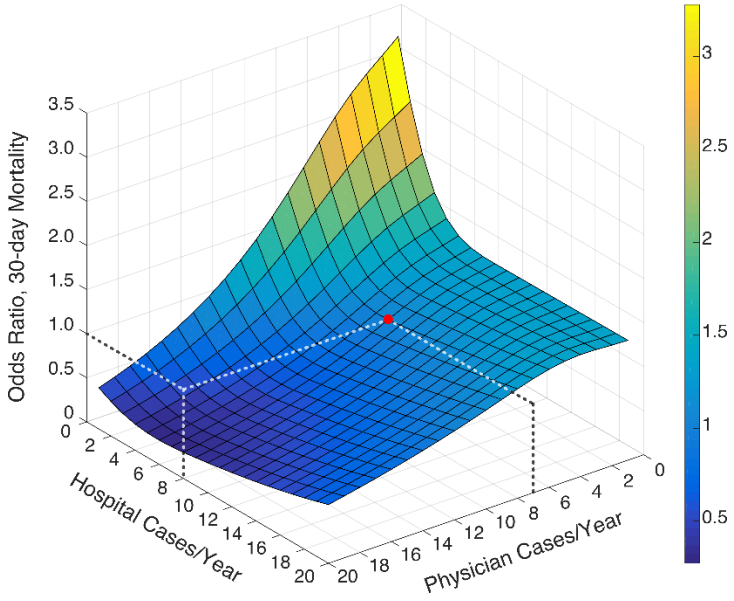
Purpose: Hospital and surgeon procedural volume for complex cardiac procedures are becoming important quality metrics. The objective is to determine the association of hospital and physician case volume on patient outcomes after an aortic root replacement for root aneurysms.

Methods: From 2009 -2014, 5,369 Medicare patients underwent an aortic root replacement for a root aneurysm. Operations were performed at 746 hospitals by 1,369 surgeons. Patients with endocarditis, aortic rupture, or Type A dissection were excluded. Procedural volume is defined as mean number of cases performed each year during the study period. The impact of hospital and surgeon volume on adjusted 30-day mortality was analyzed as a continuous variable using logistic regression with cubic splines and also as a categorical variable based on the terciles of hospital and surgeon volume. The cumulative incidence of 30-day post-operative complications were also analyzed.

Results: The mean patient age was 73.9±5.4 years (range: 66-97 years). Hospitals in the highest volume tercile (27%, 377/746) completed 3.5 or more cases/year and surgeons in the highest tercile (29%, 213/1369) performed 3.3 or more cases/year. After an aortic root replacement, we observed a nonlinear reduction in the adjusted odds-ratio for 30-day mortality as hospital and surgeon volume increased. The reduction in the odds-ratio for mortality was greatest for hospital procedural volume of 8 or more cases/year ($p<0.001$) and surgeon volume of 7 or more cases/year ($p<0.001$). Patients in the top tercile of hospital volume had the lowest incidence for post-operative stroke (Hazard Ratio [HR]=0.82, $p<0.001$), myocardial infarction (HR=0.73, $p<0.001$), hemodialysis (HR=0.83, $p<0.001$), pneumonia (HR=0.87, $p<0.001$), post-operative bleeding (HR=0.75, $p<0.001$), and re-exploration (HR=0.91, $p<0.001$).

Conclusions: In patients undergoing an aortic root replacement, there is a strong inverse relationship between hospital and surgeon case volume and post-operative outcomes. Procedural volume is an important quality metric for this complex procedure.



Survival Following Septal Myectomy for Obstructive Hypertrophic Cardiomyopathy: What Causes Late Mortality?

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Purpose: Survival of patients with obstructive hypertrophic cardiomyopathy (HCM) who undergo septal myectomy appears to be excellent, and in some series, is similar to that of age- and sex-matched populations. In this study, we investigated causes of late death in a large cohort of surgical HCM patients.

Methods: Between January 1961 and October 2017, 3,279 adult and pediatric patients underwent septal myectomy at our Clinic. Patients with isolated transapical myectomy for nonobstructive HCM or midventricular obstruction were excluded (n=130, 4.0%), and the final study population consisted of 3,149 patients who had operation for subaortic left ventricular outflow tract obstruction. We reviewed medical records of all patients from a prospectively maintained database. Vital status and causes of mortality were verified using two methods - LexisNexis® Accurint®, which is a commercially available resource, and the National Death Index (NDI), a government database which collects information on causes of mortality.

Results: There were 2,971 (94.3%) adult and 178 (5.7%) pediatric (less than 18 years) patients. Median (IQR) age was 54 (41, 65) years, and 1,746 (55.4%) were male. Isolated transaortic septal myectomy was performed in 3,009 (95.6%), and a combined transaortic and transapical procedure in 140 (4.4%). Following operation, survival estimates were 98.2%, 85.1%, and 54.0% at 1, 10, and 20 years. Overall, mortality occurred in 482 (15.3%) patients, and among these, cause of death could be obtained from the NDI in 413 (85.7%). Cardiac-related deaths occurred in 242 (58.6%), and HCM was the primary cause of death in 91 (22.0%). Other cardiac causes of mortality included coronary artery disease in 61 (14.8%), valvular disease in 17 (4.1%), and heart failure in 15 (3.6%). Non-cardiac deaths occurred in 171 (41.4%), and cancer was the most common cause of death in these patients (n=52, 12.6%).

Conclusions: This study, using two independent sources to verify vital status and cause of mortality, confirms that survival following transaortic septal myectomy is excellent. Hypertrophic cardiomyopathy was identified as the primary cause of death in less than 25%, and mortality in most patients who undergo septal myectomy appears unrelated to HCM.

First-in-Man Trial of a Novel, Balloon-Adjustable Mitral Annuloplasty Ring

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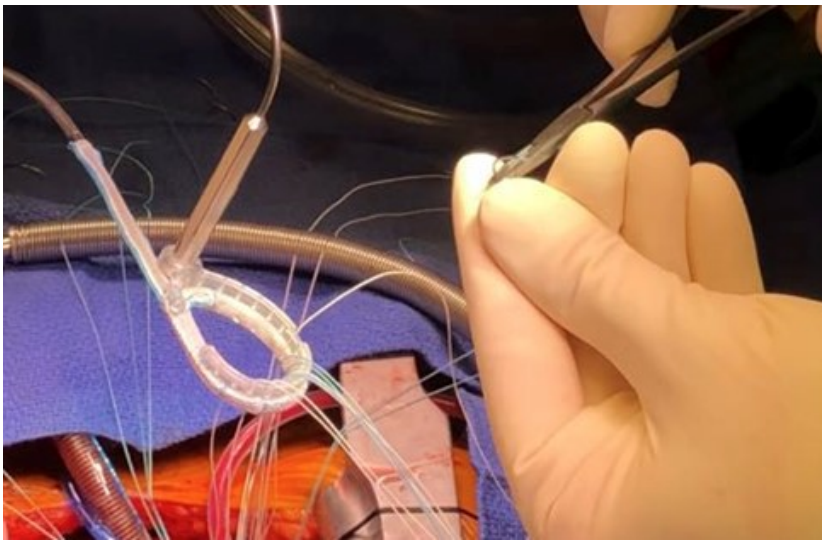
Purpose: The optimal surgical approach in functional mitral regurgitation (MI) was questioned in favour for prosthetic replacement due to the reduced risk of recurrent MI (1). However, adjustable mitral rings may provide an alternative (2). A novel, balloon-adjustable mitral-ring was assessed regarding clinical safety and feasibility in this first-in-man trial.

Methods: The ring consists of a rigid titanium structure with a connection line and an internal deformable metallic cage with eyelets for the sutures. A balloon catheter can be inserted into the ring frame and inflated independently in the area P1, P2 or P3. Balloon inflation leads to extension of the P1, P2 or P3 segment and subsequent reduction of the valve anterior-posterior diameter in this area.

Implantation technique and sizing of the ring resembles that of conventional Carpentier's annuloplasty ring. Sutures are placed on the inner side of the ring to enable annular reduction in case of adjustment.

Results: Five patients (mean age 75 years; mean EuroSCORE II 2,08; 3 female) were enrolled in the trial and successfully implanted (4 patients with 30 mm ring, 1 patient with 32mm ring). Mechanism of MR was prolapse of the P2-segment in 3 patients and annular dilation in 2 patients. No perioperative-and 30-day mortality was observed. In 1 patient the tricuspid valve was replaced and in 1 patient tricuspid repair was performed. Surgical access was median sternotomy in all patients. Median circulation time and median cross clamp time were 105 (118; 195) and 94 (90, 151) minutes respectively, median ICU stay was 2 (2, 3) days. All patients reached the primary endpoint with no mortality or device related morbidity at 30 days postoperatively. Not related adverse events were pacemaker lead revision, intermittent dialysis and wound infection. No moderate or severe recurrent mitral regurgitation was observed.

Conclusions: Successful implantation was completed in 5 patients without device-related adverse events at the 30-day postoperative follow-up. Ring implantation was safe and feasible in all patients. The opportunity of post-implant adjustment to improve leaflet coaptation is a promising new therapeutic strategy for persisting and recurrent mitral regurgitation after mitral valve reconstruction.



Safety of del Nido Cardioplegia in Complex Adult Cardiac Surgery: A Propensity-Weighted Analysis

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Purpose: Del Nido cardioplegia (dNC) is increasingly used in adult cardiac surgery, and recent studies show equipoise with blood-based cardioplegia (BBC) for short operative times. This study compared outcomes of patients who underwent complex cardiac surgeries with aortic crossclamp times exceeding 120 minutes using dNC or BBC for cardiac protection.

Methods: A retrospective review of the Society of Thoracic Surgery (STS) Adult Cardiac Surgery Database for patients who underwent surgery with aortic crossclamp times exceeding 120 minutes at a single U.S academic institution from 9/2013 through 4/2018 was performed. Patients who underwent robotic operations, operations without cardioplegia, heart transplantations, congenital heart operations or were younger than 18 years old were excluded. A propensity score was estimated for each patient based on preoperative characteristics. Propensity score weighted linear and logistic regression models were then built to compare outcomes between dNC and BBC patients.

Results: 1,609 patients met inclusion criteria for the study. 163 (10.1%) had dNC for cardioplegic arrest and 1,446 (89.9%) had BBC. Mean crossclamp times were similar between groups (164 min for dNC, 166 for BBC; p=0.50). After propensity score weighted adjustment, no significant differences in preoperative characteristics remained between the dNC and BBC groups. Similarly, there were few intraoperative differences after propensity weighting. dNC and BBC groups had similar rates of aortic surgery (OR 0.66, p=0.11), complex valvular surgery (OR 1.21, p=0.49), and combined valve/CABG surgery (OR 1.37, p=0.26). Antegrade and retrograde cardioplegia delivery methods were also similar between groups (p=0.15 and 0.19, respectively). Propensity weighted analysis of postoperative outcomes demonstrated no statistical difference with exception of lower rates of postoperative stroke (OR 0.25, p=0.01) and cardiac arrest (OR 0.34, p=0.01) in the dNC group. Rates of 30-day mortality, renal failure, and ICU length of stay were not statistically significant.

Conclusions: Del Nido cardioplegia can be used safely in complex adult cardiac cases with longer aortic crossclamp times. Postoperative outcomes for patients who had dNC for cardiac protection were similar to those who had BBC. This research may provide impetus for further trials comparing these cardiac protection strategies.

Table 1: Propensity Score Weighted Postoperative Outcomes

Outcome	OR/GMR	95% CI	p-value
Cerebrovascular Accident	0.25	0.08, 0.73	0.01
Death (30-days)	1.20	0.59, 2.47	0.61
Postoperative Cardiac Arrest	0.34	0.14, 0.81	0.01
Postoperative IABP Insertion	0.84	0.26, 2.69	0.77
Heart Block Requiring Pacemaker	2.38	0.91, 6.19	0.08
Postoperative Atrial Fibrillation	0.66	0.40, 1.07	0.09
New Renal Failure	1.61	0.78, 3.33	0.20
New Dialysis	1.48	0.68, 3.25	0.33
Postoperative Ventilator (hours)	1.19	0.86, 1.66	0.29
Postoperative Prolonged Ventilation	1.26	0.75, 2.10	0.38
Total ICU LOS (hours)	0.89	0.68, 1.15	0.37
Postoperative LOS (days)	1.03	0.92, 1.15	0.62

*OR: Odds Ratio for dichotomous variables
*GMR: Geometric Mean Ratio for continuous variables

STS Overall Composite Scores: A Better Measure of High-Quality Cardiac Surgery

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Purpose: The Society of Thoracic Surgeons leveraged the Adult Cardiac Surgery Database to develop a hospital quality rating system specific to cardiac surgery. We sought to compare the STS Composite Score with the recently criticized Centers for Medicare & Medicaid Services (CMS) Overall Hospital Quality Star Ratings.

Methods: The Society of Thoracic Surgeons (STS) Public Reporting website was reviewed to identify program-level Overall STS Composite Scores for CABG and AVR (August 2018). This dataset was then merged with data from the Centers for Medicare & Medicaid Services (CMS) Overall Hospital Quality Star Ratings (July 2018) and the American Hospital Association (AHA) 2016 Annual Survey. The correlation between STS composite scores and CMS star ratings was assessed using Pearson correlation methodology. Univariable and multivariable analyses were performed to assess the influence of AHA hospital characteristics (governance, geographic region, teaching status and total surgical volume) on mean STS composite score.

Results: STS Overall Composite Scores were available for 490 hospitals, with a mean score of 92.71 (SD 1.61). CMS Overall Hospital Quality Star Ratings were available for 474 hospitals, with a mean score of 3.21 (SD 1.27). There was a moderate, but statistically significant correlation between mean STS Composite Scores and CMS Star Ratings ($r=0.192$, $p<.001$). CMS ratings inaccurately identified the quality of cardiac surgery programs for 16.3% of hospitals. Of these discordant rankings, 36 hospitals (7.3%) received high STS and low CMS rankings and 44 (9.0%) received low STS and high CMS rankings. The likelihood of receiving discordant scores was not associated with examined AHA hospital characteristics. Hospitals with high surgical volume ($p=0.04$), non-profit status ($p=0.01$), teaching status ($p=0.02$) or in the Northeastern region ($p=0.01$) had statistically significant higher mean STS Composite Scores (Table 1).

Conclusions: STS Cardiac Composite Scores may be more reliable than CMS Overall Hospital Quality Star Ratings when evaluating hospitals that perform cardiac operations. Patients and payers should be educated to utilize the STS Quality Ratings when assessing the quality of cardiac surgical care at a hospital.

AHA Hospital Characteristic	n (%)	Mean STS Score	95% CI	p-value
Governance				p=0.01
Nonfederal Government	28 (5.9)	92.68	91.88 - 93.48	
Non-profit	379 (80.5)	92.81	92.66 - 92.96	
For-proft	64 (13.6)	92.12	91.68 - 92.55	
Federal Government	0 (0.0)	-	-	
Region				p=0.01
New England	14 (3.0)	93.69	93.09 - 94.30	
Midatlantic	64 (13.6)	93.28	92.89 - 93.66	
South Atlantic	80 (17.0)	92.56	92.18 - 92.94	
Eastern North Central	106 (22.5)	92.72	92.44 - 92.99	
Eastern South Central	30 (6.4)	92.51	91.94 - 93.08	
Western North Central	38 (8.1)	92.49	91.90 - 93.08	
Western South Central	48 (10.2)	92.43	91.95 - 92.91	
Mountain	27 (5.7)	92.19	91.55 - 92.83	
Pacific	64 (13.6)	92.74	92.36 - 93.12	
Teaching Status				p=0.02
Non-teaching	359 (76.2)	92.61		
Teaching	112 (23.8)	93.01		
Surgical Volume				p=0.04
Low (<8,500)	118 (25.1)	92.42	92.13 - 92.71	
Medium Low (8,500-12,999)	110 (23.4)	92.6	92.32 - 92.87	
Medium High (13,000-20,999)	122 (25.9)	92.81	92.53 - 93.09	
High (21,000+)	121 (25.7)	92.98	92.67 - 93.29	

Impact of Intraoperative Dobutamine Stress Echocardiography on Surgical Planning and Outcomes of Septal Myectomy

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Purpose: Septal myectomy is the gold standard for management of obstructive hypertrophic cardiomyopathy (oHCM). We studied the impact of intraoperative pre- and post-procedure dobutamine stress echocardiography on surgical planning and outcomes of septal myectomy procedures.

Methods: We identified 49 patients undergoing septal myectomy for oHCM at our institution over a 20-month period. All patients underwent resting and dobutamine stress (20-40 mcg/kg/min) echocardiography after induction of anesthesia both pre- and post-procedure. Demographic, clinical and imaging data were prospectively collected in our cardiac surgery database.

Results: Patient age ranged from 19-76 years(mean 55 years). Sixty-seven percent of patients were NYHA Class III/IV. During outpatient evaluation, mean preoperative left ventricular outflow tract(LVOT) gradient was 132mmHg and severe mitral regurgitation(MR) was found in 93%(45/49). After induction of anesthesia, mean LVOT gradient was reduced to 48.6mmHg and 39.5%(19/45) had normal LVOT gradients(<30mmHg). With dobutamine stress, pre-procedure LVOT gradient was increased to 130mmHg and no patient had an occult gradient, which facilitated surgical planning. Post-procedure, mean resting and stress gradients were reduced to normal(10.3±7.0mmHg; 24.6±8.4mmHg, respectively), and 85%(42/48) had reduction of MR to none/mild with the highest degree of MR as moderate. The initial post-procedure dobutamine stress study demonstrated 3 patients with residual gradients which led to return to bypass for additional myectomy in these patients. Stress echocardiography performed 30-days postoperatively showed stable mean LVOT gradients of 18.7±16mmHg and 92%(44/48) of patients with none-mild MR.

Conclusions: Intraoperative dobutamine stress echocardiography during septal myectomy is useful to demonstrate occult LVOT gradients in up to 39% of oHCM patients who have occult gradients under anesthesia and essential to confirm adequate myectomy. This imaging strategy is associated with reliable relief of LVOT obstruction and MR as demonstrated at 30-day

Table I. Incidence of Occult LVOT Gradient in oHCM Patients After Induction of General Anesthesia

	N	Mean (mmHg)	Percentage <30mmHg
Outpatient Preoperative Stress Gradient	49	133.7	0
Pre-procedure Resting Gradient	48	48.6	39.5
Pre-procedure Stress Gradient	47	130.2	0
Initial Post-procedure Resting Gradient	48	10.3	97.9
Initial Post-procedure Stress Gradient	46	24.5	87

Long-Term Performance of Fresh Autologous Pericardium for Mitral Valve Leaflet Repair

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Purpose: Glutaraldehyde-fixed autologous or bovine pericardium is the currently accepted method for mitral valve (MV) leaflet patch reconstruction but can be associated with late calcification. Fresh autologous pericardium (FAP) may be a durable alternative material. The long-term clinical performance of FAP was evaluated in patients undergoing MV patch repair.

Methods: Fresh autologous pericardium was routinely used to repair MV perforations or augment MV leaflets. Pre-discharge and follow-up transthoracic echocardiography was performed to assess valve function, including a semi-quantitative evaluation of patch pliability and calcification. Pliability was scored on a scale of 1 (patch stiffness similar to native leaflets) to 4 (patch very stiff). Patch echogenicity was used as an indicator of calcification and was scored between 1 (patch brightness similar to native leaflets) and 4 (patch very bright). Only patients with matched pre-dismissal and follow-up data were used for statistical comparison.

Results: Between 2002-2017, 54 consecutive patients (mean age 47±3, 53% male, 44% i.v. drug users) underwent MV repair with FAP. Infective endocarditis was present in 37/54 (69%). Leaflet patch placement was anterior (29/54, 55%), posterior (24/54, 44%) or both (1/54, 2%) and 46/54 (85%) received annuloplasty rings. Operative mortality was 1/54 (2%; right heart failure). Pre-dismissal echocardiographic follow-up was available for 48/53 (91%). Late echocardiographic follow-up was available for 42/53 (79%). Median time to follow-up was 4y (range 0-13y). There were 9 late deaths. Three patients (6% of 53) had recurrent severe mitral regurgitation (0.5, 1, 6y post-op), and two underwent reoperation. In one case, there was progression of degenerative disease. In the other, recurrent endocarditis caused patch dehiscence. At reoperation, both patches were pliable, free from calcification and comparable in thickness to adjacent native leaflet. No other patients developed dehiscence, retraction, or aneurysm. Echocardiographic data is presented in the table.

Conclusions: This experience demonstrated no evidence of late FAP patch calcification, stiffness, or aneurysmal degeneration. Fresh autologous pericardium is an excellent substrate for complex MV repairs requiring leaflet patching and can be utilized with the expectation of durable long-term MV function.

	Pre-discharge	Follow-up	P-value[a]
Pliability (n = 37)	1.1 ± 0.1	1.2 ± 0.1	0.16
Brightness (n = 36)	1.5 ± 0.1	1.8 ± 0.1	0.01
Ejection fraction (n = 37), mean ± SEM	52.2 ± 2.2%	54.7 ± 2.6%	0.35
Mitral gradient (n = 29), median (IQR)	4 (3)	4 (4)	0.39
Mitral regurgitation, none/trace	88% (42/48)	57% (24/42)	
Mitral regurgitation, mild	12% (6/48)	29% (12/42)	
Mitral regurgitation, moderate	0% (0/53)	7% (3/42)	
Mitral regurgitation, severe	0% (0/53)	7% (3/42)	

[a]Only patients with matched pre-dismissal and follow-up data were used for statistical comparison (paired t-test, statistical significance = $P < 0.05$)

Native Coronary Disease Progression Post-Coronary Artery Bypass Grafting

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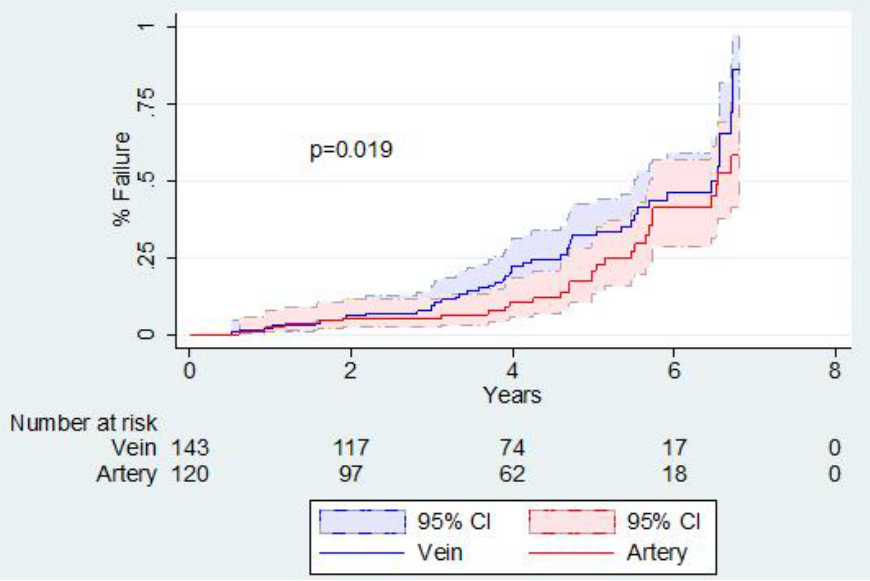
Purpose: Arterial grafts have intrinsic endothelial properties which protect them from atherosclerosis progression. It remains unclear as to whether graft type impacts proximal disease progression in the target native coronary arteries after coronary artery bypass grafting (CABG) Surgery.

Methods: Patients who underwent repeat cardiac catheterization at least 6 months post CABG were included. Pre and post CABG angiograms were examined by 2 experienced readers. Each coronary segment was viewed in at least 2 projections. Progression was defined as new stenosis of ?50% in a previously normal coronary, an increase in previous stenosis of ? 20%, or a new occlusion. The primary outcome was the occurrence of native upstream disease progression in bypassed vessels. Secondary outcomes included

complete occlusion, left main (LM) progression, and distal disease progression. Cox proportional hazard regression models were used for time-to-event outcomes.

Results: The final study population included 98 patients comprising 263 grafts (143 arterial grafts, 120 venous grafts). The median time from date of surgery to date of catheterization was 559 days (IQR 374, 910). Ninety-one target vessels showed disease progression (34.6%) with 75 progressing to complete occlusion (28.5%). Target vessel progression was not associated with graft choice (HR 0.74 (0.49, 1.13) p=0.163), but was significantly associated with age (p=0.034), previous PCI (p=0.002), ACE inhibitor (ACEi) use (p<0.001), CAD severity (p<0.001), CCS class III/IV (p=0.016) and NYHA class III/IV (p<0.001). Progression to complete occlusion was significantly associated with SVGs (p=0.09). Other factors associated with complete occlusion of non-LM coronaries included: previous PCI (p=0.007) and ACEi use (p<0.001). Peripheral vascular disease was the only significant factor associated with LM disease progression (HR 5.44 (1.92, 15.46), p=0.001), and progression was not dependent on graft choice (p=0.754).

Conclusions: Native disease progression post CABG is common, with most vessels demonstrating complete occlusion. Disease progression in non-LM coronary arteries was multifactorial, whereas LM progression was only associated with PVD. Vein graft use was significantly associated with progression to complete occlusion in non-LM coronaries, but had no effect on LM progression.



Unilateral vs Bilateral Antegrade Cerebral Perfusion in Hemiarch to Total Arch Replacement in Acute Type A Aortic Dissection: 16 Years of Experience

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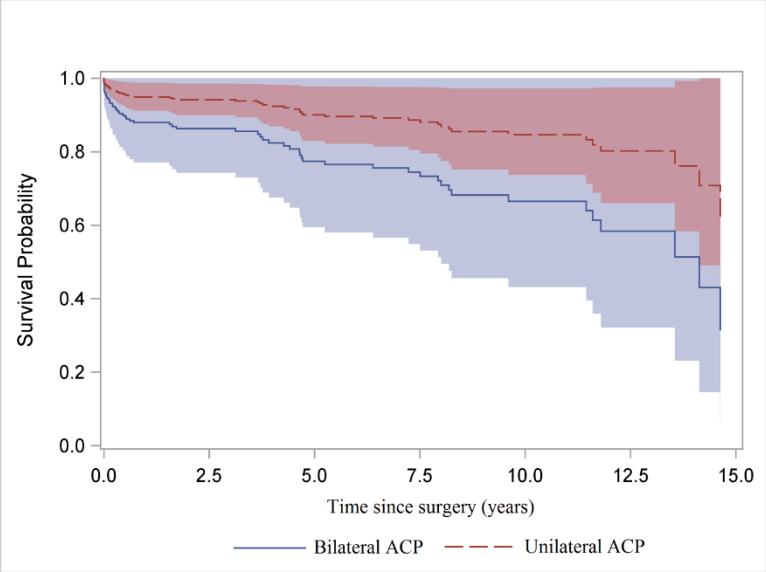
Purpose: To determine the short- and long-term outcomes of unilateral and bilateral antegrade cerebral perfusion (uniACP and biACP) in hemiarch to total arch replacement in surgical repair of an acute type A aortic dissection (ATAAD).

Methods: From 2001-2017, 307patients underwent surgical repair of an ATAAD utilizing uniACP (n=140) and biACP (n=167). After propensity score match, a total of 88 matched pairs were identified based on age, history of stroke, cerebral malperfusion, hemiarch, and zone 1, 2, 3 arch replacement. The primary outcomes were postoperative stroke and operative mortality between uniACP and biACP. We further compared outcomes of uniACP vs. biACP in subcohort A: no separate left common carotid artery (LCC) implantation Hemiarch/Zone 1 arch replacement (n=162, uniACP n=104, biACP n=58) and subcohort B: with LCC implantation-Zone 2/3 arch replacement (n=145, uniACP n=36, biACP n=109).

Results: The demographics and preoperative comorbidities were similar between the uniACP and biACP groups. Both uniACP and biACP groups had similar rates of procedures for aortic valve/root, ascending aorta, frozen elephant trunk, and other concomitant procedures. In the whole cohort, between unilateral and bilateral ACP, there were no significant differences of perioperative outcomes except biACP had a greater incidence of reoperation for bleeding with and without propensity score match. (Table) In the subcohort analysis, patients with hemiarch/zone 1 arch replacement and those with zone 2/3 arch replacement, perioperative outcomes were similar. The logistic regression showed the odds ratio of biACP vs. uniACP was 2.33 (p=0.15) for postoperative stroke and 2.77 (p=0.13) for operative mortality. The 5-year survival was better in the uniACP group (84% vs. 76%, p=0.0273). The Cox proportional hazard analysis showed the hazard ratio of late death for biACP vs. uniACP was 2.44 (95% CI: 1.02, 5.82, p=0.04). (Figure)

Conclusions: In ATAAD, both uniACP and biACP are equally effective to protect the brain with low postoperative stroke rate and operative mortality in hemiarch to total arch replacement. Unilateral ACP is recommended for its simplicity and potential lower risk of postoperative complications and better mid-term survival.



Long-term survival (Cox-Proportional Hazards analysis adjusted by age, gender, year of operation, peripheral vascular disease, ejection fraction, NYHA III/IV, arch procedures) of patients with acute type A aortic dissection repair with unilateral and bilateral antegrade cerebral perfusion. HR=2.43 (95% CI: 1.02, 5.82, P=0.04).

Table: Unilateral vs. Bilateral Antegrade Cerebral Perfusion in ATAAD

	Total (n=307)	Unilateral ACP (n=140)	Bilateral ACP (n=167)	p-value
Age (years)	59 (49, 67)	59.5 (52, 69.5)	57 (48, 66)	0.029
Preoperative Cerebral Malperfusion	17 (5.5)	10 (7.1)	7 (4.2)	0.26
CPB time (min)	227 (190, 281)	224.5 (191.5, 280)	230 (188, 285)	0.86
Cross-clamp time (min)	160 (116, 205)	144 (103, 184.5)	173 (133, 224)	<0.0001
HCA time (min)	38 (27, 49)	29 (22.5, 38)	45 (38, 55)	<0.0001
Lowest temp (°C)	18 (17, 22)	20 (18, 24)	17 (16, 18)	<0.0001
Reoperation for Bleeding	27 (8.9)	7 (5.0)	20 (12)	0.027
Stroke	24 (7.8)	9 (6.4)	15 (9.0)	0.40
Myocardial Infarction	3 (1.0)	1 (0.7)	2 (1.2)	1
New-Onset Renal Failure on Dialysis	25 (8.2)	11 (7.9)	14 (8.6)	0.82
Deep Sternal Infection	4 (1.3)	1 (0.7)	3 (1.8)	0.63
Sepsis	6 (2.0)	3 (2.1)	3 (1.8)	1
Paraplegia	2 (0.7)	1 (0.7)	1 (0.6)	1
Hours Intubated	45.5 (23, 99)	41 (22, 91)	51 (24, 106)	0.24
Reintubation	21 (6.9)	9 (6.4)	12 (7.2)	0.79
Postoperative Length of Stay (days)	11 (7, 17)	11 (7, 16)	12 (7, 18)	0.34
Intraoperative Mortality	4 (1.3)	0 (0)	4 (2.4)	0.13
30-day Mortality	18 (5.9)	5 (3.4)	13 (7.8)	0.12

Data presented as median (25%, 75%) for continuous data and n (%) for categorical data.
Abbreviations: CPB = cardiopulmonary bypass time; HCA = hypothermic circulatory arrest.

Residual Leaflet Excision for Severe Leaflet Elongation in Obstructive Hypertrophic Cardiomyopathy

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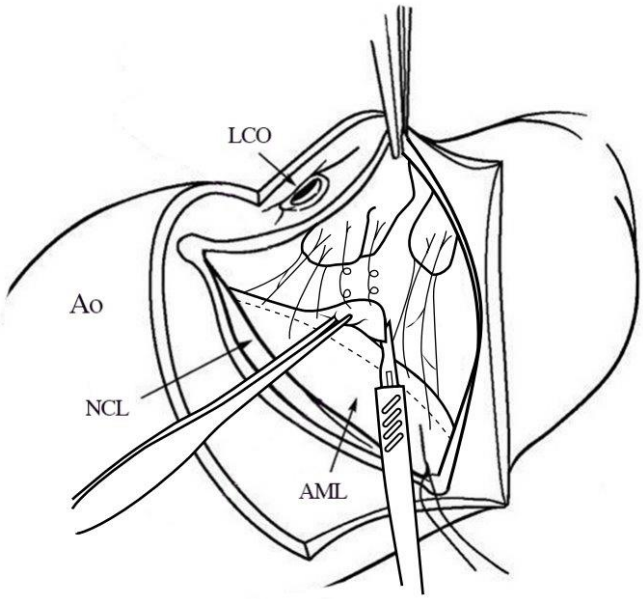
Purpose: We developed a new technique for the management of obstructed hypertrophic cardiomyopathy (HCM) in patients who have particularly long anterior leaflets (AML) >30mm, with modest septal thickening (usually <20mm). These patients often have residual leaflet (RL) tissue that extends past the coaptation plane and contributes to obstruction.

Methods: Patients with septal thickness >25mm were generally just subjected to myectomy and papillary muscle release. Patients with severe leaflet elongation (all with AML >30mm) and systolic anterior motion (SAM) were approached one of two ways depending on their echocardiographic pattern and direct inspection: Group 1 patients with long leaflets but no RL had myectomy and an anterior leaflet plication to stiffen and shorten the leaflet; Group 2 patients, identified with a RL and other supporting chordal attachments that would prevent prolapse, underwent RELEX. The RL of A2 was excised along with the associated chords.

Results: Over a five-year period, 226 patients underwent surgery for HCM. 92 patients had mitral leaflet surgery as an ancillary procedure: 38 in Group 1 and 54 in Group 2. There were no significant differences in age, gender distribution, or preoperative NYHA class. Septal thickness was also nearly identical in both groups (1.965 ± 0.17 mm). There were no significant differences between either pre-operative gradients (113.8 ± 38.2 vs. 117.0 ± 42.9) or mitral regurgitation (2.3 ± 0.9 vs. 2.4 ±1.0), nor in post-operative gradients (6.7 ±8.6 vs. 5.9 ± 10.4) or mitral regurgitation (0.6 ± 0.5 vs. 0.8 ± 0.4) ($p<0.05$). Symptom relief was similarly identical. One patient in Group 1 had a release of the plication suture line and one patient in Group 2 had an edge to edge suture placed for insufficiency, still during the initial procedure. Both procedures add insignificantly to cross clamp time at surgery.

Conclusions: RELEX assures reproducible gradient abolition when AML is long with septum <20mm. Here thickness of myectomy is necessarily limited by substrate, and alone may not be an adequate intervention to eliminate SAM. When performed with care, and cognizant of remaining leaflet support, RELEX does not result in mitral regurgitation.



Preoperative Left Ventricular Strain Predicts Left Ventricular Dysfunction After Mitral Surgery for Degenerative Mitral Regurgitation

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Purpose: Patients with normal preoperative left ventricular ejection fractions (LVEF) can develop LV dysfunction following mitral valve (MV) surgery for DMR. Our objective was to determine the optimal preoperative predictors of early postoperative LV dysfunction in these patients.

Methods: From 2004 to 2017, 520 patients with preoperative LVEF/s > 60% underwent MV surgery (98% MV repair) for DMR. Echocardiograms were performed preoperatively (Pre-Op), pre-discharge (Pre-Dsg), and on follow-up (F/U) (mean 5.0 ± 3.6 years). Patients were categorized according to their Pre-Dsg LVEF and groups were compared using the log-rank test. Multivariate logistic regression and Cox proportional hazards models determined the predictors of postoperative LV dysfunction and survival. We retrospectively calculated the preoperative global longitudinal strains for the left ventricle (LV GLS), right ventricle (RV GLS), and left atrium (LA GLS) in 119 patients to determine their value in predicting

Results: Median Pre-Op LVEF in the 520 patients was 65%. 449 patients maintained normal postoperative LV function (LVEF $\geq$50%). 71 patients (13.7%) had Pre-Dsg LVEF's <50% and 22 of them (4.2%) were <40%. Global LA GLS was less in both groups with postop LV dysfunction. Patients in the Pre-Dsg LVEF <50% and <40% groups had similar preoperative LV end-diastolic volumes and stoke volumes and similar RV end-diastolic areas and end-systolic areas (Table). However, preoperative LA endocardial GLS, LV endocardial GLS, LV myocardial GLS, RV fraction area change, RV endocardial GLS and RV stroke area were all significantly worse in the groups who developed postoperative (Pre-Dsg) LVEF's <50% and <40%. LVEF returned to normal in all patients as determined by F/U echo at the last outpatient visit. Five-year survival was similar in all groups.

Conclusions: Preoperative LA, LV, and RV strains were superior to standard hemodynamic parameters in predicting postoperative LV dysfunction following MV surgery for DMR. The preoperative identification of subclinical heart failure with preserved LV function using strain calculations should help to optimize the timing of MV surgery for DMR.

	Pre-Discharge Groups Based on LVEF			
Preoperative Measurements	LVEF ≥ 50 *(n = 48)*	LVEF < 50 *(n = 49)*	LVEF < 40 *(n = 22)*	p-value
Strain Parameters				
LA Endocardial GLS (%)	-25.2 ± 12.1	-18.0 ± 7.9	-12.8 ± 8.7	<0.001
LV Endocardial GLS (%)	-24.5 ±2.9	-19.4 ±3.6	-18 ± 2.9	<0.001
LV Myocardial GLS (%)	-19.4 ± 2.8	-16.3 ± 4.1	-12.9 ± 3.4	<0.001
RV Fraction Area Change (%)	39.5 ± 11.7	31.0 ± 9.8	27.0 ± 10.5	<0.001
RV Endocardial GLS (%)	-21.6 ± 6.2	-16.1 ± 6.2	-15.1 ± 5.2	<0.001
RV Stroke Area (ml)	5.7 ± 3.0	4.3 ± 2.1	3.2 ± 1.8	0.018
Non-Strain Parameters				
LV End-Diastolic Vol (ml)	117 ± 36.7	130.9 ± 43.2	135.3 ± 48.9	0.14
LV Stroke Volume (ml)	80.1 ± 26.2	78.7 ± 30.5	80.0 ± 31.7	0.97
RV End-Diastolic Area (ml)	13.9 ±5.0	13.9 ± 2.9	12.3 ±4.8	0.62
RV End-Systolic Area (ml)	8.0 ± 2.6	9.5 ± 2.2	9.1 ± 3.8	0.06

Current Evidence Does Not Support the National Quality Forum-Endorsed Quality Measures Requiring Administration of Beta-Blockers Within 24 Hours Prior to Isolated Coronary Artery Bypass Grafting

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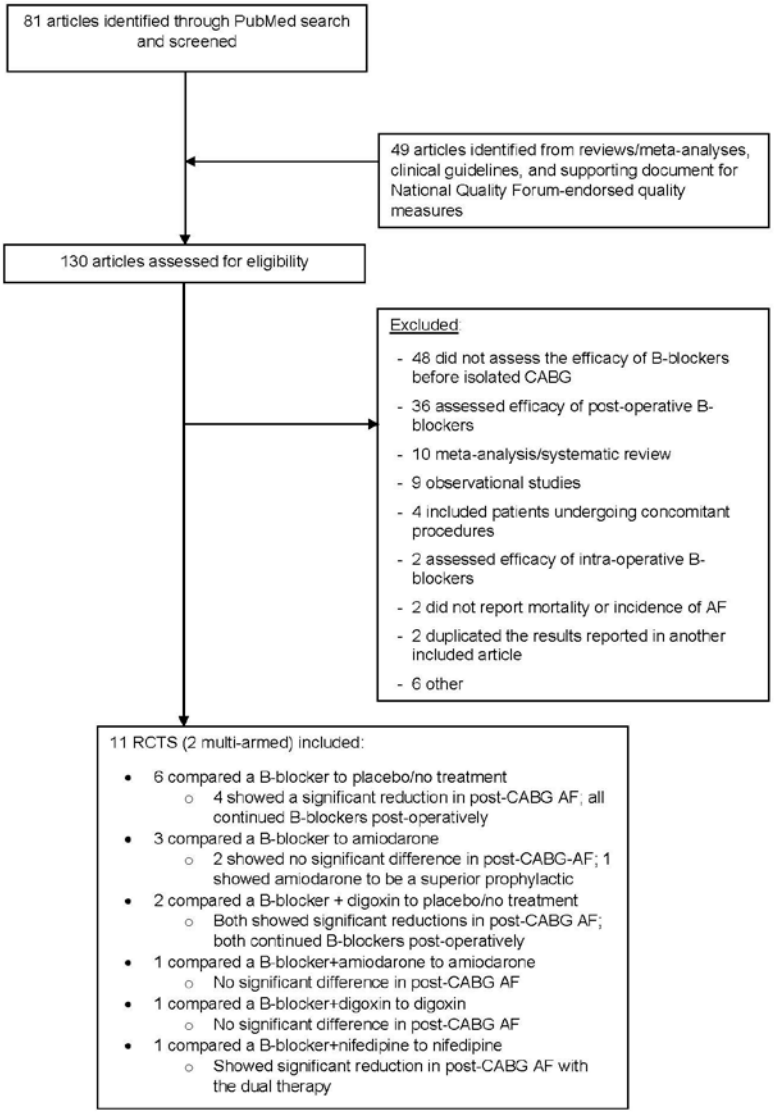
Purpose: The National Quality Forum (NQF) has endorsed 2 quality measures, used in public-reporting and value-based payment programs, that the administration of B-blockers within 24 hours prior to isolated coronary artery bypass graft surgery (CABG) to prevent post-CABG atrial fibrillation (AF). Questions have arisen about the evidence supporting these quality measures.

Methods: We conducted a systematic search of the literature for randomized controlled trials (RCTs) examining the impact of pre-operative B-blockers on AF or mortality following isolated CABG. We also reviewed the studies cited in support of the rationale underlying the NQF-endorsed measures, and related recommendations in the current ACCF/AHA and ESC/EATCS guidelines for CABG.

Results: We identified 11 RCTs testing the efficacy of pre-operative B-blockers in preventing AF following isolated CABG. These differed too widely in the B-blocker utilized, timing (start times ranging from 7 days pre-operatively to immediately after induction of anesthesia), dosage, and comparison treatments for meta-analysis. Results are summarized in Figure 1. Of the 8 comparisons to placebo (n=826 patients), 6 showed significant reductions in AF/supraventricular arrhythmias; however, all continued B-blockers post-operatively, making it difficult to separate the benefits of pre- vs post-operative administration. All 3 comparisons (n=544) between B-blockers and amiodarone showed significantly greater reductions in AF with amiodarone, and the comparison of B-blocker+amiodarone to amiodarone (n=160) showed no added benefit with the B-blocker. Seven of the RCTs addressed mortality: 2 (n=293) reported greater mortality in patients undergoing B-blocker treatment, 2 (n=491) no difference in mortality, and 1 (n=71) lower mortality for patients taking ?-blockers.

Conclusions: The current evidence provides reasonable support for a quality measure requiring perioperative administration of B-blockers to prevent AF following isolated CABG, but not limited to the 24 hours prior to surgery. The quality measures should be revised to reflect the evidence, including the greater efficacy of amiodarone.



Impact of Socioeconomic Status in Patients Undergoing Transcatheter Aortic Valve Replacement: A Statewide Analysis

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Purpose: TAVR is a widely used, yet costly, treatment for severe aortic valve stenosis. Previous studies have demonstrated poorer outcomes in patients with lower socio-economic status undergoing open heart surgery. The purpose of this study is to analyze the role of patient socio-economic status on readmission rates and mortality following TAVR.

Methods: The Maryland Health Services Cost Review Commission database was reviewed for patients who have undergone TAVR procedures based on ICD codes, since the Centers for Medicare and Medicaid Services approved their coverage in 2012. The TAVR patients were matched to 2015 median household incomes by zip codes. Continuous variables were compared using t-tests, and categorical variables were compared using chi-squared tests. Logistic regression was used to calculate odds ratios.

Results: In the State of Maryland, 1551 patients underwent TAVR procedures from Jul 2012 to Sep 2017. Readmissions within 30 days occurred in 20% of patients with 1.2 ± 0.5 readmissions per patient. Readmissions within 1 year occurred in 34% of patients with 1.8 ± 1.2 readmissions per patient. If readmitted within 30 days, the odds ratio of being readmitted again within a year was 2.2 (95% C.I. 1.7-2.9, $p < 0.01$). Patients who have more readmissions within a year tend to have higher overall mortality (1 readmission: OR 2.1, 95% CI 1.2-3.8, $p = 0.01$; 2 or more readmissions: OR 4.1, 95% CI 2.4-7.1, $p < 0.01$), compared to patients with no readmissions. When evaluated by median household income stratified by quartiles, there were no statistical differences in hospital readmissions at 30 days ($p = 0.43$) and 1 year ($p = 0.80$), as well as overall mortality ($p = 0.54$).

Conclusions: Our study demonstrates that lower socio-economic status is not associated with increased 30-day or 1-year hospital readmissions, or mortality in TAVR patients. Patients who are readmitted within 30 days are more likely to be readmitted within the same year and have higher mortality.

Implications of Methicillin-Resistant Staphylococcus aureus Carrier Status on Cardiac Surgical Outcomes: A Nationwide Perspective

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Purpose: Staphylococcus aureus remains the most common cause of sternal surgical site infections (SSI), a growing number of which result from methicillin-resistant Staphylococcus aureus (MRSA). Opinions regarding the postoperative implications of preoperative MRSA colonization currently differ. This study aimed to investigate whether MRSA carriage affects postoperative outcomes and safety of operation.

Methods: A total of 3,124,048 patients undergoing cardiac surgery (coronary artery bypass graft, valve, or aortic surgery) were identified from the Nationwide Inpatient Sample database using International Classification of Diseases, 9th Edition procedure codes. Among these, 5,940 (0.19%) were carriers of MRSA. Multivariable logistic regression analysis and propensity-score matching were used to determine the possible effect of preoperative MRSA colonization on postoperative outcomes.

Results: MRSA carriers did not differ in age or sex from non-carriers (66 vs 65 years, p = 0.12; 66% vs 68% male, p=0.09), but more often presented for urgent surgery (51% vs 47%; p=0.02). Among matched pairs, there was no difference in mortality (p=0.48), stroke, SSI, pneumonia, renal failure, cardiac complications, respiratory failure, or prolonged mechanical ventilation. Rates of MRSA infection were significantly higher (3.5% vs 0.3%; p<0.0001) among MRSA carriers, as was MRSA septicemia (0.87% vs 0%), blood transfusion (35% vs 29%; p=0.003) and length of stay (11 vs 10 days; p=0.005). Complications and increased length of stay did not translate into any significant increase in cost (p=0.12). Predictors of MRSA infection among carriers included age over 85, African American race, rural hospital location, and diabetes. Carriers with endocarditis (OR, 10.8; CI, 4.2, 27.4) and drug abuse (OR, 7.8; CI, 3.6, 16.9) were at highest risk for MRSA infection.

Conclusions: MRSA carriers undergoing cardiac surgery are not at higher risk for mortality or SSI after cardiac surgery, and can expect outcomes similar to those of non-carriers. Higher rates of postoperative MRSA infection and septicemia among carriers, although still very low, support the practice of preoperative screening and prophylaxis when possible.

Causes, Risk Factors, and Costs Associated With 30-Day Readmissions Following Mitral Valve Repair and Replacement

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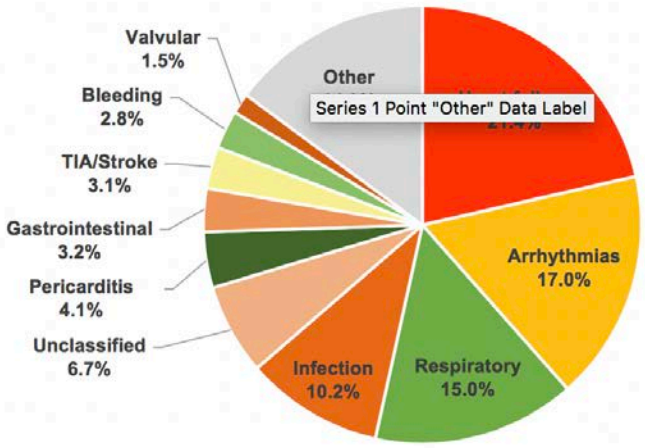
Purpose: Postsurgical readmissions are an increasingly scrutinized marker of healthcare quality. Previous reports on readmissions following mitral valve surgery are limited to single-center reports or analyses of Medicare-only populations[1,2]. We sought to estimate the risk factors and costs associated with readmissions following mitral valve surgery in a large, nationally-representative cohort.

Methods: Adult patients undergoing mitral valve repair or replacement were queried from the National Readmissions Database from 2010 to 2014. Analysis was limited to isolated mitral valve surgery, patients with previous history of valve surgery were excluded. Estimates of hospital cost were made by converting individual hospital charge data and adjusting to 2014 consumer price indices. Data was collected on the prevalence and indications for readmission within 30 days as well as the hospital-, procedure, and patient-level risk factors as determined by multivariable logistic regression.

Results: Among 76,342 patients undergoing mitral valve (MV) surgery, the rate of 30-day readmission was 17.0%. Those undergoing replacement procedures had significantly higher readmission rates (20.7% vs. 13.1%, p<0.001). Significant independent predictors of readmission following both MV repair and replacement were female sex, Medicare payer status, length of stay ?8 days, discharge to a nursing facility, chronic lung disease, chronic renal disease, and low hospital procedural volume for MV surgery. Readmissions to non-index hospitals accounted for 26.6% of all readmissions. The most common indications for readmission were heart failure (21.4%), arrhythmia (17.0%), respiratory diagnoses (15.0%), and infections (10.2%). Heart failure, infection, and respiratory diagnoses were also associated with the greatest overall cost burden, accounting for 23.5%, 18.2%, and 16.0% of total readmission-related costs respectively. The mean cost per readmission was $15,397, and among readmitted patients the cost of readmission accounted for 17.8% of the total cost of the episode of care.

Conclusions: Nearly one in five patients undergoing mitral valve surgery are readmitted within 30 days. Treatment at a low-volume center was strongly associated with readmission, and much of the readmission burden is placed on non-index hospitals. Further characterization of readmissions may improve the quality of care associated with mitral valve surgery.

Abstract Figure: Causes of Readmission Following Mitral Valve Surgery



Abstract Table: Multivariable Analysis of Factors Associated With 30-Day Readmission after Mitral Valve Surgery

	Mitral Repair		Mitral Replacement	
Variable*	**AOR (95% CI)**	**P-value**	**AOR (95% CI)**	**P-value**
Patient Characteristics				
Age ≥ 75 years	1.06 (0.90-1.26)	0.47	0.94 (0.83 - 1.07)	0.35
Male	0.83 (0.74-0.94)	0.004	0.93 (0.85 - 1.03)	0.017
Primary payer				
Private	1.00	-	1.00	-
Medicare	1.22 (1.05 - 1.42)	0.009	1.32 (1.17 - 1.50)	<0.001
Medicaid	1.21 (0.93 - 1.58)	0.153	1.50 (1.28 - 1.76)	<0.001
Other	1.35 (1.05 - 1.73)	0.017	1.08 (0.88 - 1.32)	0.47
Comorbidities				
Coronary artery disease	1.12 (0.97 - 1.29)	0.14	1.11 (1.00 - 1.24)	0.05
Myocardial infarction	1.20 (0.89 - 1.61)	0.24	1.22 (0.99 - 1.50)	0.056
Congestive heart failure	0.95 (0.63 - 1.41)	0.78	1.06 (0.85 - 1.32)	0.60
Peripheral vascular disease	1.34 (1.07 - 1.68)	0.010	1.06 (0.91 - 1.24)	0.44
Chronic lung disease	1.29 (1.11 - 1.50)	0.001	1.18 (1.06 - 1.31)	0.003
Diabetes mellitus	1.18 (1.00 - 1.39)	0.054	1.20 (1.07 - 1.34)	0.001
Chronic renal disease	1.47 (1.21 - 1.78)	<0.001	1.34 (1.20 - 1.52)	<0.001
Liver disease	1.27 (0.87 - 1.84)	0.21	1.27 (0.99 - 1.64)	0.058
Admission Characteristics				
Annual MVS, quartile				
1-13 cases	1.00	-	1.00	-
14-26 cases	0.93 (0.78 - 1.10)	0.38	1.12 (0.99 - 1.27)	0.07
27-51 cases	0.88 (0.74 - 1.06)	0.17	1.01 (0.89 - 1.14)	0.89
≥52 cases	0.82 (0.68 - 0.98)	0.030	0.86 (0.75 - 0.98)	0.024
LOS ≥8 days	1.26 (1.10 - 1.45)	0.001	1.45 (1.30 - 1.63)	<0.001
Discharge disposition				
Home (self-care)	1.00	-	1.00	-
Home with home health care	1.23 (1.08 - 1.41)	0.002	1.19 (1.07 - 1.32)	0.002
Nursing facility	1.72 (1.40 - 2.11)	<0.001	1.61 (1.41 - 1.84)	<0.001
Transitional care hospital	2.74 (1.52 - 4.94)	0.001	1.46 (1.01 - 2.12)	0.045

*Includes covariates significantly associated with readmissions on univariate analysis only

Incidence, Mortality, and Resource Utilization of Deep Venous Thrombosis and Pulmonary Embolism in Cardiac Surgical Patients: Insights From the National Inpatient Sample 2005-2015

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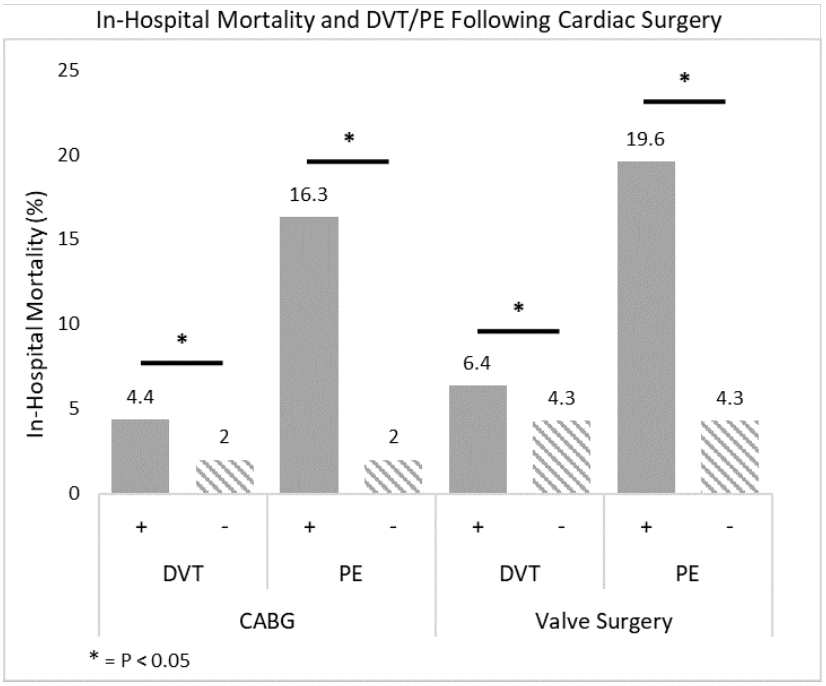
Purpose: Deep venous thrombosis (DVT) and pulmonary embolism (PE) are life-threatening complications following surgery, warranting prophylaxis. However, due to inadequate characterization, clinical guidelines for thromboembolism prevention in cardiac surgery are lacking. This study aimed to characterize the national incidence, mortality, and costs associated with DVT and PE following cardiac surgery.

Methods: The 2005-2015 National Inpatient Sample was used to identify all adult patients undergoing coronary artery bypass (CABG) or valve surgery. ICD-9 codes were used to identify patients with in-hospital DVT and PE. We excluded patients with concurrent extracorporeal membrane oxygenation or heart transplant, and endocarditis. Baseline patient and hospital characteristics were analyzed using Student's t-test and chi-squared test for continuous and categorical variables, respectively. Incremental costs and impact of DVT and PE on in-hospital mortality were evaluated using risk-adjusted multivariable logistic regression models.

Results: Of approximately 3 million patients undergoing cardiac surgery, 1.60% developed DVT and 0.38% PE. Those with DVT/PE were more commonly female (33.6 vs. 31.2%, P<0.001), older (67.7 vs. 65.7 years, P<0.001), and had a higher Elixhauser comorbidity index (4.1 vs. 3.7, P<0.001). Compared to those without, CABG and valve surgery patients with either complication (CABG: DVT=1.4%, PE=0.38%; valve surgery: DVT=2.0%, PE=0.39%) had higher rates of mortality (Figure). After adjustment for baseline differences, DVT was associated with an incremental increase in cost of $11,488 and $12,280, while PE was associated with $14,589 and $13,907 cost increase following CABG and valve surgery, respectively. Diagnosis of PE was an independent predictor of mortality in CABG (OR, 4.8; 95% CI 3.7 – 6.2) and valve surgery patients and (OR, 2.3; 95% CI 1.7 – 3.2).

Conclusions: The mortality and financial burden related to DVT and PE during hospitalization for cardiac surgery remain significant. Prophylaxis may be indicated in CABG and valve patients to improve quality of care and reduce healthcare costs. Future controlled randomized trials investigating the benefit of thromboembolism prophylaxis in cardiac surgery are warranted.



Long-Term Outcomes of Diabetic Patients Following Coronary Artery Bypass Grafting Surgery: 12-Year Data

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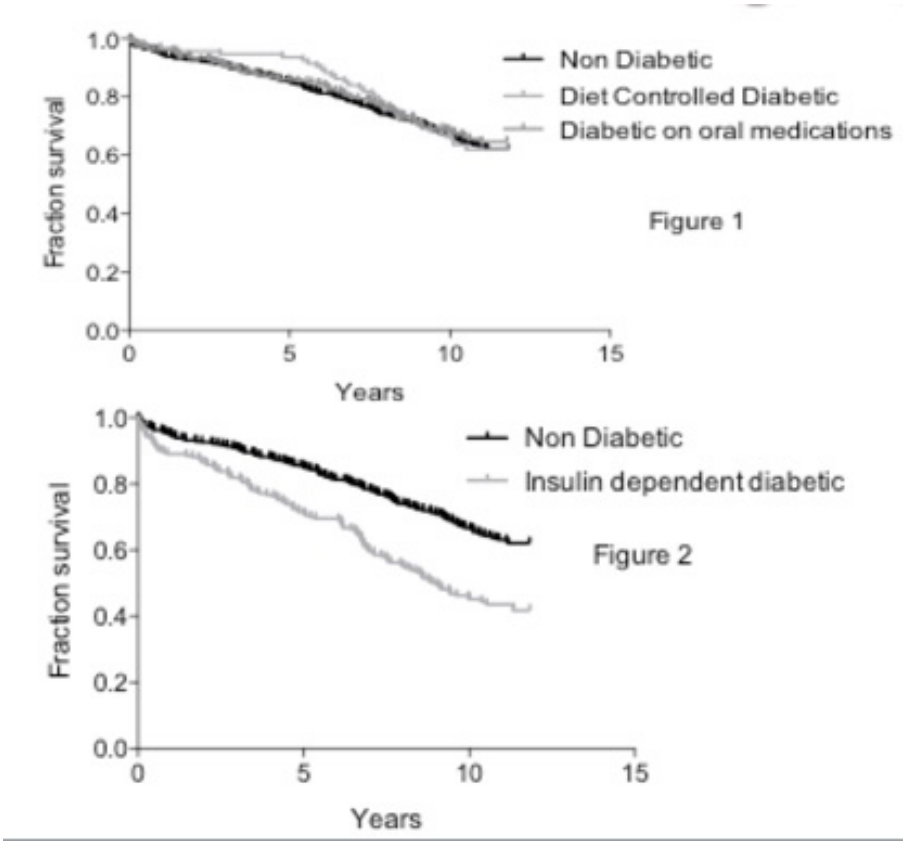
Purpose: The prevalence of diabetes in patients presenting for CABG continues to rise. EuroScore II predicts increased operative mortality in insulin-dependent diabetic patients undergoing cardiac surgery but long-term outcomes are unknown. The aim of this study was to evaluate the impact of diabetes on long term survival after coronary surgery.

Methods: We analysed prospectively collected data from all patients who underwent isolated first time CABG in our centre over a 2-year period, between January 2006 and December 2007. Patient characteristics and post-operative survival (in-hospital and late) were compared between 4 patient groups: non diabetic (ND), diabetic on diet control (DD), diabetic on oral medications (OD) and diabetic on

insulin (ID). All-cause mortality following CABG was ascertained from the NHS Spine Portal. Kaplan-Meier curves were used to calculate actuarial survival. Log-rank test was used to calculate the P-value.

Results: A total of 1095 patients underwent isolated first time CABG. 636 (58.1%) were diabetic: 211 (33.2%) were ID, 331 (52%) were OD and 94 (14.8%) were DD. Diabetic and non-diabetic patients had similar characteristics: diabetic patients vs ND (mean age 66±9 years vs 68.2±9 years, male 77% vs 79%, impaired LV function 41% vs 37%, respectively). In-hospital mortality was 5/459 (1.1%) in the non-diabetic and 5/636 (0.8%) in the diabetic patients (p= 0.74). At 12 years follow-up, there was no difference in the survival between the ND (66% survival) and non-insulin dependent diabetic patients (65% survival in DD and OD); p= 0.4) (Figure 1). However, there was a significant difference in survival between the non-diabetic (66% survival) and the insulin dependent patients (46% survival); p= < 0.0001 (Figure 2), at 12 year follow-up.

Conclusions: Insulin dependent diabetic patients experience worse long-term survival following CABG. Non-insulin dependent diabetic patients appear to have similar long-term survival to non-diabetic patients. This study, with the longest follow-up, is the first to demonstrate similar survival in non-insulin diabetic versus non diabetic patients after coronary surgery, at 12 years.



Early Results of Partial Zone 2 Arch Replacement With Staged Single-Branch Thoracic Endovascular Aortic Repair Completion in Acute DeBakey I Dissection With Arch Tear: A Pioneer Series

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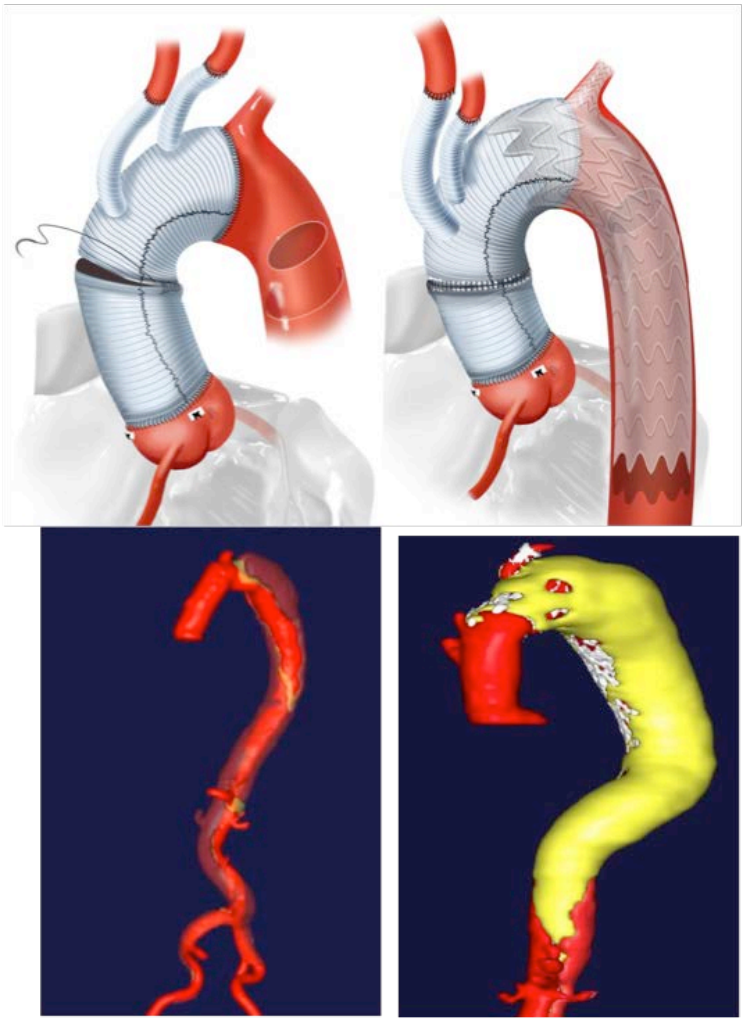
Purpose: Acute DeBakey I dissection with arch tear is a complex problem. Branched TEVAR grafts can facilitiate less complex open arch procedures but still definitively replace the arch in a staged fashion. We represent a First-in-Man experience of 18 consecutive cases of Zone2 partial arch replacement with a single branched TEVAR.

Methods: Between 2015 and 2018, we performed 18 cases of Zone 2 Arch replacement for acute type A aortic dissection with branched TEVAR completion. At the index open procedure, the aorta was resected to just proximal to the LSCA and a two-vessel arch replacement with individual grafts to the innominate artery and left common carotid were performed under circulatory arrest with antegrade cerebral perfusion. A 3-4cm TEVAR landing zone was left in Zone2. The TEVAR device used was the investigational Gore Thoracic Branched Endoprosthesis (TBE) with main body docked into the surgical graft and the single branched placed into the LSCA.

Results: At the index open surgery, all patients had a tear extending into the arch or large fenestrations or primary tear in the descending thoracic aorta (DTA) requiring more complex arch surgery. Branch vessel malperfusion was seen in 2/3 of

patients. Central cannulation was used 2/18 and axillary cannualtion was used in 16/18 cases. Zone 2 Arch was performed in all patients with a mean circulatory arrest/ACP time of 36+/-12minutes. Periprocedural outcomes included zero operative mortalities, new dialysis or strokes. There was one left recurrent laryngeal nerve injury. Single branched TEVAR was performed successfully in all cases at a median of 39 days post Type A dissection. There were no periprocedural mortalities, strokes, paralysis/paraparesis at the TEVAR implant. 100% of patients acheived false lumen thrombosis at the level of the stented aorta but thrombosis of the false lumen in the distal, abdominal aorta was uncommon (11%).

Conclusions: Acute DeBakey I dissection with arch or distal tear is a challenging problem. Zone 2 partial arch replacement with completion with a single branched TEVAR allows for total arch and DTA replacement in a staged fashion with very low complications rates and excellent remodelling of the stented portion of the DTA.



Pre-op Characteristics	N=18
Presence of either arch/DTA tear	100% (18)
Malperfusion	66%(12)
Cerebral	44% (8)
Renal	33% (6)
Limb	28% (5)
Dissected Supra-Aortic Vessels	44% (8)

30 Days Post-Op Outcomes	N=18
Mortality	0%
Post-Op CVA	0%
Paralysis(any)	0%
Rec. Laryngeal n. Injury	5.5% (1)
Dialysis	0%
FL thrombosis at level of Stent	100%
FL Thrombosis Below Stent	11% (2)

Temporal Trend and Patient Characteristics in Surgery for Endocarditis Associated With Illicit Drug Use: A Report From the Multicenter Surgical Endocarditis Collaborative

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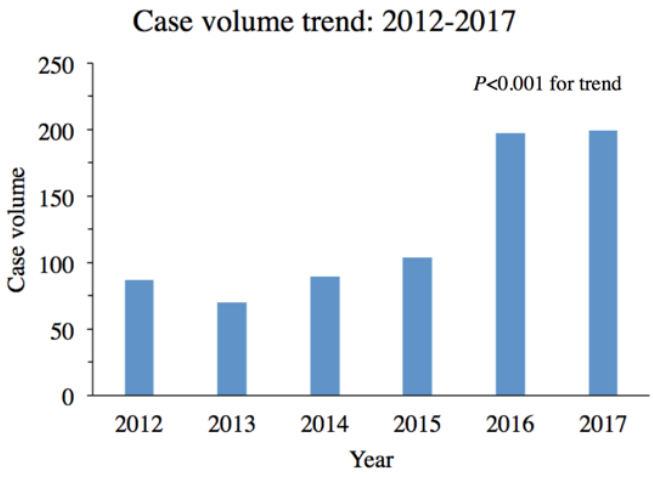
Purpose: The National opioid endemic has likely influenced the surgical volume of infective endocarditis (IE) associated with illicit drug use (IDU). Contemporary patient characteristics, operative outcomes, and temporal trends in case volume are unknown. A multicenter Surgical Endocarditis Collaborative was developed to investigate this topical matter.

Methods: A clinical registry was developed among 9 major academic centers across the U.S. for patients who underwent valve surgery for IE associated with IDU between 2011 and 2017. The Society of Thoracic Surgeons Adult Cardiac Surgery Database data definitions for data version 2.81 were used for all data fields. Descriptive analyses were performed to characterize the demographics, comorbidities, and operative outcomes. A poisson regression model was fitted to evaluate temporal changes in case volume between 2012-2017. Data from 2011 was not included in the trend analysis due to an incomplete calendar year.

Results: Among 771 patients who underwent valve surgery for IE associated with IDU, mean age was 39.5±12.7 years and 33% (253) were female. Between 2012-2017, surgical case volume increased significantly by 130% from 87 to 199 cases per year (p<0.001), and this increase was also observed at the center-level. Active endocarditis comprised 78% (602) of the cases. Most common organisms were staphylococcus aureus (37.6%, 290 cases), streptococcus (22.2%, 171 cases), and enterococcus (11.4%, 88 cases). Preoperative stroke was common at 25.8%(199). Other comorbidities were relatively infrequent: diabetes in 6.0%(46), dialysis in 7.0% (54), lung disease in 4.1%(32), immunosuppression in 6.2%(48), and peripheral vascular disease in 8.9%(68). Notably, 31.5%(243) had undergone prior valve surgery. Prosthetic valve explant was performed in 24.9% (192) of the cases. Mean cardiopulmonary bypass time was 139±85 minutes. Postoperatively, stroke occurred in 2.1%(16), renal failure in 7.0%(54), and operative mortality in 5.1%(39).

Conclusions: Surgical case volume for IE associated with IDU has increased significantly over the last 6 years. Prosthetic valve endocarditis and redo operations comprised about a third of the cases, which suggests a strong impact of recidivism and immediate need to institute measures to prevent recurrent endocarditis.



Durability of Mitral Valve Bioprostheses: A Meta-analysis of Long-Term Follow-Up Studies

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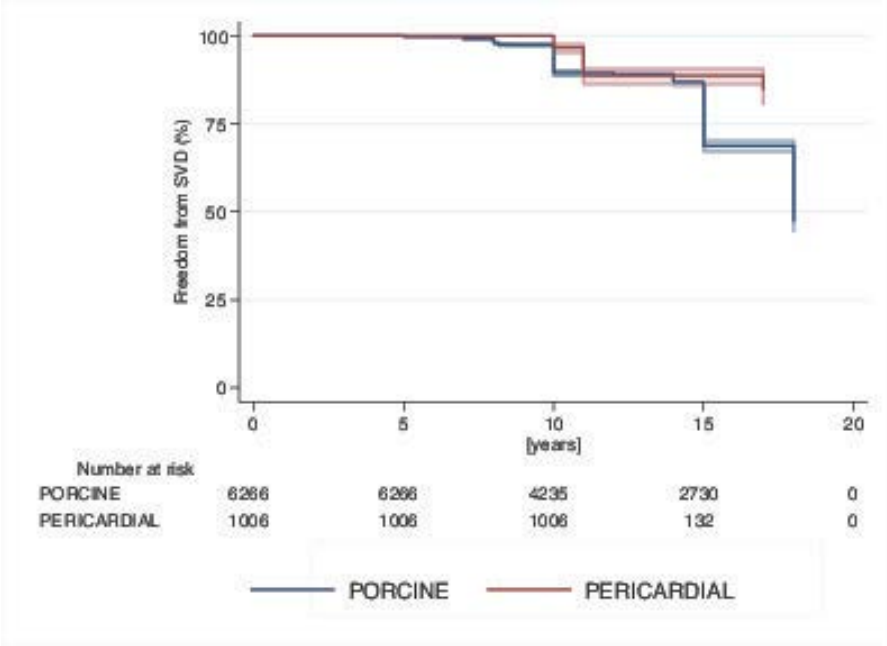
Purpose: The aim of this study was to retrieve published information of structural valve deterioration (SVD) of the most widely implanted bioprosthetic mitral valves. We sought to compare long-term freedom from SVD of pericardial prostheses and porcine valves.

Methods: Online database (i.e. PubMed Medline, Cochrane Database, Researchgate) searches identified 1570 papers. Two-hundred thirty-two were considered for eligibility while 1338 were removed mainly because they were duplicates, studies on different types of prostheses, in vitro studies, or presented a follow-up length less than 5 years. Ultimately, 49 papers, including 18780 patients, met the full criteria for inclusion. Statistical analyses were performed in Comprehensive Meta-Analsysis, v.2 (Biostat, Englewwod, NJ).

Results: The most used pericardial prosthesis showed an incidence of SVD rate per year of 0.80 with a mean FU of 9.9 years and a mean age at implantation of 61.5 years. Porcine valves had an SVD rate per year ranging from 0.06% per year (new generation prosthesis with a FU of 6.4 years and a mean patients age of 67.9) to 2.07% per year (older prosthesis with a FU of 10.9 years and a mean patients age of 54 years). The cumulative analysis of 7272 patients (porcine 6266 patients, pericardial 1006 patients) found that freedom from SVD for pericardial valves at 10-year and 15-year follow-up was 96% and 89% respectively; porcine valves showed a freedom from SVD of 89% and 69%. With a maximum follow-up time of 17 years, the log-rank test turned a p=0.002 (Figure 1).

Conclusions: Our analysis reports satisfactory durability both for pericardial and porcine mitral valve. Pericardial prostheses showed excellent freedom from structural valve deterioration already in 60-years old patients. New porcine valves present promising results at mid-term follow-up, these should be subject of further investigation to confirm an increased durability even at long-term.



Del Nido Cardioplegia in Adult Coronary Surgery: A Propensity-Matched Analysis of 863 Patients

A. B. Schutz[2]*, K. Bertapelle*[1]*, N. Beecher*[1]*, W. Long*[1]*, V. Lee*[1]*, W. Pan*[2]*, M. J. Arcaro*[3]*, Q. Zhang*[2]*, R. K. Ghanta*[2]*, E. Jimenez*[2]*, G. N. Loor*[4]

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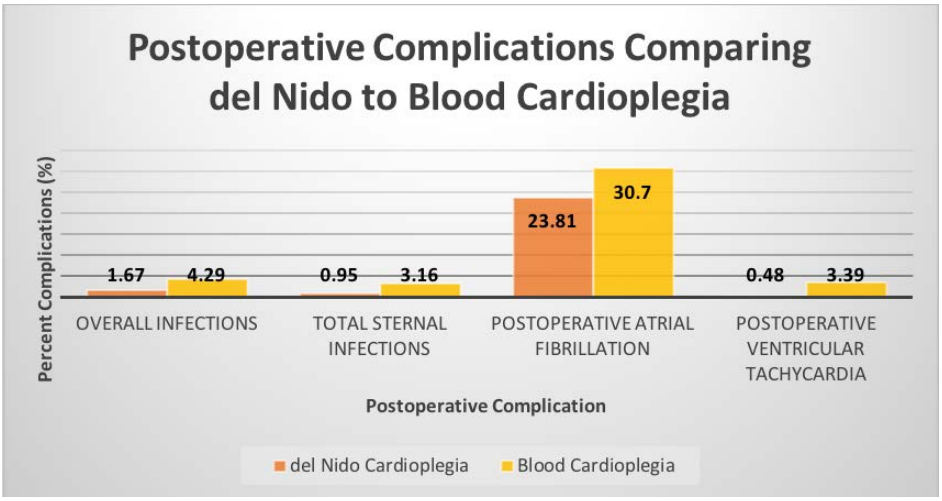
Purpose: Del Nido cardioplegia (DNC) has been shown to be safe in adult patients with normal coronary arteries undergoing valve surgery. This study compares the effect of DNC versus blood-based cardioplegia (BC) on postoperative complications in a cohort of patients undergoing coronary artery bypass grafting (CABG).

Methods: A retrospective analysis was performed on patients undergoing coronary artery bypass grafting between 2014 and 2017. STS preoperative risk scores were evaluated for all patients. Postoperative outcomes were compared by Chi-squared testing and independent two sample t-tests. A 1-to-1 matching without replacement by propensity score was performed by using the nearest neighbor method with a caliper of 0.25 standard deviation. Balance in the baseline covariates of matched data (including STS preoperative risk scores and gender) was examined by using standardized differences. Postoperative outcomes of the two methods were compared using McNemar and paired t-testing.

Results: 863 patients with coronary artery disease underwent CABG with DNC (n=420) or BC (n=444). Concomitant valve surgery was performed in 133 patients (15.4%). Both DNC and BC cases were performed by the same 3 surgeons. There were no significant differences in mean cardiopulmonary bypass (54.78 minutes vs 53.31 minutes) or cross clamp times (33.73 minutes vs 34.05 minutes) between DNC and BC, respectively. There were no significant differences in STS preoperative risk scores and no differences in overall complications (P=0.186). There were statistically significantly less overall infections (1.67% vs 4.29%, P=0.0243), total sternal infections (0.95% vs 3.16%, P=0.0233), decreased postoperative atrial fibrillation (23.81% vs 30.7%, P=0.0232), and decreased postoperative ventricular tachycardia (0.48% vs 3.39%, P=0.0021) with DNC versus BC. 335 propensity matched pairs of patients were identified. These showed similar statistically significant decreases in overall infections, sternal infections, atrial fibrillation, and ventricular tachycardia.

Conclusions: This large patient cohort demonstrates DNC as a safe alternative in patients undergoing CABG. Its ease of use and favorable outcomes are likely to result in its continued expanded application. Improved postoperative rates regarding dysrhythmias and infections may push DNC closer to the standard of care in adult cardiac surgery.



Preoperative MELD Score Is a Powerful Predictor of Early Outcomes Following Isolated Coronary Artery Bypass Grafting

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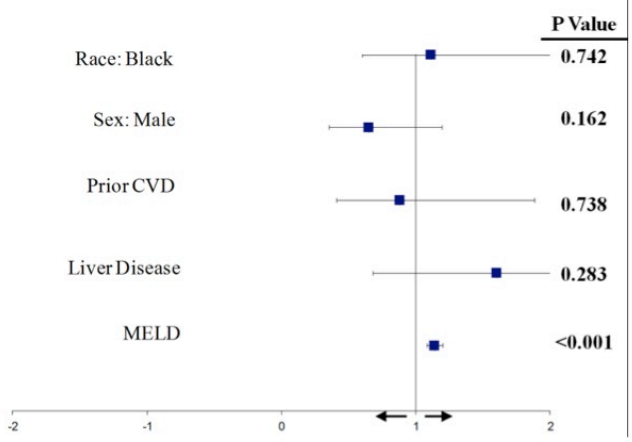
Purpose: Model for End-stage Liver Disease (MELD) score is a predictor of mortality in patients undergoing abdominal, cardiac transplant, and tricuspid valve surgery. However, currently it is not part of the STS-PROM for patients undergoing coronary artery bypass grafting (CABG). This study evaluates if a high MELD score predicts short-term mortality

Methods: A retrospective review of our institutional database from January 2011 to December 2017 revealed 2,166 patients undergoing isolated CABG procedures who had a calculable MELD score. These patients were divided into those with a MELD?15 (n=1,853) or MELD>15 with and without known liver disease (n=313). The MELD score (using STS definitions) for each patient was calculated based on a baseline INR, total bilirubin, and serum creatinine levels. In hospital morbidity and 30-day mortality were assessed and a multivariable logistic regression model was used to adjust for 30-day mortality.

Results: The mean age was similar between groups (MELD≤15: 64.5±10.6 years and MELD>15: 65.2 ± 9.9 years, p=0.295); as was the number of women (28.5% vs. 32.6%, p=0.142). Patients with MELD>15 had a higher rate of co-morbidities (Table). The STS risk of mortality was statistically higher in the MELD>15 group (7.0±9.0% vs 2.0±3.0%, p<0.001). The mean cardiopulmonary bypass time was 63 minutes in each group. With the exception of postoperative stroke, other morbidities occurred more frequently in those with a MELD>15 (Table). The all-cause mortality was higher in those with MELD>15 group (5.7% vs 1.9%, p<0.001). The MELD score was an independent predictor for short-term mortality (p<0.0001). Receiver operating characteristic curve was improved for 30-day mortality when MELD was added to the model (AUC =0.62 (without MELD and 0.74 with MELD).

Conclusions: In this large, single-institutional analysis, patients with a MELD>15 have a higher peri-operative mortality and morbidity compared to those with MELD≤15. The adjunctive use of the MELD score to STS-PROM should be considered to further risk stratify patients undergoing CABG.

Figure: Odds Ratio Estimates 30 day Mortality



Characteristics	Overall	MELD≤15 (n=1,853)	MELD>15 or known liver disease (n=313)	P value
Preoperative				
Age (years, mean ± SD)	64.7 ±10.5	64.6 ± 10.6	65.2 ± 9.9	0.295
Female Gender (%)	29.1	28.5	32.6	0.142
Black Race (%)	35	32.1	51.8	<0.001
Diabetes (%)	51.5	49.5	63.3	<0.001
Dialysis (%)	5.4	0	37.1	<0.001
PVD (%)	17	15.7	25.2	<0.001
HTN (%)	83.6	82.4	90.7	<0.001
Preoperative Afib (%)	0.9	0.8	1.6	0.178
Stroke (%)	9.1	8.1	15.1	<0.001
Heart Failure (%)	25.4	22.1	45	<0.001
Liver Disease (%)	6.8	0	47	<0.001
STS PROM (%, mean ± SD)	3.0±5.0	2.0±3.0	7.0±9.0	<0.001
Ejection Fraction (%, mean±SD)	48±12	48±12	45±12	<0.001
Postoperative Outcomes				
Sepsis (%)	1.5	1.2	3.2	0.009
Stroke (%)	1.2	1.4	0.3	0.123
Arrhythmia (%)	1.6	1.3	3.5	0.004
Renal Failure (%)	2	1.4	6.1	<0.001
Multi Organ Failure (%)	0.5	0.3	1.6	0.003
Overall LOS (days, mean±SD)	7.7 ± 6.6	7.2±5.8	10.8±9.3	<0.001
30-day mortality (%)	2.4	1.9	5.7	<0.001

Thoracic Endovascular Aortic Repair Trends and Outcomes in More Than 27,000 Medicare Patients for Descending Thoracic Aneurysms

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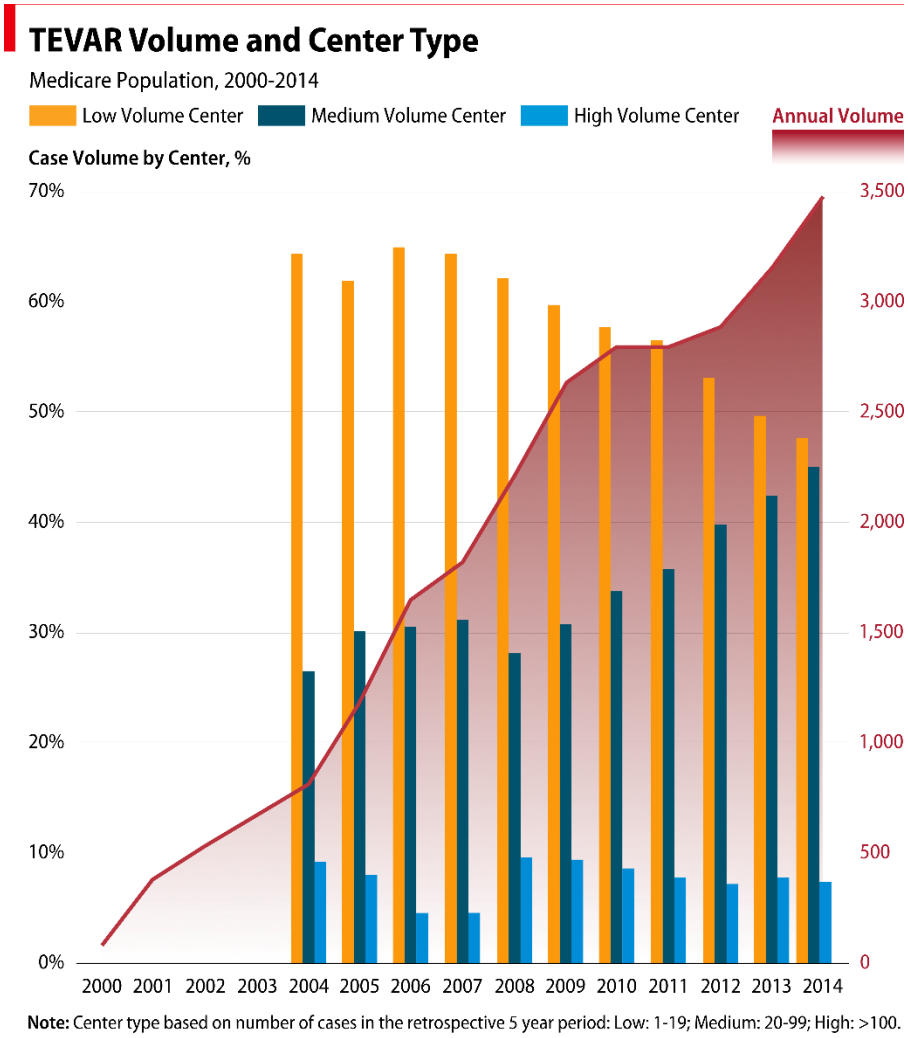
Purpose: Since FDA approval of TEVAR in 2005, adoption of this technology has replaced open surgery to become the preferred treatment for descending thoracic aneurysms (DTA). The objective is to investigate TEVAR trends during the previous 15-years in regards to patient and hospital characteristics and their impact on survival.

Methods: From 2000-2014, 27,079 Medicare patients over 66 years old underwent TEVAR for DTA. Patients with acute Type-A dissections and traumatic aortic transections were excluded. The 15-year period was stratified into three eras: early (2000-2005),

middle (2006-2010), and recent (2011-2014). Hospital centers performing TEVAR were categorized based on the procedural volume performed in the preceding five-year period: low volume (0-19 cases), medium volume (20-99 cases), or high volume (>100 cases). Multivariate cox regression was used for postoperative survival. The median follow-up was 6.1 years.

Results: TEVAR case volume has increased significantly over the previous 15 years (early: 608/yr; middle: 2,223/yr; and recent: 3,078/yr, *p*<0.001). Among all centers, 87% (574/639) performed only a single case/year in 2004, whereas 54% (822/1511) completed a single case/year in 2014. In 2014, high volume centers performed 7.0% of the overall cases, medium centers performed 45%, and low volume centers performed 48%. Patients in the early era, as compared to recent era, are older (73.09±4.74 vs 77.78±6.84, *p*<0.001) and comorbidities have significantly increased by the following amounts for renal failure: 50.9%; stroke: 31.2%; obesity: 89.9%; diabetes 17.6%; hypertension: 7.1%; p<0.001. The 30-day adjusted all-cause mortality increased by 1.5% in the recent era as compared to the early period (hazard ratio [HR]=2.8, *p*<0.001). Adjusted all-cause mortality was similar between low vs medium (HR=1.02, *p*=0.44) and low vs high volume centers (HR= 0.98, *p*=0.63).

Conclusions: TEVAR volume has significantly increased among elderly Medicare patients. Currently, patients are more acute and overall survival has worsened. While most centers perform a single case/year, hospital procedural volume revealed no impact on mortality. Providers must be cognizant of these issues when determining the benefits of TEVAR in sicker patients.



Decellularization of Bovine Pericardium Reduces the Human Xenoreactive Immune Response

S. J. Bozso, *J. Kang, M. C. Moon, J. Nagendran*
University of Alberta, Edmonton, Canada

Purpose: Emerging evidence suggests xenograft constructs used in cardiac surgery provoke cell-mediated and humoral immune responses believed to contribute to time-dependent structural valve deterioration (SVD). We aim to characterize the human immune response to decellularized bovine pericardium to determine its suitability as a xenograft scaffold for future tissue engineered heart valves.

Methods: Commercially available bovine pericardium decellularized after 1% SDS and 1% Triton X-100 washes was stored in HBSS and antibiotic. Control, native bovine pericardium that did not undergo decellularization was stored in HBSS and antibiotic. Patients

undergoing cardiac surgery were consented and 20mL heparinized blood collected. Either control or decellularized bovine pericardium, 5mL whole blood and 5mL DMEM F12 media were placed inside of a 15mL tube, then put on a rotator inside of a 37^0C incubator. To quantify the immune response, blood samples for cytokine analysis were drawn from the 15mL tube at baseline and after 3 days of incubation.

Results: We show that after undergoing decellularization, bovine pericardium elicited a significantly decreased immune response, resulting in a significant reduction in TNF-a and IFN-g production compared to control, native bovine pericardium after 3 days of incubation. Furthermore, on immunohistochemical stained sections of bovine pericardium, a significant reduction in cellular infiltrate was seen in the decellularized group. Using transmission and scanning electron microscopy, ultra-structural analysis of decellularized bovine pericardial sections revealed an intact extracellular matrix with no cell structures present. The efficacy of decellularization was confirmed with DAPI-nuclei staining, revealing complete absence of nuclei on the decellularized bovine pericardium compared to abundant cellularity of the control bovine pericardium.

Conclusions: Taken together, our data suggest decellularization of xenograft tissue, such as bovine pericardium, results in significantly less pro-inflammatory cytokine production and a blunted human xenoreactive immune response with intact extracellular matrix. As such, decellularized bovine pericardium may an effective xenograft scaffold for future tissue engineered heart valves utilizing autologous cells.

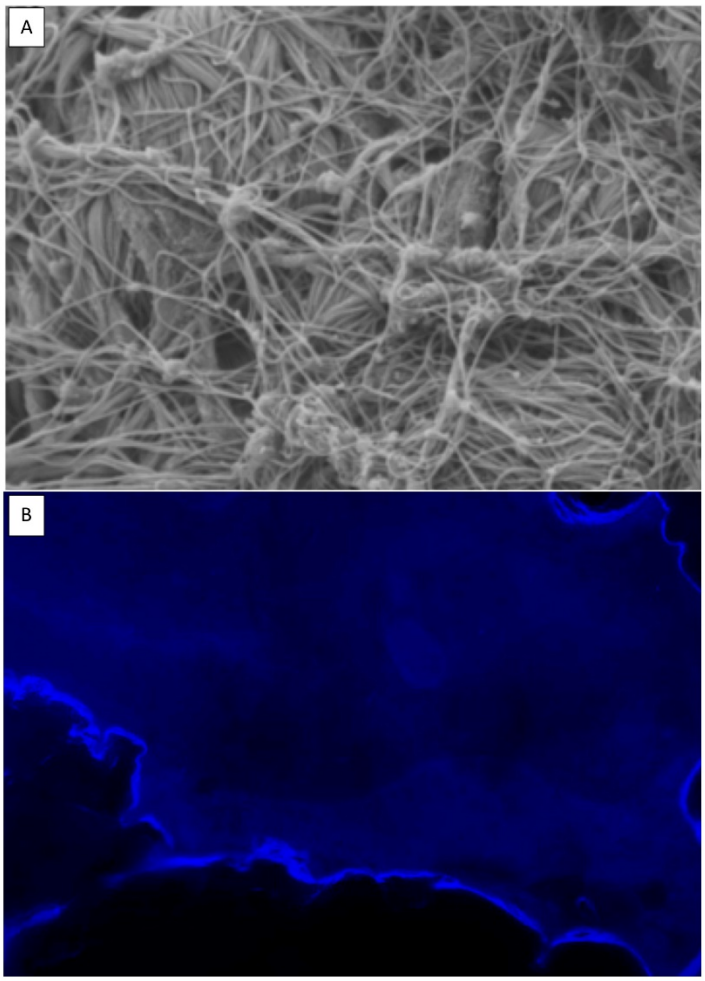
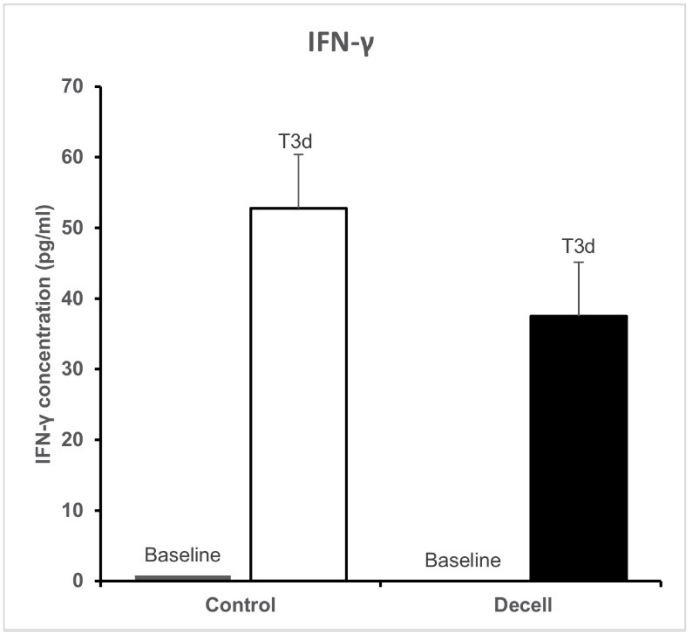


Figure 1. Representative scanning electron microscopy in control, native pericardium demonstrating the presence of cells and the qualitative representation of the extracellular matrix in control tissue (A). Representative 4',6-diamidino-2-phenylindole (DAPI)-stained nuclei of decellularized bovine pericardium demonstrating complete absence of cells



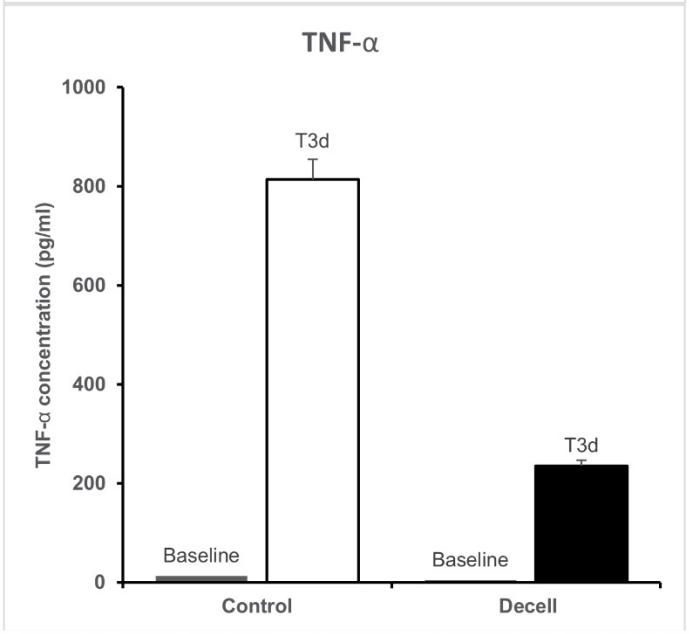


Figure 1. Quantification of IFN-g and TNF-a production in both control and decellularized bovine pericardium at baseline and after 3 days of incubation

Impact of Lesion Localization on the Durability of Mitral Valve Repair in Patients With Infective Endocarditis

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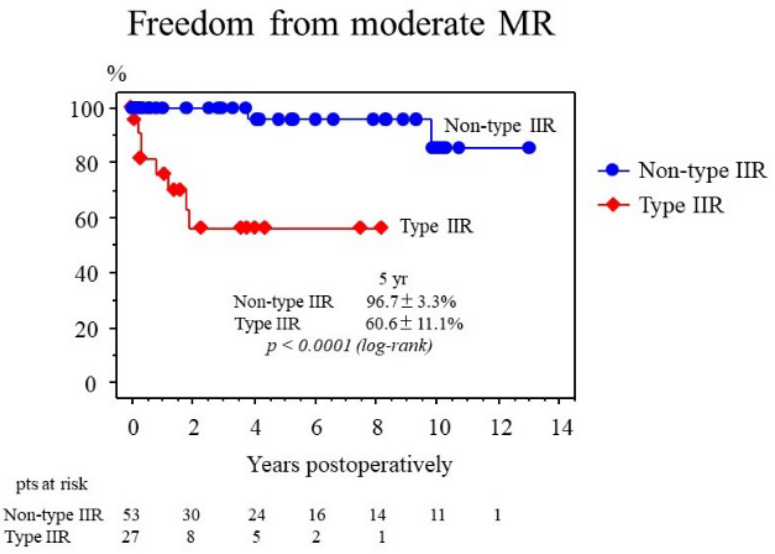
Purpose: Efforts are made to choose repair as a surgical treatment for mitral valve (MV) infective endocarditis (IE). However, some patients develop recurrent mitral regurgitation (MR). We investigated the association between the location of the infected lesion and recurrent MR.

Methods: 113 patients underwent MV surgery for IE at our institution from January 1999 to March 2018. Of these, 80 patients (55±18 years, active 63 and healed 17) who underwent MV repair were studied. Patients were divided into 4 types, according to the location of the main lesion; type I: posterior leaflet (N=35), type IIC: clear zone of anterior leaflet (N=11), type IIR: rough zone of anterior leaflet (N=27) and type III: annulus (N=7). Type IIR was divided into 2 sub-groups; IIR-large (more than one segment involvement, N=9) and IIR-small (one segment, N=18).

Results: Follow-up was 95.0% completed for 6.5±4.9 years. Survival at 12 years was 80.8±6.1%. The freedom from reoperation at 12 years was 85.3±4.6%. The rate of recurrent moderate or severe MR was 2.9% in type I, 0% in type IIC, 29.6% in type IIR, and 14.3% in

type III. The freedom from recurrent moderate or severe MR at 5 years was significantly lower in type IIR compared with the other types (60.6±11.1% vs 96.7±3.3%, *p < 0.0001*). On Cox proportional-hazards analysis, type IIR was an independent predictor of recurrent MR (hazard ratio: 11.0, 95% confidence interval: 2.6 to 76.7, *p* = 0.0007), but active IE was not (hazard ratio: 2.1, *p = 0.5062*). Moreover, the recurrence rate was higher in type IIR-large (55.6 %) than type IIR-small (16.7 %, p = 0.07).

Conclusions: Durability of MV repair in patients with posterior leaflet infection, without annuls invasion and with clear zone infection of anterior leaflet were excellent. MV repair for the rough zone infection of anterior leaflet, especially with more than one segment involvement, was associated with high risk of recurrent MR.



Bicuspid Aortic Valve Repair Using Geometric Ring Annuloplasty: 2-Year Clinical Trial Results

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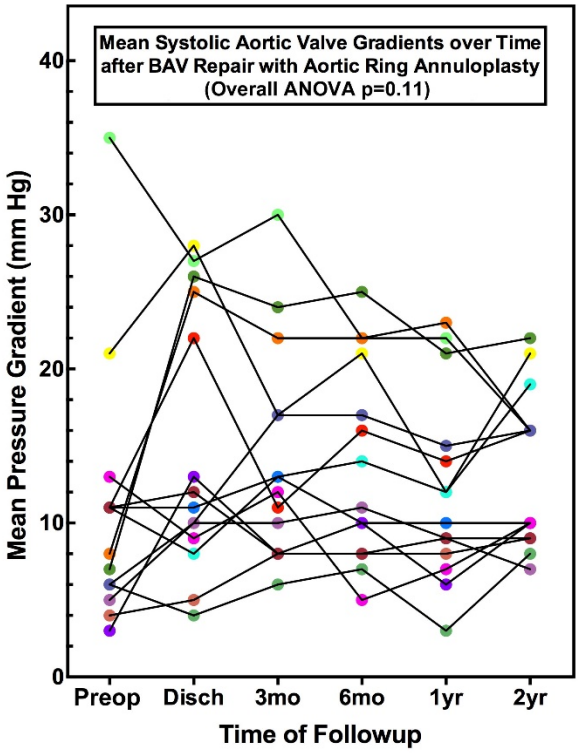
Purpose: As bicuspid aortic valve (BAV) repair evolves, more effective annular reduction would be advantageous. Moreover, with failure of tissue substitutes, effective annuloplasty could better recruit native leaflets to midline coaptation and minimize tissue replacement. A geometric annuloplasty ring has been developed, and 2-year outcomes of a regulated trial are reported.

Methods: A prospective trial of BAV ring annuloplasty was completed in 16 patients. Baseline age was 44.4±11.3 (mean±SD) years, AI Grade was 2.4±1.3, NYHA Class was 1.8±0.4, and mean systolic gradient was 13.4±12.9 mmHg. Three patients had Sievers Type-0 BAV, 11 had Type-1, and 2 were Type-2. Thirteen had left/right leaflet fusion, 1 had right/non-coronary fusion, and 2 had both. The Dacron-covered titanium rings had circular base geometry with 180° sub-commissural posts, and were implanted sub-annularly with 9 horizontal mattress sutures. Leaflet reconstruction was accomplished using leaflet plication techniques, creating an effective height of >8mm, even if modest gradients were produced.

Results: Mean pre-repair annular diameter was 27.1±1.8 mm, and average ring diameter was 22.6±1.7 mm, as objectively determined by the formula: non-fused leaflet free-edge length/1.8 = ring diameter needed for coaptation. All valves required leaflet plication/reconstruction, pericardium was avoided, and 7 patients had ascending aortic and/or remodeling root replacement for aneurysms. No early or late mortalities or major complications occurred. Two patients required early prosthetic valve replacement for technical errors, and all 16 patients were between 24-38 months postoperative at followup. No late mortalities or valve-related complications occurred, and all patients reverted to NYHA Class I long-term. Serial echocardiograms showed prolonged and stable AI reduction to Grade 0.9±0.5 at 2-years (p<0.0001), and mean valve gradients were acceptable (13.3±5.0 mmHg at 2-years; overall p=0.11). In one third of patients with more complex anatomy (Figure), discharge mean gradients exceeded 20 mmHg, but fell over the next 2 years, presumably as native leaflets adapted.

Conclusions: Geometric ring annuloplasty was safe and effective for BAV repair. AI reduction was significant, overall gradients were low, and clinical outcomes were excellent. A philosophy of optimizing leaflet effective height resulted in modest gradients in complex cases, which fell over time. Geometric ring annuloplasty could simplify and standardize BAV repair.



Rapid Implantation and Right Anterior Minithoracotomy Approach for Surgical Aortic Valve Replacement in Elderly Patients

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Purpose: Often elderly patients (>=80 yo) with aortic stenosis are deemed ideal for receiving the fastest and less invasive procedure. We present our surgical AVR experience in this field, with RAT access and sutureless valves. We believe the technique optimization and a minimal invasive approach are pivotal in making this procedure effective

Methods: Retrospectively, from July 2016 to May 2018, we collected 60 consecutive elderly patients (>=80 y.o.), undergoing isolated sAVR for tricuspid severe aortic stenosis, who matched anatomical criteria for sutureless valve implantation. Minimally invasive sAVR was performed in a single-Surgeon and single-Surgeon setting, through a 4 to 6 cm long RAT at the third intercostal space without rib avulsion or ligation of the RIMA. As usual, we perform a complete central cannulation with normotermic systemic perfusion and blood-based cardioplegia. We optimized the implantation technique as a teamwork, making a simple step-by-step process.

Results: All procedure went successfully. Complete central cannulation (arterial=distal ascending aorta, vein=atrial appendage), RAT approach and sutureless prostheses have been used in all cases. Population: male 37,5%; mean age of 83,5 ± 2,2 yrs; mean STS Risk Score of Mortality 3,61% ± 1,23% and of Morbidity/Mortality 19,66% ± 4,58%. Results: implanted prostheses were M (32), L (20), XL (5), S (3); mean CPB duration was 32,6 ± 8,2 minutes; aortic cross-clamping time 17,6 ± 3,7 minutes; median ventilation time 6,5 hrs; median ICU stay 2 days. Observed mean bleeding rate in the first 12 hours was 536 ± 150 ml, 46,5% patients needed blood transfusion (median number of bags: 1). PM implantation rate was 1,7%. The total in-hospital stay median duration was 7 days. Observed 30-day mortality rate was 1,7% (1pts), observed Morbidity/Mortality rate 5,88%. None of our patients had paravalvular aortic regurgitation more than mild at discharge.

Conclusions: Minimally invasive sAVR with suturless prostheses is an effective option for aortic valve replacement in elderly patients. Complete central cannulation, RAT approach and a thorough optimization of the implantation technique are the key points to carry out a fast and safe procedure.

Impact of Three Different Suture Techniques for Aortic Valve Replacement on Prosthesis-Patient Mismatch and Hemodynamic Remodeling

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Purpose: The study objective was to evaluate which suture technique produces better hemodynamic performance for aortic valve replacement (AVR).

Methods: We analyzed all patients underwent AVR between January 2015 and November 2017. We compared preoperative clinical information and 1-year postoperative hemodynamic data for interrupted pledget mattress suture (group A), interrupted non-pledget mattress suture (group B) and “figure of eight” non-pledget suture (group C). Transthoracic echocardiograms were performed at baseline, postoperative7 days and 1 year after surgery. We compared the incidence of prosthesis-patient mismatch (PPM)and hemodynamic parameters among the groups.

Results: A total of 389 patients underwent AVR: 212 in group A, 72 in group B and 105 in group C.The groups were similar in age (*p*=0.359), sex (*p*=0.055),body surface area (BSA,*p*=0.374), and functional class (*p*=0.285). Group B showed significantly lower postoperative PPMincidence(*p*<0.001)inpatients with small aortic annulus (annulus: 18-21mm)(*p*=0.006).The largest drop of pressure gradient (PG, peak/mean, mmHg)was shown in the group B (63.04 ± 29.80/ 40.59 ± 19.29 mmHg, *p*=0.048), but pressure gradient maintenance among the groups after surgery was similar (peak/mean, mmHg, 22.11/11.72 vs.24.24/13 vs. 22.78/12.27, *p*=0.488).

Conclusions: The interrupted non-pledget mattress suture technique can reduce the incidence of PPM and can be a reasonable surgical option in patients with a small size AVR.

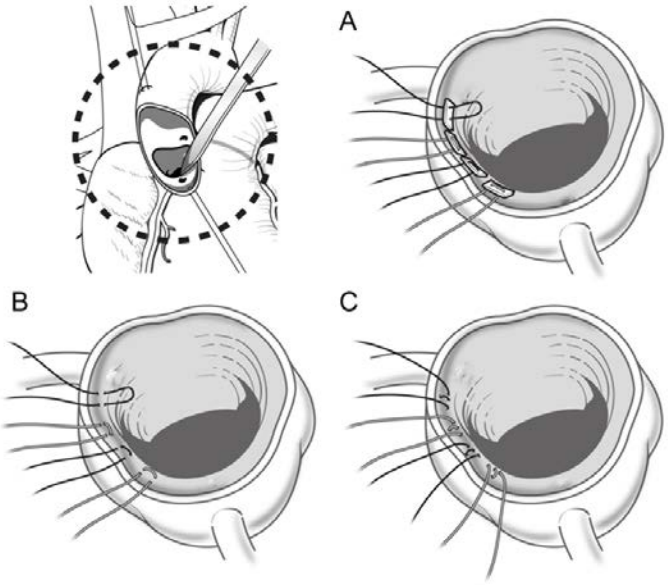

Figure1. Aortic valve replacement with interrupted mattress pledget sutures (A), interrupted mattress non-pledget sutures (B) and interrupted "figure of eight" non-pledget sutures (C)

Table1. Subgroup analysis to incidence of PPM in different suture technique

Prosthetic valve size	Hemodynamic parameter	Group A (n=212)	Group B (n=72)	Group C (n=105)	*P* value
Small valve (18-21mm)	N	118 (56.6%)	43 (59.7%)	53 (50.5%)	.214
	Peak gradient (mmHg)	23.6 ± 12.3	26.2 ± 8.5	25.6 ± 10.0	.332
	Mean gradient (mmHg)	12.4 ± 6.2	14.0 ± 4.8	13.9 ± 6.9	.199
	EOAI (cm^2)	1.7 ± 0.4	2.1 ± 23.0	1.6 ± 0.3	.132
	Postoperative moderate to severe PPM (n)	21 (17.8%)	4 (9.3%)	12 (11.4%)	<.001
Large valve (22-32mm)	N	90 (42.5%)	29 (40.3%)	54 (51.4%)	.173
	Peak gradient (mmHg)	20 ± 7.6	21.1 ± 6.7	19.3 ± 6.9	.578
	Mean gradient (mmHg)	10.8 ± 4.3	11.4 ± 4.3	10.2 ± 3.8	.488
	EOAI (cm^2)	1.7 ± 0.3	1.6 ± 0.3	1.7 ± 0.4	.349
	Postoperative moderate to severe PPM (n)	18 (20.0%)	5 (17.2%)	10 (9.5%)	.756

N = total patients with prosthetic valve size

PPM = prosthesis-patient mismatch, which defined as an EOA indexed to BSA<0.85cm^2/m^2

Severe PPM = prosthesis-patient mismatch, which defined as an EOA indexed to BSA<0.65cm^2/m^2

P-value was calculated by the chi-square test.

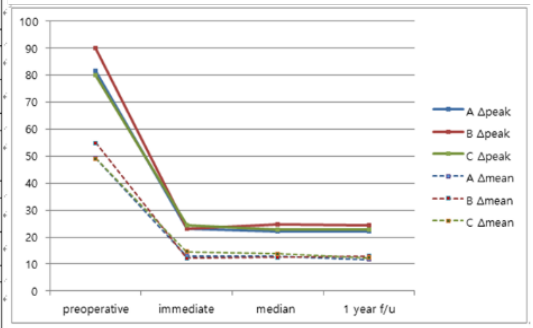

Figure 2. Hemodynamic parameters after AVR depends on suture techniques

Direct True Lumen Cannulation ("Samurai" Cannulation) for Acute Stanford Type A Aortic Dissection

***T. Kitamura**, K. K. Miyaji*
Kitasato University School of Medicine, Sagamihara, Japan

Purpose: Antegrade perfusion is desirable in cardiopulmonary bypass, but Seldinger aortic cannulation is sometimes difficult in acute Stanford type A aortic dissection, In this video, we present our surgical technique of direct true lumen cannulation ("Samurai" cannulation) for acute Stanford type A aortic dissection.

Methods: Surgical technique of Samurai cannulation: Two tourniquets are placed around the ascending aorta. After heparinization, a left ventricular vent, a right atrial drainage cannlula and a retrograde cardioplegia cannula are inserted. With a head-down position, left ventricular venting and right atrial drainage are started. When the blood pressure has dropped down to 30 mmHg, both the adventitial and intimo-medial walls of the dissected ascending aorta are incised at once with large Metzenbaum scissors. The true lumen is directly cannulated with a 24-Fr cannula with a bump. The aortic tourniquets are snared and cardiopulmonary bypass is established, followed by retrograde cardioplegia.

Results: From October 2013 to July 2018, 84 patients were operated on using "Samurai" cannulation for acute Stanford type A aortic dissection at our hospital. Mean age was 64 ± 14 years and 43 were female. Surgical procedures on the aorta included three root replacements, one David procedure, 44 ascending replacements, 10 partial arch replacements with branch reconstructions, 24 total arch replacements and two David plus total arch replacements. In-hospital mortality occurred in 9 (11%) and there were 4 disabling or fatal strokes (5%). There was no cannulation-related complication.

Conclusions: "Samurai" cannulation is a safe and easy option to establish stable and sufficient perfusion in cardiopulmonary bypass in surgery for acute Stanford type A aortic dissection.

Instabilities in Aortic Length After Thoracic Endovascular Aortic Repair and Reoperation: 12 Years of Follow-Up Imaging

***P. Moeller**[1], S. S. Naidu[2], J. E. Bavaria[3], P. Vallabhajosyula[2], G. J. Wang[3], B. M. Jackson[3], W. Y. Szeto[2], N. Desai[2]*
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Purpose: TEVAR remains an important minimally invasive tool for the treatment of descending thoracic aneurysm. The long term effects of these repairs in both reduction of the aneurysmal sac size as well as stability of the stented portion require study. We report the results of 12 years of radiographic follow-up.

Methods: All patients with TEVAR for descending thoracic aneurysms from January 2005 to December 2017 (n=371) were evaluated for immediate postoperative and follow-up CT scans suitable for 3D reconstruction of the aorta (excluding those with an interim reoperation). 70 patients were found meeting these criteria (median duration of high quality radiographic follow-up: 1.8 years). Measurements were taken of maximum diameters in the ascending, arch and descending aorta, as well as centerline, greater and lesser curvatures from the most distal patent brachiocephalic vessel to the celiac (or first uncovered mesenteric vessel), as well as between proximal and distal edges of the stented portion of the aorta.

Results: All measured segments except covered length (brachiocephalic to mesenteric, brachiocephalic to proximal stent, and distal stent to mesenteric) were found to be significantly increasing in length (Table 1) for centerline and greater or lesser curvatures. Lengths in the stented segment were not significantly different at the two timepoints. Cox regressions for mortality and

reoperation found no significant correlation between these changes and mortality, and a significant correlation between stented segment greater curvature increase and reoperation (Adjusted HR:1.06, P<0.05).

Conclusions: Increases in the centerline and greater curve length of the aorta was found to be occurring. This appears to be primarily driven by growth in the non-stented segments. However, changes in the outer curve length of the stented segment were found to be associated with greater risk of reoperation.

	Lesser	Centerline	Greater
Change in Brachiocephalic to Celiac	6.2 (0.1-14)**	7.6 (1.7-16)**	10.3 (2.2-20)**
Change in Brachiocephalic to Proximal Stent	0.2 (0-2.1)**	1 (0-4)**	0.8 (0-5.4)**
Change in Proximal stent to Distal Stent	-2.1 (-5-4.8)	0.6 (-2.9-5.4)*	0.8 (-1.7-8.35)
Change in Distal Stent to Celiac	3.7 (0-9.3)**	4.5 (0-13.8)**	3.9 (0-17.3)**

All measurements mm, median and IQR

*p<0.05 **p<0.01, Wilcoxon signed ranks test

Cardiothoracic Surgery Education Posters

Twitter Activity Enhances the Research Citation Index for Academic Cardiothoracic Surgeons

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Purpose: Academic surgeons are encouraged to promote their work on social media to reach a larger audience. We hypothesized that thoracic surgeons who are active on Twitter have a higher research citation index (h-index) than their counterparts who are not.

Methods: All thoracic surgeons registered on CTSnet.org in Canada and the United States were queried for profiles with an h-index on Google Scholar (GS) and/or Research Gate (RG) in July 2018. Surgeons with a known h-index were categorized by whether they possessed a Twitter account (T+) or not (T-). h-index values were compared using Student's t-test ($p < 0.05$). Within the T+ cohort, a step-down multivariate linear regression model was used to identify independent predictors of increased h-index among variables including time on Twitter, number and frequency tweets, number of followers, number of people followed, and number of liked posts.

Results: Of 3,741 surgeons queried, 19.3% (722) had a known h-index value through either a GS and/or RG profile. RG (686, 95.01%) profiles were more frequent than GS (188, 26.04%) profiles, therefore the h-index values reported by RG were selected as a reference for comparison. T+ surgeons (n=188) had a mean (SD) h-index of 15.02 (14.17), whereas T- surgeons (n=534) had a mean (SD) h-index of 13.86 (15.51) (p=0.38). T+ surgeons had an active account for a median (range) 5 (0-11) years, and tweeted a mean (SD) 21.3 (146.8) tweets/month. The multivariate regression model identified the number of followers (p=0.029), the number of people followed (p=0.048), and the frequency of tweeting (p=0.046) as independent predictors of a higher h-index.

Conclusions: Academic thoracic surgeons who engage in Twitter conversations, tweet more frequently, and improve their following, are more likely to have their research cited by others, and consequently have a higher h-index than their counterparts.

Sexual Harassment and Cardiothoracic Surgery: #UsToo?

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Purpose: Fifty-eight percent of women in SEM (science, engineering, and medicine) report being affected by sexual harassment (SH). In medicine and male-dominated specialties, the reported percentage is higher. We sought to determine the extent of SH in cardiothoracic surgery, a male-dominated subspecialty.

Methods: We developed a survey based on the Sexual Experience Questionnaire-Workplace (SEQ-W), physician wellness and burnout survey. The survey was open to responses for 45 days and disseminated via The Society of Thoracic Surgeons, Women in Thoracic Surgery, and Thoracic Surgery Residents Association listervs. A reminder email was issued at 28days. Student's t-tests, Fisher's exact, and Chi-square were used to compare results.

Results: Of 790 respondents, 75% were male and 82% were attendings (14% trainees, 4% non-physicians). 81% of female surgeons compared to 46% of male attending surgeons experienced SH ($p<0.001$). SH also was reported by trainees (90% female vs. 32% male, $p<0.001$). According to women, the most common offenders were supervising leaders and colleagues; for men, it was ancillary staff and colleagues. Respondents reported SH at all levels of training (medical school 32%, general surgery residency 54%, CT residency 39%, attending 40%). 75% of women surgeons compared to 51% of men surgeons witnessed a colleague be subjected to SH. 89% of respondents reported the victim as female (male 2%, both 9%, $p<0.0001$). 49% of female witnesses (50% of male witnesses) reported no intervention in response to the witnessed event; <5% of respondents reported the offender to a governing board. SH was positively associated with burnout in women but not in men.

Conclusions: Sexual harassment is present in cardiothoracic surgery among faculty and trainees. While women surgeons are more commonly affected, male surgeons also are subjected to SH. Despite witnessed events, intervention currently is limited. Policies, safeguards, and bystander training should be instituted to decrease these events.

Role of Mock Oral Examinations in Cardiothoracic Surgery Training

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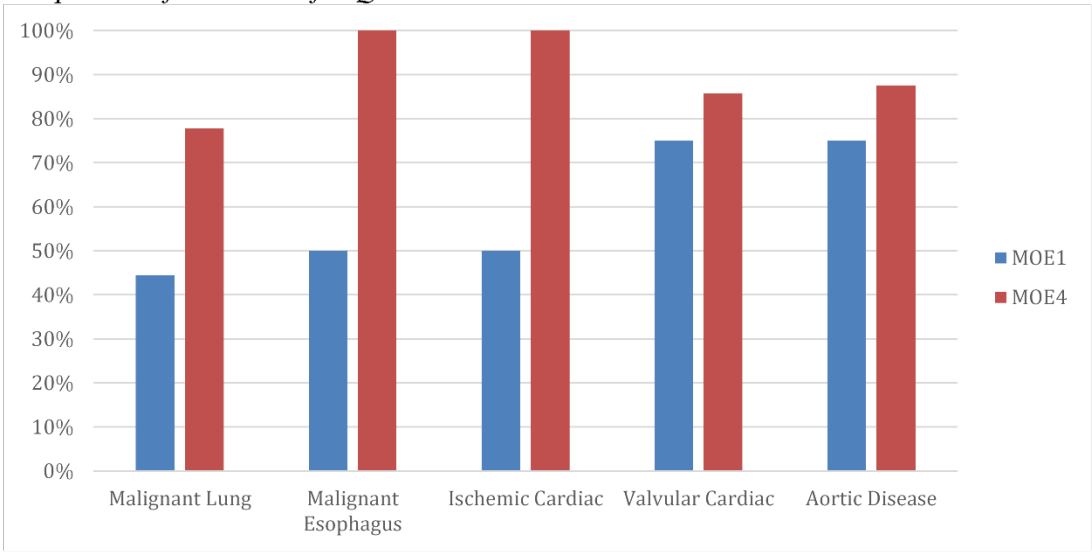
Purpose: While in-training examinations provide surrogate data on qualifying exam readiness, discrepant practices exist regarding the use of mock oral examinations (MOE) before the certifying exam (CE). While MOE are prioritized by some institutions, data are lacking to support the use of these labor-intensive, time-consuming exams in cardiothoracic surgery training programs.

Methods: We performed a retrospective review of serially administered, biannual MOE scores for cardiothoracic surgery trainees at our institution from 2014-2018. MOE questions were developed by eligible faculty. Each MOE required participation of six faculty and one coordinator over three hours, with an additional hour for debriefing. The MOE was composed of three rooms with four questions each. A pass for the room required passing at least 3 of 4 questions. Passing 2 of 3 rooms was required to pass the MOE. Cumulative pass rates (PR) for each of these four timepoints were evaluated for ten residents, along with CE PR.

Results: MOE were conducted twice each academic year, with four exams administered during training. The PR for MOE1 through MOE4 demonstrated gradual improvement, (75% [6/8], 87% [7/8], 100% [7/7], 100% [7/7]), (Table). The corresponding CE PR was 100% [8/8] for these same individuals. While not statistically significant, there were topics for which the residents appeared to improve over time from MOE1 to MOE4, including malignant lung (44% [4/9] to 78% [7/9]), ischemic cardiac (50% [1/2] to 100% [5/5]), and aortic disease (75% [3/4] to 83% [7/8]), (Figure). Additionally, given training track designations of either cardiothoracic or general thoracic surgery at our institution, individual question PR appeared to improve more dramatically from MOE1 to MOE4 in "track-related" topics compared to "non-track" topics (72% [31/43] to 100% [32/32] versus 71% [27/38] to 87% [35/40]).

Conclusions: Standardized MOE are useful educational adjuncts to assess trainees' knowledge and readiness for the CE. While we recognize that improvement in serial MOE PR is likely related to MOE exposure as well as expanding funds of knowledge, we believe these results justify use of this assessment tool in training.

Comparison of Pass Rates for Questions in Mock Oral Exams 1 and 4



MOE = mock oral exam

Mock Oral and Certifying Exam Pass Rates

Exam	Pass Rate
MOE 1	75%
MOE 2	87%
MOE 3	100%
MOE 4	100%
CE	100%

MOE = mock oral exam; CE = certifying exam

Impact of Sex on Confidence and Perception of Training in Cardiothoracic Surgery

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Purpose: Among surgical trainees, confidence gaps between men and women have been described; however, it remains unknown whether such disparities exist in cardiothoracic surgery. We aimed to examine the impact of sex on confidence and self-perceived adequacy of training among cardiothoracic surgery graduates and to correlate perceived gaps with actual performance.

Methods: Surveys were sent to 119 graduates of the Washington University cardiothoracic surgery residency from 1958-2017, among whom 57 (48%) revealed their sex. Surveys addressed confidence in several areas of practice within the field of cardiothoracic surgery. They further sought graduates' perceptions regarding their adequacy of training in these areas. Responses were quantified on 5-point Likert scales and chi-squared testing used to analyze intergroup differences. In addition, board exam pass rates and likelihood to seek additional subspecialty training were examined and compared between men and women.

Results: Five of 57 (8.8%) respondents were women, with the first female graduate in 2003. No sex-based differences existed in self-reported perceptions of preparation for patient care or technical training for adult cardiac, congenital and general thoracic surgery (Table, Figure). However, 40% of women sought additional post-residency training compared to 23% of men (p=0.401). Moreover, compared to men, women were significantly less likely to report excellent preparation for both the qualifying (women 20.0% vs. men 71.2%, p=0.020) and certifying exams (women 40.0% vs. men 73.1%, p=0.036). Importantly, despite feeling less prepared, there were no significant differences in first-time pass rates between sexes on either exam (Qualifying exam: women 75.0% vs. men 96.1%, p=0.147; Certifying exam: women 100.0% vs. men 93.8%, p=0.659).

Conclusions: A confidence-gap exists for women cardiothoracic surgery graduates, who perceive less adequate preparation for exams than men, despite a lack of difference between first-time exam pass rates. Awareness of sex-specific perceptions of adequacy in cardiothoracic surgical training can help create more inclusive and diverse environments for all.

Figure: Graduate Self-Reported Preparation for Various Aspects of A Career In Cardiothoracic Surgery

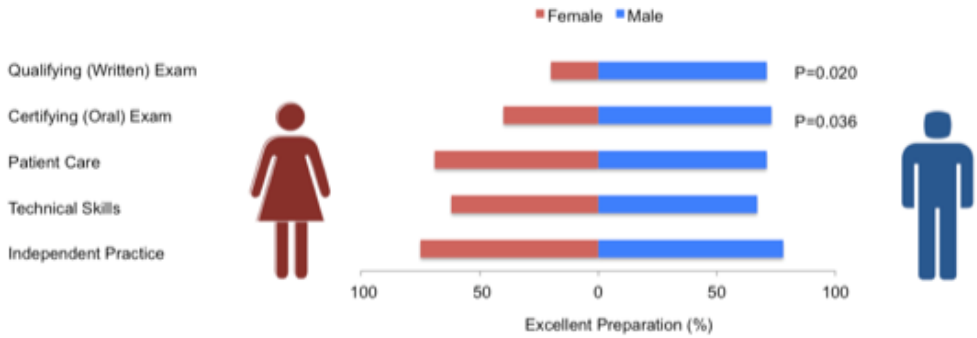

Table: Male vs Female Cardiothoracic Surgery Graduates

	Female	Male	P-Value
Qualifying exam			
Self-reported excellent preparation	**20%**	**71%**	**0.020***
Passed on first attempt	75%	96%	0.147
Certifying exam			
Self-reported excellent preparation	**40%**	**73%**	**0.036***
Passed on first attempt	100%	94%	0.659
Self-reported excellent preparation for patient care skills			
Office-based care	0%	25%	0.203
Hospital care	100%	89%	0.422
Cardiothoracic surgery intensive care	80%	83%	0.880
Creating a treatment plan	60%	72%	0.573
Postoperative care	100%	90%	0.468
Dealing with complications	100%	90%	0.468
Self-reported excellent preparation for technical skills			
Adult Cardiac Surgery – Overall	60%	69%	0.690
General Thoracic Surgery – Overall	100%	98%	0.754
Congenital Cardiac Surgery - Overall	25%	33%	0.733
Felt ready for independent practice	75%	78%	0.873

A High-Fidelity, Tissue-Based Simulation for Cardiac Transplantation

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Purpose: Several operations in cardiothoracic (CT) surgery have been accurately modeled with tissue-based simulators and are shown to be beneficial in the training of residents. However, cardiac transplantation has not yet been simulated. We describe a high-fidelity, tissue-based simulator that can be used to teach trainees to perform a cardiac transplant.

Methods: Synthetic materials were used to construct a pericardium and a portion of the anterior chest wall. Tubing was passed through openings in the simulated pericardium and secured to porcine tissue representing portions of the major vessels of the heart and the left atrial cuff that remain after the recipient's diseased organ has been removed. The assembly was set into a mannequin thorax on an operating table and draped in order to simulate a true operating environment. The appropriate vessels were cannulated for cardiopulmonary bypass, and the aforementioned tubing allowed for circulation of imitation blood using the Ramphal cardiac surgery simulator.

Results: The simulation begins at a point in time when the recipient's diseased organ has been removed and the donor organ is ready to be implanted. An attending cardiac surgeon at our institution performed the full implantation, demonstrating each of the steps in the following order: 1) evaluation of the donor organ before implantation, 2) anastomosis of the left atrium, 3) anastomosis of the inferior vena cava, 4) anastomosis of the superior vena cava, 5) anastomosis of the pulmonary artery, 6) anastomosis of the aorta, and 7) weaning from cardiopulmonary bypass. Once all the anastomoses were completed, the heart was filled with imitation blood and made to "beat." The simulation was felt to be an accurate reflection of the actual operation. The design allows for replacement of all tissue components for repetitive, deliberate practice. The operation can be practiced in component tasks, and training for intraoperative adverse events is possible.

Conclusions: We modified the existing Ramphal cardiac surgery simulator to accommodate cardiac transplantation. By doing so, deliberate practice, component task learning, and adverse event training can be included in the education process for performing such an operation. We hope that our simulation will ultimately enhance the training of CT surgery residents.

Analyzing the Content of Integrated Cardiothoracic Surgery Residency Program Websites: What Are Applicants Seeing?

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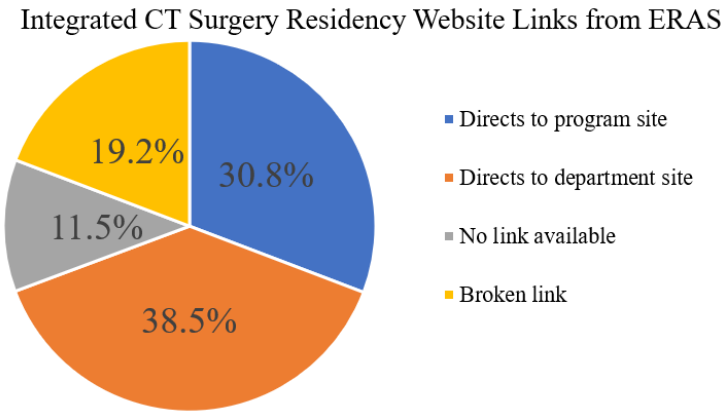
Purpose: Cardiothoracic (CT) surgery residency applicants increasingly use online resources to learn about prospective residency programs. However, the accessibility of relevant content on integrated CT surgery residency program websites has not been previously described. We analyzed all integrated CT surgery residency program websites in terms of 23 factors important to applicants.

Methods: A list of 23 criteria important to residency applicants was assembled based on studies in other specialties. Websites for all 26 integrated CT surgery residency programs participating in ERAS were reviewed for 23 factors important to applicants pertaining to contact information, application process, program information, research, resident lifestyle, and professional development. Websites were analyzed by 2 independent authors and graded regarding whether each criterion was present and with regard to functionality of the website link on ERAS. The relationship between medical school ranking, year of program inception, and website completeness was evaluated.

Results: Only 30.8% of links on the ERAS list of integrated CT surgery residency programs directed to program websites, while 38.5% directed to the department website, 11.5% were unlisted, and 19.2% were broken. On average, program websites contained 12.6 ± 3.4 (54.8% ± 15.0%) of the 23 criteria analyzed. All programs had functional websites and listed contact information as well as program descriptions. No difference was found between websites for programs affiliated with top 25 medical schools and programs not affiliated with top 25 medical schools (58.7%±15.5% criteria met, 52.2%±5.4% criteria met; p=0.31). Additionally, no difference was found between integrated CT surgery residency programs established after 2010 compared to programs established 2010 and prior (51.0%±15.3% criteria met, 59.8%±17.8% criteria met; p=0.24).

Conclusions: While some integrated CT surgery websites contain most of the criteria important to applicants, many program websites were incomplete and may benefit from an online update. We found no relationship between affiliated medical school ranking or program year established and integrated CT surgery program website completeness.



Contact information	Number of programs (*n*=26)	Percentage
Website	26	100.0
Contact email	26	100.0
Mailing address	22	84.6
Application process	**Number of programs (*n*=26)**	**Percentage**
ERAS link or ID	19	73.1
Interview dates	12	46.2
Interview process	8	30.8
Selection criteria	11	42.3
Program Information	**Number of programs (*n*=26)**	**Percentage**
Program curriculum or description	21	80.8
Rotation schedule	14	53.8
Program Description	26	100.0
Message from director	7	26.9
Faculty listing	24	92.3
Resident listing	19	73.1
Research	**Number of programs (*n*=26)**	**Percentage**
Research description	24	92.3
Faculty research projects	20	76.9
Resident publications	6	23.1
Resident lifestyle	**Number of programs (*n*=26)**	**Percentage**
Benefits	7	26.9
Salary	4	15.4
Parking	2	7.7
Meals	5	19.2
Call schedule	2	7.7
Local area information	10	38.5
Professional development	**Number of programs (*n*=26)**	**Percentage**
Jobs after graduation	13	50.0

Surgeon as Programmer: Overcoming Obstacles to the Use of Modern Internet Technology for Cardiothoracic Surgery

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Purpose: Leveraging internet technologies for patient care and academic activities can be complex and costly, frequently involving outside developers and costing tens of thousands of dollars. We describe our experience in eliminating these financial barriers, realizing the potential for a new paradigm in applications for surgical education and practice.

Methods: We have developed multiple smartphone applications for use in surgical education and practice, ranging from simple to complex. We describe the acquisition of required skillsets and the use of inexpensive resources to create state-of-the-art tools. Learning these techniques is non-trivial, but is attainable, clearly defined, and may include 1) development tools for smartphone apps, 2) establishing cloud data stores, 3) applying standard internet resources for data acquisition and reporting. We relate the trivial costs associated with even complex software development, opening new doors to creative uses of technology.

Results: Acquisition of coding skills for smartphone operating systems took ~100 hours over a period of 6 - 12 months. For simple apps such as the EuroSCORE calculator there is no data storage needed and total programming time was 25 hours with no additional costs. At the complex end of the scale the autonomy evaluation app, Zwisch Me, has been used to evaluate over 1260 cases from 15 cardiothoracic surgery training programs between 1/2016 and 8/2018 using smartphone applications for data collection and a web dashboard for data reporting. During the first year, all enrollment and data reporting was done manually, at a cost of $124. Automating user enrollment and data reporting required the addition of a dedicated website and business logic hosted on a web service. This increased costs by roughly $240, for an annual expense of $364. Total programming time for this app was about 120 hours.

Conclusions: Mobile software is underutilized in the academic surgical arena. The historically large financial barriers to adoption can be overcome by acquisition of coding skills by surgical team members. Direct physician involvement will spawn previously undreamed-of creative applications to enhance practice and education.

Thoracic Surgery Social Media Network (#TSSMN) Trainee Group Collaborating to Optimize Training Opportunities: A Pilot Study

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Purpose: Virtual journal clubs on twitter (Tweetchats) provide a platform to discuss globally publications of the leading journals in cardiothoracic surgery. The Thoracic Surgery Social Media Network (TSSMN) trainee group organised three Tweetchats to discuss key topics in cardiothoracic training, simulation, resident assessment and autonomy and non technical surgical skills.

Methods: The TSSMN trainee group has led three Tweetchats to date;"Role of Simulation in Cardiothoracic Surgery Education" December 2, 2017, "Resident Assessment and Autonomy In Cardiothoracic Surgery" March 19th, 2018, "Non Operative Technical Skills in Cardiothoracic Surgery" May 16th 2018. Each tweetchat was a structured discussion of two to four publications. The number of tweets, participants, most popular tweets and impressions are calculated for each of the Tweetchats. Live twitter poll can be performed during this presentation to assess if those present at the the meeting use twitter and if they would be interested in participating in future tweetchats.

Results: The first Tweetchat "Role of Simulation in Cardiothoracic Surgery" took place on the 2nd December 2017. Four papers were discussed. There were 45 participants generating 526 tweets which lead to 1,140,000 impressions. Various methods of simulation were discussed by the participants and tips on how to practically incorporate simulation into your training were discussed. The second Tweetchat "Resident Assessment and Autonomy In Cardiothoracic Surgery" was held on March 19th 2018. Two papers were discussed. There were 41 participants, 451 tweets which lead to 591,814 impressions. This lead to a discussion across the Atlantic on what defines autonomy. The third Tweetchat entitled "Non Operative Technical Skills in Cardiothoracic Surgery" took place on the 16th May 2018. Two papers were discussed. There were 36 participants 515 tweets which lead to 697,426 impressions. Points highlighted were it is important to have a growth mindset and create a safe environment for all to learn.

Conclusions: Twitter is a useful tool to collaborate and disseminate information. The three tweetchats organised by TSSMN trainee delegates generated approximately 1,500 tweets with 2 million impressions. By these metrics, the feasibility of a trainee led TSSMN tweet chat was confirmed.

Role of Esophagogastroduodenoscopy Simulation in General Surgery Residency Education

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Purpose: Fundamentals of Endoscopic Surgery, including a simulation-based skills exam, is now a requirement for American Board of Surgery certification.[1] However, there is currently no standardized endoscopic training curriculum utilizing simulation during general surgery training.[2] We aimed to determine if use of endoscopic simulation improves resident esophagogastroduodenoscopy (EGD) performance.

Methods: General surgery interns were randomized to a group with no simulation training, or to a group with training on an endoscopic simulator over four weeks, at a recommended fifteen minutes per week. Participants were administered pre/post-training surveys to assess attitudes and confidence in performing EGDs. The validated Global Assessment of Gastrointestinal Endoscopic Skills – Upper Endoscopy (GAGES-UE) measured endoscopic proficiency. Repeated measures analysis measured the association between GAGES-UE scores, simulation training, and time of test (pre/post). The primary outcome measured was GAGES-UE scores to determine if there was improvement in endoscopy proficiency after training.

Results: Seventeen residents completed the required training and proficiency exams. The average hours trained was 77.9 minutes +/- 37.6 minutes. The average scores improved from 39.2 +/- 14.1 points to 74.5 +/- 18.8 points ($p<0.0001$). Although not statistically significant ($p=0.50$), the experimental group had a higher average score improvement (40.6 +/- 15.3 points) than controls (33.0 +/- 24.1 points). Regarding usefulness of simulation training, 4/12 simulation group residents strongly agreed, with the remaining agreeing to its usefulness. Regarding the quality of simulation training, 3/12 residents strongly agreed and 8/12 agreed that it was satisfactory. When asked if they felt well-prepared for future live endoscopies, 6/12 residents agreed while 5/12 gave a neutral response.

Conclusions: Proficiency scores improved with simulation training in EGD. However, significance of average score increase could not be assessed due to small sample sizes. At least 15 minutes of training per week may be sufficient to improve EGD proficiency. Overall, simulation training during surgery residency is beneficial and feasible.

Congenital Heart Surgery Posters

VAMP Trial: Use of Arginine Vasopressin in Early Postoperative Management After Completion Fontan

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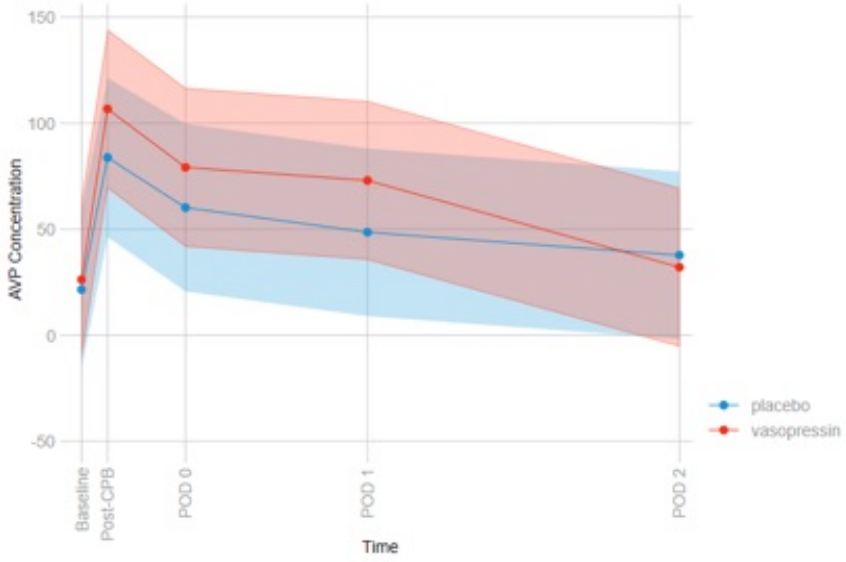
Purpose: Arginine vasopressin (AVP), a vasoactive drug with efficacy in distributive shock, is commonly used to improve postoperative circulatory insufficiency after congenital cardiac surgery. This pilot study sought to evaluate the safety and efficacy and the impact of vasopressin infusion on the early postoperative course following Fontan completion.

Methods: Single center, IRB approved double-blinded, randomized, placebo-controlled study of vasopressin use during first 24 hours after Fontan completion was performed from March 2017 to June 2018. Informed consent was obtained from eligible patients. Subject demographics, postoperative hemodynamics, urine output, chest tube drainage, fluid balance, laboratory data and hospital outcomes were collected. Serial AVP concentrations were monitored at baseline, post-cardiopulmonary bypass (CPB), and on postoperative days 0,1, and 2. Concentrations were analyzed with mixed-effect regression.

Results: Of the 25 patients screened, 22 were eligible and 20 were randomized (10 to AVP and 10 to placebo). All subjects underwent non-fenestrated extracardiac completion Fontan without reintervention or mortality. Groups were balanced for demographic and operative factors: weight 14.3 [12.7-15.7] kg, age 38 [33-45] months, 75% male, CPB time 64 [54-87] min. There were no differences in hemodynamics other than slightly increased mean arterial pressure (+1.65 mmHg, p=0.010) in the AVP group, who also received slightly less norepinephrine (-0.01 mcg/kg/min, p=0.001) and more milrinone (+0.07 mcg/kg/min, p<0.001). There were no statistical differences in urine output, fluid balance, duration of chest tube drainage, renal or liver function tests, but sodium was slightly decreased (-1.1 mEq/L, p=0.009) in the AVP group. AVP levels increased to comparable levels in both groups following CPB, without differences between groups over time (Figure 1).

Conclusions: Vasopressin infusion after Fontan completion is safe, but major hemodynamic differences in the postoperative course were not observed. Since CPB increased native AVP levels, infusion dose may be important. A larger multi-institutional study is needed to further evaluate the previously reported benefits of postoperative AVP on the postoperative course.



Evolution of a Multi-Tiered Approach to Pulmonary Valve Replacement in Patients With Right Ventricular Outflow Tract Dysfunction

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Purpose: Since 2012 we have offered transcatheter pulmonary valve replacement(PVR), since 2016 an off-pump hybrid approach, as an alternative to standard surgical PVR. Patients universally preferred the non-operative/off-pump approach when possible. Transcatheter valves are not applicable in patients without a suitably small landing zone, or if implantation would cause coronary compression.

Methods: We reviewed 53 cases in which transcatheter PVR was felt to possibly be feasible on non-invasive evaluations. All underwent catheterization with balloon sizing of the RVOT and coronary evaluation, including compression testing. The anatomy was felt to be suitable for transcatheter PVR in 40/53 patients. In 3patients, the pre-stent was not stable and these patients had surgical PVR within 24 hours. A transcatheter valve was successfully placed in 37/40. Eleven patients underwent standard on-pump PVR (including with unstable stents), and 5 who were unsuitable for transcatheter PVR had off-pump hybrid surgical RVOT plication with transcatheter PVR at the same procedure.

Results: The mean age at PVR was 28±15 years (8-65) in the total cohort: surgical PVR, 19±13 years vs. transcatheter/hybrid PVR, 31±15 years (p=0.02). Diagnoses were tetralogy of Fallot (n=40), pulmonary atresia (n=4), pulmonary stenosis (n=4), and other (n=5). Mean implanted valve size was 23±3mm (20-29) for total cohort: surgical PVR, 25±14mm vs. transcatheter/hybrid PVR, 23±3mm, p<0.001). Thirty-two (60%) patients received a Medtronic Melody, ten (19%) an Edwards Sapien, and eleven (21%) an Edwards Magna Ease valve prosthesis. Length of stay was 1.4±0.9 versus 3.5±0.7 days for transcatheter/hybrid versus surgical approach (p<0.001). The mean follow-up was 2.3±1.8 years, all patients were alive. No patient had greater than mild insufficiency, and the median maximum instantaneous gradient across the RVOT was 20 mmHg. One patient with transcatheter PVR in Dacron conduit required reoperation 2 years after implantation due to patient growth. There were no episodes of endocarditis and no stent fractures.

Conclusions: Transcatheter PVR may be accomplished in the majority of patients with RVOT dysfunction. In patients with unsuitably large outflow, hybrid off-pump plication (without CPB) with transcatheter PVR is effective. Standard on-pump PVR may be reserved for patients at risk for coronary compression by the transcatheter procedure.

Pondering High-Risk Pediatric Heart Donors: Can We Use More?

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Purpose: Donor risk factors for increased post-transplant mortality have been studied in pediatric heart transplantation; however, these studies have always analyzed the interaction between donor and recipient factors. We standardized the recipient pool so as to solely focus on the impact of the donor factors.

Methods: The United Network for Organ Sharing (UNOS) thoracic organ transplant database was searched for PHT (age < 18 years) occurring between January 2006 and December 2015. Donors were identified as high risk using two previously published methods; the donor utilization based (DUB) method and the recipient survival based (RSB) method. The two populations were not required to be mutually exclusive. Low and high risk donor cohorts were propensity matched on recipient characteristics (age, diagnosis, renal function, gender, transplant year, mechanical ventilation) and outcomes (graft survival) were analyzed using Kaplan-Meier methods.

Results: Recipients were successfully matched on all variables in both methods (Table 1). The DUB population (n=3,189) did not have statistically different graft survival times between the high risk graft recipients (n=1,064) and low risk graft recipients (n=2,125), log-rank test p-value=0.491 (Figure 1). In the DUB population, there was no difference in the number of acute rejection episodes (p-value=0.139), but the high risk cohort experienced longer post-transplant LOS than the low risk cohort (p-value=0.025). The RSB population (n=1,129) similarly did not have statistically different graft survival times between the recipients of high risk grafts (n=376) and the low risk grafts (n=753), log-rank test p-value=0.248. In addition, no differences in acute rejection episodes (p-value=0.273) or post-transplant length of stays (p-value=0.636) were observed between the high risk and low risk cohorts of the RSB population.

Conclusions: Recipients of cardiac allografts deemed “high risk” by utilization and survival based methods did not exhibit significantly different survival from matched recipients of “low risk” allografts. Therefore, it appears that donor quality may have less impact than previously thought, thus allowing for increased usage of the current donor pool.

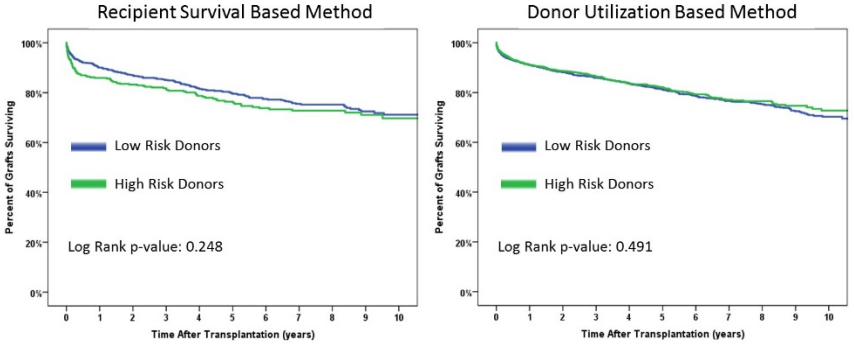

Figure 1: Kaplan-Meier Curves for recipient survival based and donor utilization based populations demonstrate similar graft survival between high and low risk groups donors for both risk stratification methods.

Table 1: RSB and DUB Population Characteristics

Variables	Overall	High Risk	Low Risk	p-value
	(RSB: n= 1158	(RSB: n= 386	(RSB: n= 772	
N (%) or Median [IQR]	DUB: n=3264)	DUB: n=1088)	DUB: n=2176)	
Age at Listing (years)*				
RSB	2 [10]	2 [11]	2 [10]	0.387
DUB	5 [13]	6 [13]	5 [13]	0.991
Age at Listing – Infant				
RSB	468 (40.4)	156 (40.4)	312 (40.4)	1
DUB	984 (30.1)	328 (30.1)	656 (30.1)	1
Gender – Female*				
RSB	487 (42.1)	166 (43.0)	220 (28.5)	0.643
DUB	1,510 (46.3)	514 (47.2)	996 (45.8)	0.427
Transplant Year*				
RSB	2010 [5]	2010 [5]	2010 [5]	0.778
DUB	2011 [5]	2011 [5]	2011 [5]	0.57
Ethnicity – Hispanic				
RSB	225 (19.4)	73 (18.9)	152 (19.7)	0.753
DUB	604 (18.5)	176 (16.2)	428 (19.7)	0.015
Diagnosis – CHD*				
RSB	577 (49.8)	195 (50.5)	382 (49.5)	0.74
DUB	1,295 (39.7)	431 (39.6)	864 (39.7)	0.96
Diagnosis				
CHD				
RSB	577 (49.8)	195 (50.5)	382 (49.5)	0.791
DUB	1,295 (39.7)	431 (39.6)	864 (39.7)	0.935
Cardiomyopathy				
RSB	496 (42.8)	160 (41.5)	336 (43.5)	-
DUB	1,677 (51.4)	563 (51.7)	1,114 (51.2)	-
Retransplantation				
RSB	57 (4.9)	22 (5.7)	35 (4.5)	-
DUB	206 (6.3)	68 (6.3)	138 (6.3)	-
Other				
RSB	28 (2.4)	9 (2.3)	19 (2.5)	-
DUB	86 (2.6)	26 (2.4)	60 (2.8)	-
Ventilator at Transplant – Yes*				
RSB	239 (20.6)	79 (20.5)	160 (20.7)	0.918
DUB	564 (17.3)	200 (18.4)	364 (16.7)	0.789
ECMO at Transplant – Yes				
RSB	78 (6.7)	35 (9.1)	43 (5.6)	0.025
DUB	170 (5.2)	72 (6.6)	98 (4.5)	0.01
eGFR – ≤ 60*				
RSB	229 (19.8)	84 (21.8)	145 (18.8)	0.23
DUB	515 (15.8)	177 (16.3)	338 (15.5)	0.541
LOS (days)				
RSB	20 (22)	20 (23)	20 (22)	0.636
DUB	18 (20)	19 (21)	18 (20)	0.025
Acute Rejection – Yes				
RSB	264 (22.8)	94 (24.4)	170 (22.0)	0.373
DUB	661 (20.3)	213 (19.6)	448 (20.6)	0.498
Graft Survival Time (days)				
RSB	1,826.5 [2,011]	1,753 [2,202]	1,858.5 [1,910]	0.168
DUB	1,797.5 [1,767]	1,795.5 [1,722]	1,798.5 [1,783]	0.887
Patient Survival Time (days)				
RSB	1,828 [1,981]	1,756.5 [2,202]	1,858.5 [1,910]	0.172
DUB	1,799 [1,765]	1,796 [1,752]	1,800 [1,775]	0.926
5 Year Mortality				
RSB	225 (27.8)	82 (30.9)	143 (26.3)	0.165
DUB	535 (25.5)	174 (25.3)	361 (25.7)	0.871

Table 1: CHD, Congenital Heart Disease; DUB, donor utilization based; ECMO, extracorporeal membranous oxygenation; eGFR, estimated glomerular filtration rate; IQR, interquartile range; LOS, length of stay; RSB, recipient survival based; *, variable used for matching

Impact of Phrenic Nerve Palsy on Late Fontan Circulation

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Purpose: Although negative effect of phrenic nerve palsy(PNP) for Fontan circulation was suspected, detailed late impact remains unclear.The objective of the study described herein was to assess the impact of PNP on late hemodynamics, respiratory function, and exercise capacity in Fontan circulation.

Methods: Of a total of 218 patients undergoing extracardiac total cavo-pulmonary connection(EC-TCPC) between 1995 and 2008, 160 patients who underwent all cardiac catheter examination, spirometry, and exercise capacity testing ten years after the operation were enrolled in the study. At first, the cohort was divided into two groups by with PNP(PNP group, n=21) or without PNP(Control group, n=139) . Then PNP group was further divided into two groups-one where PNP improved(PNP improved group, n=10) and one where PNP remained unchanged(PNP static group,n=11) at ten years after EC-TCPC.

Results: All but two patients in PNP group(90.9 %) underwent diaphragmatic plication. A hemodynamic indices at pre-Fontan evaluation did not differ among the three groups(control, PNP improved, PNP static). Outcomes 10 years after EC-TCPC were summarized in Table.For all patients, Forced vital capacity(FVC) was correlated to peak oxygen consumption(pVO2)(r=0.222, p=0.009). FVC decreased significantly for the PNP static group (p=0.00002). Mean pulmonary arterial pressure(mPAP) was significantly higher(p=0.004) and arterial oxygen saturation(SaO2) was lower(p=0.035) for the PNP static group compared with the control group. pVO2 was significantly reduced in PNP remained group, as compared to PNP improved group(p=0.04). Pulmonary vascular resistance(PVR), cardiac index(CI), single ventricular ejection fraction(SVEF) and end-diastolic pressure(SVEDP), forced expiratory volume per second(FEV1.0) and anaerobic threshold(AT) did not differ in 3 groups.

Conclusions: Diaphragmatic movement improved ten years subsequent to Fontan operation for about a half of the patients who developed PNP. In the cases where PNP remained unchanged, FVC decreased significantly long after EC-TCPC even though diaphragm was plicated. High mPAP, low SpO2 and impaired pVO2 resulted for the PNP static group.

Table

Variables	Control	PNP improved	PNP remained	p value (ANOVA)
Number of patients	139	10	11	
Spirometry				
FVC (%)	82.6 ± 16.5	80.9 ± 18.0	56.4 ± 11.7*†	0.00002
FEV1.0 (%)	91.4 ± 14.2	101.7 ± 17.3	91.2 ± 20.9	0.11
Cardiac catheter examination				
mPAP (mmHg)	9.3 ± 2.1	9.4 ± 1.6	11.5 ± 2.8†	0.0054
PVR (WU/m^2)	2.0 ± 7.2	1.3 ± 0.5	1.4 ± 0.5	0.932
CI (L/minute/m^2)	3.0 ± 0.6	3.1 ± 0.5	2.9 ± 0.5	0.71
SVEF (%)	55.6 ± 8.6	51.3 ± 9.5	58.8 ± 8.5	0.14
SVEDP (mmHg)	7.5 ± 2.9	5.6 ± 2.5	8.2 ± 3.4	0.10
SaO2 (%)	94.6 ± 2.8	95.2 ± 2.4	92.1 ± 4.6†	0.035
Exercise capacity testing				
pVO2 (ml/minute/kg)	29.6 ± 6.5	33.5 ± 5.0	26.3 ± 3.8*	0.0495
AT (ml/minute/kg)	17.9 ± 4.6	20.5 ± 2.6	17,3 ± 3.8	0.22

*: p< 0.05 vs PNP improved group. †: p< 0.05 vs Control group

More Than 25 Years of Experience With the Ross Procedure in Children: A Single-Center Experience

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Purpose: Aortic valve replacement in children poses an important challenge. Long-term outcomes following the Ross procedure are still unknown. Concerns regarding pulmonary autograft and homograft longevity requiring subsequent reoperations are well recognized. We reviewed our experience with the Ross procedure aiming to define very long-term survival and freedom from reintervention.

Methods: This is a single-center retrospective cohort including 63 consecutive children who underwent the Ross procedure. The first Ross procedure was performed in 1990. Median follow-up duration was 20.5 years and ranged up to 26.9 years. Long-term survival was assessed using Kaplan-Meier estimator.

Results: There were 51 males (81%) and mean age at surgery was 10.1 (+/- 5.8) years. Isolated aortic stenosis was the most common diagnosis and found in 28 patients (44.4%). There was one (1.6%) hospital death. Survival at 5, 15 and 25 years was 96.7%, 94.4% and 94.4%, respectively. Freedom from autograft-related reintervention was 98.1%, 86.4% and 61.2% at 5, 15 and 25 years, respectively. Fifteen patients (23.8%) underwent reoperations on the pulmonary autograft and there was no post-operative death. Among these patients, 11 patients (73.3%) underwent valve-sparing autograft reoperation. Reintervention on the pulmonary homograft was performed on 30 patients (47.6%). Freedom from homograft-related reintervention was 93.2%, 58.2% and 29.8% at 5, 15 and 25 years, respectively.

Conclusions: The Ross procedure in children is associated with excellent long-term outcomes. Ross-related reinterventions are more than twice as common on the pulmonary homograft than autograft.

Table 1. Late survival and freedom from cardiac reinterventions

Variable	1 year of follow up (95% CI)	5 year of follow up (95% CI)	15 year of follow up (95% CI)	25 year of follow up (95% CI)
Freedom from				
- All-cause mortality	98.4 (89.3-99.8)	96.7 (87.3-99.2)	94.4 (83.2-98.2)	94.4 (83.2-98.2)
- Ross-related mortality	98.4 (89.3-99.8)	98.4 (89.3-99.8)	98.4 (89.3-99.8)	98.4 (89.3-99.8)
- Cardiac non-Ross related mortality	no event	98.2 (88.0-99.8)	95.9 (84.3-99.0)	95.9 (84.3-99.0)
Freedom from				
- Any Ross related failure	95.2 (85.8-98.4)	91.7 (81.2-96.5)	50.8 (35.8-64.0)	11.4 (3.8-23.5)
- Pulmonary homograft failure	96.7 (87.5-99.2)	93.2 (82.3-97.4)	55.6 (40.1-68.6)	16.0 (6.4-29.5)
- Pulmonary autograft failure	no event	98.1 (87.4-99.7)	82.1 (67.2-90.6)	54.9 (37.8-69.1)
Freedom from				
- Any Ross related reintervention	no event	98.1 (87.4-99.7)	82.0 (67.1-90.6)	30.3 (15.7-46.2)
- Any homograft reintervention	96.7 (87.5-99.2)	93.2 (82.8-97.4)	58.2 (42.2-71.2)	28.3 (14.3-44.2)
- Any autograft reintervention	no event	98.1 (87.4-99.7)	86.4 (72.1-93.7)	61.2 (42.1-75.7)

Impact of Gestational Age on Surgical Outcomes in Patients With Functional Single Ventricles

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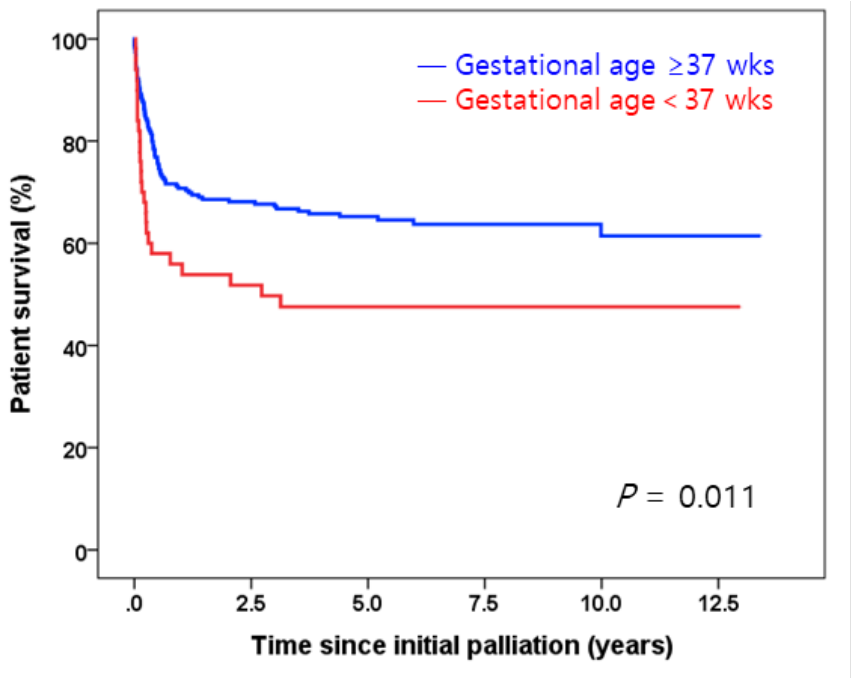
Purpose: Younger gestational age (GA) is known to be associated with worse outcomes after congenital cardiac surgery. We sought to determine the impact of GA on surgical outcomes of single ventricle palliation, focusing on the risk of attrition from the Fontan track due to inter-stage mortality or inadequacy for Fontan completion.

Methods: We conducted a retrospective study of 284 single ventricle patients who were born between January 2005 and December 2014. Classification of single ventricle was AV valve atresia (n=110. 38.6%), overriding atrioventricular (AV) valve (n=50, 17.5%), common AV valve (n = 68, 23.9%), and miscellaneous in (n = 56, 19.7%). Initial palliation was pulmonary artery banding (n = 126, 44.4%), systemic-pulmonary shunt (n = 100, 35.1%), bidirectional Glenn procedure (n = 33, 11.6%), Norwood/DKS (n = 16, 5.6%), and miscellaneous (n = 9, 3.2%). Median GA was 38.2 weeks (range: 28.6 - 41.0 weeks) with 50 prematurity (GA<37 weeks) patients.

Results: Attrition from Fontan completion occurred in 115 patients (40.5%), which was attributed to inter-stage mortality (n= 101, 35.6%) or inadequate Fontan candidacy (n = 14, 4.9%). Among the patients with prematurity, attrition rate was 56%. Five-year survival was significantly low in premature babies (47.6% vs 65.2%, p = 0.011). On logistic regression, younger GA (Odd ratio [OR] 1.14 per 1 week decrease, 95% confidence interval [CI] 1.00 to 1.29, p = 0.048), preoperative ventilator care (OR 1.97, 95% [CI] 1.14 to 3.38, , p = 0.015), right atrial isomerism (OR 3.47, 95% [CI] 1.68 to 7.14, , p = 0.001), and AV valve atresia group (OR 2.36, 95% [CI] 1.37 to 4.05 , p = 0.002) was associated with attrition from Fantan completion. On subgroup analysis for patients with prematurity, older corrected age at initial palliation appeared to be associated with higher rate of inter-stage survival.

Conclusions: Younger gestational age and the need for preoperative ventilator support are risk factors for failure to reach Fontan completion. Deferral of initial palliation in premature babies may mitigate the adverse effect of younger GA on Fontan completion.



	Univariable analysis			Multivariable analysis		
	OR	(95% CI)	*P* value	OR	(95% CI)	*P* value
Gestational age (weeks)	1.16	(1.03-1.31)	0.015	1.14	(1.00-1.29)	0.048
Corrected age at first palliation	0.99	(0.99–1.00)	0.19			
Birth weight (kg)	1.00	(0.99-1.00)	0.029			
Weight at first palliation	0.80	(0.68-0.95)	0.009			
Preoperative ventilator care	2.25	(1.35-3.73)	0.002	1.96	(1.14-3.38)	0.015
Chromosomal abnormality	2.27	(0.63-8.23)	0.21			
Atrial isomerism						
RAI	2.08	(1.08-4.010	0.028	3.47	(1.68-7.14)	0.001
LAI	0.36	(0.07-1.71)	0.19			
Classification of FSV						
AV valve overriding	0.72	(0.38-1.36)	0.30			
AV valve atresia	1.90	(1.17-3.09)	0.01	2.36	(1.37-4.05)	0.002
Common AV valve	1.32	(0.76-2.28)	0.33			
Solitary ventricle	0.30	(0.08-1.06)	0.06			
Palliation type						
Shunt	0.80	(0.48-1.32)	0.38			
PAB	1.51	(0.94-2.44)	0.09			
Norwood.DKS	2.59	(0.91-7.33)	0.07			
TAPVR repair	2.52	(0.59-10.7)	0.21			

Low Wall Shear Stress Proximal to Myocardial Bridge Is Associated With Presence of Plaque Formation

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Purpose: Myocardial bridges (MB) have been reported in 40-80% of autopsies and 1.5-16% of invasive angiographic series. Arterial segment proximal to MB is a preferential site for formation of atherosclerotic plaques[1]. We developed a novel computational framework to assess wall shear stress (WSS) as a marker of plaque location and severity.

Methods: A 3D model of the coronary tree was segmented from coronary CT angiography (CCTA), and MB location, extracted from the intravascular ultrasound (IVUS) map, was automatically "tagged" on the model. This tagged MB segment was then deformed to reconstruct models at systolic and diastolic phases. Intracoronary pressures were digitized and assigned as boundary conditions to the left main and distal LAD branches, while pressure drops at all other branches were scaled to homeostatic WSS of 15 dynes/cm^2. Computational Fluid Dynamic (CFD) simulations were performed and WSS maps were calculated to compare against the location of maximal plaque burden (MPB).

Results: Figure 1 shows WSS maps and the location of MPB. Two notable regions of low WSS, known to promote atherogenesis[2], are observed along the LAD: i) LAD-LCx bifurcation (Location A), a preferential site of plaque formation in the general population; and ii) immediately distal to the origin of the 2nddiagonal, which is colocalized with MPB on IVUS (Location B). Moderately low WSS is also noted at regions of vessel angulation immediately proximal and distal to the MB (Location D, and F). Within and more distal to the MB, high WSS is observed, which promotes an atheroprotective environment[2]. Lastly, IVUS showed eccentric plaque build-up, which aligns with eccentric distribution of low WSS along the luminal cross section at Location B.

Conclusions: Plaque formation proximal to the MB segment may be associated with physiologically low WSS, that promotes an atherogenic environment. CCTA-based CFD techniques could provide non-invasive measure of WSS as a surrogate marker of plaque location and severity, and in future, identify high-risk MB patients who would benefit from early interventions.

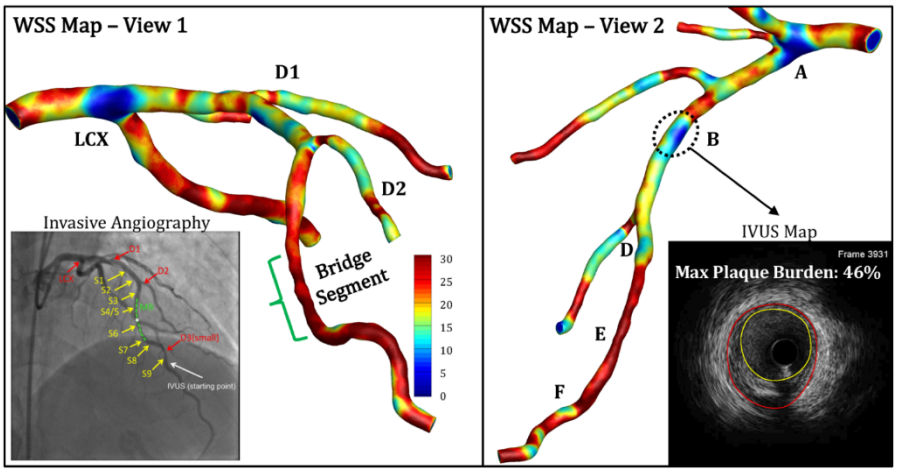

Figure 1: Wall shear stress (WSS) maps of a patient with myocardial bridge (MB), shown in two views. The left panel shows the left circumflex (LCx), diagonal 1 (D1), diagonal 2 (D2) branches, and the myocardial bridge (MB) segment. Left inset shows an angiographic view aligned to the 3D model. The right panel shows the same WSS map in a different view. Location A and B mark regions of very low WSS proximal to MB, D and F mark moderately low WSS, whereas E marks region of high WSS within the MB segment. The right inset shows IVUS of eccentric plaque.

Can Right Atrial Volume Dilatation Become an Indication for Pulmonary Valve Replacement in Patients With Repaired Tetralogy of Fallot?

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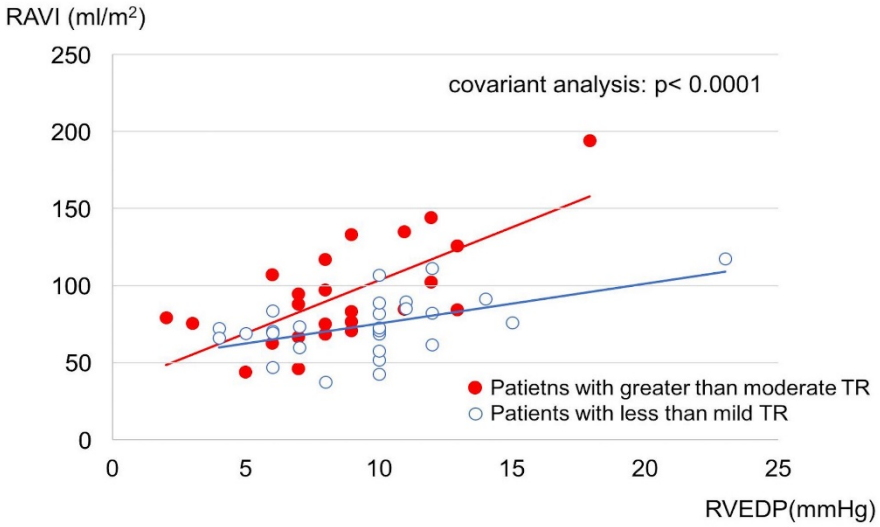
Purpose: Atrial arrhythmia and right ventricular (RV) diastolic dysfunction are associated with increased morbidity and mortality in patients with repaired tetralogy of Fallot (TOF). This study aims to identify whether preoperative right atrial volume can predict the development of atrial arrhythmia after PVR and RV diastolic dysfunction in patients with TOF.

Methods: Fifty-one consecutive adult patients with repaired TOF underwent PVR between 2003 and 2018. Atrial arrhythmia including chronic atrial fibrillation (Af), paroxysmal Af, atrial flutter, and atrial tachycardia were observed in 17 patients. They all underwent MAZE procedure (MAZE III for chronic Af and right-sided MAZE for other atrial arrhythmias) concomitant with PVR. Preoperative right atrial volume was evaluated with computed tomography and image analysis software. RV diastolic function was evaluated using RV end-diastolic pressure (RVEDP) by preoperative cardiac catheterization. The influence of preoperative variables on the development of atrial arrhythmia (including sinus node dysfunction) after PVR was analyzed.

Results: The median follow-up period after PVR was 5.9 years. In 17 patients who underwent Maze procedure concomitantly at PVR (MAZE group), atrial arrhythmia recurred in 10 patients. In 34 patients without preoperative atrial arrhythmia (non-MAZE group), atrial arrhythmia was newly developed in 10 patients. In the MAZE group, preoperative risk factors for post-operative development of atiral arrhythmia with a p-value <0.05 were greater right atrial volume index (RAVI) and higher RVEDP by univariate analysis. In the non-MAZE group, greater RAVI and longer interval from initial repair were the risk factors. Multivariate analysis showed that RAVI was a significant predictor in both groups (p = 0.018 in the MAZE group, p = 0.0001 in the non-MAZE group) (Table). RAVI showed a significant positive correlation with RVEDP and a significant interaction with the degree of tricuspid regurgitation (p < 0.0001) (Figure).

Conclusions: Right atrial volume predicts the development of atrial arrhythmia after PVR in patients with repaired TOF. The right atrial dilatation was significantly related to RV diastolic dysfunction. The right atrial volume should be taken into consideration when deciding on the indication of PVR in this patient population.



Risk factors for development or atrial arrhythmia after PVR

	Univariate Model			Multivariate Model		
Risk factor	OR	95% CI	p value	OR	95% CI	p value
Maze group (N= 17)						
RAVI (ml/m^2)	1.08	0.99-1.18	0.0045	1.08	0.98-1.19	0.018
RVEDP (mmHg)	1.65	0.92-2.95	0.011			
Non-MAZE group (N= 34)						
RAVI (ml/m^2)	1.13	1.02-1.25	<0.001	1.14	1.02-1.27	0.0001
Interval from initial repair (years)	1.10	1.01-1.20	0.013			

PVR, pulmonary valve replacement; RAVI, right atrial volume index; RVEDP, right ventricular end-diastolic pressure; OR, odds ratio; CI, confidence interval

Twenty-Year Experience With Truncus Arteriosus Repair: Changes in Risk Factors in the Current Era

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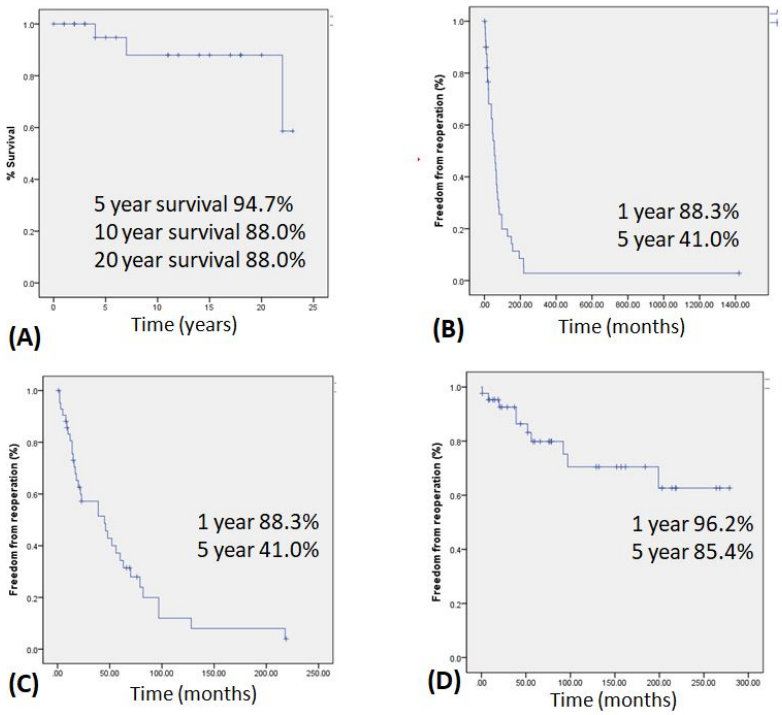
Purpose: The clinical outcomes of truncus arteriosus (TA) repair have been improving but few data are available on survival and freedom from reoperation after TA repair. The aim of this study was to evaluate the long-term outcomes and associated risk factors after repair of TA in the current era.

Methods: Fifty-one patients underwent total correction of TA from April 1982 to June 2018. Since 2003, the perioperative strategy has changed toward minimal priming volume, routine modified ultrafiltration, and early total repair. The patients were divided into two groups. Group I included patients who underwent the operation before 2003 (n = 24), and group II included those after 2003 (n = 27). The mortality and reoperation rates (conduit change or truncal valve (TV) repair/replacement) were analyzed in each group.

Results: The Kaplan–Meier estimate of survival among all hospital survivors was 94.7% at 5 years and 88.0% at 20 years. Eight hospital deaths occurred after the initial operation before 1997. Two late deaths occurred during the mean follow-up of 9.8 years. A significant independent risk factor for early mortality included surgery before 2003 (p = 0.02). Forty-three patients underwent reoperations. The percentage of patients free from any reoperation was 88.3% and 41.0% at 1 and 5 years. Age at the operation, conduit size, and initial TV regurgitation were significant risk factors in group I. However, conduit size was the only independent risk factor for reoperation in group II. The independent risk factors for a conduit-related reoperation were low body weight (p = 0.02) in group I and younger age at operation and use of a homograft or a valveless conduit (p < 0.01) in group II. Initial TV regurgitation was a significant risk factor for sequential reoperation on TV only in group I.

Conclusions: TA repair was associated with excellent results in the current era. Improved perioperative management altered the risk factors for outcomes after TA repair. However, most patients required reoperations, with a larger conduit size, younger age at the operation, choices of RV-PA conduit, and initial TV regurgitation as risk factors.

(A) Actuarial survival among hospital survivors of total repair, (B) freedom from any reoperation, (C) freedom from conduit-related reoperation, (D) freedom from truncal valve repair or replacement



Factors significantly associated with reoperation by multivariate analysis

	Total	**After 2003**
Variables	*P*	*P*
Any reoperations		
Age	0.012	-
Conduit size	0.001	0.033
Truncal valve regurgitation	0.014	-
Conduit-related		
Low body weight	0.015	-
Homograft	-	0.005
Valve vs. non-valve	-	0.004
Age	-	0.003
Truncal valve repair/replacement		
Initial truncal valve regurgitation	0.028	-

Does the Right Ventricle in Pulmonary Atresia With an Intact Ventricular Septum Handle Pulmonary Regurgitation Differently Than in Pulmonary Atresia With Ventricular Septal Defect?

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Purpose: Optimal timing of pulmonary valve replacement (PVR) following biventricular repair of pulmonary atresia with intact ventricular septum (PA/IVS) is unknown. Currently, indications are extrapolated from pulmonary atresia with ventricular septal defect (PA/VSD).[1] We sought to evaluate the right ventricle (RV) physiology of PA/IVS patients who underwent PVR at our institution.

Methods: We identified 468 patients who underwent PVR at our institution from January 1995 to December 2017. Of these, 89 patients had a primary diagnosis of pulmonary atresia and were undergoing first PVR following either biventricular repair of PA/IVS (14, Group I) or complete repair of PA/VSD (75, Group II). Demographics, preoperative and postoperative cardiac imaging, operative indications, clinical outcomes, and patient follow up were collected and reviewed. Data were analyzed using SAS 9.4, and findings are presented as median and interquartile range.

Results: Patients in Group I underwent PVR younger [45 (13-105) vs. 159 (111-206) months, p<0.001] and sooner following first surgery [51 (13-101) vs. 131 (95-174) months, p=0.004]. All patients had moderate or more severe pulmonary insufficiency. The most common indication for PVR was RV diastolic dysfunction (71%) in Group I, compared to RV dilation (76%) in Group II. Valved conduit was used more frequently in Group I (57% vs 27%) compared to bioprosthetic valve in Group II (73% vs 43%, p=0.02). Concomitant procedures were required more often in Group I (71% vs. 15%, p<0.001) and included closure of atrial septal defect (6), takedown of BT shunt (7), and tricuspid valve repair (4). Bypass times were 57 vs. 53 min (p=0.9) and hospital hospital stay 4 vs. 3 days (p=0.4). There was no major morbidity in either group and only one mortality in Group II.

Conclusions: Despite similar degrees of pulmonary insufficiency, PA/IVS patients present for PVR earlier, with more RV dysfunction and less RV dilation than patients with PA/VSD. This suggests an intrinsic difference in the RV of PA/IVS versus PA/VSD. Regardless, surgical outcomes for PVR in PA/IVS are excellent, comparable to PVR in PA/VSD.[2]

Late Neoaortic Valve Regurgitation Long After Arterial Switch Operation

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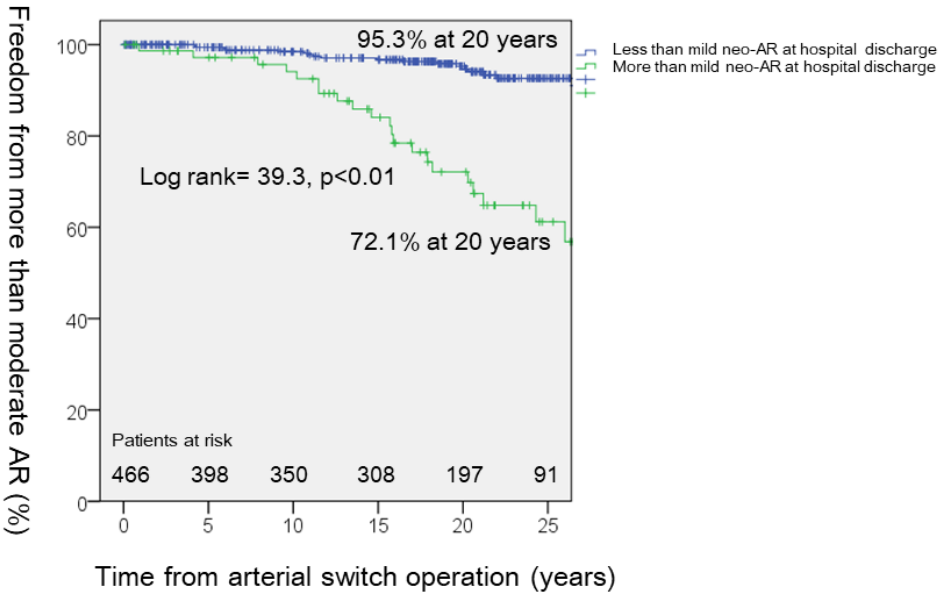
Purpose: The neo-aortic valve regurgitation (AR) is one of the long-term problems after arterial switch operation (ASO). The purposes of this study were to assess the incidence and the risk factors of the neo-AR after ASO and to review the outcome of surgical intervention to the neo-AR.

Methods: This is a retrospective study of 466 hospital survivors after ASO between 1982 and 2016. The patients with previous atrial switch operation were not included. Preoperative diagnosis included 306 transposition of great arteries (TGA) with intact septum, 119 TGAs with ventricular septal defect, and 41 double outlet right ventricles. Previous pulmonary artery banding was performed in 159 patients and 39 had more than trivial preoperative pulmonary valve regurgitation (PR). Median age at ASO was 1.0 (0.1-81.5) month. Thirteen patients had concomitant relief of left ventricular outflow tract obstruction. Seventy-six patients had more than mild neo-AR at hospital discharge.

Results: More than moderate neo-AR was found in 40 patients (8.6%) in the long-term, and its incidence at 20 years after ASO was 8.7%. By multivariate analysis, preoperative PR, concomitant relief of left ventricular outflow tract obstruction and more than mild neo-AR at hospital discharge were identified as risk factors for late aggravation of neo-AR. Among these 40 patients with more than moderate neo-AR, 17 patients underwent surgery to the neo-aortic valve. Mean age at neo-aortic valve surgery was16.7±5.5 years. The surgery included 11 aortic valve replacements, 3 aortic valve plasties, 2 Konno procedures, and 1 root replacement with stentless bioprosthesis. There were two late deaths and 5 reoperations to the neo-aortic valve in 4 patients (all 3 patients with aortic valve plasty eventually required aortic valve replacement). The reoperation free survival after neo-aortic valve surgery at 5 and 10 years were 93.3% and 77.8%, respectively.

Conclusions: Preoperative PR, concomitant relief of left ventricular outflow tract obstruction and more than mild neo-AR at hospital discharge were identified as risk factors of aggravation of late neo-AR. The surgery to the neo-aortic valve was necessary only for small number of patients and its outcome was satisfactory.

Incidence of more than moderate neo-AR in the long-term



Risk factors for more than moderate neo-aortic valve regurgitation in the long-term after arterial switch operation

Using Cox Proportional Hazard Model

Variables (Comparison)	Univariate Analysis		Multivariate Analysis	
	Odds-ratio (95% CI)	p-value	Odds-ratio (95% CI)	p-value
Concomitant relief of left ventricular outflow tract obstruction (Yes or No)	5.5 (2.0-15.6)	p< 0.01	7.1 (2.4-21.2)	p<0.01
Previous pulmonary artery banding (Yes or No)	2.2 (1.2-4.0)	0.02	-	-
More than mild neo-AR at hospital discharge (Yes or No)	5.81 (3.1- 10.8)	p< 0.01	5.6 (2.8- 11.0)	p<0.01
Preoperative pulmonary valve regurgitation (Yes or No)	3.2 (1.4 – 7.3)	p< 0.01	2.6 (1.1-6.1)	0.03
Age at arterial switch operation (More than 1 year old or less than 1 year old)	2.4 (1.2- 4.6)	0.01	2.2 (1.0-5.1)	0.06

Evaluating the Utility of Biomarkers to Improve Prediction of 1-Year Readmission or Mortality After Pediatric Congenital Heart Surgery

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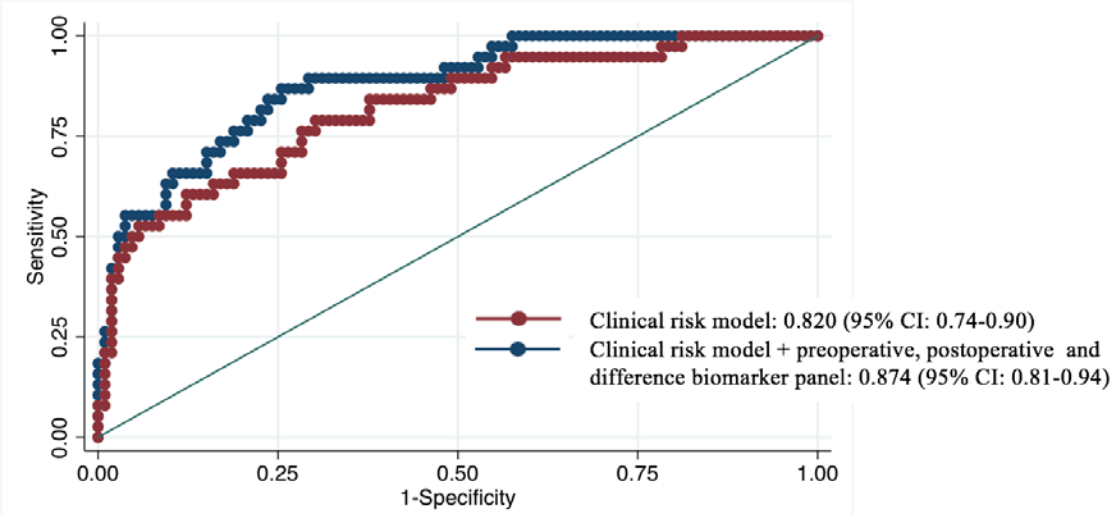
Purpose: Among pediatric congenital heart surgery patients, 20% experience 30-day hospital readmission and 4.2% of surgeries result in death. Currently, novel biomarkers have not been evaluated to improve the clinical utility of a pediatric clinical risk model to predict 1-year readmission or death after congenital heart surgery.

Methods: Patients undergoing congenital heart surgery (n=154), aged 18 years or younger, from Johns Hopkins Hospital from 2010-2014 were enrolled in the prospective cohort. Levels of ST2, Galectin-3, NT-proBNP, and GFAP were measured in pre-and postoperative samples. The composite study endpoint was readmission within 365 days following discharge or mortality either in-hospital during the surgical admission or at any location within 365 days after discharge from the surgical admission. A clinical model based on covariates used in the STS Congenital Heart Surgery Database Mortality Risk Model and a modified STS clinical model in conjunction with a novel biomarker panel were evaluated.

Results: Readmission or mortality within 365-days of cardiac surgery occurred among 39 (24%) pediatric patients. The clinical model alone resulted in a c-statistic of 0.820 (95% CI:0.74-0.90). The augmented clinical model with biomarkers improved the c-statistic to 0.874 (95% CI:0.81 – 0.94). The addition of the log-transformed biomarkers added significant predictive value to the clinical model (ROC test of equality p-value: 0.016; NRI: 0.114 [p-value 0.236], IDI: 0.094 [p-value <0.001]).

Conclusions: Novel biomarkers add predictive value when assessing the likelihood of 365-day readmission or mortality after pediatric congenital heart surgery. The current STS clinical congenital mortality risk model can be applied to identify children with increased risk of repeat hospitalizations and post-discharge mortality and may inform preventative care interventions.

Figure 1. ROC curve for the clinical risk model with and without preoperative, postoperative and pre-postoperative difference biomarkers



Receiver operating characteristic (ROC) curve for the clinical risk model with and without preoperative, postoperative and pre-post difference biomarkers. The clinical model with preoperative, postoperative and pre-post difference biomarker panel (blue line) and clinical model without preoperative, postoperative and pre-post difference biomarker panel (red line). The c-statistics for each model with 95% confidence intervals are listed in the figure.

Table 1. Risk factors to predict 365-day readmission or mortality after pediatric congenital heart surgery.

Risk factor	Unadjusted OR (95% CI)	Clinical model OR (95% CI)	Clinical model + biomarker model OR (95% CI)
Age, in days	1.00 (0.99, 1.00)	0.99 (0.99 – 1.00)	0.99 (0.99 – 1.00)
Weight, in kg	0.99 (0.97 – 1.01)	1.02 (0.98 – 1.06))	1.01 (0.97 – 1.06)
STAT category			
1	REF	REF	
2	5.17 (1.80 – 14.84)*	4.49 (1.48 – 13.66)*	3.73 (1.00 – 13.99)*
3	3.97 (1.05 – 15.01)*	2.80 (0.64 – 12.19)	2.52 (0.46 – 13.82)
4	14.47 (3.49 – 59.91)*	9.38 (1.95 – 44.99)	4.16 (0.51 – 33.76)
5	62.90 (6.36 – 60.42)*	33.43 (3.00 – 37.20)*	15.82 (0.67 – 37.51)
Any prior operation	5.15 (2.24 – 11.86)*	3.57 (1.31 – 9.74)*	4.20 (1.23 – 14.40)*
Any non-cardiac congenital anatomic abnormality	2.02 (0.77 – 5.33)	1.46 (0.49 – 4.73)	1.45 (0.37 – 5.76)
Chromosomal abnormality or syndrome	1.77 (0.82 – 3.82)	1.91 (0.7 - 5.17)	2.20 (0.69 – 6.94)*
Any preoperative factor	4.29 (1.75 – 10.50)*	2.32 (0.72 – 7.44)	1.24 (0.28 – 5.40)
Preoperative biomarkers (Log-transformed)			
ST2	2.65 (1.72 – 4.07)*		2.66 (0.95 – 7.44)
Galectin-3	2.04 (1.24 – 3.36)*		0.72 (0.16 – 3.26)
NT-proBNP	1.27 (1.05 – 1.53)*		0.75 (0.45 – 1.25)
GFAP	0.96 (0.92 – 1.01)		0.96 (0.89 – 1.03)
Postoperative biomarkers (Log-transformed)			
ST2	3.24 (1.91 – 5.49)*		1.15 (0.34 – 3.87)
Galectin-3	1.47 (0.87 – 2.49)		4.73 (0.47 – 47.22)
NT-proBNP	1.27 (1.04 – 1.55)*		1.11 (0.66 – 1.87)
GFAP	1.01 (0.95 – 1.06)		1.04 (0.94 – 1.15)
Pre-post difference biomarkers (Log-transformed)			
ST2	1.17 (1.01 – 1.28)*		0.96 (0.82 – 1.12)
Galectin-3	0.99 (0.98 – 1.00)		0.97 (0.93 – 1.01)
NT-proBNP	0.98 (0.95 – 1.00)		0.99 (0.95 – 1.03)
GFAP	0.99 (0.99 – 1.01)		1.00 (0.98 – 1.03)

Long Interval Period Between Bilateral Pulmonary Artery Banding and Second-Stage Operation Seems to Be Associated With Better Surgical Results

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Purpose: Some reports showed the advantages of bilateral pulmonary artery banding (bil-PAB) which has been performed as a first palliation for the treatment of complex congenital heart disease. We reviewed our experience of bil-PAB in low body weight neonate and young infant and assessed the predictors of postoperative mortality and mobility.

Methods: From May 2007 to December 2017, forty-four consecutive patients underwent bil-PAB at our institution, included 25 patients (52.3%) underwent flow-adjustable bil-PAB (FABPAB; bil-PAB combined with postoperative percutaneous trans catheter angioplasty with balloon dilation). We reviewed patients' clinical perioperative data, such as surgical outcomes, waiting time, body weight gain, and the pulmonary artery index from the medical records. Twenty patients (45.5%) were female. The mean weight was 2,8 kg (range, 2.1 to 3,8 kg) at the time of bil-PAB. Eightpatients (18.1%) weighed 2,500 g or less. The mean age at operation was 8.1 days (range, 2 to 28 days).

Results: There was no case of associated cerebral troubles after bil-PAB. All patients underwent second-stage operation at a mean age of 122.4 days (range, 41 to 385 days) and 4,8 kg (range, 3.1 to 8.2 kg). Univentricular palliation was achieved in 23 patients (52.2%) and biventricular repair in 21 patients (47.8%). [22 Norwood, 4 Norwood plus Glenn, 5 Truncus arteriosus, 4 Arterial switch plus aortic arch repair, 8 Aortic arch repair with VSD or PAB, 1 other]. There were 4 early deaths (4/44; 91%) after second-stage operation. Mortality was strongly associated with the interval period between bilateral PAB and second-stage operation, mortality was high (3/24; 12.5%) with a period < 100 days, and low (1/20; 5%) with a period ?100 days. FABPAB contributes to the induction of significant pulmonary arterial growth before second-stage operation.Higher mortality was encountered after univentricular repair concomitant to atrioventricular valve operation (3/4; 75%).

Conclusions: The midterm results of bil-PAB and FABPAB for thecomplex congenital heart diseasewere favorable. FABPAB also helps to maintain the systemic oxygen saturation level. Long interval period between bil-PAB and second-stage operation seem to be associated with better surgical results.

Contemporary Mid-Term Outcomes in Pediatric Patients Undergoing Vascular Ring Repair

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Purpose: The mid-term outcomes and risk factors for reintervention after division of a vascular ring (VR) are still largely unclear.[1-3] The purpose of this single-institution study was to assess the mid-term outcomes of patients undergoing VR repair and need for later reintervention.

Methods: All patients that underwent surgical repair of an isolated VR from 1996 through 2018 at our institution were included in the study. Patients that underwent concomitant intracardiac repair at the same time were excluded. Data analysis included demographics, type of anomaly, other congenital heart disease, clinical symptomatology, operative technique, perioperative outcomes, reoperation rates, and mortality.

Results: 148 patients (80(54%) males, median age 1.04 years (interquartile range [IQR] 0.4-5.2 years), median weight 12.8 kg (IQR 7.5-26.5)) underwent VR repair via left thoracotomy. The cohort included: 73 patients with double aortic arch; 70 right aortic arch (RAA), aberrant left subclavian (ALS), left ligamentum arteriosum (LLA); 4 RAA, left descending aorta (circumflex arch), and LLA; and 1 RAA, mirror-image branching, and LLA from the descending aorta. Table shows VR types and surgical intervention. Eleven patients (7.4%) had unrepaired associated cardiac diseases. There was 1(0.7%) outpatient perioperative mortality 15 days postoperatively for unclear reasons. Perioperative complications occurred in 20(14%) patients: 18(12%) chylothorax (3 required reintervention), 1 pneumothorax, 1 vocal cord paresis. Three patients required reintervention: 2 required diverticulum resection and subclavian reimplantation at 3 and 4 years (1 RAA-ALS and 1 DAA), 1 patient with DAA s/p left arch division required aortic translocation 9 years later for persistent tracheal compression.

Conclusions: Surgical repair of VR has favorable mid-term outcomes although postoperative chylothorax is not uncommon. A small proportion of patients that do not undergo diverticulum resection and left subclavian reimplantation at the time of VR repair will require reintervention in the future.

VR type	Surgical intervention
Double aortic arch (n=73) - 60 right-dominant - 13 left-dominant	- Division of left arch (n=59) - Division of left arch with KD resection with LSA reimplantation (n=1) - Division of right arch (n=13)
RAA-ALS (n=70)	- Division of LLA (n=53) - KD resection with LSA reimplantation (n=17)
RAA, left descending aorta, LLA (n=4)	- LSA reimplantation to LCA with LLA division (n=4)
RAA, mirror-image branching, LLA (n=1)	- KD resection and LLA division (n=1)

Abbreviations: (KD) Kommerell Diverticulum, (LSA) Left Subclavian Artery, (LLA) Left Ligamentum Arteriosum, (LCA) Left Carotid Artery.

Beyond 30 Days: An Analysis of Unplanned Readmissions During the First Year Following Congenital Heart Surgery

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Purpose: Hospital readmission is rapidly becoming a quality indicator for hospitals and surgical programs. Here we investigate the incidence and etiologies for unplanned hospital readmissions within the first year following congenital heart surgery at our institution and to determine the impact of readmissions on long-term survival.

Methods: We retrospectively reviewed 263 patients undergoing CHS at our institution from 08/2011-06/2015. Scheduled readmissions including second stage palliation for single-ventricle patients were excluded.

Results: Seventy patients (27-infants, 21-children, 22-neonates) were readmitted 119 times (1.7times/patient). Incidence of 30-day post-discharge readmission was 16% (n=41). Of these, 16 (39%) readmissions occurred within 10 days post-discharge. Leading causes of 30-day readmissions included viral illness (33%), wound infections (15%) and cardiac causes (13%). Readmissions within 12-months post-CHS included viral illness (34%), respiratory distress (16%), gastrointestinal (14%) and cardiac causes (8%). On multivariate analysis, age, STAT-category, surgery and intubation time, ICU and hospital length-of-stay (HLOS) were risk factors associated with unplanned readmissions.Median time-to-first readmission was 21 (IQR: 12-58) days. Median HLOS at readmission was

2 (IQR:1-8) days. The 1-, 3-, 6- and 12-month freedom from first readmission was 83%, 73%, 71% and 69%, respectively. Socio-economic status had a significant effect on hospital readmissions; subjects with higher family income were less likely to be readmitted ($p<0.001$). There was no significant difference in survival between readmitted and non-readmitted patients ($p=0.68$). Time-to-readmission and readmission frequency didn't impact patient survival ($p>0.05$).

Conclusions: Sicker patients with complex surgeries and patients from families with lower socio-economic status are more likely to be readmitted within a year following CHS. Such patients may need to be enrolled to complex management programs in order to avoid preventable hospital readmissions.Readmissions do not impact long-term survival of patients after CHS.

Tracheal Resection With Innominate Artery Transposition in Morquio Syndrome

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Purpose: Tracheal stenosis caused by infiltration from Morquio Syndrome and associated anterior compression of the trachea from the innominate artery can be a challenging case that requires a comprehensive approach to surgical treatment and a multidisciplinary team to address the abnormalities of the aorta and great vessels, airway and cervical spine.

Methods: This video was created utilizing a mixture of media that includes video footage from the operation using overhead cameras, intraoperative photographs, medical illustrations commissioned for this project, and also infusion of 3D reconstruction images that were made for surgical planning of this procedure.

Results: The tracheal stenosis shown here is a result of both disease infiltration and extrinsic compression. Treatment required cervical spine stabilization, resection of the stenotic trachea with a tension-free reconstruction, and transposing the abnormal horizontally-positioned innominate artery lower down on the ascending aorta. This facilitated exposure of the trachea and resulted in a more vertical position of the vessel that had no direct contact with the trachea after transposition, which further reduced the possibility of extrinsic tracheal compression. This multifactorial pathology was accomplished with advanced imaging for surgical planning and education, and a multidisciplinary team approach between the cardiac surgical, ENT and orthopedic services.

Conclusions: This video highlights the importance addressing all abnormalities of the pathology present with this disease. Also, the importance of advanced imaging to fully understand the anatomy, educate and facilitate complex surgical planning for the multidisciplinary team is essential to optimize outcome.

Surgical Strategies for Neonates and Young Infants With Pulmonary Atresia and Ventricular Septal Defect: Staged Repair vs Primary Repair

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Purpose: Initial surgical options for pulmonary atresia with ventricular septal defect (PA/VSD) in neonates and young infants are either palliative shunt operation or early total correction. Staged repair strategy may be associated with a higher risk of inter-stage mortality, and primary repair strategy may lead to frequent post-repair reinterventions.

Methods: From 2004 to 2017, 65 patients with PA/VSD who underwent surgical intervention before the age of 90 days were identified and enrolled in this retrospective study. The cohort was divided into two groups; group R who underwent primary repair (n=15), and group P who underwent Blalock-Taussig shunt or right ventricle to pulmonary artery (RV-PA) conduit (n=50). Risk of multiple reoperations among the survivors was analyzed using Prentice-Williams-Peterson (PWP) model, and Cox proportional hazards model was fitted to determine the risk factors for decreased time to composite adverse outcome (death, reoperations) after birth.

Results: Median follow-up was 42.9 (IQR 19.4-98.7) months. Two groups did not differ in age at initial operation (Group R: 36.5 ± 27.9 days, Group P: 28.4 ± 15.6 $p=0.298$), BSA (Group R: 0.2 ± 0.0, Group P: 0.2±0.0, $p=0.105$), but differed in pulmonary artery index (Group R: 164.5±51.9 mm^2/m^2, Group P: 124.6±50.9 mm^2/m^2, $p=0.010$). During the follow-up duration, there were nine surgical mortalities (Group P=7, Group R=2)24 first reoperations after repair (Group P=16, Group R=8), and 11 second reoperations (Group P=3, Group R=8). Five-year survival was comparable between the two groups (group R=86.7%, group P=83.6%, $p=0.754$), but staged repair showed a decreased risk of multiple reoperations compared to primary repair (HR 2.73, 95% CI:0.2751-0.7204, $p=0.0086$). Cox model showed primary repair as the only risk factor for decreased time to death/first reoperations (HR 2.53, 95% CI:1.002-5.453; $P=0.049$) and death/second reoperations (HR 2.90, 95% CI:1.09-7.75, $p=0.026$) after birth.

Conclusions: Staged repair strategy, as compared to initial total repair, was associated with higher inter-stage mortality with less frequent reinterventions after repair, which may be attributable to the use of larger conduits upon repair. Lowering the inter-stage mortality in the staged repair may allow for better surgical outcome in the future.

1st Reintervention or Death After Birth

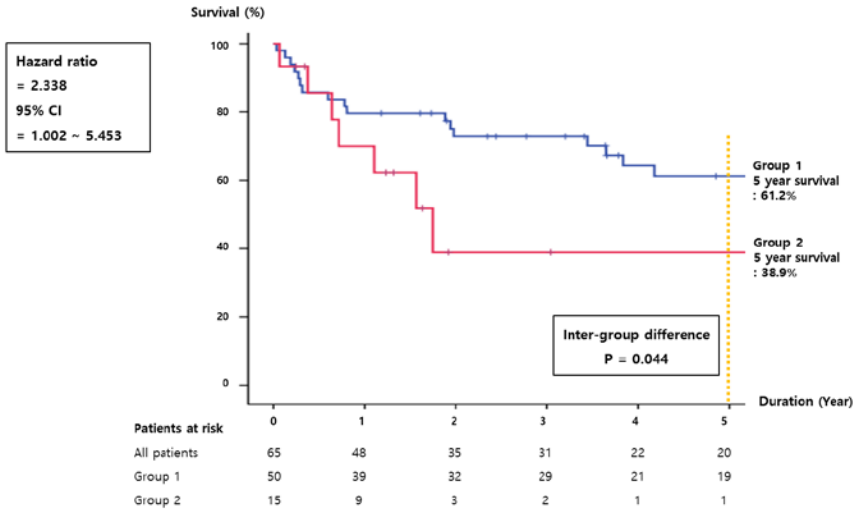

Table 1.

Freedom from 1st Reinventervention 1 or Death after Birth

	Univariate	Multivariate analysis		
	P value	Hazard ratio	95% CI	*P* value
Group	**.049**	2.34	1.002-5.453	**.049**
Sex	.350			
Prematurity	.162			
Birth weight	.480			
JDS	.683			
Pre op BWT	.911			
PAI	.180			
Preoperative ventilator(+)	.182			

Freedom from 2nd Reintervention or Death after Birth

	Univariate	Multivariate analysis		
	P value	Hazard ratio	95% CI	*P* value
Group	**.033**	2.91	1.090-7.752	**.033**
Sex	.934			
Prematurity	.340			
Birth weight	.688			
JDS	.581			
Pre op BWT	.328			
PAI	.351			
Preoperative ventilator(+)	.158			

JDS: Juxtaductal stenosis, BWT: Body Weight, PAI: Pulmonary Artery Index

Rescue Cardiac Surgeries After Pediatric Interventional Catheterization: A 10-Year Retrospective Study

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Purpose: Due to the progress in interventional pediatric cardiology, more congenital cardiac anomalies are being treated in the catheterization laboratory.We retrospectively reviewed all those cases done in our institute over the last 10 years.Cases needing rescue cardiac surgeries need to be studied because reports in the literature are very few.

Methods: All the pediatric interventional catheterizations done in our institute from January 2008 till January 2018 were included in this retrospective study. The total number of interventions were 2495 over this period of 10 years. We performed 26 emergency cardiac surgeries after interventional catheterization. The interventions were 9 ASD device closures, 6 PDA coil closures, 2 PDA Amplatzerdevice removal, 5 balloon dilatations (valvuloplasty, angioplasty) with stent and 4 cases of VSD closures. Surgical approaches as well as morbidity and mortality were reviewed to assess our decision of timing of the surgery as well as the surgical technique.

Results: The number of emergency interventions was 26 cases out of 2495 (1.04%).We had 26 patients (17 males and 9 females),median age 4(2-12) years. 9 patients had ASD closure with Amplatzer device, 8 of which slipped into the right atrium or were entangled into the tricuspid valve while 1 patient had the device passing through the Eustachian valve with a large residual ASD in the superior rim. 6 patients had trial of PDA coil closure which slipped into the LPA. 2 patients had the PDA closed with an Amplatzer device which was protruding in the aorta. 4 patients had LPA and RPA stent application but were dislocated and 1 patient had pulmonary valvuloplasty but had injury of the RV. 4 patients had VSD closure , 3 were slipped Amplatzer devices into the RV. There was one mortality case (3.8%) due to infective endocarditis after VSD closure, while 2 had severe chest infection.

Conclusions: The number of emergency interventions of 26 cases out of 2495 (1.04%)is acceptable specially when we consider the learning curve in interventional catheterization.Immediate emergency surgical intervention is required if problems of bleeding or slipped devices happens and the quicker the surgical interference, the better the results.

Critical Care Posters

Experience With Centrifugal Pump-Based Biventricular Assist Device for Pediatric Heart Failure Patients

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Purpose: Ventricular assist device (VAD) is an important treatment option for heart failure. However, because of a small size, there are limitations to apply VAD for pediatric patients. Even though implantable VAD is available in many countries, the centrifugal pump-based VAD system is still important in the aspect of financial problem.

Methods: From January 2000 to July 2018, we have 11 pateints (median: 8.9 years, range: 0.3-15.9 years) who were supported by centrifugal pump-based biventricular-VAD (Bi-VAD) for heart failure. Five dilated cardiomyopathy, 5 acute fulminant myocarditis, and 1 stress induced cardiomyopathy patients were included. Recently (6 of 11 (54.5%) patients since 2016), we have actively tried to apply Bi-VAD for the patients who has tolerable pulmonary function, or the patients whose pulmonary function was recovered after initial ECMO support. All patients were cannulated by centrally with median sternotomy. The median body weight of the patients was 34.5 kg (range: 7.3-73.3 kg).

Results: We applied Bi-VAD in 5 patients initially, and we changed from ECMO to Bi-VAD support after pulmonary function recovery in 4 patients. For 2 patients, we applied a left VAD first due to left ventricular dysfunction subsequently added a right VAD due to progressed right ventricular dysfunction. Four patients (36.4%) were successfully weaned from VAD and 4 patients underwent heart transplantation. Median mechanical support duration was 17.5 days (range: 1 to 47 days). There were 3 (27.3%) early mortalities. Two of 3 mortalities occurred before 2006. All mortality patients are supported because of dilated cardiomyopathy. One of 3 early mortality patients supported Bi-VAD initially and rest 2 patients supported LVAD and ECMO initially. There is no significant difference in early mortality, morbidity and weaning rate between initial Bi-VAD group and others. According to the diagnoses, myocarditis showed a tendency of successful weaning from Bi-VAD or bridging to heart transplantation (p=0.061).

Conclusions: Pediatric patients who have tolerable pulmonary function, we tried to apply a centrifugal pump-based VAD, especially the Bi-VAD recently. The centrifugal pump-based Bi-VAD system was a reasonable option for a bridge to heart transplantation or recovery, especially the myocarditis patients in our experience before considering the implantable VAD system.

Platelet Nadir Following Cardiopulmonary Bypass Is Independently Associated With Postoperative Mortality, Infection, Acute Kidney Injury, and Prolonged Intensive Care Unit Stay

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Purpose: Thrombocytopenia is common following cardiopulmonary bypass, and is associated with increased mortality. Platelets activation and consumption can cause microvascular dysfunction and impaired immunity, making it plausible that post-bypass thrombocytopenia predisposes to a number of post-operative compliations. This retrospective study compares complication rates in patients with post-bypass thrombocytopenia to those without.

Methods: Patients were identified using our institutional Society of Thoracic Surgeons (STS) database from 2012-2016, and a total of 1,363 cases met inclusion criteria. Post-bypass thrombocytopenia was defined as a platelet nadir $<75x10^3/\mu L$ (25^{th} percentile value for platelet nadir). Infection was defined as having one of the following: 1) documented surgical site infection, 2) positive blood or urine culture, 3) imaging suggestive of new-onset pneumonia. We performed unadjusted, multivariate, and propensity matched analyses adjusting for the variables listed in Table 1. Propensity matching used 1:1 greedy matching. All statistical tests were considered to be significant at a 2-sided $p < .05$.

Results: Patients with post-bypass thrombocytopenia were older, had lower BMI, were more likely to be female, had higher rates of congestive heart failure, and had lower white blood cells, hematocrit, and platelets at baseline. Surgeries and perfusion times were longer, and patients were given blood products more often. Post-bypass thrombocytopenia patients had higher rates of post-operative mortality, infection, dialysis requirement, acute kidney injury (AKI), and prolonged ICU LOS **(Table 1)**. Propensity matching was successful as defined by a standard error < 0.1 in all categories following matching. The variables used for adjustment in the multivariate model and matching in the propensity score models are given under Characteristics in Table 1. In all models, patients with post-bypass thrombocytopenia were more likely to experience adverse outcomes including infection, AKI, dialysis requirement, prolonged ICU stay, and mortality (**Figure 1)**.

Conclusions: Post-bypass thrombocytopenia was independently associated with poor outcomes including infection, AKI, dialysis, prolonged ICU stay, and mortality. Further studies are needed to determine the mechanisms by which thrombocytopenia may contribute to morbidity and mortality, and to evaluate interventions to reduce thrombocytopenia in this population.

Figure 1. Primary and secondary outcomes by platelet nadir <75x10^3/μL

Outcome	Platelet Nadir <75x10^3/μL (N = 353) OR (95% CI)	*P* value
Overall infection		
Unadjusted	2.27 (1.70-3.05)	**<.0001**
Multivariable adjusted	1.71 (1.18-2.45)	**.005**
Propensity matched	2.02 (1.38–2.97)	**<.0001**
Confirmed infection		
Unadjusted	2.16 (1.55-3.01)	**<.0001**
Multivariable adjusted	1.84 (1.23-2.75)	**.003**
Propensity matched	1.90 (1.23-2.93)	**.004**
Suspected infection with negative culture		
Unadjusted	1.98 (1.21-3.25)	**.007**
Multivariable adjusted	1.41 (0.73-2.73)	0.3
Propensity matched	1.86 (0.96-3.61)	.07
Intensive care unit stay ≥ 72 hr		
Unadjusted	2.20 (1.72-2.81)	**<.0001**
Multivariable adjusted	1.61 (1.20-2.16)	**.002**
Propensity matched	1.98 (1.46-2.70)	**<.0001**
Acute Renal Failure^		
Unadjusted	5.72 (3.08-10.62)	**<.0001**
Multivariable adjusted	7.02 (2.96-16.69)	**<.0001**
Propensity matched	9.72 (2.94-32.18)	**<.0001**
Acute Kidney Injury†		
Unadjusted	1.76 (1.34-2.32)	**<.0001**
Multivariable adjusted	1.83 (1.27-2.63)	**.001**
Propensity matched	1.72 (1.20-2.46)	**.003**
30-day mortality		
Unadjusted	7.38 (3.36-16.2)	**<.0001**
Multivariable adjusted	4.35 (1.65-11.45)	**.003**
Propensity matched	4.15 (1.55-11.09)	**.005**

†Acute kidney injury was defined AKI is defined as a rise of 0.3 mg/dL or greater above baseline. Baseline creatinine – median value in 3 months preceding surgery

^Acute renal failure was defined as tripling of creatinine, absolute maximum value of creatinine >4.0 mg/dL, or new dialysis requirement

Table 1. Baseline characteristics and outcomes of patients with and without platelet nadir <75x10³/μL.

*Characteristics**	*Platelet Nadir ≥75x10³/μL (n=1,008) N (%)*	*Platelet Nadir <75x10³/μL (n=355) N (%)*	*P value*
Female	261 (25.9)	126 (35.5)	**.001**
Age, years, mean (SD)	59.2 (13.7)	65.0 (13.6)	**<.0001**
Race/ethnicity			**.01**
Black	73 (7.2)	15 (4.2)	
Caucasian	746 (74.0)	281 (79.2)	
Hispanic	152 (15.1)	38 (10.7)	
Other/Unknown	37 (3.7)	21 (5.9)	
Body mass index, mean (SD)	29.1 (6.6)	26.8 (5.2)	**<.0001**
Comorbidities			
Sleep apnea	204 (20.3)	66 (18.6)	.4
Hypertension	702 (69.6)	238 (67.0)	.4
Diabetes	334 (33.1)	89 (25.1)	**.005**
Chronic lung disease	214 (21.2)	69 (19.4)	.5
Liver disease	26 (2.6)	13 (3.7)	.3
Congestive Heart Failure	422 (41.9)	210 (59.2)	**<.0001**
Cancer within 5 years	90 (8.9)	125 (9.2)	.6
Peripheral vascular disease	53 (5.3)	24 (6.8)	.3
Cerebrovascular disease	102 (10.1)	38 (10.7)	.8
Dyslipidemia	593 (58.8)	202 (56.9)	.5
Smoker at time of surgery	265 (26.3)	73 (20.6)	**.03**
History of IV drug abuse	23 (2.3)	5 (1.4)	.3
Baseline eGFR, mL/min, (SD)	79.5 (21.0)	71.6 (21.2)	**<.0001**
Baseline platelets, 10³/μL (SD)	232 (63.2)	177 (66.3	**<.0001**
Platelet Nadir, 10³/μL (SD)	115.8 (32.6)	57.2 (13.7)	**N/A**
Hematocrit, mean (SD)	41.2 (5.6)	39.9 (6.3)	**<.0001**
White blood cell count, mean (SD)	7.6 (2.5)	6.7 (2.1)	**<.0001**
Perfusion time, hours, mean (SD)	131.2 (59.7)	142.2 (78.5)	**<.0001**
Surgical time, hours, mean (SD)	5.8 (1.7)	7.1 (2.2)	**<.0001**
Cardiogenic shock	10 (1.0)	7 (2.1)	.1
Intraoperative blood products	341 (33.8)	216 (60.8)	**<.0001**
Intraoperative platelets, units, mean (SD)	0.4 (0.8)	1.1 (1.3)	**<.0001**
Immunosuppressive medication prior to surgery	27 (2.7)	20 (5.6)	**.009**
Steroid use	28 (2.8)	15 (4.2)	.2
Previous cardiovascular intervention	302 (30.0)	151 (42.5)	**<.0001**
Outcomes*			
30-day mortality	9 (0.9)	22 (6.2)	**<.0001**
Surgical site infection	38 (3.8)	18 (5.1)	.3
Positive blood or urine culture	28 (2.8)	27 (7.6)	**<.0001**
Suspected pneumonia	28 (2.8)	28 (7.9)	**<.0001**
Acute Kidney Injury†	199 (19.8)	109 (30.7)	**<.0001**
Renal Failure^	16 (1.6)	30 (8.5)	**<.0001**
ICU length of stay ≥ 72 hours	379 (37.6)	202 (56.9)	**<.0001**

*Values are frequency and column percents unless otherwise specified.
†Acute kidney injury was defined AKI is defined as a rise of 0.3 mg/dL or greater above baseline. Baseline creatinine – median value in 3 months preceding surgery
^Acute renal failure was defined as tripling of creatinine, absolute maximum value of creatinine >4.0 mg/dL, or new dialysis requirement

Are We Feeding Extracorporeal Membrane Oxygenation Patients? A Prospective, Observational Study

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Purpose: Though there are around 6,000 patients per year on ECMO internationally and inadequate energy intake is associated with increased mortality, we lack detailed information regarding the nutritional management of ECMO patients. Thus, in a prospective observational study, we characterized how ECMO patients receive nutrition in comparison to other critically-ill patients.

Methods: Prospective observational data was gathered from patients receiving a nutrition support consult between January 2015 and July 2018 in the cardiovascular surgery intensive care unit of a single institution. This data detailed the daily perturbations in delivery of nutritional support, including rate of feeds, hours held, protein/caloric goals met, route, and pertinent complications. The ECMO cohort (n=55), 98.4% post-cardiotomy, and non-ECMO cohort (n=240), all post-cardiac surgery, were compared in reference to demographics, nutrition delivery, and outcomes. Target caloric goal for was estimated as 25 kcal/kg for those who did not undergo a metabolic cart study.

Results: ECMO patients received significantly less of their total caloric goal compared to non-ECMO patients (30% vs. 43%, p=0.003). Despite having higher daily protein goals (116g vs. 104g, p=0.013), ECMO patients were still fed less protein (33 vs. 48g, p<0.001)

compared to non-ECMO patients. Tube feeds were run at a slower rate (27 vs 37ml/hr, p<0.001) and held for longer (8.2 vs. 4.6 hrs/day, p<0.001) in ECMO patients. The most common reasons for holding feeds in the ECMO population were procedures (55.6 vs. 48.5%, p=0.037), requirement of high dose pressors (13.2 vs. 5.3%, p<0.001), and high residual (6.3 vs. 2.6%, p=0.004). Type of ECMO, VA (n= 43) vs. VV (n=18), and ECMO cannulation, central (n=30) vs. peripheral (n=31), did not impact nutritional support. Gastric ulcers were more common in ECMO patients (8.9 vs 1.3%, p=0.007), but rates of ischemic bowel (1.6 vs. 2.5) or diarrhea (26.8 vs 24.9) were similar.

Conclusions: Compared to other critically-ill patients, ECMO patients received significantly less nutrition support, both in protein and total caloric intake. Contributing factors were rate of delivery, procedure holds, high pressors, and high gastric residuals. Future research should address optimal nutrition support in ECMO patients, as it may influence outcomes.

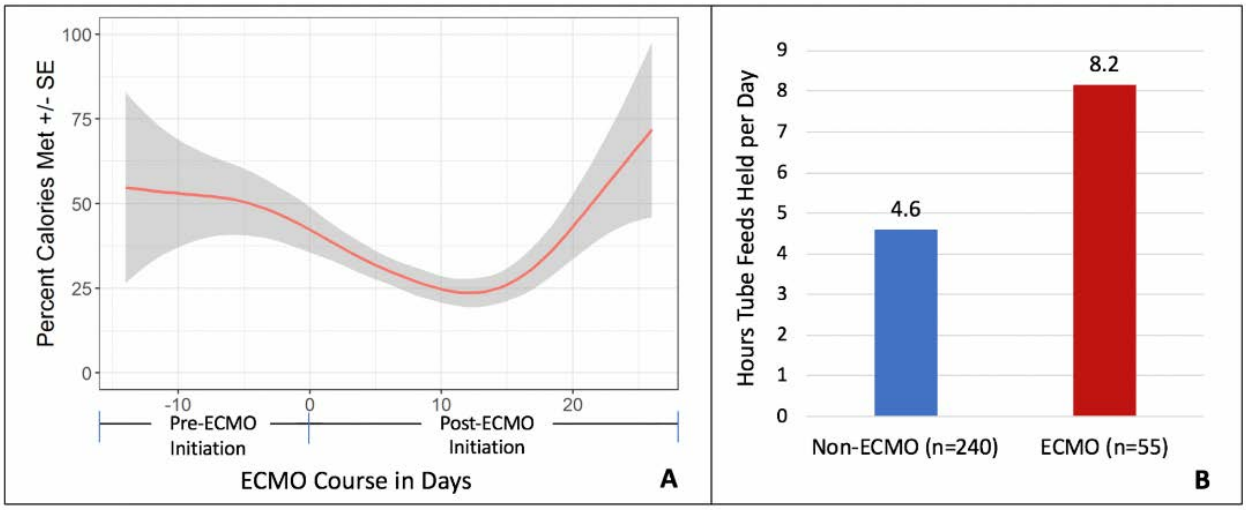

FIGURE: The impact of ECMO on nutritional support in percent of calorie goal met per day and hours that tube feeds are held per day.

TABLE: Demographic information regarding nutrition and outcomes of ECMO and non-ECMO patients. This data omits patients on ECMO who did not receive concurrent nutritional support. A student's t-test or chi square test was run for these variables.

	Non-ECMO	ECMO	p-value
Nutrition Demographics	n = 240	n = 55	
Caloric Goal in kcal (mean (sd))	1594 (452)	1596 (363)	0.968
Percent Goal Calories Met (mean (sd))	42.95% (31.06)	30.12% (25.58)	**0.005**
Calories (%) from Propofol and Dextrose (mean (sd))	13% (0.22)	33% (0.36)	**<0.001**
Protein Goal in g (mean (sd))	48.46 (26.48)	32.88 (23.68)	**<0.001**
Percent Protein Goal Met (mean (sd))	54.96% (25.75)	34.44% (24.36)	**<0.001**
Rate of Tube Feeds (ml/hour) (mean (sd))	37.11 (16.64)	27.00 (14.13)	**<0.001**
Volume of Tube Feed in ml (mean (sd))	657.04 (347.55)	419.34 (288.96)	**<0.001**
Hours of Tube Feeds Held per Day (mean (sd))	4.61 (5.32)	8.17 (6.70)	**<0.001**
Vasoactive-Inotropic Score (VIS)	3.01 (5.27)	6.14 (4.94)	**<0.001**
Tube Feed Formula Category			**0.009**
Intact	100 (41.7%)	14 (25.5%)	
Semi-Elemental	111 (46.2%)	39 (70.9%)	
Elemental-Low Fat	3 (1.2%)	0 (0.0%)	
Route of Nutrition Delivery			
NG Tube	177 (73.8%)	50 (90.9%)	**0.011**
ND Tube	28 (17%)	4 (7.3%)	0.481
PEG	4 (1.7%)	0 (0%)	0.751
PEG-J	8 (3.3%)	0 (0%)	0.361
Days of Nutrition Support (mean (sd))	19.32 (42.72)	24.61 (42.10)	0.411
Enteral nutrition + PPN	23 (9.6%)	1 (1.8%)	0.104
Reasons for Tube Feed Holds	n = 1137	n = 288	
Procedure	551 (48.5%)	160 (55.6%)	**0.037**
Pressors	60 (5.3%)	38 (13.2%)	**<0.001**
Nursing Care	82 (7.2%)	14 (4.9%)	0.197
Possible Extubation	88 (7.7%)	5 (1.7%)	**<0.001**
High Residual	30 (2.6%)	18 (6.2%)	**0.004**
Physical Therapy	36 (3.2%)	0 (0%)	**0.004**
Other	290 (25.5%)	53 (18.4%)	**0.015**
Outcomes	n = 240	n = 55	
30 Day Mortality	47 (19.8%)	36 (64.3%)	**<0.001**
Hours in ICU (mean (sd))	280.81 (379.40)	417.37 (566.31)	**0.018**
Gastric Ulcer Complication	3 (1.3%)	8 (9.8%)	**0.001**

Upper Extremity Deep Vein Thrombosis Following Cardiac Surgery

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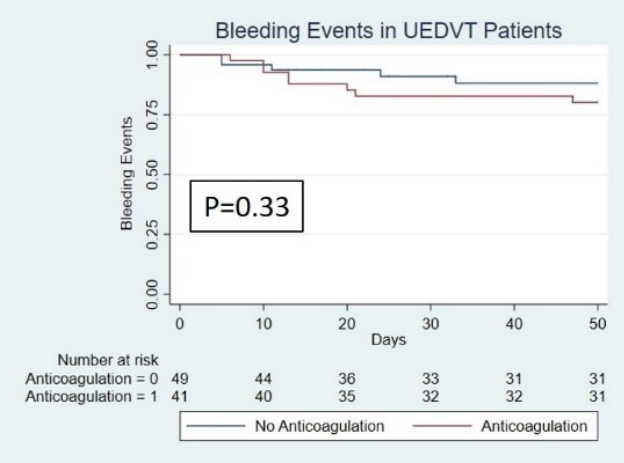
Purpose: The optimal management of upper extremity deep vein thromboses (UEDVT) in critically ill cardiac surgical patients remains controversial. Most UEDVTs in this population are line-associated, the incidence of pulmonary embolus is lower, and it is uncertain if anticoagulation is beneficial.

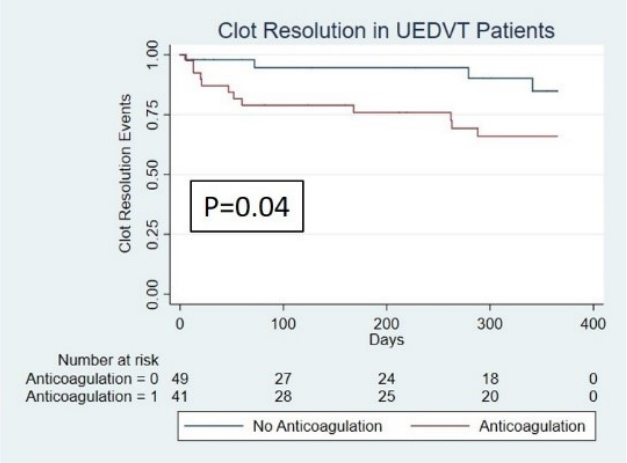
Methods: We conducted a retrospective, single-institution study, of patients who presented with UEDVT following cardiac surgery from 2016 to 2017. Patients were included if they were diagnosed with an UEDVT on duplex ultrasound within their admission for cardiac surgery or stay in the cardiovascular surgical intensive care unit. Patient characteristics, primary diagnosis, hypertension, indication for surgery, whether patients received anticoagulation and outcomes were reviewed. Our primary exposure was anticoagulation after diagnosis of UEDVT. The primary outcomes were bleeding events, and development of pulmonary embolism. Secondary outcomes included clot resolution. Multivariate logistic regression and Kaplan-Meier analysis were used to analyze outcomes.

Results: 91 patients with UEDVT were included in our study. 9 (9.89%) patients had cancer, and 24 (26.4%) experienced bleeding events following cardiac surgery. Seven (6.59%) presented with PE, of whom 2 (2.19%) were on anticoagulation but still developed PE. Fourty-one patients (45.1%) were placed on anticoagulation and 32 out of those 41 (78%) experienced clot resolution. Anticoagulation treatment for UEDVT after cardiac surgery was not associated with bleeding on univariate or multivariate analysis (OR: 1.08, p=0.89, 95%CI: 0.35-3.27). Association between anticoagulation and development of PE was also insignificant (OR: 0.45, p=0.36, 95%CI: 0.08-2.46). Anticoagulation treatment for UEDVT after cardiac surgery was significantly associated with clot resolution on

multivariate analysis (OR: 9.13, p<0.01, 95%CI: 4.28-36.1). Kaplan-Meier curve demonstrated no difference in bleeding events and development of PE following anticoagulation treatment (Figure 1). However, it showed significant likelihood of clot resolution (p=0.04).

Conclusions: Although anticoagulation is not associated with bleeding events nor prevented pulmonary embolism in cardiac surgery patients, it was significantly associated with clot resolution. In our limited sample size, this study demonstrated that anticoagulation may be utilized to resolve upper extremity thrombi following cardiac surgery without the risk of bleeding.





Feasibility and Safety of Systemic Anticoagulation-Free Veno-Venous Extracorporeal Membrane Oxygenation in Adult Respiratory Failure Patients

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Purpose: Veno-venous extracorporeal membrane oxygenation (VV-ECMO) is increasingly used for patients with refractory respiratory failure. Bleeding diasthesis resulting from standard anticoagulation is the predominant cause of morbidity associated with VV-ECMO. Given the improvements in ECMO components reducing their thrombogenicity, we explored whether VV-ECMO can be utilized without therapeutic levels of anticoagulation.

Methods: Single center analysis of patients undergoing VV-ECMO between January 2016 and December 2017. Overall, 41 patients (mean age, 47.4 ± 15.2 year) with respiratory failure underwent VV-ECMO implantation and were categorized into the following groups: A) No anticoagulation (AC-): 18; B) Received anticoagulation (AC+):8; C) Switched to anticoagulation due to a newly diagnosed pre-existing thrombotic event after initial anticoagulation free-approach (AC-/+): 15. Anticoagulation levels were targeted to maintain activated clotting time (ACTs) of 160-180 seconds in the AC+ and 180-220 seconds in AC-/+ group. No ACTs were checked in AC- groups and they received standard venous thromboprophylaxis.

Results: Two patients in AC- group (11.1%) and none in AC+ group had GI bleeding requiring endoscopy (p=0.35). In mixed group, 2 patients (11.9%) had a GI bleeding while not receiving anticoagulation, and 6 patients (35.7%) experienced this complication after being placed on anticoagulation. Events per patient-day (EPPD) for GI bleeding was 0 during anticoagulation free, and 0.02 during systemic anticoagulation (p=0.02). Planned oxygenator exchange was not significantly different between the AC- and AC+ groups (0.01 EPPD vs 0, p=0.52). In AC-/+ patients, oxygenator dysfunction was 3 times (0.02 EEPD) anticoagulation free, and 5 times (0.01 EPPD) during systemic anticoagulation (p=0.40). Overall survival was not significantly different between the groups (p=0.41). No circuit thrombosis or heparin-induced thrombocytopenia were observed in any groups. No differences were found in the incidence of new pulmonary embolism or venous thrombosis in the three groups after initiation of ECMO.

Conclusions: VV-ECMO can be used without continuous systemic anticoagulation.

Effect of Patient Obesity on Extracorporeal Membrane Oxygenation Outcomes and Ventilator Dependency

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Purpose: The effect of body habitus for patients who require extracorporeal membrane oxygenation (ECMO) support has not been well-studied, and may provide insight into patient survival and outcomes. We sought to determine if there is a correlation of body mass index (BMI) with ECMO outcomes.

Methods: A retrospective chart review was performed for patients who required any form of ECMO support at our institution between 2008 and 2016. Time variables and outcomes variables were studied. Time variables included overall hospital length of stay, hospital

and ventilator days after ECMO wean, and the total number of days in the intensive care unit. Outcomes results included ability to wean from ECMO, extubation status, hospital survival and 30 day survival. Descriptive statistics were used to summarize data. Spearman correlation, Fisher's exact test and independent t-test were used to assess associations.

Results: 231 patients required ECMO with a mean BMI of 29 (+/- 6.47, BMI range 17.6-57.9). The mean BMI did not differ based on type of support provided (ie: VV versus VA). Neither the raw BMI nor obesity classification scores (see Table) correlated with any of the time variables studied (ie: duration of support, or hospital, ICU or ventilator days). There was also no difference between BMI groups for ability to wean from ECMO or survival parameters. Overall ability to wean from ECMO was 60% (n 139). A total of 17% (n 40) of patients were extubated while still on ECMO support, and an additional 32% (n 85) were extubated after weaning, at a median of 4 days after decannulation. The majority (69%) of extubated patients remained off the ventilator. Neither the raw BMI nor obesity classification predicted if or when patients were extubated and their ability to remain off the ventilator.

Conclusions: Patient outcomes and time variables were not statistically impacted by degree of patient obesity. Respiratory outcomes, including ability to extubate and remain ventilator-free, were also independent of patient BMI. These data suggest extremes of body habitus alone should not be used as absolute exclusion criteria for ECMO support.

	Normal Weight BMI < 25	Overweight BMI 25-30	Obese BMI 30-35	Severely Obese BMI > 35	P value
Number of Patients	50	76	59	46	n/a
Duration of Support (Days)	5	5.5	6	3	0.52
Veno-Arterial Support	46%	47%	50.9%	37%	0.68
Time Variables					
Total Hospital LOS (median)	29	24.5	20	22.5	0.17
ICU Days (median)	15	15	12	21	0.43
Hospital Days after ECMO (median)	21	19.5	18.5	17	0.33
Vent Days after ECMO (median)	3	1	1	2.5	0.54
Outcome Parameters					
Extubated on ECMO	12%	21%	22%	11%	0.58
Weaned from ECMO	60%	64.5%	59.3%	54.3%	0.74
Survival to Discharge	52%	60%	53%	47.8%	0.54
Overall 30 Day Survival	50%	58.7%	50.9%	45.6%	0.53
30 Day Survival of Patients Weaned	83%	63%	83%	100%	n/a

Ten-Year Trends in Traumatic Cardiac Injury and Outcomes: A Trauma Registry Analysis

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Purpose: Traumatic cardiac injury has a high rate of mortality in trauma victims. The Oklahoma Trauma Registry (OTR) collects data from all state-licensed acute care hospitals in the state of Oklahoma. This study investigates the trends and outcomes of traumatic cardiac injuries in Oklahoma over a 10-year period.

Methods: The OTR registers trauma patients with major severity and one of the following criteria: length of hospital stay ? 48 hours, dead on arrival or death in the hospital, hospital transfer, ICU admission, or surgery on the head, chest, abdomen, or vascular system. Patients with cardiac injuries were identified from OTR data during the years from 2005-2014. Their characteristics, mechanisms of injury, associated injuries, and outcomes of trauma were analyzed. These patients were further divided into blunt and penetrating injuries, and operative versus non-operative management.

Results: 426 of 107,549 total trauma patients suffered traumatic cardiac injury. 160 patients (37.6%) suffered penetrating trauma including 73 (45.6%) gunshot wounds and 84 (52.5%) stabbing. 266 blunt trauma patients included 200 (75.2%) motor vehicle and 12 (4.5%) motorcycle crashes, 2 (0.8%) auto-pedestrian accidents, 17 (6.4%) falls, 14 (5.3%) struck by objects, and 21 (7.9%) with other mechanisms. Overall, 72 (16.9%) patients underwent operative management for their cardiac injury (65 penetrating and 7 blunt injuries). Mortality occurred in 156 patients (35.7%) including 82 (51.9%) penetrating and 70 (26.3%) blunt injuries P<0.001). 36 of 72 patients (50%) with operative management died, versus 116 of 354 (32.8%) non-operative patients (P=0.005). Operative mortality was similar in patients with both penetrating and blunt injury. Over ten years, the percentage of cardiac injury decreased, but there was a mortality increase in patients with cardiac injury, correlating with an increase in proportion of penetrating injury (Figure).

Conclusions: Traumatic cardiac injury, particularly penetrating injury, continues to be a significant source of mortality in trauma patients. Analysis of state-base trauma registries can identify trends in the etiologies of injuries and mortalities, serving as a reference point for quality improvement, therapeutic triage, and preventative action plans.

Figure – Trends of penetrating versus blunt cardiac injuries (blue line) and mortalities (red line)

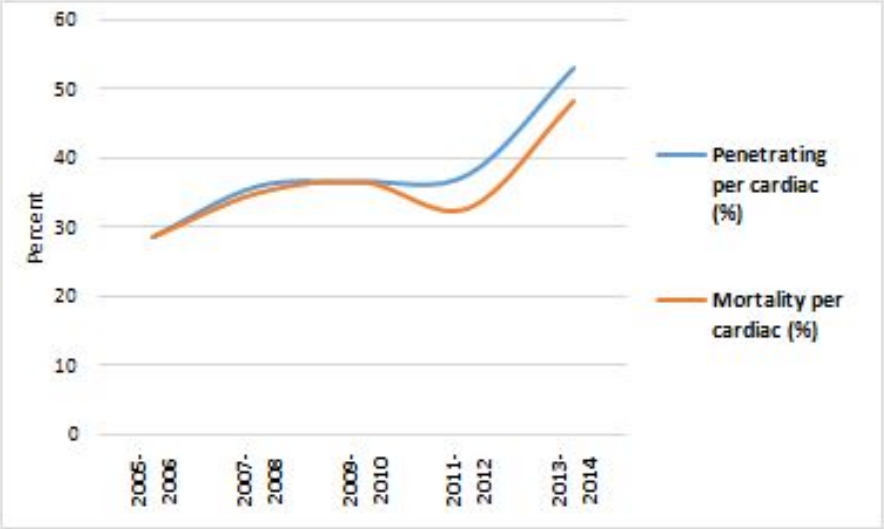

Table – Associated injuries in penetrating and blunt trauma with traumatic cardiac injuries

	Blunt injury N=266	Penetrating injury N=160
Skull/facial fracture	30 (11.3%)	6 (3.8%)
Intracranial bleeding	63 (23.7%)	1 (0.6%)
Spinal fracture	71 (26.7%)	6 (3.8%)
Cervical	23 (8.6%)	2 (1.3%)
Thoracic	31 (11.7%)	4 (2.5%)
Lumbar	33 (12.4%)	0
Sacral/coccyx	8 (3%)	0
Nerve/spinal cord injury	2 (0.8%)	2 (1.3%)
Rib fracture	143 (53.8%)	20 (12.5%)
Pneumothorax / Hemothorax	99 (37.2%)	96 (60%)
Liver injury	42 (15.8%)	27 (16.9%)
Spleen injury	29 (10.9%)	9 (5.6%)
Kidney injury	12 (4.5%)	13 (8.1%)
Gastrointestinal injury	16 (6%)	23 (14.4%)
Pelvic fracture	33 (12.4%)	0
Vascular injury	18 (6.8%)	31 (19.4%)
Upper extremity fracture	56 (21.1%)	8 (5%)
Lower extremity fracture	51 (19.2%)	2 (1.3%)

Does Early Postoperative Echocardiography Lead to Clinically Significant Interventions?

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Purpose: Conventional monitoring of left ventricular assist devices for patients consists of vitals, Swan–Ganz catheter, device parameters, and echocardiograms [1]. However, the accuracy and efficacy of these adjuncts is difficult to ascertain. We sought to assess the utility of early echocardiograms in order to determine its' impact on clinical interventions

Methods: We performed a retrospective analysis for patients at our institution that underwent a left ventricular assist device implantation from February 2007 to February 2018. We reviewed all echocardiograms and peri-procedural events until post-operative day three. We assessed the indications for the echocardiograms, the urgency, and the interventions that were performed. There were a total of 12 broad categories for indications including right heart failure, hypotension, bleeding, tamponade, device alarms, and tachyarrhythmia. We classified urgency into three categories: emergent, non-emergent pathology, and protocol. Lastly, there were five interventional categories: none, speed changes, reoperation, TEE, medication changes, and device adjustments.

Results: Of the 382 patients, 193 (50.5%) had received echocardiographs. Most of these were conducted on postoperative day one, and were (204, 87.2%) transthoracic. The main indication sited was to assess device function (n=82, 32.5%) due to a recent speed adjustment, or to attempt to optimize the current settings. Other common reasons include right heart failure (n=58, 23%), and hypotension (n=21, 8.3%). Regarding urgency, non-emergent pathology (n=112, 47.9%) and per protocol/guidance (n=95, 40.6%), were far more common than emergent (n=27, 11.5%). Eighty-five patients (33.5%) did not have any intervention. Of those who did, 84 (33.1%) had speed adjustments, 64 (25.2%) had medication changes, 10 (3.9%) underwent a TEE, 9 (3.5%) had to have a surgical intervention, and only 2 (0.8%) needed a right ventricular device implantation.

Conclusions: Compared to recent reports of using echocardiograms in the early postoperative patients [1], our cohort had a larger percentage of patients receiving intervention (7% versus 66.5%). Larger, multicenter studies are needed to validate these findings.

Intervention	1st Echo	2nd Echo	3rd Echo	Total
Speed	72	11	1	84 (33.1%)
Reoperation	7	2	0	9 (3.5%)
TEE	10	0	0	10 (3.9%)
Meds	54	8	2	64 (25.2%)
RVAD Implant	2	0	0	2 (0.8%)
None	67	17	1	85 (33.5%)

MELD-XI Is Predictive of Mortality in Extracorporeal Membrane Oxygenation

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Purpose: Venous-arterial extracorporeal membrane oxygenation (VA-ECMO) is a life-saving method of supporting critically ill patients. However, it is expensive and associated with high morbidity and mortality, making early predictive outcome modeling extremely valuable. The MELD-XI scoring system has been shown to have prognostic value in other critically ill patient populations.

Methods: A single-center retrospective review was performed on all patients managed on VA-ECMO from May 2011 to January 2018 (n=247). Patients were included in the study if they had creatinine and total bilirubin labs drawn during the first 48 hours on ECMO from which MELD-XI scores were calculated (n=184). Patient demographics, comorbidities, and indication for ECMO were compared with univariate analysis. Receiver operating characteristic (ROC) curve analysis was performed for MELD-XI in regards to index hospitalization mortality and the Youden Index was calculated to establish the optimized stratification point.

Results: Patients with a high-risk MELD-XI score of 14 or greater did not differ significantly from patients with MELD-XI less than 14 in terms of baseline patient characteristics including age, sex, comorbidities and past cardiac history. Indication for ECMO was also similar between groups, with the only statistically significant difference being a higher rate of decompensated NICM in the low-risk group (19% vs 8%, p=0.01). The high-risk MELD-XI group had significantly greater overall mortality during index hospitalization compared to patients in the low-risk group (80% vs 39% mortality, p<0.0001). Quartile stratification of average MELD-XI during the first 48 hours of ECMO demonstrated progressively worse prognosis associated with higher MELD-XI scores with the fourth quartile showing a seven-fold increased risk of mortality compared to the first quartile (Table 1). The AUC for predicting index hospitalization mortality was 0.69 for MELD-XI with a Youden index (J) of 0.36 and optimized cutoff of 12.98.

Conclusions: Higher MELD-XI scores during the first 48 hours on ECMO are associated with increased mortality. These findings suggest that the MELD-XI scoring system can be applied to the VA-ECMO patient population early in their course of ECMO as a prognostic tool to aid in complex clinical decision making.

Table 1. Higher MELD-XI scores associated with increased mortality

Quartile	MELD-XI Score*	Mortality No. (%)	Odds Ratio Mean [95% CI]	p-value
1st	4.2	16 (34%)	-	-
2nd	12.8	27 (57%)	2.65 [1.13 - 6.03]	0.024
3rd	19.7	34 (72%)	5.07 [2.10 - 12.2]	<0.001
4th	30.7	36 (78%)	6.98 [2.77 - 17.6]	<0.001

**mean score over first 48 hours on ECMO*

General Thoracic Surgery Posters

Plasma Exosome Count Is Correlated With Grade of Lung Cancer Stages: Comparison Between Pulmonary Vein vs Peripheral Vein

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Purpose: We evaluate whether exosomes increase in lung cancer and more prominent at cancer outflow blood in pulmonary vein than peripheral vein of animal lung cancer model and lung cancer patients.

Methods: A total of 10 rabbits were used in this research (5 in normal group and 5 in lung cancer group). A total of 35 consecutive primary lung cancer patients who underwent major pulmonary resection through video-assisted thoracoscopic surgery (VATS) and 5 healthy controls were included. Blood was collected from peripheral vein in all group, and the tumor outflow pulmonary blood was sampled intraoperatively only in lung cancer group. Quantitative analysis of exosomes was performed by nanoparticle tracking assay, CD63 enzyme-linked immunosorbent assay, and western blotting.

Results: The development of solitary lung cancer nodules were confirmed on Positron Emission Tomography in all rabbit two weeks after VX2 cell injection. In VX2 lung cancer group, exosome-count was significantly increased at periphery and more increased significantly at the tumor drainage pulmonary vein comparing to normal group. In human subjects, exosome-count and exosomal CD63 in the periphery was increased about 10.3-fold ($p < 0.000$) and 3.42-fold ($p < 0.000$) in the lung cancer patients compared to the control. Moreover, their levels at the pulmonary were increased about 19-fold ($p < 0.000$) and 5.98-fold ($p < 0.000$) compared to periphery of the controls. According to the Jonckheere Terpstra test ($p < 0.000$), exosome count with exosomal CD63 were found to be up-regulated across the progression from normal to lung cancer staging.

Conclusions: We firstly demonstrated that exosomes were increased according to the cancer stage, and they were more increased significantly in cancer-outflow pulmonary vein compared to the periphery. We hoped that exosomes sampled from pulmonary blood during lung cancer surgery might provide more accurate prognostic information comparing to those from peripheral vessels.

Figure 1-1

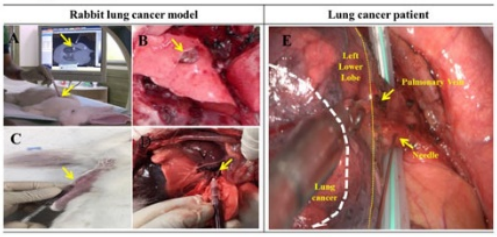

Figure 1-1. Rabbit lung cancer model and blood sampling from animals and patients.
(A) Real-time CT guided VX2 lung cancer cell injection. Arrow : Injection site of VX2 carcinoma cells, matrigel, and lipiodol mixture, (B) Two weeks after, confirmed of lung cancer nodule. Arrow : VX2 lung cancer nodule, (C) Blood sampling in peripheral ear vein. Arrow : Site of peripheral blood vessel collection, (D). Blood sampling in pulmonary vein. Arrow : Site of pulmonary blood collection , (E) Blood sampling to primary lung cancer drainage pulmonary vein in lung cancer patients.

Figure 1-2

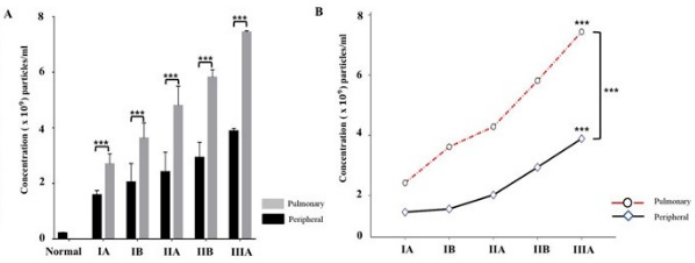

Figure 1-2. Comparison of exosome and its tendency according to TNM stage
(A) Comparison of exosome counts in the lung cancer TNM stage (Eight of IA patients, 15 of IB, six of IIA, three of IIB, and three of IIIA)., (B) Tendency evaluation and significance evaluation by change of blood sampling site according to stage change of cancer. One-way or one-way repeated ANVA and post-hoc scheffe were used for group analysis. Error bars depict S.D. for two independent experiments. Significant level *,P<0.05, **,P<0.005. ***,P<0.0005

Composite Formulation of Fibrin Glue and Poly(lactic-co-glycolic acid) Microparticles for Sustained Delivery of Local Anesthetics

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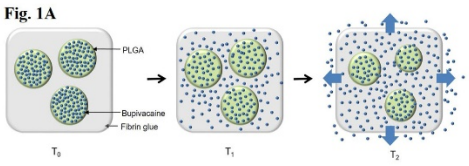
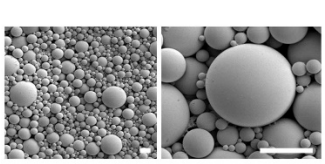
Purpose: To control a post-operative pain, a local anesthetics is often injected at the site of interest. However, this bolus drug injection is limited in its short residence time. To resolve this, we prepared biodegradable poly lactic-co-glycolic acid (PLGA) microparticles (MP) loaded with bupivacaine (BPC) and formulated them in fibrin glue.

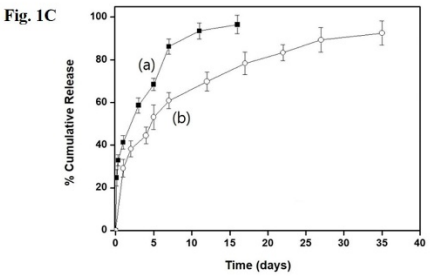
Methods: The BPC-MPs were prepared by the oil and water emulsion method. To make a composite formulation for bupivacaine delivery in fibrin glue, we added the BPC-MPs to the thrombin solution, which was then mixed with the fibrinogen solution. The size and morphology of the BPC-MPs were examined using a scanning electron microscope and the in vitro drug release profiles was measured. In L5 spinal nerve injury rat model, pain was evaluated according to the different doses and compositions of the BPC-MPs in fibrin glue.

Results: The BPC-MPs were successfully prepared with the enough drug loading amount and bupivacaine encapsulation efficiency (Fig.). The average particle size of BPC-MPs was 30–150 µm. The in vitro drug release profiles showed a burst release of 29.2% on the first day, then slowly released for more than a month (38.24 and 92.52% of bupivacaine was released at 2 and 35 days, respectively). In L5 spinal nerve injury rat model, the BPC-MPs in fibrin glue exhibited the pain suppressing effect was confirmed for a much longer period than when the bupivacaine solution alone was administered.

Conclusions: This composition are promising system for enhanced bioavailability of a locally-administered anesthetics. This approach would eliminate the need for multiple daily injections or continuous catheter infusion, thus allowing the patient to regain mobility earlier with reduced hospitalization.







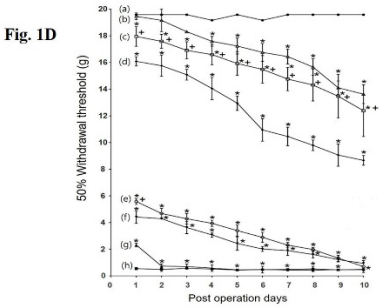


Figure 1A. A schematic illustration of the formulation of fibrin glue with bupivacaine loaded microparticles and their sustained drug release concept.

Figure 1B. Scanning electron micrographs of BPC-MPs. The Scale bars = 30µm.

Figure 1C. Cumulative release of bupivacaine from (a) BPC-MP and (b) BPC-MP in fibrin glue. Data points are means standard deviations (n =3).

Figure 1D. Changes in mechanical sensitivity to von Frey filaments: (a) no treatment, (b) BPC-MPs in fibrin glue-10X, (c) BPC-MPs in fibrin glue-4X, (d) BPC-MPs-4X, (e) BPC-MPs in fibrin glue-1X, (f) BPC-MPs-1X, (g) 0.5% bupivacaine-HCl solution, and (h) normal saline. The values are expressed as means ± S.D. *p<0.05; compared with each groups and the no treatment group, +p<0.05; compared with BPC-MPs in fibrin glue groups and BPC-MPs groups at the same dose.

A New Possible TNM-M Factor: Cluster-Circulating Tumor Cells in Surgical Cases of Lung Cancer

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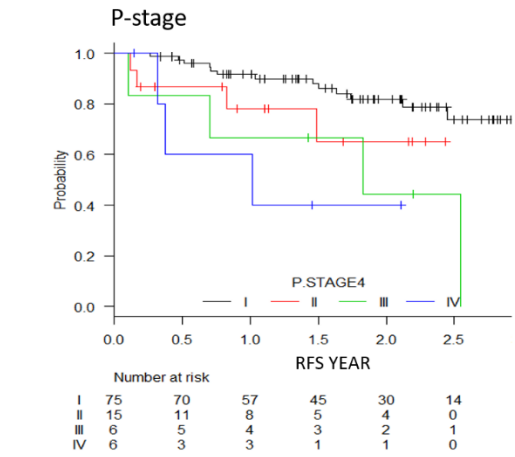
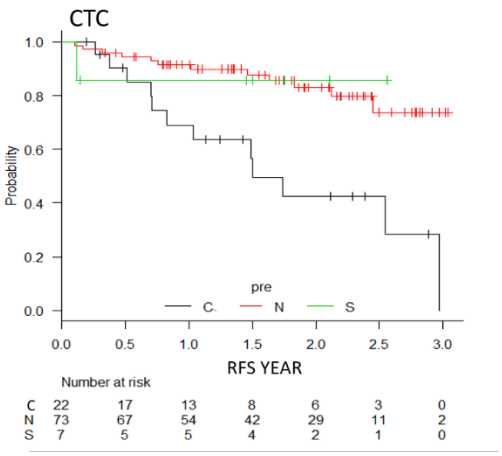
Purpose: The cancer lesion dislodges tumor cells into circulating blood as circulating rumor cells (CTCs), detecting cluster formation of which is a surrogate marker of high tumorigenesis. Because the blood circulating apparatus is an organ, detecting cluster CTC may be an M factor. Thus, clinical implications of cluster CTCs were investigated.

Methods: Accumulated patients' (n=104) characteristics was 62 males and 42 females, median age of 71 (38 - 85) and clinical stage of I in 87 cases II in 17 cases. The CTCs were extracted from peripheral arterial blood just before surgery using a micro-pore size selection method and diagnosed microscopically. The CTCs were classified morphologically as singular and clustered. Thus, the patients could be divided into 3 groups as group N (CTC not detected), group S (only singular CTC detected) and group C (cluster CTCs detected) and implication of CTC was analyzed according to prognosis and clinical-pathological characteristics of the tumor.

Results: Pathological stage was I in 76 cases, II in 16 cases, III in 6 cases and IV in 6 cases and pulmonary resection was pneumectomy in 1 case, lobectomy in 68 cases segmentectomy in 12 cases and wedge resection in 22 cases. CTC was detected in 27 cases (30.0%), thus the prevalence of CTC detection was N in 77 cases (74.0%), S in 7 cases (6.7%) and C in 20 cases (19.2%). Two-year recurrence free survival rate was 84.6% in group N, 85.7% in group S and 54.6% in group C (p=0.0002). Hazard ratio, referred to group N, of group C was 4.1 (95% C.I.; 1.9 – 9.6) which is independent in multivariate analysis of pathological stage. In addition, predictors of detecting cluster CTCs were the SUVmax of tumor, the solid part size on CT and the serum CEA level.

Conclusions: Cluster CTC detection was an independent indicator of cancer recurrence of pathological stage and associated with clinical-pathological surrogate markers of poor prognosis. These observations might be an evidence for cluster CTC detection as clinical M factor.





Variables	H.R.	95% C.I.		p-value
p-stage				
I	Ref.			
II	1.6	0.5	5.2	0.4
III	2.7	0.8	8.5	0.1
IV	7.5	2.0	28.0	0.003
CTC				
N	Ref.			
S	0.8	0,1	6.4	0.8
C	3.7	1.6	8.8	0.002

Quantitative Volumetric Computed Tomography Histogram Approach to Prediction of Lymph Node Metastasis in a Patient With Clinical Stage I Non–Small-Cell Lung Cancer

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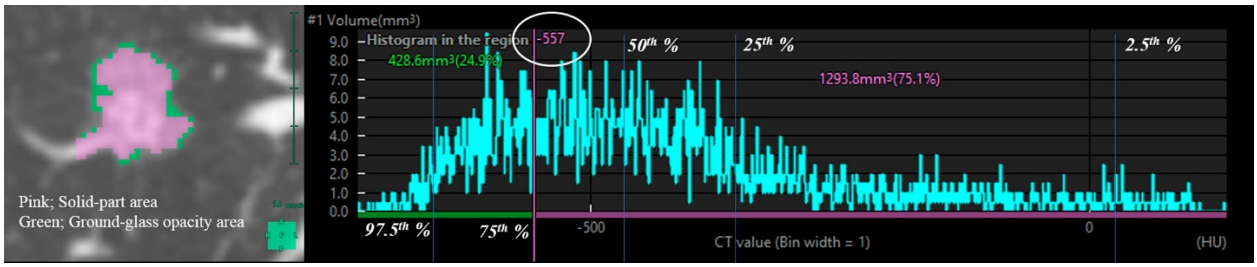
Purpose: Available quantitative CT-histogram parameters of lung tumors by extracting spectral information at the voxel level are reported to help distinguish between invasive and non-invasive lung cancers. This study aimed to determine if quantitative CT-histogram analysis of tumors could be used to classify patients with regard to pathological lymph node status.

Methods: The predictive factors associated with lymph node metastasis (LNM) were identified by the training dataset including 682 patients with clinical stage I NSCLC in accordance with the 8th TNM classification who underwent HRCT, 3DCT lung modeling, and complete anatomical resection with lymph node dissection between January 2008 and December 2013 and validated by another dataset with 277 patients. Quantitative CT-histogram parameters of tumors (2.5th, 25th, 50th, 75th, and 97.5th percentile CT attenuation values (Figure), skewness, and kurtosis), HRCT parameters (whole tumor size and solid-part size), and clinical factors were evaluated while overall survival (OS) analysis was performed.

Results: In the training dataset, the number of patients with clinical stage 0, IA1, IA2, and IA3 was 75, 118, 263, and 22 while the proportion of LNM was 0%, 0.8%, 14.4%, and 15.0%, respectively. The number of LNM in the training set was 73 (10.7%), and the 5-year OS proportions of patients with LNM+ and LNM- were 69.5% and 92.8%, respectively (p<0.001). Multivariable analysis showed the 75th percentile CT attenuation value (75%-CT; p<0.001) and age (p=0.027) were significantly associated with LNM. The receiver operating characteristic area under the curve for 75%-CT used to identify LNM was 0.76, and the factor was dichotomized at the cut-off level for LNM, which gave the accuracy of 70.1% in the training dataset and 71.2% in the validation dataset. Among all 953 patients, LNM (p=0.001), vascular invasion (p<0.001), and skewness (p=0.005) were independent determinants for unfavorable OS on multivariate survival analysis using Cox's regression model.

Conclusions: LNM is a strong predictor of outcomes for clinical stage I NSCLC patients. Novel quantitative CT-histogram parameters of a primary tumor based on 3DCT can be used for noninvasive prediction of LNM and survival outcome, and be helpful to determine appropriate surgical strategies such as the indication for limited resection.



Incidence, Management, and Outcomes of Intraoperative Catastrophes During Robotic Anatomical Pulmonary Resection

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Purpose: Intraoperative catastrophes during robotic anatomical pulmonary resections are potentially devastating events, given the telerobotic nature of these procedures. The present study aimed to assess the incidence, management, and outcomes of intraoperative catastrophes for patients with primary lung cancers.

Methods: This was a retrospective, multi-institutional study that evaluated patients who underwent robotic anatomical pulmonary resections from 2002 to 2018. Standardized data forms were collected from each institution after ethics approval. Intraoperative catastrophes were defined as events necessitating emergency thoracotomy or requiring an additional unplanned major surgical procedure. Patients who underwent elective conversion or additional procedure for technical or oncological reasons were excluded from statistical analysis. Standardized questions were presented to participating surgeons to outline intraoperative management strategies of catastrophic events from their experience.

Results: During the study period, 1936 patients underwent robotic anatomical pulmonary resection at 6 participating institutions, including 1639 lobectomies (85%). Thirty-five patients (1.8%) experienced an intraoperative catastrophic event. The most common was intraoperative haemorrhage from pulmonary artery or pulmonary vein, which occurred in 28 (80%) and 2 (6%) patients, respectively. Injury to the airways occurred in 4 patients (11%), and liver injury occurred in 1 patient (3%). After a catastrophic event, 30 patients (89%) underwent a conversion to thoracotomy. Two patients underwent an unplanned bilobectomy, and two patients underwent an unplanned pneumonectomy. Six patients (17%) were operated by surgeons who had 20 or fewer case experience. Four patients experienced at least one major complication postoperatively, and the median length of hospitalization was 6 days (interquartile range 4-8). There were no intraoperative deaths and 2 perioperative deaths, with a 30-day mortality of 5.7%. Detailed management strategies were outlined by participating surgeons.

Conclusions: The incidence of catastrophic events during robotic anatomical pulmonary resections for lung cancer was low, and the most common complication was haemorrhage. These events were associated with increased perioperative morbidity and mortality, and prolonged hospitalization. Awareness of potential intraoperative catastrophes and their management strategies are critical to minimize adverse outcomes.

Postoperative Opioid Consumption in Thoracic Surgery Patients: How Much Is Actually Used?

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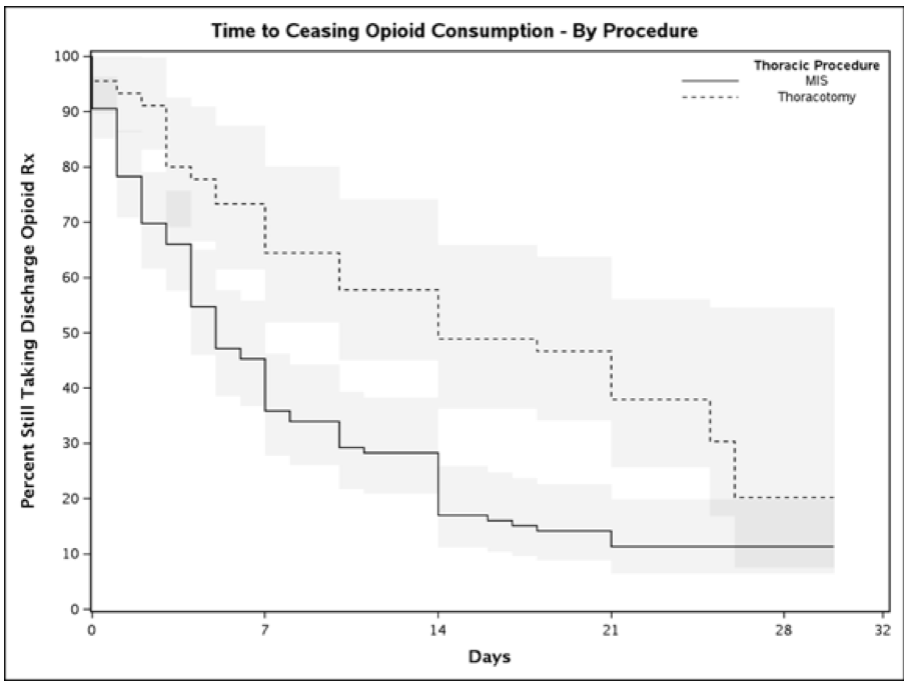
Purpose: Utilization of opioids prescribed at hospital discharge following surgical lung resection is largely unknown. The object of this initiative was to perform a prospective, multi-center survey of patients following lung resection to assess the amount of opioids consumed and disposition of unused opioids to inform development of evidence-based prescribing guidelines.

Methods: Adults undergoing lung resection via minimally invasive (MIS, n=108) or thoracotomy (n=45) were identified prospectively from three academic centers (3/2017 - 1/2018) to complete a 29-question telephone survey 21-35 days post-discharge. Society of Thoracic Surgeons (STS) data were merged with patient and survey data. Discharge opioids were converted into Morphine Milligram Equivalents (MME) and compared across patient and surgical details.

Results: Of the 153 patients who completed the survey, 89.5% (137) received opioids at discharge with median prescription of 320 [IQR 225, 450] MME following MIS and 450 [IQR 300, 600] following thoracotomy, p=0.001. Median opioid consumption varied by surgical approach: 90 [IQR 0, 262.5] following MIS and 300 [50, 382.5] following thoracotomy, p<0.001. Mean (±SD) days to opioid cessation was 6.8(±5.6) for MIS and 11.6(±8.3) for thoracotomy, p=0.002. The majority of patients, 68.2% (101), had residual opioids at time of survey, with the median remaining opioid totaling 51.0% of the original prescription. Only 6.3% of patients with opioids remaining had properly disposed of them.

Conclusions: Patients undergoing MIS lung resection used significantly less opioids over a shorter duration of time than those following thoracotomy. Development of evidence-based, procedure-specific guidelines with tailored pain regimens should reduce the amount of post-operative opioids remaining in the community.



Staple Line Thickening After Sublobar Resection: Reaction or Recurrence?

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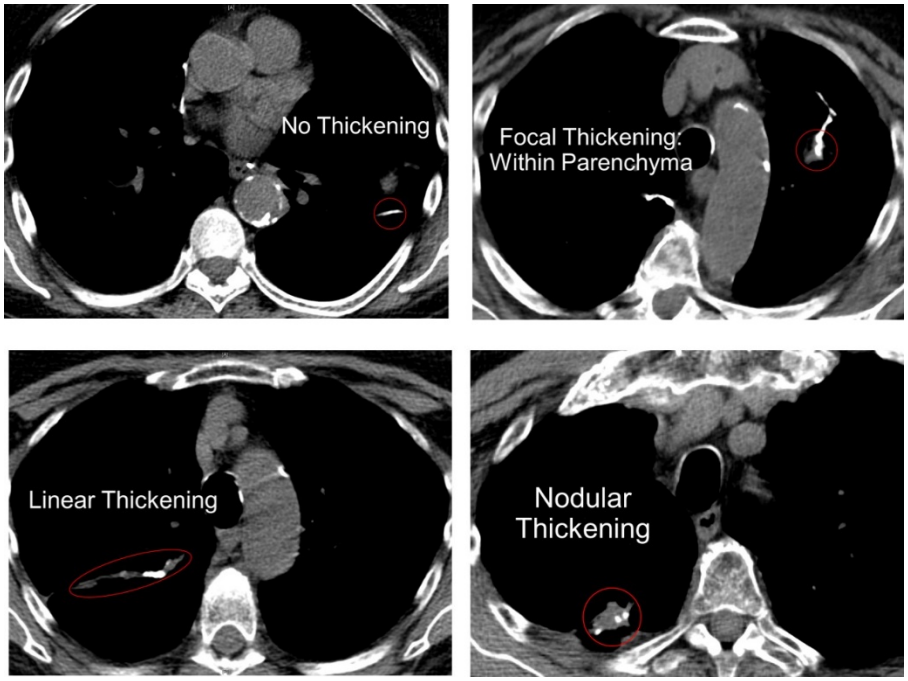
Purpose: Sublobar resection (SLR) is increasingly utilized for early stage NSCLC. However, stapling across lung parenchyma may lead to tissue granulation which could be confused radiographically with recurrence. We sought to determine the rate, time course, and radiographic characteristics of tissue thickening after SLR and to determine the association of each with recurrence.

Methods: Seventy-eight consecutive patients (90 unique staple lines) with postoperative imaging who underwent wedge resection or segmentectomy for NSCLC from 2010-2012 (to ensure longitudinal follow up) were included. CT scans at 6, 12, 18, 24, and 36 months postoperatively (363 scans) were each re-reviewed. Each scan was individually evaluated to characterize the morphology and size of staple line granulation tissue and compared to previous scans. Patients with multiple sites of tissue granulation were followed at each major site. Radiological and clinical findings were analyzed and predictors of recurrence were determined.

Results: On initial postoperative scans, 3.3%(N=3) of staple lines showed no thickening, 17.8%(N=16) showed thickening <2mm, while the majority (78.9%,N=71) showed thickening >/=2 mm. Soft tissue (Figure) was characterized as linear in 30.0%(N=27), as focal in 23.3%(N=21), and as nodular in 43.3%(N=39). Radiological reports remarked on the appearance/change of granulation tissue along the staple line 77% of the time. Over time, 27.8% (N=25) of staple lines did not change, 54.4%(N=49) had regressive changes and 17.8%(N=16) had progressive changes (all >2mm). Among 78 patients, 7.7%(N=6) had biopsy proven recurrence along the staple line. Of those, half (n=3) also developed metastatic cancer. The mean time elapsed before a staple line recurrence was 1122 days. Predictors of staple line recurrence included an increase in the largest dimension by >2mm (83.3% recurrence vs. 13.1%, p = 0.001, PPV=31%, NPV=99%) and radiological concern for malignancy (66.7% recurrence vs 13.1%, p = 0.006, PPV=27%, NPV=97%).

Conclusions: Staple line thickening is a frequent occurrence following SLR, often commented upon by radiologists, but rarely indicative of recurrence. The characteristics and initial size of granulation tissue do not predict recurrence. Increases in tissue >2mm at the staple line predict local recurrence, which typically occurs after a long time interval.



Clinical/Pathologic-Based Prognostic Indices Incorporating Growth Pattern-Based Grading of Stage IA/1B Lung Adenocarcinoma

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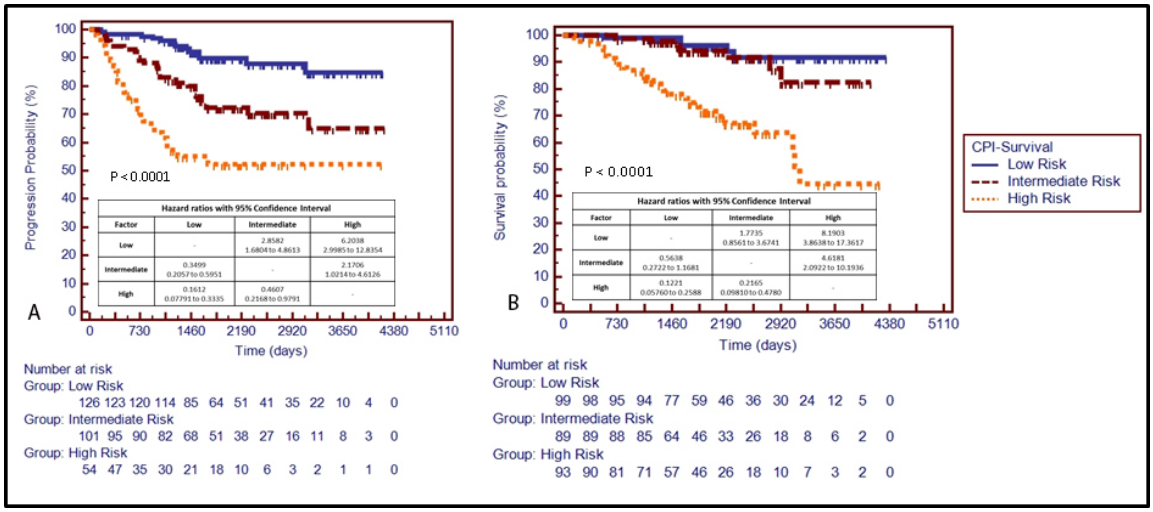
Purpose: Our objective is to define clinical/pathologic prognostic indices using a modified Mayo growth-pattern grading system in stage IA/IB adenocarcinoma by investigating (1) which model provided significant risk stratification for both progression and survival and (2) the influence of other novel pathologic details including STAS and necrosis.

Methods: Cohort: 281 pIA/IB adenocarcinoma patients having R0 resection from 2006-2015 were followed with CT every 3 months x 2 years, every 6 months x 1 year, then yearly. Histologic Classification: *Predominant, Overall, or Worst* classification per Boland, et.al[1] by two clinicians with 100% interobserver agreement. Additional clinical/pathologic characteristics included age, pack-years, gender, surgical extent, number resected lymph nodes, size, pleural invasion, LVI[2], necrosis, STAS[3], and nuclear/cytologic grade. Statistics: Time to progression (TTP) and overall survival (OS) were determined from surgery. Multivariate regression analysis using backwards Cox proportional hazards model defined independent prognostic variables then used for Prognostic Index modeling.

Results: In univariate analyses, predominant (p=0.0016), worst (p=0.0013), and overall (p<0.0001) classifications significantly defined differences in TTP and OS. Additionally, age, pack years, gender, LVI, necrosis, pleural invasion, STAS and size were significantly associated both with TTP and OS. Multivariate modeling using only univariately significant variables determined that of the three growth patterns, only *overall* was independently associated with both TTP and OS. STAS and gender were also independently associated with progression, and STAS, gender, age, LVI and *overall* classification were independently associated with OS. Spread through air spaces was associated with a significantly increased risk of local and systemic progression for both lobectomy (p=0.0092) and sublobar resections (p<0.0001) and was also associated with decreased OS for both lobar (p=0.0425) and sublobar resections (p<0.0001). Prognostic modeling based on the multivariate findings segregated patients into low, medium and high risk cohorts for TTP and OS (Figure).

Conclusions: *Overall* pattern grading (low risk:>80% lepidic; high risk: >20% solid, micropapillary, cribiform or fused glands; medium risk: all others), STAS and gender predict significantly shorter TTP and poorer OS. These data also reveal that STAS has prognostic implications in a North American population that are independent of resection extent.



Latest National Trends After Robotic-Assisted, Video-Assisted, and Open Lobectomy: A Propensity-Matched Comparative Analysis

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Purpose: Majority of Population-based studies comparing approaches to lobectomy are based on older data. Prior to 2012, the ICD-PCS codes were less specific for robotic and VATS lobectomy. The goal of this study was to compare outcomes reflecting current practice of robotic, VATS, and open lobectomy using a large national database.

Methods: The national inpatient sample (NIS) database was queried from January 2012 to December 2015 for adults with lung cancer undergoing elective; robotic, VATS, or open lobectomy using ICD-9 and ICD-10 codes. Two sets of matchings were performed (A: Robotic Vs VATS, and B: VATS Vs Open). Comorbidities, Elixhauser's indices of readmission/mortality, and admission costs were identified using methods provided by the Healthcare Cost and Utilization Project. Propensity matching was based on Elixhuaser's indices, Elixhauser comorbidities, calendar year, demographics, and type of lobectomy (Upper, middle, or lower lobe). primary outcomes included inpatient mortality and morbidity. Secondary outcomes included cost and resource utilization.

Results: Over the 4-year period, a total of 135,725 cases were identified (9,475 robotic, 51,600 VATS, and 74,650 Thoracotomy). Propensity matched groups A and B consisted of a total of 11,730 and 58,750 cases respectively. Patient demographics, comorbidities, and Elixhauser's indices of mortality and readmission were similar in both comparisons. In group A (Table-1), mortality rate was 1.2% Vs 1.3% (P=0.676). The incidence of arrhythmia was 17% Vs 20% (P<0.001), postoperative bleeding 6% Vs 9% (P<0.001), blood transfusion 3% Vs 4% (P<0.001), and lymph node sampling/dissection 51% Vs 49%, P=0.021. In group B (Figure 1), mortality rate was 0.9% Vs 1.4% (P<0.001). Results of group B comparison are summarized in figure 1. The incidence of arrhythmia was 19% Vs 20% (P<0.001), postoperative bleeding 8% Vs 12% (P<0.001), blood transfusion 4% Vs 7% (P<0.001). and lymph node sampling/dissection 51% Vs 49%, P=0.021.

Conclusions: Robotic and VATS lobectomy have comparable in-hospital mortality and complication profile. Postoperative atrial arrhythmia and blood transfusion rates are lowest after robotic lobectomy, but admission costs are higher than VATS. Open lobectomy demonstrated higher mortality, higher overall morbidity, and no difference in cost when compared to VATS.

Propensity-Matched Group A (N= 11,730)	**Robotic (%) N = 5865**	**VATS (%) N = 5865**	**P-value**
Primary Outcome			
Mortality	70 (1.2)	75 (1.3)	0.676
Cardiovascular:			
Acute MI	25 (0.4)	35 (0.6)	0.196
SV Arrhythmia	1000 (17.0)	1165 (19.9)	**0.000**
Post-operative Stroke	5 (0.1)	5 (0.1)	1.000
DVT	35 (0.6)	30 (0.5)	0.534
Pulmonary Embolism	45 (0.8)	40 (0.7)	0.586
Respiratory:			
Airleak	735 (12.5)	605 (10.3)	**0.000**
Bronchopleural Fistula	20 (0.3)	40 (0.7)	**0.010**
Tracheostomy	45 (0.8)	30 (0.5)	0.082
Reintubation	140 (2.4)	160 (2.7)	0.242
Respiratory Failure	240 (4.1)	230 (3.9)	0.638
Bleeding			
Post op bleeding	365 (6.2)	515 (8.8)	**0.000**
Intraop bleeding	90 (1.5)	80 (1.4)	0.440
Blood transfusion	160 (2.7)	240 (4.1)	**0.000**
Infectious/Other:			
Chylothorax	20 (0.3)	20 (0.3)	1.000
Wound infection	0 (0.0)	10 (0.2)	**0.002**
Sepsis	55 (0.9)	65 (1.1)	0.359
UTI	90 (1.5)	155 (2.6)	**0.000**
PNA	250 (4.3)	295(5.0)	**0.048**
Empyema	5 (0.1)	10 (0.2)	0.196
Lymph node sampling/dissection	3000 (51.2)	2875 (49.0)	**0.021**
Secondary Outcome			
LOS (Days)	5.49	5.65	**0.076**
Home Disposition	5430 (92.6)	5345 (91.1)	**0.004**
Cost ($)	26,652	22,099	**0.000**

Propensity-Matched Group B (N= 58,750)	**VATS (%)** N = 29,375	**Open (%)** N = 29,375	**P-value**
Primary Outcome			
Mortality	255 (0.9)	410 (1.4)	**0.000**
Cardiovascular:			
Acute MI	145 (0.5)	175 (0.6)	0.093
SV Arrhythmia	5670 (19.3)	**5935 (20.2)**	**0.006**
Post-operative Stroke	10 (0.0)	**40 (0.1)**	**0.000**
DVT	115 (0.4)	115 (0.4)	1.000
Pulmonary Embolism	110 (0.4)	130 (0.4)	0.196
Respiratory:			
Airleak	2765 (9.4)	**3330 (11.3)**	**0.000**
Bronchopleural Fistula	95 (0.3)	**160 (0.5)**	**0.000**
Tracheostomy	220(0.7)	**335 (1.1)**	**0.000**
Reintubation	680 (2.3)	**1130 (3.8)**	**0.000**
Respiratory Failure	1055 (3.6)	**1605 (5.5)**	**0.000**
Bleeding			
Post op bleeding	2230 (7.6)	**3650 (12.4)**	**0.000**
Intraop bleeding	355 (1.2)	**625 (2.1)**	**0.000**
Blood transfusion	1190 (4.1)	**2110 (7.2)**	**0.000**
Infectious/Other:			
Chylothorax	120 (0.4)	**155 (0.5)**	**0.034**
Wound infection	45 (0.2)	60 (0.2)	0.143
Sepsis	315 (1.1)	355 (1.2)	0.120
UTI	800 (2.7)	**1040 (3.5)**	**0.000**
PNA	1490(5.1)	**2050 (7.0)**	**0.000**
Empyema	65 (0.2)	**110 (0.4)**	**0.001**
Lymph node sampling/dissection	**14,480 (49.3)**	12,270 (41.8)	**0.000**
Secondary Outcome			
LOS (Days)	5.76	**7.40**	**0.000**
Home Disposition	**26,975 (91.8)**	25,890 (88.1)	**0.000**
Cost ($)	22,441	**24,365**	**0.000**

A Tumor-Specific Staging System for Neuroendocrine Tumors of the Lung Needs to Incorporate Histological Grade: An Analysis of the National Cancer Database

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Purpose: Neuroendocrine tumors of the lung (NETL) are staged with AJCC-TNM for NSCLC. However, NETL have distinct clinical behavior with grade providing critical prognostic information. Recent work used grade and T-category, not nodal status, to create a tumor-specific staging system. We aim to further determine components of a tumor-specific staging system.

Methods: The National Cancer Center Database (NCDB) identified 58,736 NETL patients from 2004-2014. After excluding cases with incomplete staging information, non-surgical cases, missing vital status, postoperative 90-day mortality, and induction chemotherapy, 12,415 patients were analyzed. All staging was converted to the 8th edition. The data were randomized into training (n=8,324) and validation (n=4,091*)* sets and analyzed separately. Recursive partitioning followed by Cox-regression was performed to classify by grade (G1=typical carcinoid, G2=atypical carcinoid, G3=large cell neuroendocrine), T-category, and nodal status. Overall survival (OS) based on both individual grade and an integrated grade-specific staging was compared by Kaplan-Meier analysis.

Results: Overall, 7,524 G1, 1,211 G2, and 3,680 G3 tumors were analyzed in the training and validation sets with no differences in demographics and pathological characteristics between the sets. Recursive partitioning identified grade as the most significant factor driving OS. Subsequent partitions identified nodal status then T-category in G2 and G3 as additional important factors. Similarly, Cox-regression identified grade to be the most important factor in OS (***G2*** *HR=3.05[95%CI: 2.65-3.5*]; **G3** *HR=9.03[8.22-9.92]*); increasing nodal status (***N1*** *HR=1.55[1.4-1.7]; **N2** HR=1.85[1.66-2.05]; **N3** HR=3.36[1.98-5.69]*), and T-category (***T3*** *HR=1.24[1.04-1.47*]; ***T4*** *HR=1.30[1.07-1.58*]) were also significant. When each grade is separately staged by AJCC-TNM there is poor separation of the curves with clustered survival in all stages of G1 and improved survival stratification within G2 and G3. **(Image)** When grade was integrated with nodal status and T-category to approximate a tumor-specific staging system, distinct overall survival stratification occurs at each proposed stage. **(Table)**

Conclusions: Grade is the dominant driver of overall survival in patients with NETL followed by nodal status and to a lesser degree T-category. Incorporation of grade with traditional TNM parameters seems feasible and creates a more rigorous staging system. A tumor-specific staging system for NETL is required to prognosticate survival.

Image: Overall Survival of Grades by AJCC-TNM 8th Edition Pathologic Staging

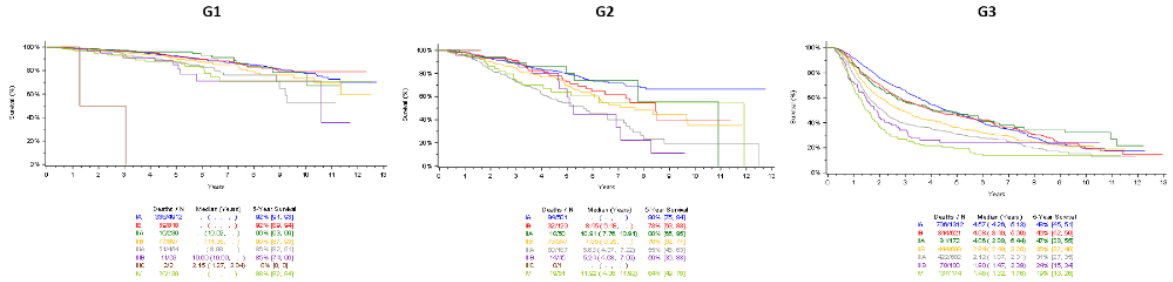

Table: Overall Survival of Proposed Tumor-Specific Staging System with Grade Incorporation

Proposed Pathologic Stage	Tumor-Specific Staging		Number of Patients	5-Year Survival [95% CI]
	Grade	N, T		
IA	G1	N0-1, T1-3	6832	92% [91,93]
IB	G1	N2-3, T1-4	658	86% [83,90]
IIA	G2	N0, T1-4	784	77% [74,81]
IIB	G2	N1-3, T1-4	421	61% [55,67]
IIIA	G3	N0, T1-3	2115	46% [44,48]
IIIB	G3	N0, T4	165	38% [31,46]
IIIC	G3	N1-3, T1-4	822	27% [24,30]

Clinical and Pathologic Correlation in Surgically Resectable Non–Small-Cell Lung Cancer

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Purpose: Accurate staging of non-small cell lung cancer (NSCLC) is critical for identifying patients who benefit from multi-modality therapy. Data regarding the correlation between clinical and pathologic staging are predominantly from single-centers. We evaluated clinical and pathologic correlation and its effects on receipt of guideline-concordant therapy in a national cohort.

Methods: Retrospective cohort study of surgically resected NSCLC patients in the National Cancer Database (NCDB) diagnosed between 2004 and 2014. Primary tumor and nodal staging information were analyzed in all patients who received upfront surgery to calculate concordance between clinical and pathologic stage. This analysis was repeated in patients who received neoadjuvant therapy to estimate downstaging rate. Staging accuracy and Spearman's rank correlation coefficients were calculated for each stage. Multivariable Cox regression was used to evaluate the association between receipt of guideline-concordant therapy and overall risk of death.

Results: Among 96,968 patients, correlation between clinical and pathologic stage was strong (r = 0.70), with stage-specific accuracy ranging from 56.6 to 73.9%. Concordance of primary tumor staging was high (71.2% - 84.5%). The positive predictive value of nodal staging was 78.1%. Neoadjuvant therapy was associated with downstaging in 22.9-41.2% of primary tumors T2 or greater and 17.8% of positive nodes. T1 tumors were downstaged only 1.6% of the time. Stage IA and IB patients had high rates of guideline-concordant treatment (97.0% and 98.3%). Stage IIA-IIIA patients had lower rates of guideline-concordance (47.9%, 47.3%, and 32.1%). Receipt of guideline-concordant care was associated with a significantly lower risk of death (HR 0.84, 95% CI 0.80-0.88). This pattern was consistent across stages with the exception of stage IIIA (HR 1.07, 95% CI 1.00-1.16) due to a subset of guideline-concordant patients who did not respond to neoadjuvant therapy (HR 1.22, 95% CI 1.11-1.34).

Conclusions: Less than half of Stage IIA-IIIA NSCLC patients receive guideline-appropriate therapy which is associated with inferior survival. Given that current diagnostic modalities for clinical staging are reasonable, identifying patient or provider factors which contribute to these differences is crucial to improve the overall quality of patient care and long-term outcomes.

Optimal Surgical Timing After Neoadjuvant Therapy for Non–Small-Cell Lung Cancer

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Purpose: Patients with clinically/pathologically diagnosed stageIIIa non-small cell lung cancer (NSCLC) considered for surgery are recommended to undergo neoadjuvant chemotherapy with or without radiation. Timing of operative intervention after therapy is not standardized. We investigate the timing of operative intervention after neoadjuvant therapy and its impact on outcomes in this demographic.

Methods: The National Cancer Database was queried for patients with clinical and pathological Stage IIIa NSCLC between 2010-2015. Patients were then divided into short(<77days), mid(77-114days) and long delay(>114 days) groups based on their interquartile values. These groups were then compared for age, race, gender, insurance type, Charlson-Deyo Score, length of stay, readmission rate and overall survival impact based on timing of operation.

Results: There were 31357 patients with clinical and pathological Stage III NSCLC. 5946 patients underwent surgical intervention. Preoperatively, 3593 patients underwent chemo-radiotherapy, 2185 underwent chemotherapy only and 168 patients received radiation alone. The short, mid and long delay groups were clinically and statistically similar in age, gender, insurance type, comorbidity index, treating facility type and distance from home (Table 1). Long delay groups had more African American patients and with larger tumor size compared to other groups. Postoperative length of stay, rates of 30 day readmission as well as 30 and 90 day mortality were similar across all delay groups. Cox modeling demonstrated a significant difference in survival when patients underwent earlier operative intervention compared to late and when patients received chemoradiation compared to chemotherapy alone.(Figure 1b) Short, mid and long delay groups 1-year survival was 82%, 83% and 80% and 3-year survival was 59%, 58% and 52% respectively (p=0.0003)(Figure 1a).

Conclusions: The delay in surgical resection of stage IIIa non-small cell lung cancer is not associated increased early mortality however it is associated with worse 3 year post-resection survival.

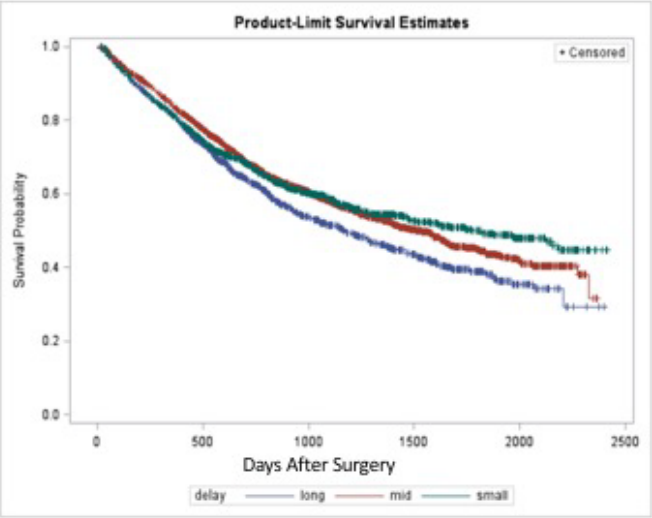

Figure 1a: Survival Curve for Short, Mid and Long Delay

Parameter	Referance	Hazard Ratio	p-value
Age		1.009	0.0044
Sex(Female)	Male	0.761	<.0001
Race (AA)	Other	0.927	0.3538
Insurance Type(None)	Private	1.135	0.3431
Insurance Type(Medicaid)	Private	0.954	0.6263
Insurance Type(Medicare)	Private	1.222	0.0005
Insurance Type(Other)	Private	1.418	0.0492
Academic	Non-academic	0.939	0.151
Charlson-Deyo Score		1.099	0.0022
Distance to Treatment Center		1	0.4952
Neoadjuvant Treatment(Chemo Only)	Chemoradiation	1.608	<.0001
Neoadjuvant Treatment(Radiation Only)	Chemoradiation	0.994	0.8891
Delay to Surgical Intervention(Long)	Short	1.239	0.0005
Delay to Surgical Intervention(Mid)	Short	1.03	0.5825

Figure 1b: Cox Hazard for Post Resection Stage IIIa NSCLC Survival

	All Patients	Short Delay (1558 pts)	Mid Delay (2950 pts)	Long Delay (1438 pts)	p-value
Age		63 (55-69)	63 (56-69)	63 (56-69)	0.7
Gender-Female	2857 (48%)	742 (48%)	1411 (48%)	704 (49%)	0.7
Race-AA	546 (9%)	147 (9%)	237 (8%)	162 (11%)	0.002
Insurance-private	2774 (47%)	736 (49%)	1401 (48%)	647 (45%)	
Insurance-medicare	2426 (42%)	618 (41%)	1210 (42%0	598 (42%)	0.08
Insurance-medicaid	400 (7%)	95 (6%)	187 (6%)	118 (8%)	
Academic Institution	3335 (56%)	856 (55%)	1687 (57%)	792 (55%)	0.2
Charlson-Deyo Score > 0	2087 (35%)	547 (35%)	1024 (35%)	516 (36%)	0.7
Tumor Size (mm)		42 (27-64)	42 (27-64)	45 (28-72)	0.0003
Distance to treatment center		11 (5-28)	12 (5-29)	13 (5-32)	0.1
Length of Stay (days)		5 (4-8)	5 (4-7)	5 (4-8)	0.07
30-day mortality	135 (3%)	34 (3%)	67 (3%)	34 (3%)	0.8
90-day mortality	284 (6%)	80 (6%)	130 (5%)	74 (6%)	0.3
No readmission at 30 days	5514 (93%)	1441 (93%)	27224 (92%)	1349 (94%)	0.2

Table 1: Patient Demographics

STS Composite Score Rating for Pulmonary Resection for Lung Cancer

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Purpose: The Society of Thoracic Surgeons (STS) has previously developed composite quality measures for lobectomy and esophagectomy. We sought to develop a composite measure including all pulmonary resections for lung cancer. In addition, we explored variation in utilization of minimally invasive approach among STS participants and its impact on composite ratings.

Methods: The STS lung cancer composite score is based on two outcomes: risk-adjusted mortality and risk-adjusted major morbidity (any vs none). General Thoracic Surgery Database (GTSD) data were included from 1/2015 – 12/2017. 95% Bayesian credible intervals were used to create "star ratings" for centers with >30 cases. The Bayesian model was performed with and without inclusion of minimally invasive approach as a covariate to assess the impact of approach on the composite quality measure. Number of lymph nodes examined, nodal stations examined and margin status are not included in star ratings, but will be reported in participant feedback reports.

Results: The study population included 38,461 lung cancer patients from 256 participating centers. Procedures included wedge resection (15.4%, 5,917/38,461), segmentectomy (6.9%, 2,659/38,461), lobectomy (70.7%, 27,201/38,461), sleeve lobectomy (1.1%, 422/38,461), bilobectomy (3.0%, 1,152/38,461) and pneumonectomy (2.9%, 1,110/38,461). 68% (26,128/38,461) of patients had pathologic stage I cancer. Overall operative mortality was 1.3% (495/38,461); Major complication rate was 7.9% (3,045/38,461). Median nodes examined was 10 (IQR 5-16); Median nodal stations sampled was 4 (IQR 3-5). Positive resection margins were identified in 3.7% (1,420/38,461). 214 centers with >30 cases were assigned star ratings. There were 8 one-star, 192 two-star and 14 three-star programs. 70.6% of resections were performed through a minimally invasive approach. On a participant basis, the median percentage of cases performed using minimally invasive techniques was 75.4% (IQR 59.0-84.7) (figure 1). Exclusion of minimally invasive approach as a covariate, which was adjusted for in previous models, altered the star ratings for 3% (6/214) of programs.

Conclusions: Participants in the STS GTSD perform lung cancer resection with low morbidity and mortality. Nodal evaluation data suggest participants are meeting contemporary staging standards. There is wide variability among participants in application of minimally invasive approaches. Risk adjustment for surgical approach results in modest overall changes to participant star ratings.

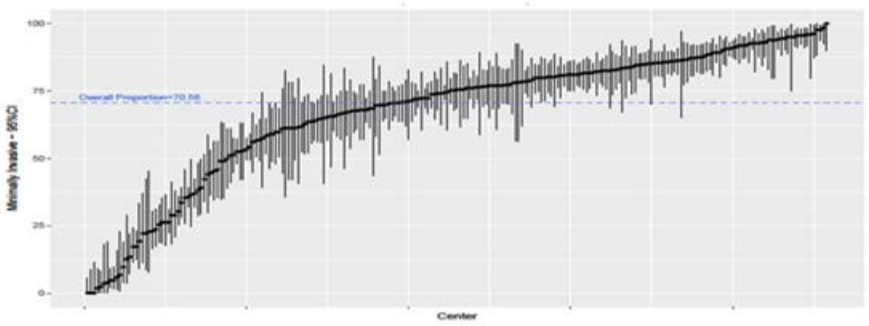

Figure: Participant proportion of procedures performed with minimally invasive approach with 95% confidence intervals.

Table 1: Overall Frequency and Participant Variation in Mortality/Morbidity (n=38,461)

Main Outcomes	Number	Overall Percent	Participant Median (IQR)
Operative Mortality*	495	1.29%	1.2% (0-2.1)
Major Morbidity Composite**	3,045	7.92%	7.9% (5.1-11.2)
Components of Major Morbidity			
Return to OR	1,123	2.92%	2.7% (1.1-4.7)
Pneumonia	1,379	3.59%	3.1% (1.3-5.3)
Initial Vent Support > 48hrs	124	0.32%	0% (0-0.4)
Respiratory Failure	1,025	2.67%	2.3% (0.6-3.9)
Tracheostomy	244	0.63%	0% (0-1.0)
ARDS	208	0.54%	0% (0-0.8)
Pulmonary Embolus	198	0.51%	0% (0-0.8)
Bronchopleural Fistula	139	0.36%	0% (0-0.5)
Myocardial Infarction	127	0.33%	0% (0-0.5)

*Operative Mortality: in-hospital deaths and deaths within 30 days of surgery

**Major Morbidity Composite: at least one of the individual components present

Effect of Socioeconomic Status on Treatment and Mortality in Patients With Non–Small-Cell Lung Cancer

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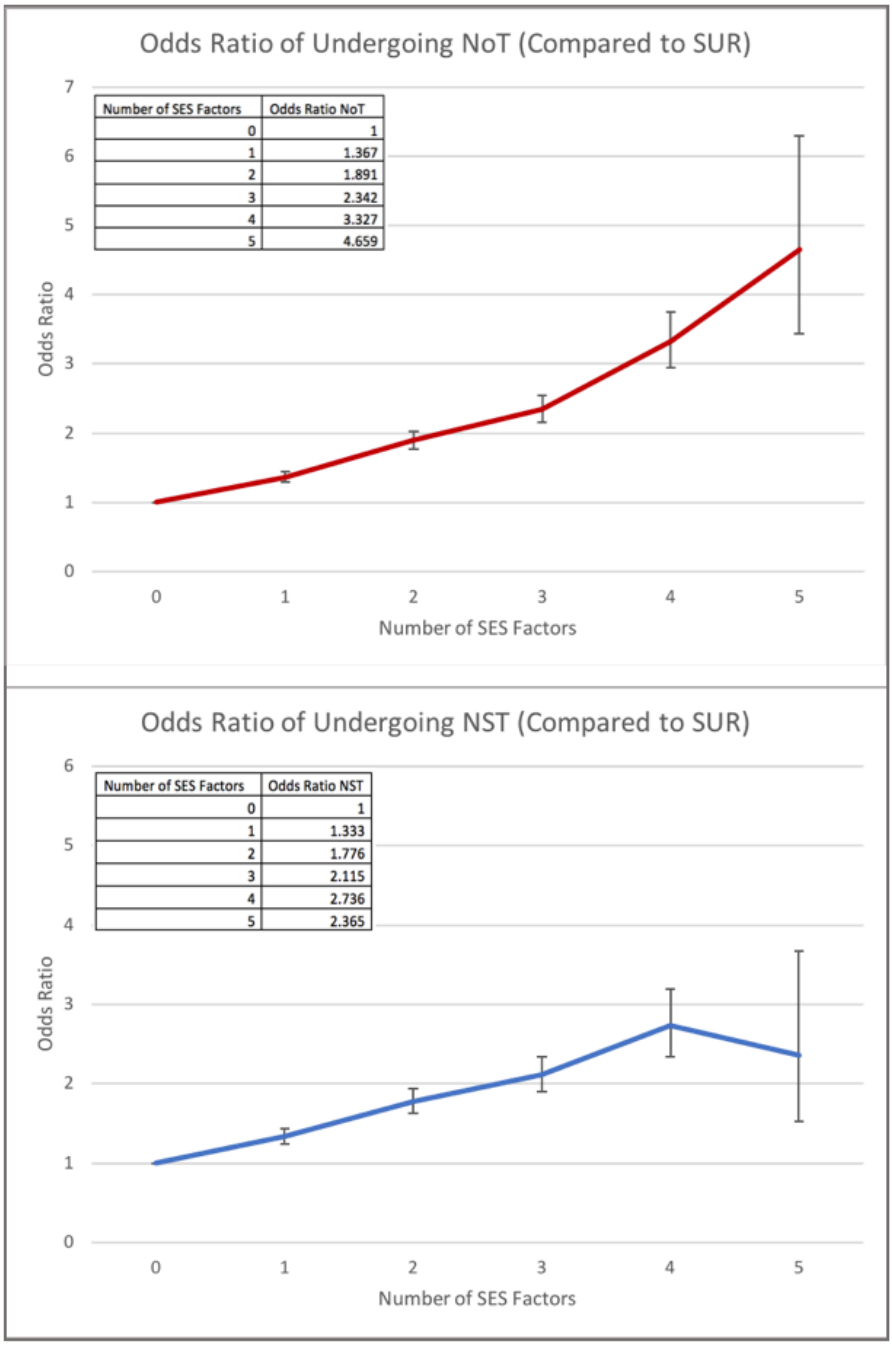
Purpose: Treatment decisions for patients with non-small cell lung cancer (NSCLC) are based upon patient and tumor characteristics. However, socioeconomic status (SES) may also play a role. The objective of this study was to assess the contribution of SES factors to treatment modality and outcomes among patients with stage I NSCLC.

Methods: The National Cancer Database (NCDB) Participant User Data File was queried to identify patients with stage I NSCLC for whom surgery alone would constitute guideline concordant therapy. The cohort was divided into those who underwent surgery only (SUR), those who underwent nonstandard treatments such as chemotherapy with or without radiation (NST), and those who underwent no therapy (NoT). The SES of patients who made up the treatment groups was assessed using income, race, education, insurance type, residence in relation to an urban area, and distance to the treating facility. The 5-year survival of all 3 treatment groups was analyzed.

Results: The cohort included 69,168 patients with stage I NSCLC (SUR – 51,208, NST – 6,369, NoT – 11,591) and 0-5 SES factors (no patient had all 6). Factors associated with not undergoing surgery were low income, nonwhite race, lack of access to education, Medicaid or no insurance, rural residence, and great circle distance <12.5 miles. Multiple risk factors in any one patient resulted in a disproportionate risk of undergoing NoT rather than SUR. For each additional SES factor, the rate of rise for risk of NoT increased as a quadratic function (Figure 1), such that a patient with 5 SES factors was at significantly higher risk of undergoing NoT versus SUR (OR=4.7; 95% CI 3.44-6.30). For NST versus SUR, each additional SES factor conferred a nearly constant increase in rise of risk. SUR was associated with a significantly higher 5-year survival (71.8%) compared to NST (22.7%) and NoT (21.8%), (p<0.0001).

Conclusions: SES factors increase the risk of not undergoing guideline concordant therapy for Stage I NSCLC. As the number of SES factors increases, the risk of NoT rises quadratically while the risk of NST rises constantly. The SUR group was associated with a significantly higher survival than NST and NoT groups.



End-Stage Renal Disease After Lung Transplantation: An 11-Year National Cohort Study

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Purpose: End stage renal disease (ESRD) is a dreaded complication after lung transplantation and is associated with inferior post-transplant survival. In this study, we sought to identify the incidence and risk factors for the development of ESRD in lung transplant recipients.

Methods: We studied lung transplant recipients in the US between 01/01/2006-12/31/2016 using SRTR data. We included recipients greater or equal to 12 years old. We excluded patients with ESRD prior to transplant. For ascertainment of our outcome of interest (ESRD), we linked our cohort data to the United States Renal Data System (USRDS). ESRD was defined as the initiation of dialysis,

waitlisting, or kidney transplantation, whichever was identified first. We used Kaplan-Meier methods to estimate the cumulative incidence of ESRD and used multivariate Cox regression to determine risk factors associated with ESRD.

Results: Among 17,054 lung transplant recipients, 514 developed ESRD at a mean of 3.57±2.45 years. Median follow up time was 2.9 years. The risk of ESRD increased over time. The cumulative incidence at 1, 3, and 5 years was 0.6% (95% CI, 0.5-0.7), 1.9% (1.7–2.2), and 4.1% (3.6–4.5). Pre-transplant risk factors associated with ESRD included GFR 60-89 (HR 1.56, P<0.001), GFR 30-59 (HR 3.25, P<0.001), GFR < 30 (HR 3.03, P=0.03), black or African-American race (HR 1.45, P=0.01), hypertension (HR 1.42, P=0.01), diabetes mellitus (HR 1.32, P=0.01), and ventilator requirement (HR 1.67, P=0.01). Post-transplant risk factors associated with ESRD included post-operative acute renal failure requiring dialysis (HR 3.24, P<0.001) and cyclosporine use for maintenance immunosuppression (HR 1.60, P=0.01).

Conclusions: The five-year risk of end stage renal disease after lung transplantation is about 4 per 100. Paying attention to modifiable risk factors might reduce the long-term risk of ESRD. GFR<60 was the strongest risk factor for ESRD, and these candidates might benefit from consideration for simultaneous kidney/lung transplant.

Figure 1: Kaplan-Meier methods were used to estimate the cumulative incidence of end stage renal disease among 17,054 persons who received lung transplants between January 1, 2006 and December 31, 2016.

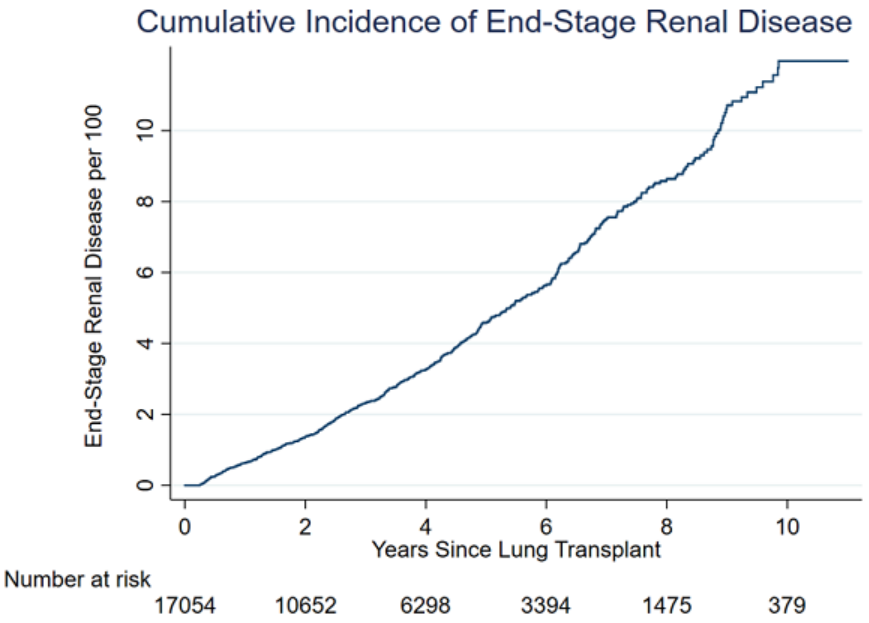

Table 1: Risk Factors Associated with End Stage Renal Disease in Lung Transplant Recipients			
Variable	**Hazard Ratio**	**95% CI**	**P Value**
Age (per 10-year increment)	0.99	(0.90-1.08)	0.77
Pretransplantation glomerular filtration rate (GFR)			
≥ 90 ml/min/1.73 m^2	1.00 (reference)		
60-89 ml/min/1.73 m^2	1.56	(1.24-1.98)	<0.001
30-59 ml/min/1.73 m^2	3.25	(2.34-4.51)	<0.001
< 30 ml/min/1.73 m^2	3.03	(1.10-8.31)	0.03
Postoperative acute renal failure requiring dialysis	3.24	(2.18-4.80)	<0.001
Female sex	1.12	(0.92-1.36)	0.26
Race			
White	1.00 (reference)		
Black or African American	1.45	(1.09-1.94)	0.01
Asian	0.14	(0.02-1.03)	0.05
Other	1.20	(0.44-3.21)	0.72
Calcineurin-inhibitor use for maintenance immunosuppression			
Tacrolimus	1.00 (reference)		
Cyclosporine	1.60	(1.17-2.18)	0.01
Sirolimus use for maintenance immunosuppression			
No	1.00 (reference)		
Yes	1.46	(0.36-5.88)	0.59
Hypertension before transplantation	1.42	(1.13-1.79)	0.01
Diabetes mellitus before transplantation	1.32	(1.06-1.65)	0.01
ECMO before transplantation	0.95	(0.49-1.83)	0.89
Ventilator before transplantation	1.67	(1.16-2.40)	0.01
Smoking before transplantation	0.98	(0.79-1.22)	0.87
Lung Allocation Score at time of Transplant			
0-29	1.00 (reference)		
30-39	0.60	(0.15-2.43)	0.47
40-49	0.49	(0.12-2.00)	0.32
≥ 50	0.58	(0.14-2.37)	0.45

Prior and Perioperative Revascularization Does Not Affect Survival in Lung Transplant Patients

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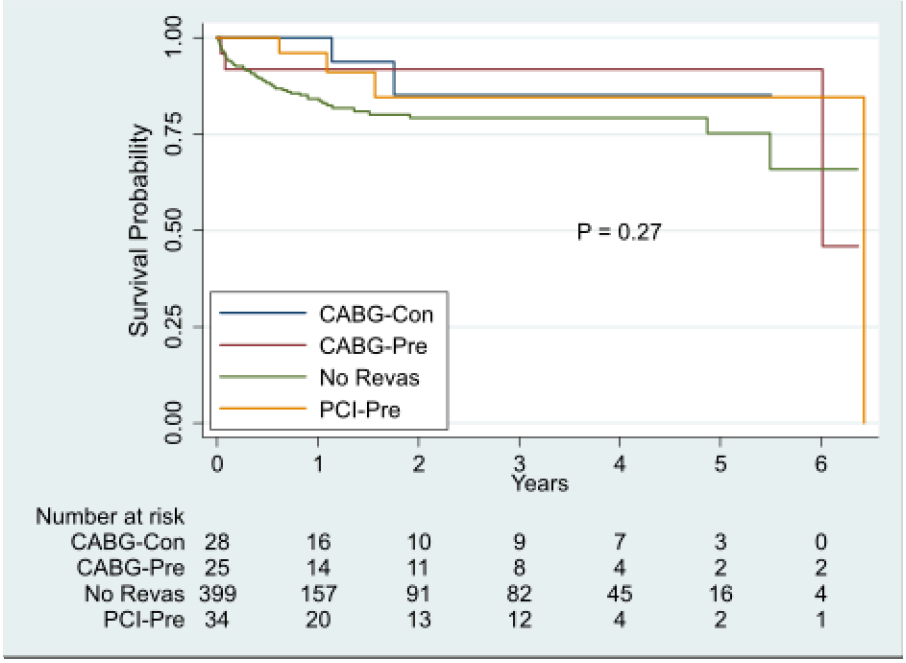
Purpose: Coronary artery disease can be often found in lung transplant patients, and not very long ago was viewed as a contraindication to the procedure. Although this mindset is changing, the effect of prior or perioperative revascularization on survival outcomes in lung transplant patients is not adequately established.

Methods: We performed a single center retrospective analysis of all patients referred for single or double lung transplant from 2012-2018. Patients were split into four groups: 1) Patients that had received a pre-operative PCI, 2) Patients that had received coronary artery bypass grafting prior to transplantation, 3) patients that had received concomitant coronary artery bypass grafting during transplantation, and 4) patients that had lung transplantation with no need for revascularization. Groups were compared for a number of parameters such as LAS, incision type, age, use of CPB pump, and most importantly survival days.

Results: Of the patients screened, 34 required preoperative PCI, 25 received previous CABG, 28 required concomitant CABG, and 398 had no revascularization done. The groups show no statistical difference in age (63+/-10), gender, or lung allocation score (50 +/- 20). All groups were more likely to have been diagnosed with IPF, but the relative ratio of patients with COPD was greatest in the group not requiring revascularization (p=0.001). Groups show no difference for use of CPB pump (p=0.21). Patients that had previously undergone CABG were more likely to receive a single lung transplant over a double (21 vs 4, P=0.003), whereas rates of each were similar in the other groups. Length of stay was not statistically different between the groups (p= 0.23). Survival analysis showed no statistical difference between the groups for up to six years (p=0.27), where applicable, and postoperative adverse cardiac events were similar amongst all groups.

Conclusions: These results suggest that revascularization, either in the past or peri-operatively, does not negatively impact survival in lung transplant patients. This serves as support that revascularization therapies in CAD patients do not affect their survival outcomes negatively when compared to a cohort not requiring revascularization.



Influence of Sarcopenia and Nutrition on Lung Transplant Candidates: Short- and Long-Term Outcomes

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Purpose: Sarcopenia may be an important factor on outcomes following lung transplantation (LTx). Serum albumin has been demonstrated as important predictor of outcomes in LTx. We sought to measure sarcopenia in a cohort of LTx patients, analyze its effect on outcomes, and compare sarcopenia to albumin as a marker of outcomes.

Methods: We identified LTx recipients from May 2013 through May 2018 at our institution who underwent computed tomography (CT) and bloodwork at listing evaluation. Muscle mass was estimated from CT measurement of skeletal muscle cross-sectional surface area (SA) at the L3 level. Skeletal muscle index (SMI) was determined by the formula $SMI=SA/Height^2$. Sarcopenia was defined as SMI<43 for men with BMI/=25, and SMI<41 for women per literature. Albumin levels <3.5mg/dL were classified as low. Correlations between sarcopenia or albumin and overall survival, hospital length of stay (LOS), readmissions, and discharge to a rehabilitation facility were evaluated.

Results: Of 132 patients meeting eligibility criteria, most were men(73/132, 55%) and the most common diagnoses were Idiopathic Pulmonary Fibrosis(IPF, 53/132 40%) followed by Chronic Obstructive Pulmonary disease(COPD, 50/132, 38%), and Cystic Fibrosis(CF, 12/132, 9%). 72%(95/132) of subjects were sarcopenic. By diagnosis, 64%(34/53) of IPF patients were sarcopenic, compared to 82%(41/50) of COPD patients, and 58%(7/12) of CF patients. Survival was not associated with sarcopenia combined across diagnoses (**Figure 1A**,$p_{logrank}$=0.99). Hospital LOS, 30- and 90-day readmissions, and discharge to a rehabilitation facility were not influenced by sarcopenia. In contrast, 21%(28/131) of the patients had low albumin which was associated with decreased survival among all diagnoses (**Figure 1B**,$p_{logrank}$=0.01). There was a trend towards longer LOS in hypoalbuminemic patients for all diagnoses (p=0.12), this difference was only significant for COPD patients (median LOS 12 vs 38 days,p=0.004). Low albumin was not significantly associated with hospital readmissions or discharge to a rehabilitation facility.

Conclusions: Sarcopenia is prevalent in patients prior to LTx. The presence of sarcopenia did not predict an increase in mortality, hospital LOS, readmissions, or discharge to a rehabilitation facility among LTx patients. This is in contrast to pre-operative albumin levels, which are an important predictor of short-term and long-term outcomes.

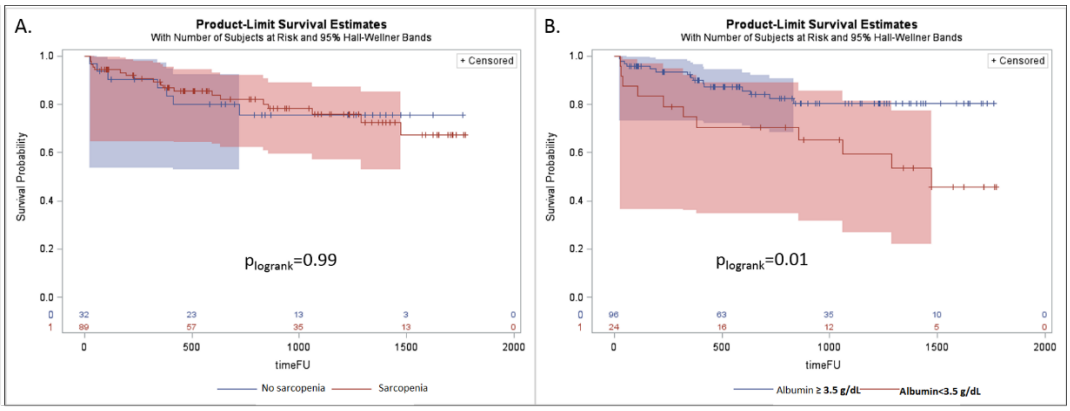

Figure 1. A. Sarcopenia, as defined by Skeletal Muscle Index (SMI)<43 for men with Body Mass Index (BMI)≤24.9, SMI<53 for men with BMI≥25, and SMI<41 for women, did not significantly predict survival in lung transplant patients, $p_{logrank}$=0.99. **B.** Low pre-operative serum albumin levels, defined as <3.5 mg/dL, were significantly associated with increased mortality in lung transplant patients, $p_{logrank}$=0.01.

Resection of Subglottic and Cervical Tracheal Stenoses With Laryngeal Mask Airway Ventilation: Long-Term Surgical Results

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Purpose: To report the long-term surgical results of patients who have undergone cervical tracheal (TR) or cricotracheal (CTR) resection of a benign stenosis, with Laryngeal Mask Ventilation (LMAV) as the primary method of intraoperative ventilation.

Methods: All patients between Jan 2006 and May 2018 undergoing TR or CTR for benign laryngotracheal strictures at a single institution were retrospectively identified and reviewed. A combined team of Thoracics and Otolaryngology-Head and Neck surgery were present for all CTR; the majority of resections were performed by the same two surgeons. Primary outcome was the rate of restenosis requiring any reintervention.

Results: Fifty-five consecutive patients (4 males, 51 females; mean age 53 years) underwent TR (17/55) or CTR (38/55). LMAV succesfully ventilated all patients during surgery and after completion of airway anastomosis. Crossfield ventilation was used intraoperatively after transection of the airway until anastomosis was complete. There were no mortalities within 30 days. Mean follow-up was 29.8 months (0.9-126.1). Successful resolution of the preoperative stricture was ultimately achieved in 95% (52/55). Thirteen patients (24%, 13/55) required one or more endoscopic interventions and/or T-tube/tracheostomy placement for recurrent stenosis (median 70 days, range 8-442). Ten of the 13 patients had complete resolution of their recurrence after a mean of 1.5 procedures (range 1-3). Only two patients (4%, 2/55) did not respond to post-resection treatments and were never decannulated. Three patients (5%, 3/55) experienced major complications at 30 days; bleeding (1), partial anastomotic dehiscence (1), stroke (1). No intraoperative complications were associated with use of LMAV.

Conclusions: Resection of benign subglottic and cervical tracheal stenoses with laryngeal mask airway ventilation is an effective and safe treatment strategy and provides excellent long term results. LMAV avoids the need for stenosis dilation at anesthesia induction and facilitates intraoperative bronchoscopy.

Primary Thoracic Neurogenic Tumors: Clinical, Pathological, and Long-Term Outcomes

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Purpose: Thoracic neurogenic tumors are uncommon neoplasms arising from nerve tissues. We report our single-center experience in treating this rare intrathoracic neurogenic tumors.

Methods: Using a prospective database, we analyzed the clinical, surgical and pathological records of patients receiving the resection of an intrathoracic neurogenic tumor between May 1998 and June 2018. There were 82 patients (24 females) with an average age of 53 years (29 to 75 years). Survival was calculated by Kaplan-Meier method.

Results: Mean diameter was 32 mm (range, 12-68 mm). Histology included 49 schwannomas (11 malignant), 15 neurinomas (2 malignant), 14 neurilemmomas, and 4 paragangliomas. Location included 55 posterior mediastinum, 13 thoracic inlet, 7 anterior mediastinum, 7 lung parenchyma, and 3 chest wall. Symptoms were reported by 51 patients (62.2%) and included cough in 23, dyspnea in 15, neurologic symptoms in 11, and wheezing in 2. In 3 patients (3.6%), the tumor showed an intraspinal extension.

Operation was performed by thoracotomy in 42 (51.2%) cases and thoracoscopy in 40 (48.8%). Resection was complete in 80 patients (97.6%). Postoperative radiotherapy was administered in 2 cases. Mortality was nil. Morbidity rate occurred in 4 patients (4.8%) including 2 prolonged air leaks, 1 hemothorax, and 1 chylothorax. Five-year survival was 97% (mean follow-up, 4.9 years.) Malignant tumors had a worse prognosis (p=.02). No recurrence occurred during the follow-up neither for malignant nor for benign tumors.

Conclusions: The treatment of choice for thoracic neurogenic tumors is complete resection. Adjuvant radiotherapy should be used to treat incomplete resection for malignant neoplasms. Long-term prognosis is favorable for benign neurogenic tumors.

Esophageal Cancer Patient Outcomes After Neoadjuvant Chemoradiotherapy and Subsequent Esophagectomy According to Pathologic Tumor Regression Grade

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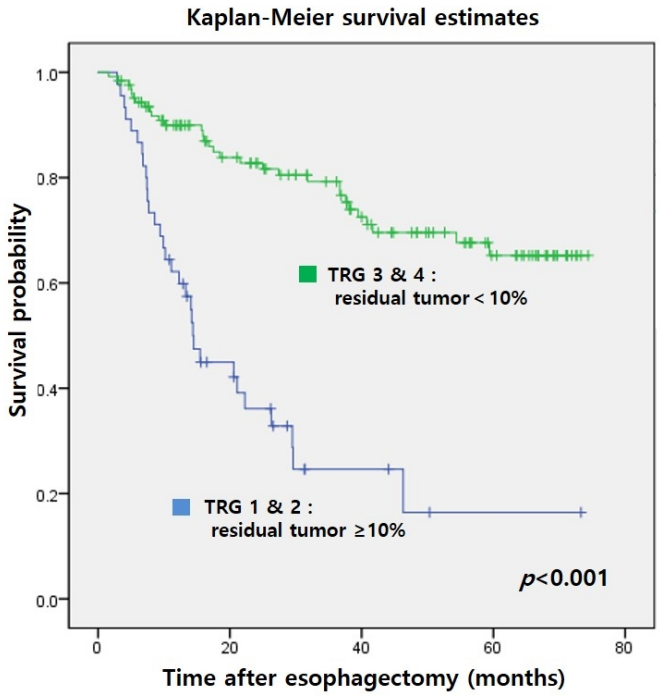
Purpose: The effect of neoadjuvant chemoradiotherapy (CRT) for esophageal cancer varies from patient to patient. We aimed to investigate the prognostic value of pathologic tumor regression grade (TRG) in patients who underwent neoadjuvant CRT followed by surgery for esophageal squamous cell carcinoma.

Methods: We enrolled 175 esophageal cancer patients who underwent neoadjuvant CRT followed by esophagectomy at our institution from January 2012 to December 2017. Patients were classified according to four pathologic TRGs. TRG 1, 2, and 3 were defined as the main mass of residual tumor comprising more than 50%, between 10% and 50%, and less than 10% of the initial tumor, respectively. TRG 4 was defined as the absence of residual tumor. The patients' electronic medical records were retrospectively reviewed, and overall survival (OS) period and progression-free survival classified by TRG were calculated using Kaplan-Meier analysis.

Results: The patients' mean age was 64.9 ± 8.2 years, and 161 (92%) were male. The OS period was 49.5 ± 2.4 months, and the 3- and 5-year survival rates were 64.2% and 52.9%, respectively. Recurrence occurred in 75 patients (42.8%) . Patients with TRG 1 had a OS period of 23.8 ± 3.7 months, and patients with TRG 2, 3, or 4 had OS periods of 25.3 ± 6.3 months, 50.0 ± 4.8 months, and 60.1 ± 2.8 months, respectively. Patients were divided into two groups to identify the most significant changes in survival according to the TRG. Patients with low TRGs (TRG 1 and 2) had a OS period of 30.4 ± 4.3 months and a 3-year progression-free survival rate of 23.0%, whereas those with high TRGs (TRG 3 and 4) had a OS period of 57.6 ± 2.6 months and a 3-year progression-free survival rate of 73.0%.

Conclusions: For esophageal squamous cell carcinoma patients who undergo esophagectomy following neoadjuvant CRT, a pathologic TRG is an accurate predictor of clinical outcomes.



Extended Lymphadenectomy Is Associated With Significant Improvement in Survival After Preoperative Chemoradiation for Esophageal Cancer: An Analysis of the National Cancer Database

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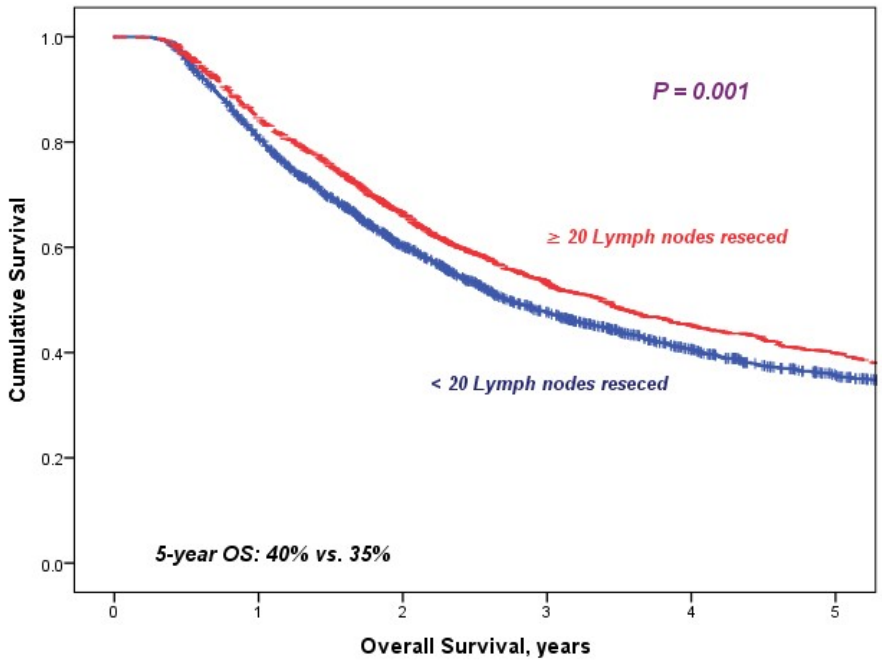
Purpose: A post-hoc analysis of the CROSS-trial data showed that the number of dissected lymph nodes was not associated with improved survival in patients undergoing upfront surgery but not in those treated with induction chemoradiation (CRT). We sought to explore the role of nodal-dissection following CRT in the National Cancer Database

Methods: The NCDB was queried (2004-2014) for patients who underwent esophagectomy following induction CRT. Predictors of overall survival (OS) were assessed by Cox-regression multivariable analysis (MVA). The optimal number of dissected LNs associated with highest survival benefit was determined by multiple regression analyses followed by bootstrap validation and ROC curve.The whole cohort was divided into two groups based on the predefined cutoff number. The two groups were propensity-matched; controlling for age, gender, race, comorbidity, histology, grade, stage, and margin-status (caliper 0.2). Overall survival was estimated using Kaplan Meier method and differences were compared using log-rank test.

Results: Esophagectomy following induction CRT was done in 14503 patients. Predictors of improved OS on MVA were: younger age, female gender, adenocarcinoma, grade I-II tumors, clinical stage I-II, R-0 resection and the total number of resected nodes (HR for every 10 nodes:0.925, 95% CI:0.905-0.944, P<0.001). The cutoff number of resected LNs that was associated with the highest survival benefit was 20 nodes (HR:0.867,95% CI:0.814-0.922). In the patients with node-negative disease, a statistically significant survival advantage was noted with dissection of up to 35 nodes. While, in node-positive disease, a survival advantage was noted with dissection of up to 20 nodes. In the PM group comparison (Table) there was a 14% relative increase in OS in the “> 20 LNs” group, compared to the “< 20 LNs” group (5-year OS:40% vs. 35%, P=0.001) (Figure).

Conclusions: The total number of resected nodes is a significant determinant of improved survival following induction chemoradiation in patients with either node-negative or node-positive disease.



Esophagectomy following induction CRT, Propensity matched groups	*< 20 LNs* (n=2270)	*=>20 LNs* (n=2270)	*P value*
Age, in years (median, IQR)	62 (55-69)	62 (56-68)	0.466
Gender (Male)	1906 (84%)	1923 (85%)	0.488
Race (White)	2113 (93%)	2102 (92.5%)	0.895
Charlson Comorbidity Index (0)	1701 (75%)	1700 (75%)	0.985
Histology (adenocarcinoma)	1887 (83%)	1902 (84%)	0.759
Tumor grade of differentiation (1-2)	1062 (47%)	1044 (46%)	0.592
Tumor location (Lower third-GE junction)	1973 (87%)	1952 (86%)	0.362
Stage (III-IV)	949 (42%)	968 (43%)	0.568
Number of lymph nodes resected (n=2270)	11 (7-15)	25 (22-30)	<0.001
Number of positive nodes (median, IQR)	0 (0-1)	0 (0-2)	<0.001
Positive resection margin (R1-R2)	110 (5%)	118 (5%)	0.587

High Volume Predicts Guideline-Concordant Care for Stage III Esophageal Cancer

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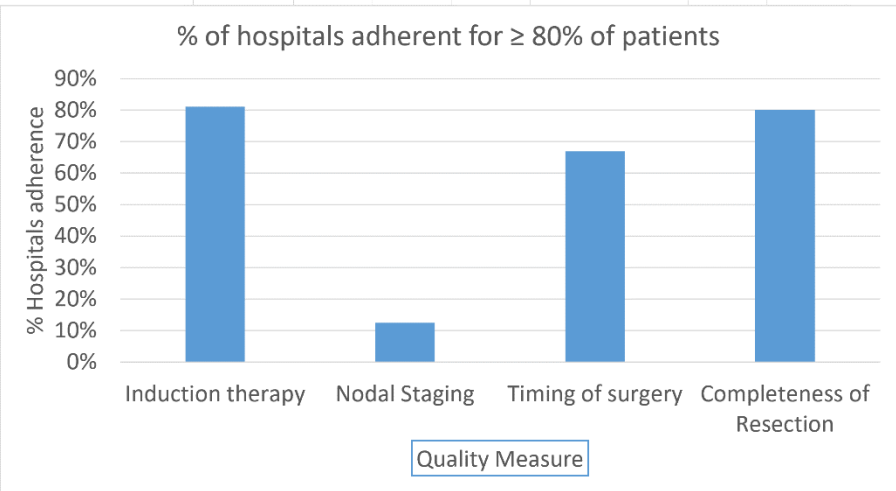
Purpose: Esophageal cancer is a common, but deadly disease, requiring multidisciplinary coordination of care and surgical proficiency for adequate treatment. We hypothesize that quality of care is not consistent nationally.

Methods: From the NCCN guidelines, we developed quality measures for management of stage III esophageal cancer: utilization of neoadjuvant therapy, surgical sampling of at least 15 lymph nodes, resection within 120 days of chemotherapy and/or radiation, and completeness of resection. Measure adherence was examined in 1230 hospitals participating in the National Cancer Database from 2004 to 2014. Hospitals with ?80% adherence to a measure were considered adequately adherent for that measure. We examined the influence of patient volume, cancer program accreditation, rate of Medicaid insurance status, geographic region, patient travel distance on guideline adherence using logistic regression modeling.

Results: Quality measure adherence was worst in operative nodal assessment with only 12.5% of hospitals meeting the minimum threshold and best for utilization of neoadjuvant therapy (81.1%) (Figure). Hospitals treating fewer than six patients per year were less likely to provide recommended neoadjuvant therapy prior to surgery (p = 0.003) and an R0 resection (p = 0.014). Similarly, hospitals performing fewer than two esophagectomies annually were less likely to have appropriate rates of neoadjuvant therapy (p = 0.009) and R0 resection (p = 0.001). Both comprehensive (p = 0.010) and non-comprehensive (p = 0.007) community cancer programs were more likely to provide timely surgical resection after neoadjuvant treatment than academic/research centers. Medicaid insurance status and patient travel distance to facility did not predict hospital adherence.

Conclusions: Major gaps in the delivery of guideline directed care in esophageal cancer exist at the hospital level in the U.S. Care provided at higher volume hospitals was more likely to be guideline concordant. Future studies to address how hospital volume supports quality measure adherence may provide valuable opportunities for improvement.



Odds ratios	Induction therapy	Nodal Staging	Timing of Surgery	R0 resection
Mean number of patients treated/year				
≤6	0.48 (0.29,0.78)*	2.86 (1.41,5.81)*	1.09 (0.75,1.59)	0.56 (0.36,0.89)*
>6	REF	REF	REF	REF
Mean number of surgeries/year				
≤2	0.27 (0.10,0.72)*	3.39 (0.73,15.72)	0.69 (0.41,1.15)	0.13 (0.04,0.44)*
>2	REF	REF	REF	REF
Type of Cancer Program/Facility				
Community	2.00 (1.11,3.59)*	1.18 (0.61,2.32)	2.00 (1.20,3.33)*	1.60 (0.87,2.94)
Comprehensive Community	1.55 (0.96,2.51)	0.66 (0.36,1.23)	1.67 (1.13,2.47)*	0.99 (0.61,1.62)
Academic/Research	REF	REF	REF	REF
Integrated Network	2.37 (0.78,7.23)	0.46 (0.10,2.11)	1.97 (0.99,3.95)	0.48 (0.21,1.07)
Insurance status				
>35% Medicaid/uninsured	REF	REF	REF	REF
≤35% Medicaid/uninsured	0.98 (0.37,2.59)	1.52 (0.43,5.39)	1.55 (0.67,3.58)	1.31 (0.49,3.51)
Region type				
Large urban	REF	REF	REF	REF
Medium urban	0.92 (0.59,1.45)	0.94 (0.53,1.66)	0.69 (0.49,0.99)	1.00 (0.64,1.56)
Small urban	0.79 (0.52,1.21)	1.12 (0.68,1.84)	1.49 (1.02,2.16)*	0.89 (0.59,1.35)
Unknown region	3.40 (0.43,26.8)	1.10 (0.22,5.46)	1.61 (0.43,6.03)	1.23 (0.26,5.88)
Distance patient travels to facility				
0-5 miles	REF	REF	REF	REF
5-10 miles	0.67 (0.26,1.75)	0.60 (0.26,1.39)	1.02 (0.46,2.26)	0.48 (0.16,1.44)
>10 miles	0.78 (0.30,2.00)	0.51 (0.22,1.17)	0.93 (0.43,2.04)	0.50 (0.17,1.51)

Patient-Reported Symptoms for Esophageal Cancer Patients Undergoing Curative-Intent Treatment

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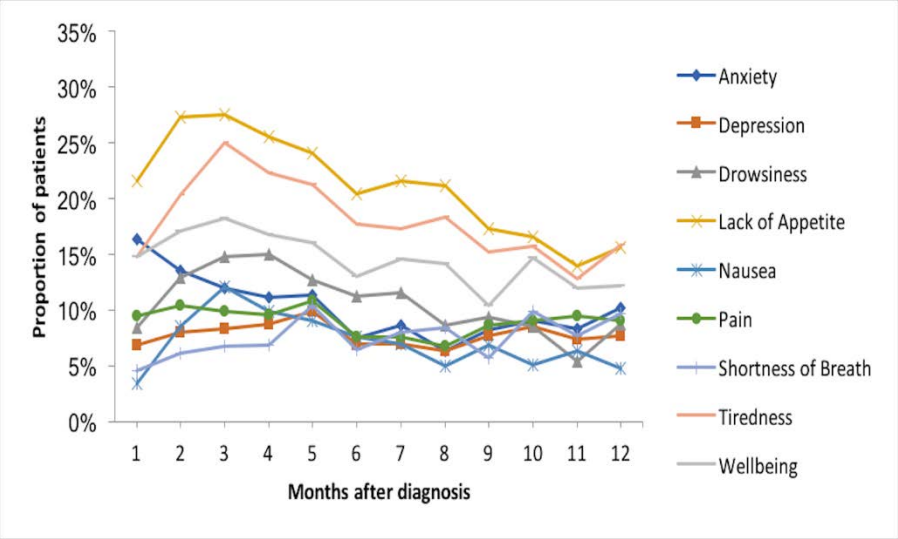
Purpose: Esophageal cancer (EC) patients experience considerable symptom burden through multi-modality curative treatment. This study used the Edmonton Symptom Assessment System (ESAS) collected as part of standard clinical care to describe symptom trajectories and predictors of high symptom burden for patients undergoing curative-intent treatment of esophageal cancer.

Methods: This retrospective cohort study used linked administrative data from Ontario. EC patients treated with surgery, chemoradiotherapy, or multimodality therapy at a regional cancer centre (RCC) between 2009-2016 with at least 1 ESAS assessment in the 12 months following diagnosis were included. ESAS is a validated tool that measures 9 common cancer symptoms. It is used to capture patient-reported symptoms at every RCC visit. The outcome was severe (score greater than 7) ESAS scores in the 12 months following diagnosis. Modified Poisson regression analyses were used to identify predictors of severe symptom scores.

Results: Among 1,751 patients identified in the study, a median of 7 (IQR 4-12) ESAS assessments were available per patient. This population included 250 patients treated with surgery alone, 632 with chemoradiotherapy alone, 208 with surgery and chemotherapy, and 661 with surgery and chemoradiotherapy. Severe scores were reported for lack of appetite (n=918, 52%), and tiredness (n=787, 45%). These symptoms were sustained for one year following diagnosis (Figure). Predictors of high ESAS scores for all symptoms included female sex, high comorbidity, lower socioeconomic status, younger age, and temporal proximity to diagnosis. Transient worsening of fatigue, nausea and lack of appetite were seen, corresponding with the time of neoadjuvant chemoradiotherapy. The proportion of patients with severe anxiety showed the greatest decline over time.

Conclusions: This study demonstrates a high symptom burden for EC patients undergoing surgery and multimodal therapy. In the year following diagnosis, symptom burden remained high. Given the nutritional challenges EC patients face, focused intervention to improve appetite may significantly enhance quality of life for patients undergoing curative intent therapy.



Video-Assisted Thoracoscopic Pneumonectomy to Treat Complications of Unilateral Congenital Pulmonary Venous Stenosis in an Adult

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Purpose: The case presented is an extremely rare case of congenital pulmonary venous stenosis manifesting with intractible pleural effusions in an adult patient. The significance of the case is the unusual nature of it as well as the minimally invasive approache to the surgical treatment of the problem.

Methods: The surgical approach as illustrated is that of a video-assisted right pneumonectomy.

Results: Minimally invasive lung resections can be considered regardless of the complexity of the disease.

Conclusions: N/A

En-Bloc Thymectomy With Aortic Arch Reconstruction Under Circulatory Arrest for Invasive Malignant Thymoma

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Purpose: 57 years old female with a mediastinal mass invading the aortic arch, main PA and LUL of the lung and biopsy consistent with Thymoma. After initial no response to chemotherapy was deemed inoperable. Transferred to our center, alternative agents were indicated and En-bloc thymectomy with aortic reconstruction was performed.

Methods: Case presentation and Surgical Video of En-bloc Thymectomy with Aortic reconstruction under deep circulatory arrest, left PA artery reconstruction and left upper lobe lobectomy.

Results: Patient received adjuvant radiotherapy. Close follow up determined left pleural implants outside the radiation field 4 years after surgery, she underwent left pleurectomy and additional radiation, after 5 years patient was deemed cancer free.

Conclusions: Thymoma invading vital structures like the aorta is considered inoperable, on selected patients chemotherapy, En-Bloc resection and adjuvant therapy could represent a viable option in specialized high volume centers.

Traumatic Pneumonectomy and Management of Severely Contaminated Pleural Space

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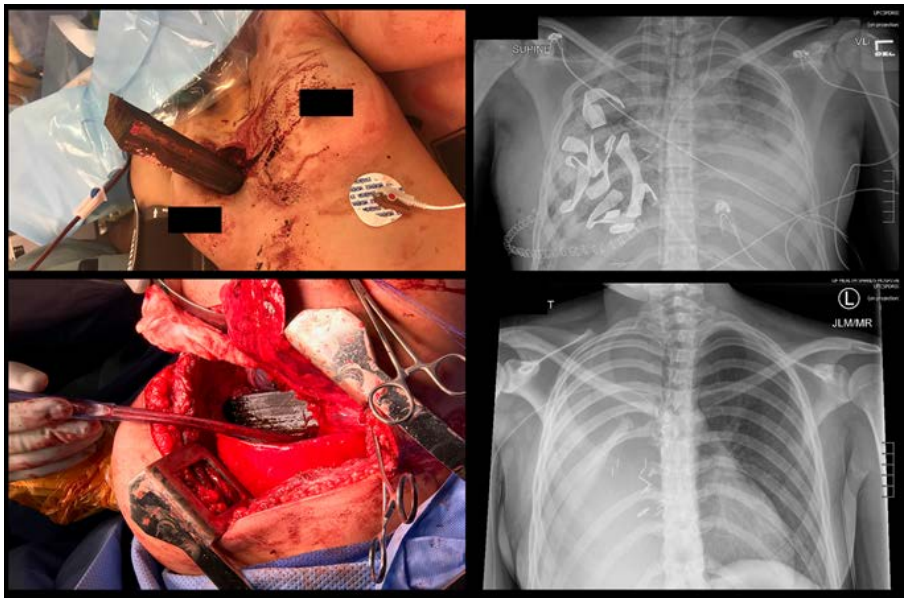
Purpose: Traumatic pneumonectomy is a rare event that carries high morbidity and mortality. The optimal management for post-traumatic pneumonectomy is not well delineated, particularly in the setting of a severely contaminated pleural space.

Methods: Patient with penetrating chest trauma after a motor vehicle crash with thoracic impalement with a wooden fence post with right parasternal entry and right paraspinal exit. She underwent an emergent right pneumonectomy, tracheoplasty secondary to traumatic injury to the take off of the right main stem bronchus, and placed on veno-venous extracorporeal membrane oxygenation (V-V ECMO) for post-operative support given her contralateral pulmonary contusions, large volume resuscitation, and to protect the complex tracheal reconstruction. Patient underwent six washouts and debridements with placement of sponges soaked in iodine-povidone : warm saline 1:10 ratio for management of contaminated pleural space.

Results: Impalement by a wooden fence post resulted in an emergent pneumonectomy and required complex tracheoplasty secondary to traumatic injury to the takeoff of the right main stem bronchus. Post-operatively the patient was placed on V-V ECMO due to hypoxia secondary to contralateral lung with severe pulmonary contusions and large volume resuscitation, as well as for protection of the complex tracheal reconstruction. With V-V ECMO support, the patient was extubated on post injury day three, was able to ambulate daily in the intensive care unit, and ultimately was decannulated twenty-five days after her injury. For the management of her severely contaminated pleural space, the patient required six washouts and debridements with iodine-povidone soaked gauze packs, broad spectrum antibiotic coverage including fungal coverage, and final closing of her chest was accomplished on post injury day twenty. She was discharged post injury day sixty-three and is doing well as an outpatient.

Conclusions: Traumatic pneumonectomy is a rare event with potential for high morbidity and mortality. Use of veno-venous ECMO support and serial washouts with iodine soaked gauze for a contaminated pleural space after traumatic pneumonectomy is an effective treatment strategy. This complex case highlights the importance for highly-specialized advanced multidisciplinary care.



Quality Posters

Do Regional Consortia Improve Quality in Cardiac Surgery? 30-Year Experience of the Northern New England Cardiovascular Disease Study Group

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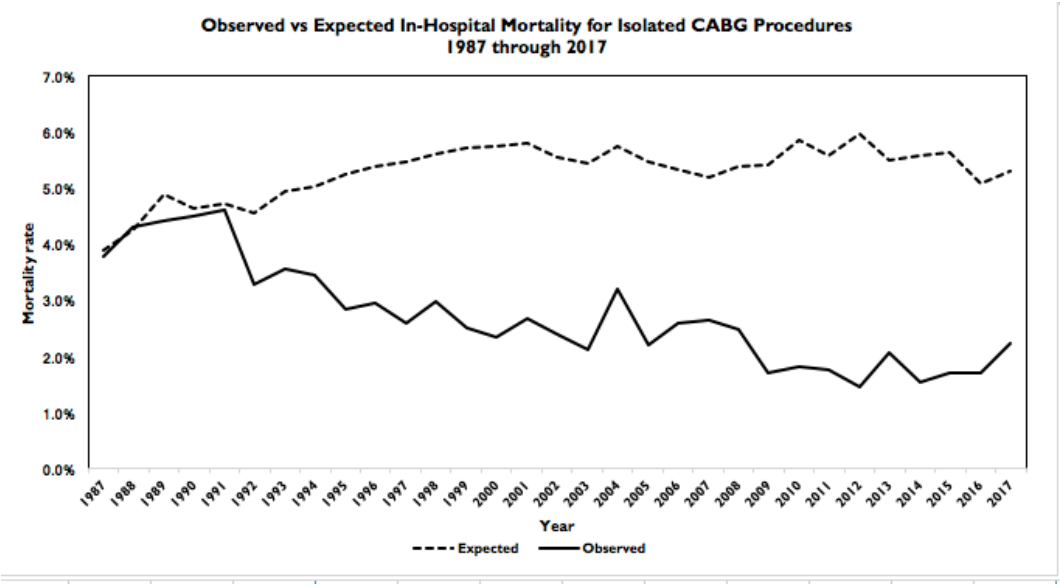
Purpose: The Northern New England Cardiovascular Disease Study Group (NNECDSG) was founded in 1987 as a regional voluntary consortium to improve cardiovascular quality in Maine, New Hampshire and Vermont. We sought to assess the impact of the NNECDSG on the quality and cost of coronary artery bypass grafting (CABG) over time.

Methods: Data from all patients undergoing isolated CABG at five medical centers participating in the NNECDSG from 1987 - 2017 were retrospectively reviewed (n=67,942). Patients were divided into three cohorts based on decade of surgery for the analysis of in-hospital observed : expected mortality and length of stay. Additional variables were added in 2000 allowing comparison of peri-operative morbidity and rate of red blood cell (RBC) transfusion. During the study period, all hospitals in the NNECDSG participated in quarterly in-person meetings focused on quality improvement and all surgeons received their individual risk-adjusted outcomes.

Results: During the study period, there was a significant decline in median length of stay ($p < 0.001$) from 7 days in the first decade to 5 days in the most recent time period, representing a potential cost savings of $4,000 per patient ($p < 0.001$). Observed : expected in-hospital mortality rates demonstrated significant decline over time (Figure) ($p < 0.001$). Among 7 post-operative complications, 5 complications showed significant reductions over time (Table). Specifically, return to the operating room for bleeding, renal failure, in-hospital mediastinitis, prolonged intubation, and low output heart failure. Stroke and pneumonia did not demonstrate a significant decline. Use of RBC transfusions decreased significantly from a mean of 1.5 units per patient to a mean of 0.6 units per patient ($p < 0.001$) representing a potential cost-savings of $108 per patient.

Conclusions: Because of collaborative quality improvement initiatives, the NNECDSG has succeeded in significant, sustained improvements in quality and cost for CABG over the past 30 years. These data support the utility of regional consortia in improving quality in cardiac surgery.



In-hospital Complications:	2000-2005 % (n)	2006-2011 % (n)	2012-2017 % (n)	% Overall change 2000-2017 (p-value)
Number of patients	22,008	15,067	15,509	
Stroke	1.5 (330)	1.6 (241)	1.3 (202)	-0.14 (p=0.28)
Return to O.R. for bleeding	2.6 (572)	2.0 (301)	1.7 (264)	-0.85 (p<0.001)
Renal failure/insufficiency	4.5 (990)	4.4 (663)	2.8 (434)	-1.68 (p<0.001)
Mediastinitis or sternal dehiscence*	0.7 (154)	0.6 (90)	0.4 (62)	-0.33 (p=0.01)
Pneumonia	2.2 (484)	2.4 (362)	2.1 (326)	-0.12 (p=0.44)
Prolonged intubation (>24 hrs) and/or reintubation	9.3 (2047)	11.1 (1672)	8.9 (1380)	-0.41 (p<0.001)
Low output failure**	5.7 (1254)	5.9 (889)	4.7 (729)	-1.05 (p=0.001)

*Renal failure or insufficiency= A new peritoneal or hemo-dialysis that occurred after the procedure or an increase in serum creatinine to ≥2.0 and two times most recent pre-operative creatinine level. **Low output failure = intra- or postop IABP or return to CPB or ≥2 inotropes at 48 hrs.

Value in the Quality Collaborative: Lung Cancer Resection Spending by Hospital STS General Thoracic Surgery Database Participation

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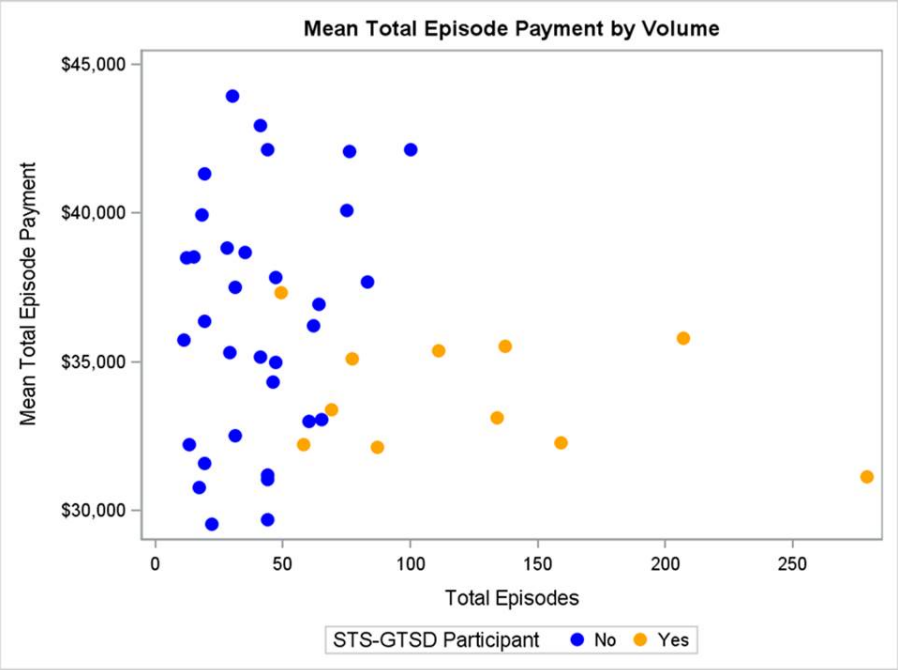
Purpose: The Society of Thoracic Surgeons-General Thoracic Surgery Database (STS-GTSD) facilitates evaluation of thoracic surgery quality and outcomes on an ongoing basis. We sought to determine if STS-GTSD participation within the context of a statewide collaborative was associated with differences in outcomes or episode spending for lung-cancer resection.

Methods: Medicare fee-for-service and Blue Cross/Blue Shield preferred-provider-organization beneficiaries were compared with regard to lung cancer resection 90-day episode payments among STS-GTSD and non-STS-GTSD participating hospitals between 2012 and 2017 within one state. Eleven hospitals participating in a statewide cardiothoracic-surgery quality collaborative with 1367patients were compared with 1393patients from 33non-participating hospitals with at least 10 lung-cancer resections over the study period. Payments were price-standardized and risk-adjusted to account for differences in prices and case-mix between hospitals. We also compared unadjusted differences in the distribution of index admission diagnosis-related group(DRG) codes, hospital length-of-stay, and 90-day readmission rates between participating and non-participating hospitals.

Results: Total 90-day episode payments were lower for STS-GTSD participating hospitals, averaging $33,045 vs. $37,500 for non-participating hospitals (p<0.001). Average component spending was lower for the index hospitalization ($19,582 vs. $21,394,p<0.001), post-acute care ($4663 vs. $6116,p<0.001), and readmissions ($2640 vs. $3790,p=0.019) at participating hospitals vs. non-STS-GTSD participating hospitals, respectively, although professional fees were not significantly different ($6200 vs. $6160,p=0.84). The distribution of index admission DRG codes was different between the groups with regard to procedures with major complications and comorbidities for STS-GTSD participating vs. non-participating hospitals(10.7% vs. 24.7%), but not all complications and comorbidities (both 50%). There were also differences in unadjusted length of stay (7.3 vs. 8.7 days,p<0.001) and readmission rate (15.4% vs. 19.7%,p<0.001). Individual hospital average payments by lung-cancer-resection volume are shown in figure 1 for STS-GTSD participating and non-participating hospitals.

Conclusions: In assessing episodic payments for lung-cancer resection, we found that STS-GTSD-participant hospitals had lower episode spending. Participating hospitals also had shorter hospitalizations, lower major-complication rates, and fewer readmissions. Consideration of both quality and cost in a data-driven, collaborative approach may have a positive effect on the value of surgical care.



Outcomes of Nonelective Coronary Artery Bypass Grafting Performed on Weekends

J. P. Beller[1]*, W. Z. Chancellor*[1]*, J. H. Mehaffey*[1]*, R. B. Hawkins*[1]*, E. D. Krebs*[1]*, A. M. Speir*[2]*, L. T. Yarboro*[1]*, G. Ailawadi*[1]*, N. R. Teman*[3]

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Purpose: Increased mortality has previously been reported in patients with acute myocardial infarction (AMI) and those needing emergency general surgery over the weekend. The purpose of this study was to determine if a similar phenomenon exists in coronary artery bypass grafting (CABG) in order to target quality improvement initiatives.

Methods: All patients undergoing isolated, non-elective CABG (2011-2017) with Society of Thoracic Surgeons (STS) predicted risk scores from a regional STS database were included. Patients were stratified by day of operation: weekend vs. weekday. Outcomes including degree of revascularization, quality metrics, resource utilization, major morbidities, and operative mortality were assessed. Hierarchical regression modeling, controlling for center, preoperative risk and time to operation, was used to assess risk-adjusted effect on mortality and major morbidity.

Results: Of 16,158 patients, 3% (458) underwent CABG over the weekend. Compared to weekday CABG patients, weekend patients had lower ejection fractions (50% vs. 55%, p<0.01) and a higher frequency of AMI (79% vs. 66%, p<0.01). Weekend operations were more often emergent (35% vs. 5%, p<0.01) with shorter median time from admission to surgery (1 vs. 3 days, p<0.01). Importantly, there were similar rates of complete revascularization (84% vs. 86%, p>0.05) and equivalent cardiopulmonary bypass times (92 vs. 93 minutes, p>0.05). Postoperatively, patients remained ventilated (8.7 vs. 5.9 hours, p<0.01) and in the intensive care unit longer (2.2 vs. 2.0 days, p<0.01). Mortality was lower than expected in all (weekday O/E: 0.85; weekend O/E: 0.80) with no increased mortality in weekend operations after risk-adjustment (Table 1). However, after risk-adjustment there remained higher odds of complications including prolonged ventilation (OR 1.37, p=0.03), renal failure (1.98, p=0.01), and reoperation (2.10, p <0.01).

Conclusions: Patients requiring operation on weekends are higher risk. Contrary to outcomes following AMI, the increased mortality risk is mitigated following CABG. Nevertheless, a “weekend effect” after CABG is evident with independent risk of post-operative adverse events. Focused quality improvement efforts should emphasize strategies to reduce post-operative complications.

	Risk-Adjusted Odds Ratio	95% Confidence Interval	p-value
Operative Mortality[1]	1.37	0.81 - 2.31	0.24
Major Morbidity[2]	1.29	0.99 - 1.68	0.06
Surgical Reoperation[3]	**2.10**	**1.32 - 3.25**	**<0.01**
Renal Failure[3]	**1.98**	**1.20 - 3.26**	**0.01**
Prolonged Ventilation (>24H)[3]	**1.37**	**1.03 - 1.81**	**0.03**
Permanent Stroke[3]	0.45	0.14 - 1.42	0.17

Table 1: Risk adjusted Mortality and Major Morbidity for Weekend Surgery

1. Risk-adjusted using STS Predicted Risk of Mortality
2. Risk-adjusted using STS Predicted Risk of composite Major Morbidity or Mortality
3. Risk-adjusted using STS Predicted risk of specified morbidity

One-Year Patient-Reported Outcomes Are Adversely Affected by Postoperative Complications

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Purpose: Currently reported outcomes after cardiac surgery focus on a patient's status at 30 days and lack long-term meaningful data. The purpose of this study was to determine the impact of complications after cardiac surgery on patient-reported outcomes (PRO) at one-year after surgery.

Methods: All patients undergoing cardiac surgery at an academic institution (2014-2015) were contacted one year after surgery to obtain vital status and PRO using the validated Patient-Reported Outcomes Measurement Information System (NIH-PROMIS). NIH-PROMIS is a validated tool provided by the National Institute of Health with a standardized scale 0-100 and a population mean of 50±10. These records were merged with Society of Thoracic Surgeons (STS) data and multivariate linear regression was used to evaluate the risk-adjusted effects of complications after cardiac surgery on one-year PRO.

Results: A total of 782 eligible patients underwent cardiac surgery with PRO data available for 91% of living patients (648/716). Mean PROMIS scores were: global physical health (GPH)=48.8±10.2, global mental health (GMH)=51.3±9.5, and physical functioning (PF)=45.5±10.2. Occurrence of a STS major morbidity (prolonged ventilation, renal failure, reoperation, stroke, deep sternal wound infection) significantly reduced one-year PRO (GPH 45.4±8.9, p<0.001; GMH 48.6±9.5, p=0.01; PF 40.9±10.2, p<0.001). After risk adjustment, incidence of a STS major morbidity, prolonged ventilation or renal failure had a significant adverse effect on one or more PRO domains (**Table**). Despite a relatively high incidence, postoperative atrial fibrillation did not have a risk-adjusted association with and PRO domains examined.

Conclusions: Complications after cardiac surgery continue to negatively influence patient quality of life one-year after surgery. Using the NIH-PROMIS, prolonged ventilation and renal failure have the largest impact on one-year patient reported outcomes. Finally, one-year patient reported outcomes are meaningful metrics that better define quality in healthcare.

Abstract Table: Risk-Adjusted Effect of Complications on 1- Year Patient Reported Outcomes

Variable	Parameter Estimate	95% Confidence Interval		p-value
Global Mental Health				
Postoperative Atrial Fibrillation	0.97	0.05	1.89	0.292
Prolonged Ventilation	-2.48	-3.94	-1.02	**0.009**
Reoperation	1.57	-0.40	3.54	0.426
Stroke	-0.30	-3.00	2.40	0.912
Renal Failure	-5.10	-7.76	-2.43	**0.006**
Any Major Morbidity	-1.20	-2.31	-0.08	**0.028**
Global Physical Health				
Postoperative Atrial Fibrillation	0.79	-0.15	1.73	0.402
Prolonged Ventilation	-3.82	-5.32	-2.33	**0.011**
Reoperation	2.63	0.61	4.65	0.194
Stroke	1.12	-1.65	3.89	0.687
Renal Failure	4.28	1.55	7.01	0.118
Any Major Morbidity	-1.28	-2.43	-0.13	0.266
Physical Function				
Postoperative Atrial Fibrillation	0.34	-0.56	1.25	0.705
Prolonged Ventilation	-2.35	-3.79	-0.91	0.103
Reoperation	0.84	-1.10	2.78	0.664
Stroke	-4.19	-6.85	-1.53	0.116
Renal Failure	2.00	-0.63	4.62	0.447
Any Major Morbidity	-2.19	-3.29	-1.09	**0.047**

Postoperative Management of Endocarditis: Cost-Effective Strategies for the Opioid Crisis

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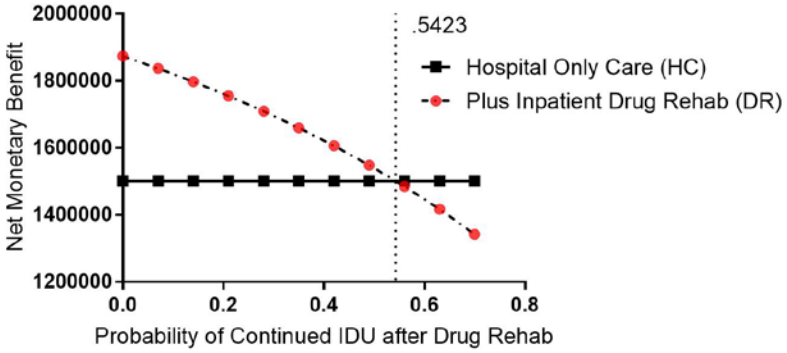
Purpose: With the opioid crisis showing no sign of abating, strategies are needed to facilitate postoperative care for injection drug use (IDU)-related endocarditis. The current standard—6 weeks of intravenous antibiotics—yields frequent reinfection and IDU relapse. Consequently, we examined the cost-effectiveness of inpatient rehabilitation postoperatively to optimize outcomes and costs.

Methods: Two postoperative strategies were assessed: hospital care only (HC) versus HC plus inpatient drug rehabilitation (DR). Monte-Carlo simulation evaluated effectiveness in life-years and average cost/patient calculated over a 20-year time horizon. Willingness-to-pay was set at $100K/life-year. To determine probabilities of continued postoperative IDU, recurrent infection, and mortality, best-available evidence was obtained and combined with institutional data from IDU patients. At baseline, probability of postoperative IDU was set to 35% after DR vs 60% after HC. The probability of re-infection was set to 15.3%/year in IDU vs 0.3%/year in non-IDU.

Results: Addition of inpatient drug rehabilitation to standard hospital care is the most favorable strategy, with an average per-patient cost savings of $8,922 and 1.57 life-years gained over 20 years. The cohort with DR had 50% fewer reoperations. Sensitivity analysis demonstrates DR remains cost-effective if the probability of post-operative IDU can be reduced by at least 7% (from 60% to 53%; Figure). If DR were to reduce IDU by 30% (from 60% to 30%) per-patient cost savings approach $17,600 with 1.84 life-years gained. If the probability of reinfection were 3%, then DR would become more expensive, ($135,876/pt vs $111,955/pt), but still cost-effective, with an incremental cost of $39,000/life-year. Above 12% probability of reinfection, DR is both cost-saving and more effective.

Conclusions: Addition of postoperative inpatient drug rehabilitation for IDU-related endocarditis appears cost-effective, even if only a modest reduction in IDU is achieved. Collaboration between hospitals and payors to finance pilot programs that provide postoperative addiction treatment and intravenous antibiotics after cardiac surgery could dramatically improve endocarditis care.

Cost Effectiveness of Postoperative Inpatient Drug Rehabilitation



Improving Operating Room Turnover Time in a New York City Academic Hospital via Lean Methodology

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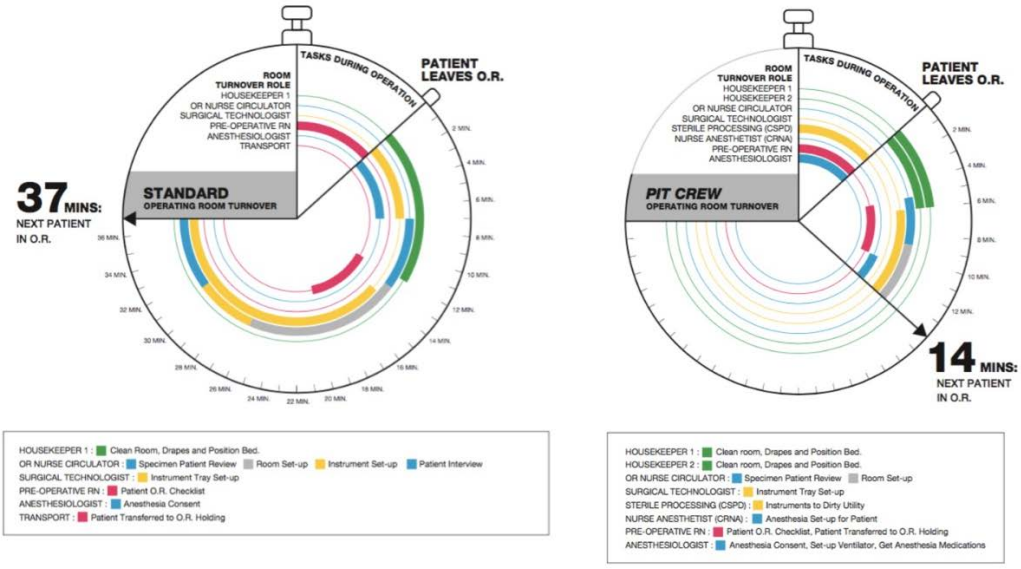
NYU Langone Health, New York

Purpose: Prolonged operating room turnover time erodes patient and employee satisfaction and value.

Methods: Lean and value stream mapping was applied to three operating room teams at an academic health center in New York City and a solution called Performance Improvement Team (PIT Crew) was piloted.

Results: Overall, 10% of non-valued operating room turnover steps were eliminated, and 25% of previously sequential steps were performed synchronously. Seven institutional dogmas were eliminated and three hospital policies were changed. After 35 pilot turnovers, median operating room turnover time improved from 37 minutes (range 26-167) in historical matched controls to 14 minutes (range 10-45, $p<0.0001$) for the PIT Crew. Cost of the PIT Crew was $1298 daily and estimated return on investment was $19,500 per day.

Conclusions: Lean and value stream mapping identifies non-valued steps in operating room turnover and affords opportunities for efficiency. Once institutional rules and dogma are changed, culture and workflow improve and turnover time can significantly improve. This process adds cost but is profitable. Scalability and sustainability is under further study.



Predictors of Increased Costs Following Index Adult Cardiac Operations: Insights From a Statewide Publicly Reported Registry

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Purpose: The Pennsylvania Health Care Cost Containment Council (PHC4) state-mandated registry provides publically reported data on hospital-level outcomes. The aim of this study was to identify predictors of increased costs following index adult cardiac operations.

Methods: The PHC4 database was queried for isolated coronary artery bypass grafting (CABG), isolated valve, or CABG plus valve surgery performed between 2014 and 2016. Average charges during the index hospitalization were provided by the database and used to estimate costs using charge-to-cost ratios for each individual hospital. These ratios were developed using hospital's cost reporting from Medicare claims data for routine and ancillary services. Observed and expected operative mortality and 30-day readmission were evaluated using multivariable risk models developed by PHC4. Multivariable linear regression analysis was utilized to evaluate the risk-adjusted impact of multiple hospital-level characteristics on costs.

Results: During the study period, 29,578 patients underwent isolated CABG (n=16,641), isolated valve surgery (n=8,618), or CABG plus valve surgery (n=4,319) at 60 hospitals. The predicted risk of mortality was 1.5%, 1.7%, and 4.3% for isolated CABG, isolated valve, and CABG plus valve surgery, respectively. The predicted risk of 30-day readmission was 10.2%, 13.2%, and 14.3% for the same operative categories. The median cost of isolated CABG was $61,573 (interquartile range [IQR] $50,780 to $77,482). The median cost of isolated valve surgery was $68,835 (IQR $56,039 to $89,465) and CABG plus valve surgery $83,574 (IQR $69,806 to $114,407). In multivariable analysis, hospital-level predictors of increasing costs in isolated CABG included higher predicted mortality rates, higher observed-to-expected (OE) mortality ratios, and non-teaching status (**Table**). No hospital-level independent predictors of increased costs were identified for isolated valve or CABG plus valve surgery.

Conclusions: Hospitals that performed higher risk cases and had higher OE ratios for operative mortality in isolated CABG were found to have increased costs. These data collectively emphasize the importance of programmatic risk assessment and outcome optimization in isolated CABG not only from a clinical standpoint but also economic.

Multivariable Linear Regression Model for Increased Costs in Isolated CABG

Covariates	Coefficient (95% Confidence Interval)	p-value
Hospital Volume of Isolated CABGs	-17 (-81 to 48)	0.60
Actual Mortality Rate	-37753 (-83819 to 8312)	0.11
Predicted Mortality Rate	62645 (12349 to 112942)	0.02
Observed to Expected Mortality	65264 (712 to 129816)	0.04
Actual Readmission Rate	13340 (-8188 to 34868)	0.22
Predicted Readmission Rate	-16229 (-40868 to 8410)	0.19
Observed to Expected Readmission	-119918 (-336423 to 96587)	0.27
Number of Hospital Beds	-25 (-74 to 24)	0.31
Non-Teaching Status	28885 (7384 to 60463)	0.01

** a positive coefficient denotes a positive relationship whereas a negative coefficient denotes an inverse relationship*

Index vs Non-Index Readmission After Cardiac Surgery: Where Do Patients Go to Be Readmitted? Implications on Mortality, Complications, and Costs of Care

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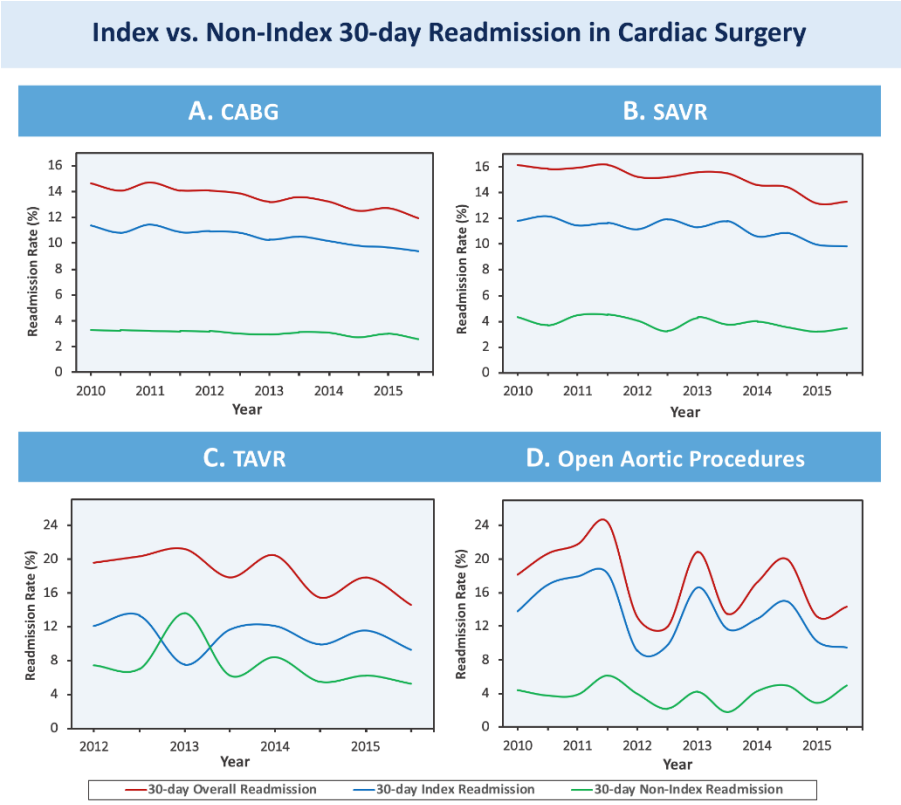
Purpose: The Center for Medicare & Medicaid Services has identified readmission as an important quality metric in assessing hospital performance and value of care. However,the frequency and implications of readmission after cardiac surgery readmission to a facility other than the one where the index surgery was performed remains unclear.

Methods: In this multicenter, population-based, nationally-representative study, we utilized weighted 2010-2015 National Readmission Database claims to identify all US adult patients who underwent CABG (*n*=964,201), SAVR (*n*=346,389), TAVR (*n*=51,092) and open aortic procedures (*n*=12,918) during their index (initial) hospitalization. We examined differences in patient characteristics, annual trends, and readmission outcomes between surviving patients readmitted to index (the same) versus non-index (different) hospitals within 30- and 90- post-discharge days. Differences in readmission predictors, mortality, major complications, LOS, total cost, and need for subsequent readmissions were assessed for all procedure using risk-adjusted survival analysis (Cox proportional-hazards) and quintile regression.

Results: Readmission at 30- and 90-days was 13.5% and 20.7% for CABG, 15.4% and 22.1% for SAVR, 17.4% and 27.6% for TAVR, and 17.5% and 25.3% for open aortic procedures, respectively. Of these, non-index readmissions accounted for 22.7%, 25.6, 36.7%, and 22.7% at 30-days, and 25.5%, 28.8%, 42.1% and 25.1% at 90-days. Overall trends in index vs non-index readmissions by procedure type at 30-day are illustrated in the **Figure**. Older, Medicare patients with more comorbidities (Charlson Comorbidity Index) and higher incomes living in suburban areas accounted for the majority of non-index readmissions within 90-days for all procedure types. Despite all this, for all procedure types, rates of all-cause mortality, major complications, readmission LOS, total hospital costs following readmission at index hospitals were higher compared with non-index hospitals. Similarly, rates of subsequent readmission following initial readmission to index hospitals was also considerably higher compared with non-index readmissions.

Conclusions: Non-index readmissions account for a considerable proportion of short-term readmissions after cardiac surgery, and is highest for TAVR. While the socioeconomic predilection of index readmission may drive risk to a greater extent than the medical risk factors, index readmission was associated with worse outcomes across procedure types.



What Influences Patient Satisfaction After Cardiac Surgery? A Prospective Analysis of Predictors of Patient Hospital Experience

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Purpose: Despite increased emphasis on improving patients' subjective hospital experience, limited data exist on identifying what influences patient satisfaction. Our goal was to prospectively examine predictors of patient satisfaction following cardiac surgery as measured through the standardized Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey.

Methods: We prospectively enrolled patients undergoing elective cardiac surgery from January 2016-October 2017 (n=100). After informed consent, patients completed a standardized preoperative survey covering health status, demographics and physician satisfaction, and then subsequently completed the HCAHPS survey at their 30-day postoperative visit. Survey data were linked to clinical outcomes including post-operative complications and length of stay. The primary outcome measure was the frequency of a "top-box" global rating of hospital experience (i.e. "9" or "10") as defined by the Centers for Medicaid and Medicare Services Value-Based Purchasing program. Ordinal logistic regression was used to evaluate predictors of patient hospital experience scores.

Results: Among those enrolled, 99 patients formed the study cohort (1 death before 30 days) and the survey response rate was 100% in this group. The overall frequency of post-operative complications was 33.3% (n=33), the most common of which was atrial fibrillation (n=29). Univariate analysis of top-box ratings across clinical domains is shown in Table 1. Total length of stay (LOS) was the only domain associated with a greater frequency of top-box ratings (test for trend p=0.038). Among patients with a LOS < 5 days, 90.2% (n=61) provided top-box ratings whereas among those with a LOS > 8 days, 69.2% (n=31) provided top-box ratings. In multivariable ordinal regression (Figure), LOS > 8 days (OR 0.14, CI: 0.03-0.61) and post-operative decline in mental health (OR 0.25, CI: 0.07-0.92) were associated with worse global hospital experience scores whereas the occurrence of a postoperative complication was associated with higher scores (OR 4.85, CI: 1.55-15.18).

Conclusions: Patient hospital experience was adversely affected by length of stay and self-reported decline in mental health. Complications improved hospital experience scores while surgeon satisfaction and perceived change in overall health had no effect. Current application of patient experience as a measure of the quality of surgical care requires further examination.

Figure 1. Multivariable ordinal logistic regression of potential predictors of patients' global hospital experience rating

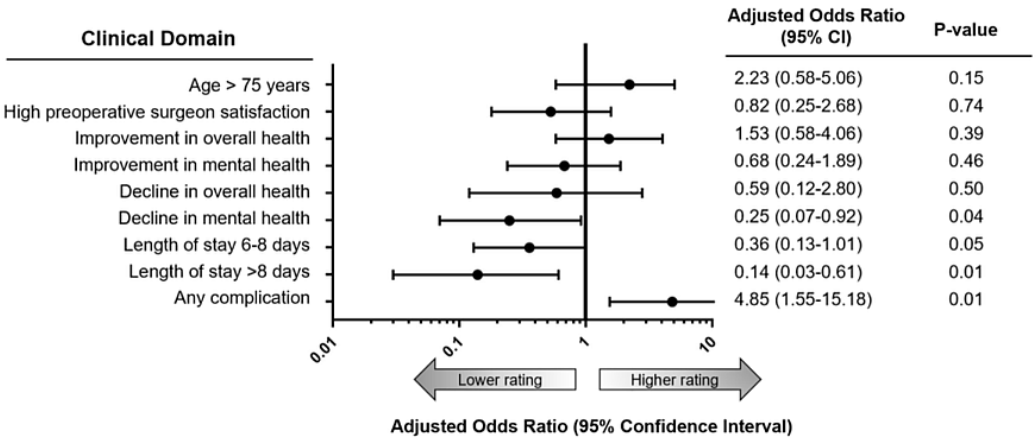

Table 1. Frequency of "top-box" response to global hospital rating for potential predictors of patient experience

Potential Predictors of Patient Experience	n (N = 99)	Global Hospital Stay Top-Box Rating[1]	p value[2]
Preoperative Surgeon Satisfaction Rating			0.538
Bottom Tercile	43	83.7%	
Middle Tercile	37	89.2%	
Top Tercile	18	77.8%	
Clinical Course			
Post-operative complication			0.533
None	66	83.1%	
Any	33	87.9%	
Overall length of stay, days			0.038
<=5	61	90.2%	
6-8	24	79.2%	
8+	31	69.2%	
ICU length of stay, hours			0.051
<48	76	88.2%	
48-72	10	80.0%	
72+	12	66.7%	
Specific Complications			
Atrial fibrillation			0.134
No	70	81.2%	
Yes	29	93.1%	
Prolonged intubation >24hr			0.765
No	94	84.9%	
Yes	5	80.0%	
30-Day readmission			0.582
No	95	85.1%	
Yes	4	75.0%	
Reoperation			0.169
No	97	85.4%	
Yes	2	50.0%	
Preoperative Characteristics			
Age, years			0.120
<65	37	86.5%	
65-75	38	76.3%	
>75	23	95.7%	
Number of prior surgeries			0.496
<3	60	81.6%	
>=3	39	86.7%	
Education			0.876
No College	42	84.2%	
Any College	57	85.4%	
Baseline overall health			0.294
Very good / Excellent	35	85.7%	
Good	27	92.3%	
Fair / Poor	36	77.8%	
Baseline mental health			0.139
Very good / Excellent	62	88.7%	
Good	23	78.3%	
Fair / Poor	12	75.0%	

1. Top-Box" response indicates the most positive response category ie. "9" or "10" for Global Hospital Rating
2. Statistical tests: (a) chi-squared test (b) nonparametric test of trend (c) one-way analysis of variance