

## Curriculum Vitae

### Frederic Tremaine Billings, IV (Josh)

Vanderbilt University Medical Center  
Department of Anesthesiology  
Division of Critical Care  
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Date of Birth: 3-20-1976

### Brief Biography

Dr. Billings is a professor of anesthesiology and medicine in the division of anesthesiology critical care medicine in the Department of Anesthesiology at Vanderbilt University Medical Center. He is a physician-scientist who cares for critically ill cardiothoracic surgery patients during surgery as anesthesiologist, postoperatively in the intensive care unit (ICU) as intensivist, and in the conduct of his research. His research program focuses on mechanisms of surgery-induced organ injury, specifically the impact of perioperative oxygenation, oxidative damage, and vascular dysfunction on kidney, brain, and heart injury, and developing and testing new therapy for perioperative organ injury in patients having major surgery. He is Director of the B.H. Robbins Scholars Program, the Department's physician-scientist development program.

### EDUCATION and TRAINING

- |             |   |
|-------------|---|
| 1994 – 1998 | Washington and Lee University, Lexington, VA<br>Bachelor of Science, Chemistry; Honor's Thesis: <i>Mathematical Predictions of Bacterial Colonization</i> .<br>Degree awarded 6/1998  |
| 1998 – 2002 | Louisiana State University School of Medicine, Shreveport, LA<br>Medical Doctorate<br>Degree awarded 6/2002   |
| 2002 – 2006 | Vanderbilt University Medical Center, Nashville, TN<br>Intern and Resident of Anesthesiology<br>Training completed 6/2006   |
| 2006 – 2008 | Columbia University College of Physicians and Surgeons, New York, NY<br>Clinical Fellowships in Cardiothoracic Anesthesiology and Critical Care Medicine<br>Training completed 7/2008 |
| 2008 – 2010 | Vanderbilt University Medical Center, Nashville, TN<br>Masters of Science in Clinical Investigation<br>Degree awarded 5/2010  |

### LICENSURE and CERTIFICATION

- |            |  |
|------------|--|
| 06/14/2005 | Tennessee state medical license #: 40140 |
|------------|--|

06/13/2006	New York state medical license #: 240841
04/20/2007	Certified Diplomate, American Board of Anesthesiology
02/12/2008	Certified Diplomate, National Board of Echocardiography
09/13/2008	Certified Diplomate, Critical Care Medicine, American Board of Anesthesiology

## **ACADEMIC APPOINTMENTS**

08/2008 – 12/2016	Assistant Professor, Department of Anesthesiology, Physician-Scientist Tenure Track, Vanderbilt University School of Medicine, Nashville, TN
07/2015 – 12/2016	Assistant Professor, Department of Medicine, Physician-Scientist Tenure Track, Vanderbilt University School of Medicine, Nashville, TN
01/2017 – 08/2023	Associate Professor with Tenure, Department of Anesthesiology, Physician-Scientist Track, Vanderbilt University School of Medicine, Nashville, TN
01/2017 – 08/2023	Associate Professor with Tenure, Department of Medicine, Physician-Scientist Track, Vanderbilt University School of Medicine, Nashville, TN
09/2023 – present	Professor with Tenure, Department of Anesthesiology, Physician-Scientist Track, Vanderbilt University School of Medicine, Nashville, TN
09/2023 – present	Professor with Tenure, Department of Medicine, Physician-Scientist Track, Vanderbilt University School of Medicine, Nashville, TN

## **HOSPITAL APPOINTMENTS**

07/2002 – 07/2006	Resident of Anesthesiology, Vanderbilt University Medical Center, Nashville, TN
08/2006 – 07/2007	Clinical Fellow in Cardiothoracic Anesthesiology, Department of Anesthesiology, New York Presbyterian Hospital, NY
08/2007 – 07/2008	Clinical Fellow in Critical Care Medicine, Department of Anesthesiology, New York Presbyterian Hospital, NY
08/2008 - present	Staff Physician, Vanderbilt University Medical Center, Nashville, TN

## **PROFESSIONAL ORGANIZATIONS**

2002 – present	American Society of Anesthesiologists
2006 – present	Society of Critical Care Medicine
2007 – present	Society of Critical Care Anesthesiologists
2007 – present	International Anesthesiology Research Society
2007 – present	Society of Cardiovascular Anesthesiologists
2012 – 2015	Southern Acute Kidney Injury Network (SAKInet)
2014 – present	Shock Society
2015 – present	Association of University Anesthesiologists
2020 – present	FAER Academy of Research Mentors in Anesthesiology (ARMA)
2022 – present	Outcomes Research Consortium

## **PROFESSIONAL ACTIVITIES**

### **INTRAMURAL SERVICE**

2003 – 2006	Vanderbilt Department of Anesthesiology Education Committee, Member
2004 – 2005	Resident Council, Class Representative
2004 – 2006	Critical Care Curriculum Redesign Project, Resident Member
2004 – 2006	Vanderbilt's Anesthesiology Resident Manual, Editor
2006 – 2006	Vanderbilt's Resident Critical Care Curriculum Guide, Editor
2009 – 2009	Anesthesia Research Strategic Planning Committee, Member
2009 – 2010	Masters of Science in Clinical Investigation, Class Representative
2009 – present	Electronic Transesophageal Echocardiography (TEE) Report (Initiator, Designer, and Developer)
2009 – 2013	Anesthesiology Mock Oral Boards, Examiner
2010 – 2013	Vanderbilt Postdoctoral Association Research & Shared Resources Symposium, Judge
2011 – present	Vanderbilt Anesthesiology Clinical Research Advisory Committee (VACRAC), Member
2012 – 2012	30 <sup>th</sup> Annual Physician-Scientist Research Forum, Judge
2014 – present	Clinical Research Center (CRC) Resources Advisory Panel, Member
2014 – present	Division of Anesthesiology Critical Care Medicine Research Conference, Director
2014 – 2018	BH Robbins Scholars Physician-Scientist Development Program, Co-Director
2014 – present	Anesthesiology Research Executive Committee (AREC), Member
2015 – present	T-32 Physician Scientist Training Grant, Preceptor and Mentor
2017 – present	Edge for Scholars NIH Mock Study Section (review NIH grants three times annually), Member
2018 – present	BH Robbins Scholars Physician-Scientist Development Program, Director
2018 – present	T-32 Oversight and Selection Committee, Member
2018 – present	Vanderbilt Genetics Institute
2020 – 2020	ICU ventilator training for non-intensivist physicians, COVID-19 response
2021 – 2023	Vanderbilt University Summer Research Program (VUSRP) Application Review Committee, Member
2021 – present	Vanderbilt Faculty Research Scholars (VFRS) Grant Review Study Section, Member
2024 – present	Vanderbilt Department of Anesthesiology Appointments and Promotions Committee (APC), member

### **EXTRAMURAL SERVICE**

10/2012 – 10/2012	Society of Critical Care Anesthesiologists, Research Abstract Reviewer and Poster Presentation Judge
10/2014 – 09/2016	American Society of Anesthesiologists Abstract Review Subcommittee on Critical Care, Member
05/2015 – 05/2019	Society of Cardiovascular Anesthesiologists Scientific Program Committee, Member
09/2015 – 09/2015	NIH, Cardiovascular Differentiation and Development (CDD) Study Section <i>ad hoc</i> reviewer, Center for Scientific Review, Bethesda, MD
10/2015 – 10/2015	American Society of Anesthesiologists, Research Abstract Reviewer and Poster Presentation Moderator

04/2016 – 05/2019	Society of Cardiovascular Anesthesiologists, Research Abstract Reviewer and Poster Presentation Moderator
08/2016 – 08/2016	NIH, Pathobiology of Kidney Disease (PBKD) Study Section <i>ad hoc</i> reviewer invitation, Center for Scientific Review, Bethesda, MD
11/2016 – 11/2016	NIH, Digestive, Kidney and Urological Systems (DKUS) Integrated Review Group Clinical R21-ZRG1 DKUS-R (55) <i>ad hoc</i> reviewer invitation, Center for Scientific Review, Bethesda, MD
02/2018 – 02/2018	NIH, Surgery, Anesthesiology, Trauma (SAT) Study Section reviewer invitation, Center for Scientific Review, Bethesda, MD
04/2020 – 04/2023	Association of University Anesthesiologists (AUA), Scientific Advisory Board, Member
05/2020 – 05/2024	Society of Cardiovascular Anesthesiologists, Acute Kidney Injury subcommittee of the Quality and Safety Leadership committee, Member
06/2020 – present	Multicenter Perioperative Outcomes Group, Cardiac Anesthesia Quality Improvement Subcommittee, Member
07/2020 – present	Association of University Anesthesiologists, International Anesthesia Research Society, Society of Critical Care Anesthesiologists abstract review panel and Poster presentation moderation
04/2021 – 04/2021	Society of Cardiovascular Anesthesiologists Multi-institutional collaborative clinical/translational research (MICoR) grant review study section, Member
06/2021 – present	Anesthesia Research Collaborative (ARC, a combined initiative of the American Society of Anesthesiologists, the Foundation for Anesthesia Education and Research, and the International Anesthesia Research Society) Working Committee on Transforming patient-centered outcomes research in anesthesiology, Member
07/2021 – present	International Anesthesia Research Society session proposal review panel
09/2021 – present	Foundation for Anesthesia Education and Research institutional academic champion
12/2021 – 9/2023	Pragmatic Critical Care Research Group Data and Safety Monitoring Board (DSMB), Member
07/2022 – 05/2024	Planning/organizing committee for 3rd FASEB AKI bench to bedside conference
08/2022 – 08/2022	NIH Scientific Review Branch, Emergency Care Clinical Trials Special Emphasis Panel ZNS1 SRB-G 50 for infrastructure funding of the Hubs for the SiREN multicenter clinical trial network
01/2024 – 01/2024	Room in the Inn service to inner city Nashville homeless, providing and serving dinner for homeless people during freezing conditions
06/2023 – present	Shock Society, Mentorship Committee, member

### **AD HOC MANUSCRIPT REVIEW**

2009 – present	<i>Hypertension</i>
2009 – present	<i>Journal of Clinical Anesthesiology</i>
2010 – present	<i>Critical Care Medicine</i>
2011 – present	<i>Journal of the American College of Cardiology</i>
2011 – present	<i>Circulation</i>
2011 – present	<i>Lancet</i>
2013 – present	<i>Kidney International</i>
2013 – present	<i>Clinical Journal of the American Society of Nephrology</i>

2013 – present	<i>Anesthesia and Analgesia</i>
2014 – present	<i>CardioRenal Medicine</i>
2014 – present	<i>Journal of the American Society of Nephrology</i>
2015 – present	<i>British Journal of Anesthesiology</i>
2016 – present	<i>British Medical Journal Open</i>
2017 – present	<i>Science Translational Medicine</i>
2018 – present	<i>Canadian Journal of Anesthesiology</i>
2018 – present	<i>Anesthesiology</i>
2019 – present	BMC Anesthesiology

## HONORS AND AWARDS

### INTRAMURAL

1997	Robert E. Lee Scholarship Recipient, providing salary support for undergraduate laboratory research
2000	Superior Performance Award, Medical Microbiology
10/2005	Resident Scholar, Foundation for Anesthesia Education and Research (FAER)
05/2007	3 <sup>rd</sup> place winner, basic sciences, 10 <sup>th</sup> Annual Academic Evening Research Symposium, Columbia University, NY, NY
05/2008	1 <sup>st</sup> place winner, basic sciences, 11 <sup>th</sup> Annual Academic Evening Research Symposium, Columbia University, NY, NY
2008 – 2011	Department of Anesthesiology Career Development Award, a 3-year internal award guaranteeing 60% non-clinical research provision,
08/2008	Merit Scholarship, Masters of Science in Clinical Investigation Program
05/2010	Best Bench, Translational, and Clinical Research; Vanderbilt University Department of Anesthesiology Annual Research Symposium; 2 <sup>nd</sup> place
2013	Charles Bernard Pittinger, M.D., Prize for Excellence in Clinical/Translational Research, Department of Anesthesiology
2015	B. E. Smith, M.D., Mentorship Award for demonstrating excellence in faculty professional development
2016	Charles Bernard Pittinger, M.D., Prize for Excellence in Clinical/Translational Research, Department of Anesthesiology
2017	Biomedical Science Impact Award, Dean's Office, Vanderbilt University Medical Center
2023	Charles Bernard Pittinger, M.D., Prize for Excellence in Clinical/Translational Research, Department of Anesthesiology
2023	Charles Bernard Pittinger, M.D., Prize for Excellence in Bioinformatics Research, Department of Anesthesiology

### EXTRAMURAL

1999	AHEC Rural Fellowship Scholarship Recipient
2009	Young Investigator Award, Society of Critical Care Anesthesiologists
2015	Best Poster Presentation for abstract, Association of University Anesthesiologists annual meeting, "Intraoperative normoxia, oxidative damage, and organ injury following cardiac surgery"

2015 Elected, Association of University Anesthesiologists  
2020 Elected, Foundation for Anesthesia Education and Research (FAER)  
Academy of Research Mentors in Anesthesiology (ARMA)

## **TEACHING ACTIVITIES**

### **MEDICAL SCHOOL COURSES**

- Critical Care Immersion, Instructor
- Critical Care Skills week central line workshop, Instructor
- Invasive hemodynamic monitoring, shock, and vasoactive drugs, Lecturer
- Airway management, Lecturer

### **GRADUATE SCHOOL COURSES**

- School of Nursing graduate course, Acute Kidney Injury, Lecturer

### **CONTINUING MEDICAL EDUCATION**

- Designed, developed, and direct the Division of Anesthesiology Critical Care Medicine's biweekly Research Conference (2014 – present). The Research Conference alternates between didactic lectures and research project design/analysis studios for divisional fellow and faculty research projects. Lecture topics I present annually include:
  - Orientation to research
  - Biostatistics I – confidence intervals, sample size calculations, univariate analyses
  - Biostatistics II – multivariable analyses, regression, mixed effects, confounders
  - Writing an abstract for a scientific meeting or medical journal
  - Peer review process
  - Investigating mechanisms of biologic processes and clinical outcomes
  - Querying the EMR for medication exposure, clinical lab data, and nursing flow sheet data for integration into research datasets
  - Decision points in clinical trial design

### **CLINICAL TEACHING**

- Department, Cardiothoracic Division, and Critical Care Division lecture series Lecturer  
Topics:
  - Radiocontrast nephropathy
  - Intraoperative prevention of post cardiac surgery morbidity
  - Non-steady state physiology
  - ICU management of post cardiac surgery patients
  - TEE of congenitally corrected transposition of the great vessels
  - Introduction to the cardiovascular intensive care unit
  - Anesthetic management of transcatheter aortic valve replacement (TAVR)
  - Acute kidney injury
  - TEE assessment of the aortic valve
  - Intra-aortic balloon pump counter-pulsation
  - ICU ventilator management
  - Observational clinical study design and statistics
  - Perfusion during and following cardiac surgery

- Clinical markers of renal function and renal hemodynamics
- Diagnosis and management of acute coronary syndrome
- How to write an abstract for a scientific meeting or medical journal
- Renal physiology and perioperative protection
- Experimental design and statistics
- Tissue oxygenation
- Pragmatic clinical trials
- Anesthesia for patients with kidney disease
- Exploring a research niche
- Strategies writing a specific aims page, grantsmanship
- Development and use of a urinary biomarker to study AKI in cardiac surgery
- How to build a data dictionary

## RESEARCH SUPERVISION

- |                |  |
|----------------|--|
| 2010 – 2014    | <p>Rajesh Ramakrishna, M.B.B.S.<br/>         My role during period: Primary mentor; Current Position: Staff Physician, Torbay Hospital, Torquay, UK<br/>         Project:<br/>             Omega-3 fatty acid supplementation, body mass index, and risk of acute kidney injury following cardiac surgery</p>  |
| 2012 – 2013    | <p>Chen Li, B.S.<br/>         My role during period: Primary mentor; Current Position: Biomedical engineering graduate school, Dartmouth University, Hanover, NH<br/>         Project:<br/>             Quantification of perioperative oxidative damage</p>   |
| 2014 – present | <p>Marcos Lopez, M.D., M.S.<br/>         My role during period: Primary mentor; Current Position: Associate Professor, Vanderbilt University Medical Center<br/>         Current project:<br/>             The effects of perioperative oxygenation on endothelial function<br/>         Recent accolades:</p> <ul style="list-style-type: none"> <li>▪ <b>R01 grant award, 2022-2027</b><br/>             Society of Critical Care Anesthesiologists Young Investigator Award, 3/18/2022</li> <li>▪ American Society of Clinical Investigation (ASCI) Young Physician Scientist Award, 3/23/2021</li> <li>▪ <b>K23 career development award, 2018-2023</b></li> <li>▪ Charles Bernard Pittinger, M.D., Prize for Excellence in Clinical/Translational Research, Department of Anesthesiology, 2018 and 2020</li> <li>▪ Foundation for Anesthesia Education and Research (FAER) mentored research training grant award, 2016-2018</li> <li>▪ Department of Anesthesiology Innovation grant award</li> <li>▪ Vanderbilt institute for clinical and translational research (funded by CTSA award UL1TR000445) grant award</li> </ul> |
| 2015 – present | <p>Loren E. Smith, M.D., Ph.D.; My role during period: Primary mentor, T32 advisor; Current Position: Assistant Professor, Vanderbilt University Medical Center<br/>         Current project:<br/>             Impact of high density lipoprotein particles and postoperative acute kidney injury</p>  |

Recent accolades:

- **K23 career development award, 2020-2025**
- Foundation for Anesthesia Education and Research (FAER) mentored research training grant award, 2018-2020
- 2016 Foundation for Anesthesia and Research (FAER) Margaret Wood Resident Research Award recipient
- 2016 Society of Critical Care Anesthesiologists (SOCCA) Young Investigator Award
- Department of Anesthesiology Innovation grant award
- Vanderbilt institute for clinical and translational research (funded by CTSA award UL1TR000445) grant award

2015 – 2016

Siddharth Dave, MD

My role during period: Research Mentor; Current Position: Assistant Professor, Department of Anesthesiology and Pain Management, University of Texas Southwestern Medical Center

Project:

Impact of intraoperative right ventricle dysfunction on acute kidney injury and delirium following cardiac surgery

2015 – 2017

Jason B. O'Neal, MD

My role during period: Co-mentor and T32 advisor; Current Position: Anesthesiologist, American Anesthesiology of Georgia, Atlanta

Project:

Neuroinflammation during cardiac surgery

2016 – 2021

Puneet Mishra, MD

My role during period: Co-Mentor; Current Position: Assistant Professor, Vanderbilt University Medical Center

Current project:

The effect of preoperative geniculate nerve ablation on short and long-term pain following total knee arthroplasty

Recent accolades:

Abbott/St. Jude Medical Research Grant

Completed the B.H. Robbins Scholar Program in 2021

2016 – 2016

Mason Fisher

My role during period: Summer student mentor; Current Position: Medical Student, The Ohio State University

Project:

Systemic oxygenation during cardiopulmonary bypass

2017 –2018

Allison Janda, MD

My role during period: Research mentor; Current Position: Assistant Professor, Department of Anesthesiology, University of Michigan

Project:

AKI and progression to CKD in patients with heart failure receiving ventricular assist device

2017 – 2017

Morgan Chien-Hale

My role during period: Summer student mentor; Current Position: Medical student, UC Davis

Project:

ROCS trial oxygenation protocol adherence

2017 – 2019

Jared Cummings, MD; My role during period: Mentor; Current Position: Assistant Professor, Vanderbilt University Medical Center

Project:

- Intraoperative prediction of cardiac surgery-associated acute kidney injury using urinary biomarkers of cell cycle arrest
- 2017 – 2019 Courtney Zola, MD; My role during period: mentorship committee member; Current Position: T32 research fellow  
Current project:  
Pulmonary hypertension in patients with HIV
- 2018 – present Rob Freundlich, MD, MS; My role during period: mentorship committee member; Current Position: K23 awardee and Associate Professor, Vanderbilt University Medical Center  
Current project:  
Predicting, detecting, and treating postoperative decompensation  
Recent Accolades:  
▪ **K23 career development award 2020-2025**
- 2018 – 2023 Amanda Stone, PhD; My role during period: mentorship committee member; Current Position: K23 awardee and Assistant Professor, Vanderbilt University Medical Center  
Current project:  
Parent and Child Psychosocial Predictors of Postoperative Pain and Opioid Use  
Recent Accolades:  
▪ **K23 career development award 2021-2026**
- 2018 – 2019 Alex Palidino, MD; My role during period: research mentor; Current Position: Cardiothoracic anesthesiology fellow  
Current project:  
Brachial artery flow-mediated dilation and pulmonary arterial capacitance
- 2018 – 2023 Christina Jelly, MD; My role during period: research mentor; Current Position: Assistant Professor, Vanderbilt University Medical Center  
Current project:  
Enhanced recovery after cardiac surgery (observational study and pragmatic clinical trial)
- 2018 – 2023 Matthew Semler, MD; My role during period: K23 research advisory committee member; Current Position: Assistant Professor, Department of Medicine, Vanderbilt University Medical Center  
Current project:  
The Pragmatic Investigation of optima Oxygen Targets (PILOT) trial
- 2019 – 2020 Aaron Lloyd, MD; My role during period: research mentor; Current Position: Critical care fellow  
Current project:  
Perioperative Dexmedetomidine use and Atrial Fibrillation following Cardiac Surgery
- 2019 – 2023 Melissa Kimlinger, MD; My role during period: research mentor; Current Position: Anesthesiology Resident at Massachusetts General Hospital  
Current project:  
Effects of oxygen treatments on kidney injury, extra-renal organ injury, oxidative damage, vascular function, and HIF-signaling during renal ischemia and reperfusion in mice  
Recent accolades:  
▪ Supporting Careers in Research for Interventional Physicians and Surgeons (SCRIPS) scholarship, 2021-2022
- 2019 – present Kara Siegrist, MD; My role during period: research mentor; Current Position: Assistant Professor, Department of Anesthesiology

- Current project:  
Effect of dantrolene on strength, muscle function, respiratory mechanics, respiration, and ventilatory support: a randomized clinical trial
- 2021 – 2021 Lauren Pomerantz, MD; My role during period: FAER-sponsored summer research mentor; Current Position: Anesthesiology Resident at Emory (2022-2026)  
Project:  
Intraoperative cerebral oxygenation, electroencephalography, and delirium following cardiac surgery  
Recent accolades:  
  - 2021 First place FAER medical student abstract award American Society of Anesthesiologists annual convention
- 2021 – 2024 Eric Mace, MD; My role during period: research mentor; Current Position: T32 fellow (2021-2023) and VUMC Department of Surgery Resident (2018-2025)  
Current project:  
Effects of oxygen tension on mechanisms of vascular function and organ injury  
Accolades:  
  - 2022 Shock Society Early-Stage Investigator Award finalist
- 2022 – 2024 Tom No; My role during period: research mentor; Current Position: Vanderbilt University undergraduate  
Current Project:  
Measuring Kidney Damage and Renal Function Impairment Caused by Supraphysiologic Oxygen Tension  
Accolades:  
  - 2022 Vanderbilt Undergraduate Summer Research Program scholarship award
- 2023 – 2023 Carly Chellman, BS; My role during period: Vanderbilt Anesthesiology Summer Research Program mentor; Current Position: A.T. Still University medical student (2022-2026)  
Project:  
Effect of intraoperative oxygen administration on tissue oxygen delivery and organ injury
- 2024 – current Anne Chen, BS; My role during period: Research mentor; Current Position: Vanderbilt University medical student (2022-2026)  
Project:  
Impact of oxygen delivery on cerebral injury following ischemia-reperfusion in mice
- 2024 – current Matthew Nordness, MD; My role during period: Research mentor; Current Position: VUMC Department of Anesthesiology Resident (2022-2026)  
Project:  
A longitudinal ordinal AKI scale to predict Major Adverse Kidney Events 90 days after cardiac surgery  
Accolades:  
  - 2024 Foundation for Anesthesia Education and Research resident scholar

## RESEARCH PROGRAM (reverse chronologic order)

### Pending

**IMPACT** (Billings) \$ 950,000 09/2024 – 08/2027  
Multicenter Perioperative Outcomes Group and the Association of University Anesthesiologists

*Impact of intraoperative oxygenation practices on patient outcomes (Intraop Ox)*

This multicenter cluster randomized, cluster crossover pragmatic clinical trial will test the hypotheses that intraoperative oxygenation strategies impact postoperative organ injury and mortality.

Role: PI

**Active**

**R01 AG083777** (Johnson-Akeju) \$ 13,995,357 06/2024 – 05/2029  
NIA

*Minimizing ICU Neurological Dysfunction with Dexmedetomidine-induced Sleep*

This multicenter placebo-controlled randomized clinical trial will test the hypotheses that dexmedetomidine will reduce delirium, cognitive dysfunction, and associated morbidities in non-intubated patients post cardiac surgery.

Role: Site-PI

**R01 AG085287** (Billings, Bruehl) \$ 4,401,012 09/2023 – 07/2028  
NIA

*Reducing perioperative oxidative stress to prevent postoperative chronic pain following total knee arthroplasty*

This placebo-controlled randomized clinical trial will test the hypotheses that 10-week glycine N-acetylcysteine supplementation reduces perioperative and postoperative oxidative stress and pain intensity, improves functional outcomes, and reduces opioid analgesic use 6-weeks, 6-months (primary), and 12 months following total knee arthroplasty.

Role: Co-PI

**R35 GM145375** (Billings) \$ 2,413,005 06/2022 – 05/2027  
NIGMS

*Oxygen and perioperative organ injury*

This project will determine the effects of hypoxia, normoxia, hyperoxia, and severe hyperoxia on mechanisms of perioperative organ injury, in order to develop novel treatments to reduce organ injury and improve patient outcomes.

Role: PI

**Supplement** (Billings) \$ 126,625 06/2023 – 05/2024

This equipment supplement supports the purchase a Dual Rodent Hemodynamic and Perfusion Monitoring System from ADInstruments. This System allows us to measure the effect of variable oxygen delivery and tensions and related impacted molecules (e.g., reactive oxygen species, cell-free hemoglobin) on systemic, regional, and organ-specific hemodynamics and perfusion.

**R01 HL157583** (Dikalov) \$ 2,432,800 04/2021 – 03/2025  
NHLBI

*Sirtuin 3 inactivation and SOD2 acetylation in vascular dysfunction and hypertension*

This study will test the hypothesis that inactivation of endothelial or smooth muscle Sirt3 induces endothelial or vascular dysfunction which is prevented by targeting mitochondrial isolevuglandins in mice and human arterioles.

Role: Co-I

**U34 TR003298** (Billings) \$ 382,328 07/2020 – 06/2022  
NCATS

*Repurposing montelukast for cardiac surgery-associated acute kidney injury*

This study will characterize perioperative urinary cysteinyl leukotrienes LTC<sub>4</sub>, LTD<sub>4</sub>, and LTE<sub>4</sub> expression, define cohort operating characteristics, and support start-up tasks for a phase II multicenter clinical trial of montelukast to reduce AKI following cardiac surgery.

Role: PI

**K23 HL148640** (Freundlich) \$ 803,961 6/2020 – 05/2025  
NHLBI

*Reducing Reintubation Risk in High-Risk Cardiac Surgery Patients with High- Flow Nasal Cannula - the "I-CAN" study*

The goals of this study are to develop and validate a model to predict postoperative reintubation after cardiac surgery using data readily available from the electronic health record and complete a pilot randomized clinical trial of post-extubation high flow nasal cannula to prevent reintubation in cardiac surgery patients identified as high-risk for reintubation.

Role: Co-I, mentorship committee member

**K23 GM134482** (Smith) \$ 878,555 5/2020 – 4/2025  
NIGMS

*Perioperative high-density lipoproteins and postoperative AKI*

The goals of this study are to test the hypothesis that circulating HDL composition and functional capacities are associated with AKI following major vascular or cardiac surgery and that exogenous HDL treatment reduces renal ICAM-1, TLR-2, and TLR-4 expression; renal neutrophil expression; and renal damage in mice.

Role: Mentor

**K23 GM129662** (Lopez) \$ 804,350 09/2018 – 08/2023  
NIGMS

*Perioperative oxygenation, endothelial dysfunction, and organ injury in cardiac surgery*

The goals of this study are to test the hypotheses that normoxia during cardiac surgery improves endothelial function compared to hyper-oxygenation, that intraoperative oxidative stress correlates with postoperative endothelial dysfunction, and that perioperative endothelial dysfunction is associated with postoperative brain and kidney injury.

Role: Mentor

**K23 HL143053** (Semler) \$ 925,585 07/2018 – 06/2023  
NHLBI

*Oxygen saturation targets during mechanical ventilation of critically ill adults: a clinical trial*

The goal of this study is to test the hypothesis hemoglobin oxygen targets in critically ill ICU patients effect mortality.

Role: Consultant

**AUA Clinical Trials IMPACT Initiative** (Billings) \$ 15,000 07/2018 – 07/2019  
Association of University Anesthesiologists

*Intraoperative Normoxia Reduces Kidney, Heart, and Pulmonary Injury Compared to Hyperoxia*

This seed grant will support the collection and analysis of preliminary data and the evaluation of centers for a large multicenter clinical trial of intraoperative oxygenation targets to reduce organ injury.

Role: PI

**FAER MRTG** (Smith) \$ 175,000 01/2018 – 12/2019  
Foundation for Anesthesia and Research

*High density lipoprotein particle characteristics and the risk of acute kidney injury after cardiac surgery*

This project will evaluate perioperative physical and functional properties of high-density lipoprotein particles in patients who were randomized to perioperative atorvastatin or and did or did not develop acute kidney injury following cardiac surgery.

Role: Mentor

**R01 HL135144** (Girard) \$ 1,912,965 05/2017 – 02/2023  
NHLBI

*Mitochondrial stress response and sepsis-associated brain dysfunction*

This project will test the hypothesis that mtDNA haplogroups predict metabolic pathways, mitochondrial dysfunction, delirium, and long-term cognitive dysfunction in patients with acute respiratory distress syndrome.

Role: Co-I, site PI

**R01 AG048915** (Bruehl) \$ 2,008,437 03/2017 – 02/2022  
NIA

*Psychosocial and oxidative stress mechanisms of post-surgical chronic pain*

This project will evaluate oxidative stress as a mechanism contributing to chronic pain and complex regional pain syndrome following total knee arthroplasty (TKA) and will determine whether any predictive effects of depressive symptoms on subsequent post-TKA pain are mediated by associations with oxidative stress.

Role: Co-I

**FAER MRTG** (Lopez) \$ 175,000 07/2016 – 06/2018  
Foundation for Anesthesia and Research

*The effects of perioperative oxygenation on endothelial function*

The goal of this study is to test the test the hypotheses that normoxia during cardiac surgery improves endothelial function compared to hyperoxia and that endothelial dysfunction correlates with intraoperative oxidative stress.

Role: Mentor

**R01 GM112871** (Billings) \$ 1,758,385 08/2015 – 07/2022  
NIGMS

*Hyper-oxygenation, oxidative stress, and kidney injury following cardiac surgery*

The Risks of Oxygen during Cardiac Surgery (ROCS) trial will test the hypothesis that patients randomized to receive physiologic oxygenation (normoxia) during cardiac surgery will have decreased production of reactive oxygen species, oxidative damage, and organ injury than those randomized to receive hyper-oxygenation (hyperoxia).

Role: PI

**UAB-UCSD O'Brien Center Voucher** (Billings) \$ 15,000 08/2014 – 07/2015  
NIDDK P30 DK079337

*The effect of high-dose perioperative atorvastatin on 7-plex urinary AKI biomarkers*

This project measured novel markers of oxidative damage in samples from patients randomized to hyperoxia or normoxia during cardiac surgery to develop preliminary data for subsequent clinical trials.

Role: PI

**K23 GM102676** (Billings) \$ 904,718 08/2012 – 07/2017  
NIGMS

*Mitochondrial dysfunction, oxidative stress, and surgical acute kidney injury*

The goals of this study are to test the hypothesis that mitochondrial dysfunction is associated with oxidative stress and kidney injury during cardiac surgery and to test the hypothesis that a mitochondrial-targeted antioxidant reduces oxidant injury in patients undergoing cardiac surgery.

Role: PI

**FAER MRTG** (Billings) \$ 175,000 07/2011 – 06/2013  
Foundation for Anesthesia and Research

*The effect of atorvastatin on renal oxidant injury in patients undergoing cardiac surgery*

The goal of this study was to test the effect of atorvastatin on renal oxidant injury in patients undergoing cardiac surgery. **Declined.**

Role: PI

**K12 ES015855** (Billings) \$ 244,226 07/2011 – 07/2012  
NIEHS

Vanderbilt Environmental Health Scholars Program (VEHSS)

*Mitochondrial dysfunction, oxidative stress, and acute kidney injury*

This mentored scientist career development program supports the development of patient-oriented researchers in the area of environmental health. The candidate's project (7/2011-7/2012) focused on the effect of cardiac surgery on mitochondrial DNA copy number.

Role: PI

**VPSD award** (Billings) \$ 160,000 08/2008 – 07/2010

Vanderbilt Physician-Scientist Development program

*Association of statin use and acute kidney injury following cardiac surgery*

The goal of this competitive program is to support research time and endeavors in the laboratory and under the close mentorship of an established physician-scientist. My project examined the associations between preoperative and early postoperative statin use and acute kidney injury in a recently completed clinical trial of cardiac surgery patients.

Role: PI

### **Extramural funded industry research projects (reverse chronologic order):**

**VUMC73644** (Billings) \$436,009 11/2019 – 02/2022

Astellas Pharma Global Development

*A Phase II Proof of Concept, Double-Blind, Randomized, Placebo-controlled Study to Evaluate the Efficacy of ASP1128 (MA-0217) in Subjects at Risk for Acute Kidney Injury following Coronary Artery Bypass Graft (CABG) and/or Valve Surgery.*

This study tests the hypothesis that ASP112, a PPAR delta modulator, reduces acute kidney injury in patients with an elevated urinary NephroCheck concentration following cardiac surgery.

Role: site PI

**THR-184** (Billings) \$111,411 01/2014 – 06/2015

Thrasos Therapeutics

*A Phase II Multi-Center, Parallel-Group, Randomized, Double Blind, Proof-of-Concept, Adaptive Study Investigating the Safety and Efficacy of THR-184 Administered via Intravenous Infusion in Patients at Increased Risk of Developing Cardiac Surgery Associated-Acute Kidney Injury (CSA-AKI).*

This study tested the hypothesis that THR-184, a bone morphogenetic protein agonist, reduces acute kidney injury following cardiac surgery.

Role: site PI

### **INVENTIONS and PATENTS**

VU19104P1, "Montelukast for Nephritis and Nephropathy." Pulley JM, Shirey-Rice JK, Jerome RN, Billings FT, Zaleski NM. 7/1/2020.

### **PUBLICATIONS and PRESENTATIONS**

#### **ARTICLES IN REFEREED JOURNALS**

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12. Burjek NE [M], Wagner CE, Hollenbeck RD, Wang L, Yu C, McPherson JA, and **Billings FT 4<sup>th</sup>**. Early bispectral index and sedation requirements during therapeutic hypothermia predict neurologic function at intensive care unit discharge. *Critical Care Medicine* 42(5):1204-1212, 2014.
13. **Billings FT 4<sup>th</sup>**, Yu C, Byrne JG, Petracek MR, and Pretorius M. Heme oxygenase-1 and acute kidney injury following cardiac surgery. *Cardiorenal Medicine* 4:12-21, 2014.
14. Devin JK, Pretorius M, Nian H, Yu C, **Billings FT 4<sup>th</sup>**, and Brown NJ. Substance P increases sympathetic activity during combined angiotensin converting enzyme and dipeptidyl peptidase-4 inhibition. *Hypertension* 63:951-957, 2014.
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19. Gamboa JL, **Billings FT 4<sup>th</sup>**, Bojanowski MT, Gilliam LA, Yu C, Roshanravan B, Roberts LJ, Himmelfarb J, Ikizler TA, and Brown NJ. Mitochondrial dysfunction and oxidative stress in patients with chronic kidney disease. *Physiological Reports* 4(9):e12780, 2016.
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23. O'Neal JB, **Billings FT 4<sup>th</sup>**, Liu X, Shotwell MS, Liang Y, Shah AS, Ehrenfeld JM, Wanderer JP, and Shaw AD. Risk factors for delirium after cardiac surgery- a historical cohort study outlining the influence of cardiopulmonary bypass. *Canadian Journal of Anesthesia* 64(11):1129-1137, 2017.
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26. O'Neal JB, **Billings FT 4<sup>th</sup>**, Liu X, Shotwell MS, Liang Y, Shah AS, Ehrenfeld JM, Wanderer JP, and Shaw AD. Effect of Preoperative beta-blocker Use on outcomes following cardiac surgery. *American Journal of Cardiology* 120(8):1293-1297, 2017.
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vascular dysfunction and hypertension while Sirt3 depletion in essential hypertension is linked to vascular inflammation and oxidative stress. *Circulation Research* 126(4): 439-452, 2019.

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38. Ramkrishnan A, Fontes ML, Lombard FR, Abdelmalak M, Yurim H, Shi Y, Shotwell MS, **Billings FT 4<sup>th</sup>**, Pretorius M, Wanderer JP, Vyas R, Absi TS, Shah AS, and Kertai MD. Mean platelet volume and cardiac-surgery-associated atrial fibrillation: a retrospective study. *Journal of Cardiothoracic and Vascular Anesthesia* 35(8):2533-2536, 2021.
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Acute Kidney Injury Associated with Cardiac Surgery. *Anesthesia and Analgesia* 135(4):744-756, 2022.

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## BOOKS, BOOK CHAPTERS, AND INVITED REVIEW ARTICLES

1. **Billings FT 4<sup>th</sup>** and Riedel B: Statins, Essence of Anesthesia Practice, 3<sup>rd</sup> edition, Edited by Roizen and Fleischer, W.B. Saunders Company, 2010.
2. **Billings FT 4<sup>th</sup>** and Shaw AD. Clinical trial endpoints in acute kidney injury. *Nephron Clinical Practice*. 127: 89-93, 2014.

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6. Smith LE [M] and **Billings FT 4<sup>th</sup>**. Statins and the kidney. Critical Care Nephrology, 3rd edition, Edited by Ronco, Bellomo, Kellum and Ricci, Elsevier, 2017.
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10. McIlroy DR, Lopez MG [M], and **Billings FT 4<sup>th</sup>**. Perioperative clinical trials in AKI. *Seminars in Nephrology* 40(2): 173-187, 2020.
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14. Balakrishna A, Walco J, **Billings FT 4<sup>th</sup>**, Lopez MG. Perioperative acute kidney injury: implications, approach, prevention. *Advances in Anesthesia* 41(1):205-224, 2023.

## EDITORIALS

1. **Billings FT 4<sup>th</sup>**, Jiang Y, and Shaw AD. Renal oxygen flux during cardiopulmonary bypass; tubular damage to preserve glomerular filtration – what's a kidney to do? *Anesthesiology*. 126: 199-201, 2017.
2. McIlroy DR and **Billings FT 4<sup>th</sup>**. Perioperative oxygen administration: finding the sweet spot. *British Medical Journal* 379:o2897, 2022.

## ABSTRACTS

1. **Billings FT 4<sup>th</sup>**, MJ Kim, MH Kim, S Wang, and HT Lee. Dexmedetomidine protects against radiocontrast induced nephropathy in mice. *Anesthesiology*, 107:A742, 2007.
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4. **Billings FT 4<sup>th</sup>**, Kim M, Song J, Wang S, and Lee HT. Alpha-2 adrenergic agonists protect against radiocontrast induced nephropathy in mice. *Anesthesiology*, 109:A1022, 2008.
5. Wahlandar S, Romano M, Brady J, **Billings FT 4<sup>th</sup>**, and Lee HT. Renal failure after non-ionic, isoosmolar contrast administration is not contrast dose-dependent. *Critical Care Medicine*. 38: 12 (Suppl) Abstract 608, 2008.

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11. Ramakrishna R [M], Hendricks P, and **Billings FT 4<sup>th</sup>**. Omega-3 fatty acid supplementation, body mass index, and risk of acute kidney injury following cardiac surgery. *Anesthesiology*, Oct:A182, 2011.
12. Pretorius M, Murray C, Yu C, Byrne JG, **Billings FT 4<sup>th</sup>**, Petracek M, Greelish J, Hoff S, Ball S, Mishra V, Body S, and Brown NJ. Angiotensin-converting enzyme inhibition or mineralocorticoid receptor blockade decreases acute renal failure but not atrial fibrillation in patients undergoing cardiac surgery. *Anesthesia and Analgesia*, 114:S-46, 2011.
13. **Billings FT 4<sup>th</sup>**, Balaguer J, Yu C, Wright P, Petracek M, Byrne JG, Brown NJ, and Pretorius M. Comparative effects of ARBs and ACE inhibitors on the fibrinolytic and inflammatory responses to cardiac surgery. *Anesthesia and Analgesia*, 114:S-49, 2011.
14. **Billings FT 4<sup>th</sup>**, Pretorius M, Schildcrout JS, Mercaldo ND, Byrne JG, Ikizler TA, and Brown NJ. Obesity predicts acute kidney injury following cardiac surgery: role of oxidative stress. *Anesthesia and Analgesia*, 114:S-63, 2011.
15. Burjek NE [M], **Billings FT 4<sup>th</sup>**, Hollenbeck RD, Wang L, Yu C, McPherson JA, and Wagner CE. Early BIS and sedative requirements during therapeutic hypothermia predict neurologic outcome at ICU discharge. *SOCCA*; 2012.
16. **Billings FT 4<sup>th</sup>**, Byrne JG, Yu C, and Pretorius M. Heme oxygenase-1 expression is associated with acute kidney injury after cardiac surgery. *Circulation*; 126:A16438; 2012.
17. Devin JK, Pretorius M, **Billings FT 4<sup>th</sup>**, and Brown NJ. Interactive effect of ACE Inhibition and DPP4 inhibition on substance P-stimulated TPA release. *Hypertension*, 60:A613, 2012.
18. **Billings FT 4<sup>th</sup>**, Gamboa J, Yeung CK, Shen DD, Himmelfarb J, and Ikizler TA. Endogenous coenzyme Q10, oxidative stress, and kidney injury following cardiac surgery. *Shock*. 39:S2; 2013.
19. Devin JK, Pretorius M, **Billings FT 4<sup>th</sup>**, Nian H, and Brown NJ. Glucagon like peptide-1 (GLP-1) does not cause vasodilation even when dipeptidyl peptidase 4 (DPP4) is inhibited. *Hypertension*, 62:A95, 2013.
20. Gamboa JL, **Billings FT 4<sup>th</sup>**, Bojanowski MT, Wang Z, Ikizler TA, and Brown NJ. Mitochondrial DNA copy number and oxidative stress in patients with chronic kidney disease. *Hypertension*, 62:A32, 2013.
21. **Billings FT 4<sup>th</sup>**, Yeung CK, Shen DD, Ikizler TA, and Himmelfarb J. The effect of Coenzyme Q10 dose-escalation on oxidative stress in hemodialysis patients. *Journal of the American Society of Nephrology*, 24:540A, 2013.
22. **Billings FT 4<sup>th</sup>**, Bikineyeva A, Gamboa J, and Dikalov S. The effect of oxygen tension on the production of reactive oxygen species in blood *ex vivo*. *Shock*, 41:S2; 2014.

23. Butterworth RM [M], Wanderer J, Shaw AD, and **Billings FT 4<sup>th</sup>**. Impact of cardiopulmonary bypass on acute pulmonary dysfunction following cardiac surgery. *Anesthesia and Analgesia* Society of Cardiovascular Anesthesiology, 2015
24. **Billings FT 4<sup>th</sup>**, Pretorius M, and Shaw AD. The incidence of major adverse kidney events (MAKE) following cardiac surgery. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2015.
25. Bennett JM [M], Eagle SS, Pretorius M, and **Billings FT 4<sup>th</sup>**. Impact of aortic cross clamp and cardioplegia on myocardial injury. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2015.
26. Hernandez A [M], Westman AL, Shaw AD, and **Billings FT 4<sup>th</sup>**. Patterns of early distant organ injury following adult cardiac surgery. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2015.
27. Pretorius M and **Billings FT 4<sup>th</sup>**. Impact of acute kidney injury (AKI) on long-term kidney function in patient undergoing LVAD placement. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2015.
28. Lopez M [M], Pandharipande P, Pretorius M, Shaw AD, and **Billings FT 4<sup>th</sup>**. Intraoperative hyperoxic reperfusion of the brain and ICU delirium. *Shock*, 43:S1; 2015.
29. **Billings FT 4<sup>th</sup>**. Intraoperative normoxia, oxidative damage, and organ injury following cardiac surgery. *Shock*, 43:S1; 2015.
30. Kohorst K [M], Ford J, and **Billings FT 4<sup>th</sup>**. Anesthetic management of a left atrial myxoma causing functional mitral stenosis. *Anesthesiology*. 2016.
31. Liang Y [M], Morse JL, Shotwell MS, O'Neal J, Shaw AD, and **Billings FT 4<sup>th</sup>**. Association between intraoperative cerebral hypoperfusion and postoperative delirium. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists, 2016.
32. Liang Y [M], Morse JL, Shotwell MS, O'Neal J, Shaw AD, and **Billings FT 4<sup>th</sup>**. Association between intraoperative jugular venous congestion and postoperative delirium. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists best of meeting abstract, oral presentation, 2016.
33. Smith LE [M], Smith DK, Linton MF, and **Billings FT 4<sup>th</sup>**. A novel association between high-density lipoprotein levels and the risk of acute kidney injury after cardiac surgery. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 36:A197; 2016.
34. Lopez MG [M] and **Billings FT 4<sup>th</sup>**. Intraoperative oxidative stress and postoperative delirium. *Critical Care Medicine*, 44(12)S1; 2016.
35. Hizel L, Lopez MG, Price C, and **Billings FT 4<sup>th</sup>**. Working memory and recall domains of the mini-mental status examination predict postoperative delirium. *Journal of the International Neuropsychology Conference*, 23(S1); 2017.
36. O'Neal JB, Liang Y, McNeil B, Shaw AD, and **Billings FT 4<sup>th</sup>**. Perioperative markers of brain injury and the risk of delirium following cardiac surgery. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists. 2017.
37. Smith LE [M], Smith DK, Remaley AT, Linton MF, and **Billings FT 4<sup>th</sup>**. Perioperative decline in high-density lipoprotein particles is associated with increased risk of AKI after cardiac surgery. *Anesthesia and Analgesia*. 124(5):1002, 2017.
38. Lopez MG [M], Pretorius M, and **Billings FT 4<sup>th</sup>**. Plasma free hemoglobin, oxidative damage, and acute kidney injury in cardiac surgery. *Anesthesia and Analgesia*. 124(5):116, 2017.
39. Smith LE [M], Smith DK, Remaley AT, Linton MF, and **Billings FT 4<sup>th</sup>**. Perioperative high-density lipoprotein particle changes and the risk of acute kidney injury after cardiac surgery. Southeast Lipid Research Conference. 2017.
40. Saklayen SL [M], **Billings FT 4<sup>th</sup>**, and Lopez MG. Cardiac index and brachial artery flow

- mediated dilation. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists best of meeting oral abstract. 2018.
41. Janda AM [M], Pretorius M, and **Billings FT 4<sup>th</sup>**. Kidney function following left ventricular assist device, *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists. 2018
  42. Cummings JJ [M], Shi J, Shaw AD, and **Billings FT 4<sup>th</sup>**. Early identification of acute kidney stress using intraoperative cell cycle arrest biomarkers in cardiac surgery, *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiologists best of meeting oral abstract. 2018
  43. Smith LE [M], Smith DK, Remaley AT, **Billings FT 4<sup>th</sup>**, and Linton MF. Preoperative small HDL particle concentration is associated with paraoxonase-1 activity and the risk of acute kidney injury after cardiac surgery. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 38:Suppl\_1; 2018.
  44. Smith LE [M], Smith DK, Remaley AT, Yancey PG, **Billings FT 4<sup>th</sup>**, and Linton MF. Intraoperative HDL and apoA-I loss and AKI after surgery. Southeast Regional Lipids Conference. 2018.
  45. Lopez MG [M], Saklayan SL [M], DeMatteo A, Wang Z, and **Billings FT 4<sup>th</sup>**. Intraoperative oxidative stress and endothelial function in cardiac surgery patients. *Shock*, 49:6s, 2018.
  46. Smith LE [M], Smith DK, Remaley AT, **Billings FT 4<sup>th</sup>**, and Linton MF. The pattern of perioperative high-density lipoprotein particle loss is independently associated with acute kidney injury after cardiac surgery. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 39:Suppl\_1; 2019.
  47. Lopez MG [M], Hughes CG, Shotwell MS, and **Billings FT 4<sup>th</sup>**. Intraoperative oxidative damage, delirium, and neuronal injury following cardiac surgery. *Shock*, 51:6s, 2019.
  48. Paldino A [M], **Billings FT 4<sup>th</sup>**, and Lopez MG [M]. Brachial artery flow-mediated dilation and pulmonary arterial capacitance. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2019.
  49. Shuey MM, Farber-Eger E, Mosley JD, **Billings FT 4<sup>th</sup>**, and Cox NJ. A polygenic risk score for atrial fibrillation is associated with the development of post-operative atrial fibrillation following cardiac surgery independent of a patient's history of atrial fibrillation. *American Society of Human Genetics*. 2019.
  50. Subati T, Christopher IL, **Billings FT 4<sup>th</sup>**, Shoemaker MB, Yoneda ZT, Van Amburg JC, Trykall DZ, Barnett JV, and Murray KT. Cytotoxic atrial preamyloid oligomers are increased in human atrial fibrillation. *Heart Rhythm*, 5-2020.
  51. Smith LE, Smith DK, Allen R, Vickers K, Linton MF, and **Billings FT 4<sup>th</sup>**. HDL-associated microRNAs associated with acute kidney injury after cardiac surgery. *Anesthesia and Analgesia*. 130(5):846, 2020.
  52. Lloyd A, Freundlich R, Elsayes AB, Jelly C, Hernandez A, and **Billings FT 4<sup>th</sup>**. Perioperative dexmedetomidine use and atrial fibrillation following cardiac surgery. *Anesthesia and Analgesia*. 130(5):248, 2020.
  53. Bruehl S, Anderson S, Milne G, Shinar A, Polkowski G, Schildcrout J, Mishra P, Shi Y, and **Billings FT 4<sup>th</sup>**. Persistent pain following total knee arthroplasty: a preliminary evaluation of perioperative oxidative stress mechanisms. International Association for the Study of Pain. 2020.
  54. Kimlinger MJ [M], Lopez MG, Baker T, Campbell D, and **Billings FT 4<sup>th</sup>**. Effect of intraoperative oxygen delivery on systemic oxygen consumption. *Anesthesiology*. 2020.
  55. Dikalova A, Tkachuk L, Lopez MG, **Billings FT 4<sup>th</sup>**, and Dikalov S. Mutation of lysine 68 to arginine mimics deacetylation of mitochondrial superoxide dismutase, protects from vascular oxidative stress and attenuates angiotensin II-induced hypertension. *Hypertension* 76:Supplement 1 AP080. 2020.
  56. Dikalova A, Mayorov V, Xiao L, Panov A, Amarnath V, Zagol-Ikapitte I, Vergeade A, Ao M,

- Yermalitsky V, Nazarewicz R, Boutaud O, Lopez MG, **Billings FT 4<sup>th</sup>**, Davies SS, Roberts LG, Harrison DG, and Dikalov SI. Mitochondrial isolevuglandins contribute to vascular oxidative stress and a mitochondria-targeted scavenger of isolevuglandins reduces mitochondrial dysfunction and hypertension. *Hypertension* 76:Supplement 1 AP074. 2020.
57. Dikalova A, Tkachuk L, Lopez MG, **Billings FT 4<sup>th</sup>**, and Dikalov SI. Essential hypertension is linked to acetylation of mitochondrial superoxide dismutase and deacetylation mimetic mutation of lysine 68 to arginine protects from oxidative stress and hypertension. *Circulation* 142:Supplement 3 A15061. 2020
  58. Siegrist K [M], Ream J, and **Billings FT 4<sup>th</sup>**. Impact of dantrolene on strength and respiratory mechanics. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2021.
  59. Hillenbrand K. and **Billings FT 4<sup>th</sup>**. Intracardiac thrombosis during type-B aortic dissection repair. *Anesthesia and Analgesia*. Society of Cardiovascular Anesthesiology, 2021.
  60. Kimlinger MJ [M], Barajas M, Harris R, Zhang MZ, Hernandez A, Riess M, and **Billings FT 4<sup>th</sup>**. Impact of hyperoxia on renal tissue oxygenation, reactive oxygen species production, and oxidative damage in a murine ischemia reperfusion model. *Anesthesia and Analgesia*. 132(5):971, 2021.
  61. DeBeax AC, Zhou J, Baker T, Campbell DD, **Billings FT 4<sup>th</sup>**, and Lopez MG. Endothelial glycocalyx degradation and postoperative acute kidney injury in cardiac surgery patients. *Anesthesia and Analgesia*. 132(5):2082, 2021.
  62. Pomerantz L, Lopez MG, Shotwell MS, and **Billings FT 4<sup>th</sup>**. Intraoperative cerebral oxygenation, electroencephalography, and delirium following cardiac surgery. *Anesthesiology*. 2021. *First place FAER medical student abstract award*.
  63. Lopez MG, Pandey AK, Shotwell MS, Harrison DG, and **Billings FT 4<sup>th</sup>**. The effect of intraoperative oxygenation on vascular reactivity in human resistance arterioles. *Circulation* 144:Suppl 1, Abstract 9356, 2021.
  64. Bruehl S, **Billings FT 4<sup>th</sup>**, Anderson S, Polkowski G, Shinar A, Schildcrout JS, Shi Y, Milne G, Dematteo A, Mishra P, and Harden RN. Perioperative oxidative stress prospectively predicts CRPS-related outcomes in the 6 months following total knee arthroplasty. US association for the study of pain, 2022.
  65. Kimlinger MJ, Mace EH, and **Billings FT 4<sup>th</sup>**. Impact of supplemental oxygen during renal ischemia and reperfusion in mice. *Anesthesia and Analgesia*. 134(5):1083, 2022.
  66. McIlroy DR, Shotwell MS, Lopez MG, Housey MV, Olsen J, Hennessy C, Wanderer J, Semler M, Kheterpal S, and **Billings FT 4<sup>th</sup>**. Oxygen administration during surgery and postoperative organ injury. *Anesthesia and Analgesia*. 134(5):973, 2022.
  67. **Billings FT 4<sup>th</sup>**, McIlroy DR, Shotwell MS, Lopez MG, Housey MV, Wanderer J, Semler MS, Wunsch HM, and Kheterpal S. Oxygen administration practices during surgery in the United States. *Anesthesia and Analgesia*. 134(5):1080, 2022.
  68. Lopez MG, Shotwell MS, Mace EH, Harrison DG, and **Billings FT 4<sup>th</sup>**. Impaired vascular reactivity is associated with acute kidney injury and delirium in cardiac surgery. *Anesthesia and Analgesia*. 134(5):213, 2022.
  69. Onyemekwu CA, Tan X, Gamboa J, **Billings FT 4<sup>th</sup>**, Hulgán T, Pandharipande PP, and Girard TD. Associations between plasma cell-free mitochondrial DNA, delirium, and coma during sepsis. *American Journal of Respiratory and Critical Care Medicine* 2022;205:A3700.
  70. Kimlinger MJ, No TJ, Mace EH, and **Billings FT 4<sup>th</sup>**. Hyperoxia increases kidney injury during renal ischemia and reperfusion in mice. *Shock* 2022.
  71. Mace EH, Lopez MG, Kimlinger MJ, Shotwell MS, and **Billings FT 4<sup>th</sup>**. Soluble guanylate cyclase activation rescues hyperoxia-induced dysfunction of vascular relaxation. *Shock* 2022.
  72. Lopez MG, Zhou J, and **Billings FT 4<sup>th</sup>** Perioperative endothelial dysfunction is

independently associated with kidney injury following cardiac surgery. *Shock* 2022.

73. Larach DB, Kertai MD, and **Billings FT 4<sup>th</sup>**, Anderson SB, Polkowski GG, Shinar AA, Milde GL, Mishra P, Bruehl S. Preoperative Predictors of Prolonged Opioid Use in the 6 Months Following Total Knee Arthroplasty. *International Anesthesia Research Society* 2023.
74. Mace EH, Lopez MG, No TJ, Kimlinger MJ, Hennessy C, Shotwell MS, Dikalov SI, Harrison DG, and **Billings FT 4<sup>th</sup>**. Soluble guanylyl cyclase stimulation attenuates hyperoxia-induced vascular dysfunction in mice. *International Anesthesia Research Society* 2023.
75. Onyemekwu C, Tan XE, Potter KM, Prendergast NT, Mullet SJ, Wendell SG, Toney NA, Gu X, **Billings FT 4<sup>th</sup>**, Gamboa JL, Hulgán T, Samuels DC, Tang G, and Girard TD. Novel sampling methodology to identify metabolites associated with delirium in a sepsis cohort. *American Journal of Respiratory and Critical Care Medicine* 207(A2494), 2023.
76. Mace EH, Lopez MG, No TJ, Kimlinger MJ, Hennessy C, Shotwell MS, Dikalov SI, Harrison DG, and **Billings FT 4<sup>th</sup>**. Hyperoxia impairs vasorelaxation by modifying nitric oxide agonism of soluble guanylyl cyclase in mice. *Shock* 2023.
77. Chellman C, Hennessey C, Shotwell MS, Lopez MG, **Billings FT 4<sup>th</sup>**. Intraoperative oxygen treatment, tissue oxygen delivery, and organ injury following cardiac surgery. IARS 2024.
78. Wei J, Ao M, Baker T, **Billings FT 4<sup>th</sup>**, Lopez MG. Endothelial Dysfunction and Postoperative Atrial Fibrillation after Cardiac Surgery. IARS SOCCA, 2024.

## PRESENTATIONS AT SCIENTIFIC MEETINGS

### INVITED LECTURES (INTERNAL)

- |            |   |
|------------|---|
| 04/21/2006 | Department of Anesthesiology Grand Rounds. Vanderbilt University Medical Center, "Tracheal stenosis," Nashville, TN   |
| 02/20/2008 | Critical Care Fellows Conference, Columbia University, "Radiocontrast nephropathy," New York, NY  |
| 05/14/2008 | Neuro-Radiology Conference. Columbia University, "Radiocontrast nephropathy and therapeutic options." New York, NY  |
| 10/09/2008 | Critical Care Fellows Conference; Vanderbilt University, "Radiocontrast nephropathy," Nashville, TN   |
| 10/19/2009 | Perioperative Transesophageal Echocardiography and Pacemaker Workshop; Vanderbilt University, "Intraoperative assessment of the aortic valve," Nashville, TN                  |
| 12/04/2009 | Annual Retreat; Newman Society, "Early postoperative statin use is associated with a lower incidence of acute kidney injury following cardiac surgery," Nashville, TN         |
| 05/22/2010 | Perioperative Transesophageal Echocardiography Workshop; Vanderbilt Critical Skills Summit 2010, "Assessing the aortic valve," Nashville, TN                                  |
| 01/19/2012 | Oxidative Stress Monthly Research Seminar; Vanderbilt University School of Medicine, "Cardiac surgery-induced oxidative stress," Nashville, TN                                |
| 12/02/2013 | Department of Medicine Dinner and Data Lecture Series; Vanderbilt University School of Medicine, "Mitochondrial dysfunction and AKI following cardiac surgery," Nashville, TN |
| 11/07/2014 | Plenary Lecture. Vanderbilt University Translational Research Forum, "Oxidative injury during cardiac surgery," Nashville, TN   |
| 12/02/2014 | AKI Interest Group; Vanderbilt University, "Risk of oxygen exposure during cardiac surgery," Nashville, TN  |

04/07/2015 Clinical Pharmacology Grand Rounds; Vanderbilt University, "Oxidative injury during cardiac surgery," Nashville, TN

07/10/2015 Department of Anesthesiology Grand Rounds; Vanderbilt University, "Oxygen toxicity during surgery," Nashville, TN

01/08/2018 Perioperative Clinical Research Institute (PCRI) team meeting; Vanderbilt University, "Pragmatic clinical trials," Nashville, TN

01/07/2019 Intern Professional Development series; Vanderbilt University, "Oxygen, a dangerous drug," Nashville, TN

02/06/2020 BH Robbins Scholars seminar; Vanderbilt University, "Strategies to develop and write a Specific Aims page: grantsmanship," Nashville, TN

01/22/2021 Department of Anesthesiology Grand Rounds, Vanderbilt University Medical Center, "Highlights from the BH Robbins Scholars Program: 3 scholars offer 3-minute talks and discussion," Nashville, TN

10/07/2022 Department of Anesthesiology Grand Rounds, Vanderbilt University Medical Center, "Informing Perioperative Anesthesia through Clinical Trials (InPACT)," Nashville, TN

02/14/2023 Cardiothoracic Anesthesiology lecture series, Vanderbilt University Medical Center, "Progression of VUMC cardiac anesthetics and outcomes," Nashville, TN

06/15/2023 Vanderbilt Anesthesiology Summer Internship Program, Vanderbilt University Medical Center, "Making discovery and science a part of your career," Nashville, TN

**INVITED LECTURES (EXTERNAL), including invited presentations at scientific meetings**

05/17/2008 Association of University Anesthesiologists, Durham, NC, "Alpha-2 agonists protect against radiocontrast nephropathy in mice"

09/08/2013 Southern Acute Kidney Injury Network Investigators meeting, Medical University of South Carolina, Charleston, SC, "Statins to prevent AKI"

09/06/2014 Southeastern Kidney Disease Consortium (SEKDC) Conference, Charleston, SC, "Perioperative management of acute kidney injury"

10/14/2014 American Society of Anesthesiologists annual meeting, New Orleans, LA. Panel presentation (Anesthesia for the Patient too Sick for Anesthesia), "Pathophysiology and treatment of rhabdomyolysis-induced acute kidney injury"

10/27/2015 American Society of Anesthesiologists annual meeting, San Diego, CA. Panel presentation (Anesthesia for the Patient too Sick for Anesthesia), "Pathophysiology and treatment of rhabdomyolysis-induced acute kidney injury"

04/04/2016 Society of Cardiovascular Anesthesiologists Annual Meeting, San Diego, CA. "AKI pathobiology and diagnosis"

05/20/2016 Association of University Anesthesiologists Annual Meeting, San Francisco, CA. "President's panel: how to produce successful researchers"

10/25/2016 American Society of Anesthesiologists annual meeting, Chicago, IL. Panel presentation (Anesthesia for the Patient too Sick for Anesthesia), "Anesthetic implications of acute renal failure"

04/25/2017 Society of Cardiovascular Anesthesiologists annual meeting, Orlando, CA. Panel presentation, "100% oxygen is always best – Con"

05/08/2017 International Anesthesia Research Society annual meeting, Washington, D.C. Panel presentation (Oxygen therapy: too much of a good thing), "Hyperoxia: The Lessons from the Perioperative Arena"

10/24/2017 American Society of Anesthesiologists annual meeting, Boston, MA. Panel presentation (Anesthesia for the Patient too Sick for Anesthesia), "Perioperative Management of AKI"

04/28/2018 Society of Cardiovascular Anesthesiologists annual meeting, Phoenix, AZ. Panel presentation, "Does our intraoperative fluid management make a difference? Fluids in, Fluids out"

04/30/2018 Society of Cardiovascular Anesthesiologists annual meeting, Phoenix, AZ. Panel presentation, "Protecting the Kidney - the science of organ protection"

10/16/2018 American Society of Anesthesiologists annual meeting, San Francisco, CA. Panel presentation (Cardiac Surgery Associated-Acute Kidney Injury), "Optimizing fluids and hemodynamics in the postoperative period for prevention and mitigation of acute kidney injury"

02/26/2019 AKI & CRRT international conference, San Diego, CA. "AKI following cardiac surgery: a clinical model"

05/20/2019 Society of Cardiovascular Anesthesiologists annual meeting, Chicago, IL. Panel presentation (Bench to bedside: best evidence about risk, mechanism, and therapy of organ injury for the clinician), "Reperfusion injury and oxidative stress – the translational story"

07/23/2019 Federation of American Societies for Experimental Biology (FASEB) Acute Kidney Injury Conference: From Bench to Bedside (and Back Again), Pacific Grove, CA. "Perioperative Clinical Trials in AKI"

07/08/2020 University of California Los Angeles Department of Anesthesiology Grand Rounds, Los Angeles, CA. Panel presentation and discussion Joseph Meltzer, Vadim Gudzenko, F.T. Billings IV, Anahat Dhillon, "Perioperative care of patients on ECMO and LVAD support"

03/25/2021 Society of Critical Care Anesthesiologists webinar. AKI, time for a reboot? - Using biomarkers to predict risk of sustained kidney injury.

04/24/2021 Society of Cardiovascular Anesthesiologists annual meeting, Panel presentation (Acute Kidney Injury in Cardiac Surgery), "Renal replacement therapy following cardiac surgery"

04/25/2021 Society of Cardiovascular Anesthesiologists annual meeting. Panel presentation (Protective ventilation for thoracic surgery after COVID exposure), "Optimal FIO<sub>2</sub> during lung surgery"

03/19/2022 International Anesthesia Research Society annual meeting. Panel presentation, "Intraoperative Oxygen Administration, Mechanisms, and Outcomes - The Perioperative Sweet Spot"

05/13/2022 Cardiovascular outcomes research in perioperative medicine (COR-PM) annual meeting. Frameworks for Planning Clinical Outcomes Research panel: "Outcome Selection"

10/21/2022 Multicenter perioperative outcomes group annual retreat, New Orleans, LA. Best of MPOG presentation "Intraoperative oxygen administration"

10/23/2022 American Society of Anesthesiologists annual meeting, New Orleans, LA. Panel presentation (Recent updates in cardiac surgery associated-acute kidney injury), "Hemolysis in cardiac surgery associated AKI"

- 10/24/2022 American Society of Anesthesiologists annual meeting, New Orleans, LA. Panel presentation (ARC - Transforming patient-centered outcomes research panel presentation), "Draft recommendation for an ARC Network"
- 05/12/2023 Foundation for Anesthesia Education and Research Mentored Research Training Grant annual meeting, Washington, D.C. Panel presentation (Mid-career Panel), "Tracking towards independent funding and the R35 grant mechanism"

### **VISITING PROFESSORSHIPS**

- 09/10/2012 Medical University of South Carolina, Charleston, SC. Special Seminar in Nephrology, "Cardiac surgery-induced oxidative stress and kidney injury"
- 03/09/2015 Cornell University and Memorial Sloan Kettering Medical Center combined Grand Rounds for Anesthesiology, New York, NY. "Oxidative injury during cardiac surgery"
- 12/10/2015 Columbia University College of Physicians and Surgeons Department of Anesthesiology Grand Rounds, New York, NY. "Oxygen toxicity during surgery"
- 08/03/2016 University of California San Francisco, Department of Anesthesia and Critical Care Medicine Grand Rounds, San Francisco, CA. "Oxygen toxicity during surgery" and Research Conference Presentation, "Decision points in clinical trial design"
- 10/11/2017 University of Texas Southwestern, Department of Anesthesiology and Pain Management Grand Rounds, Dallas, TX. "Oxygen toxicity during surgery" and Research Conference Presentation, "Decision points in clinical trial design – results of the Statin AKI cardiac surgery RCT"
- 01/16/2020 Columbia University College of Physicians and Surgeons Department of Anesthesiology Research Seminar, New York, NY. "Approach to Mentorship"

### **SCIENTIFIC PEER REVIEWED PRESENTATIONS:**

- 10/15/2007 American Society of Anesthesiologists, San Francisco, CA. Podium presentation: "Dexmedetomidine protects against radiocontrast nephropathy in mice"
- 10/20/2008 American Society of Anesthesiologists, Orlando, FL. Podium presentation: "Alpha-2 adrenergic agonists protect against radiocontrast nephropathy in mice"
- 10/16/2009 American Society of Critical Care Anesthesiologists, New Orleans, LA. Podium presentation: "Early postoperative statin use is associated with less acute kidney injury following cardiac surgery." Recipient of the *Young Investigator Award*
- 05/13/2011 Association of University Anesthesiologists, Philadelphia, PA. Podium presentation: "Intraoperative circulating hemoproteins, oxidative stress, and acute kidney injury following cardiac surgery"
- 05/19/2012 Association of University Anesthesiologists, Cleveland, OH. Podium presentation: "Obesity predicts kidney injury following cardiac surgery: role of oxidative stress"
- 06/04/2013 Annual Conference on Shock, San Diego, CA. Podium presentation: "Endogenous coenzyme Q10, oxidative stress, and kidney injury following cardiac surgery"

- 06/07/2015 Annual Conference on Shock, Denver, CO. Podium presentation: "Intraoperative normoxia, oxidative damage, and organ injury following cardiac surgery"
- 11/07/2015 American Society of Nephrology, San Diego, CA. High-impact Late-breaking Clinical Trials session: "High-dose perioperative atorvastatin and acute kidney injury following cardiac surgery"
- 02/23/2016 Society of Critical Care Medicine, Orlando, FL. Hot Topics and Late-Breaking Science: "High-dose perioperative atorvastatin and acute kidney injury following cardiac surgery"
- 05/01/2018 International Anesthesia Research Society, Chicago, IL. Collaborative Research Initiative for Perioperative Clinical and Translational Science: "Intraoperative normoxia reduces kidney, heart, and pulmonary injury compared to hyperoxia"
- 03/18/2022 International Anesthesia Research Society, Honolulu, HI (virtual). Podium presentation: "Oxygen Administration Practices during Surgery in the United States"

**MODERATIONS OF PANELS AT SCIENTIFIC MEETINGS:**

- 04/03/2016 Society of Cardiovascular Anesthesiologists annual meeting, San Diego, CA. "Mechanisms of disease in end-organ dysfunction"
- 04/24/2017 Society of Cardiovascular Anesthesiologists annual meeting, Orlando, FL. "Cardiac protection: from caves to the arctic, to the OR"
- 05/01/2018 Society of Cardiovascular Anesthesiologists annual meeting, Phoenix, AZ. "Enhanced recovery after cardiac surgery (ERACS)"
- 05/20/2019 Society of Cardiovascular Anesthesiologists annual meeting, Chicago, IL. "Bench to bedside: best evidence about risk, mechanism, and therapy of organ injury for the clinician"
- 05/13/2021 Association of University Anesthesiologists annual meeting, virtual. Best of oral abstracts: Respiratory and Airway
- 08/03/2021 Association of University Anesthesiologists Scientific Advisory Board Webinar, Acute Respiratory Failure – Lessons Learned from COVID-19, Proposal development and speaker selection
- 03/17/2022 Association of University Anesthesiologists annual meeting, Honolulu, HI. Best of oral abstracts: Pharmacology
- 04/14/2023 Association of University Anesthesiologists annual meeting, Denver, CO. Scientific Advisory Board session II