SCA NEWS

SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS
Knowledge • Care • Investigation

PRESIDENT'S MESSAGE

Volume 43, Number 26
August/September 2024

Kathryn E. Glas
MD, MBA, FASE
President
Society of Cardiovascular Anesthesiologists

"Please take a moment to familiarize yourself with ACCME rules."

ANNOUNCEMENT REGARDING ACCME RULES/GUIDELINES

The ACCME rules for disclosure of financial relationships changed at the beginning of 2022. Based on these new rules, if you have any conflicts of interests, you will not be able to serve on SCA's program planning committees (Annual Meeting and Workshops, SCA Echo, SCA Echo Board Review and the Thoracic Anesthesia Symposium and Workshops).

The SCA, as an ACCME accredited provider, would like all its members to be aware of this rule as it may impact your participation on planning committees as well as involvement in educational activities as faculty/speaker.

The new rules exclude owners or employees of ineligible companies from controlling content or participating as planners or faculty in accredited education. **Click here** for rules of eligibility. There are three exceptions to this exclusion—employees of ineligible companies can participate as planners or faculty in these specific situations:

a. When the content of the activity is not related to the business lines or products of their employer/company.

b. When the content of the accredited activity is limited to basic science research, such as preclinical research and drug discovery, or the methodologies of research, and they do not make care recommendations.

c. When they are participating as technicians to teach the safe and proper use of medical devices, and do not recommend whether or when a device is used.

For questions, please contact SCA Director, Education, Nicole Cranston at ncranston@veritasamc.com.

Best Regards,

Kathryn E. Glas MD

Save *the* Date

Chairs' Message

Join us from February 20-23, 2025, in the dynamic city of Atlanta, Georgia, for SCA Echo!

This four-day conference will immerse you in a series of multidisciplinary panels that explore the critical role of echocardiography in surgical decision-making, especially concerning valvular disease and mechanical circulatory support. Delve into the complex clinical challenges that present in the operating room and impact surgical strategies. Participate in enriching discussions on transcatheter procedures in structural heart disease, and do not miss our **exclusive "Learn from the Experts" sessions.** These sessions will highlight advanced echocardiographic techniques and dissect heart structures to deepen your understanding of echo-anatomic correlations in both transcatheter and surgical interventions.

Do not miss this opportunity to enhance your skills and connect with experts in the field of echocardiography!

Alina Nicoara, MD, FASE
Co-Chair

Charles Nyman, MBBCh
Co-Chair

Kimberly Howard-Quijano, MD
Vice-Chair

Registration Opens
Thursday, October 24, 2024!

THORACIC ANESTHESIA 2025

Save *the* Date

Dear Colleagues,

Please plan to join us at the 13th Annual Thoracic Anesthesia Symposium and Workshops in belle Montreal, Canada! We are excited to see you there for a robust exchange of ideas, techniques, and advances in the field of Thoracic Anesthesia.

We recognize how valuable your time is and the wide array of choices available to you for continuing medical education. In addition to didactic sessions presented by international experts in Thoracic Anesthesia, the Thoracic Anesthesia Symposium Planning Committee is also excited to offer a selection of updated and new Workshops featuring hands on experience with 3D printed models, precision ultrasound guidance, and augmented reality technology.

As always, we aim for the Symposium to provide you with critical updates on relevant topics in Thoracic Anesthesia, to enhance your learning of important techniques and skills, to promote discussion and debate of controversial topics in our field, and to facilitate networking. We are also pleased to offer novel research and challenging case presentations in both poster and oral presentation formats as well as several problem-based learning discussions. Each session is thoughtfully designed to present clear and timely information pertinent to our unique subspecialty.

During the next months leading up to our meeting in Montreal, please check out the SCA DocMatter Thoracic Channel (DLT Exchange) for lively discussions curated by our Planning Committee members along with teasers of our 2025 Symposium content.

We look forward to reconnecting familiar colleagues to meeting new ones!

On behalf of the SCA and the 13th Annual Thoracic Anesthesia Symposium and Workshops, we are so excited see you in Montreal!

Look forward to:

- A focus on dramas, traumas, along with everyday challenges in thoracic anesthesiology.
- Exploration of the latest literature and current controversies by international experts in the field.
- Hands-on workshop featuring new and updated workshop stations with live models, custom high-fidelity 3D phantom models, and 3D anatomic visualization!

At the SCA Thoracic Anesthesia Symposium you can:

- Choose 3 in-person workshops and register for an optional live PBLD for a conference experience tailored to YOUR educational needs.
- Network with 200 other professionals in anesthesiology to help you gain insight into your practice and career.
- Connect with our exhibitors to learn about new products and programs.

Sincerely,

Rebecca Klinger, MD, MS
Chair, Thoracic Anesthesia Symposium and Workshops Program Committee

ABSTRACT INFORMATION

Abstract Opens
Monday, September 16, 2024

Abstract Closes
Monday, December 2, 2024

Save *the* Date

Message from the Scientific Program Chair

Dear Colleagues,

Please join us at the Society of Cardiovascular Anesthesiologists 47th Annual Meeting and Workshops in beautiful Montreal, Canada, April 26-29, 2025. Do not miss a top-notch educational program and opportunities to congregate with friends and colleagues while surrounded by a unique mix of European and North American culture.

Enjoy small group sessions, workshops, and presentations and panel discussions on all the hot topics and developments in our field. The program will address the latest research, as well as clinical controversies in our practice, with experts from the world of cardiology, cardiothoracic surgery, perfusion, critical care medicine, regional anesthesiology, law, and finance enriching our panel discussions. The workshops are hands-on opportunities to learn cutting edge technology from masters in the field in smaller, more interactive settings. Problem-based learning discussion sessions offer opportunities to learn by working through clinically challenging cases in a focused, small group setting led by experts.

Research focused sessions will have experts presenting and discussing latest trials and cutting-edge work, the work of our SCA members will be presented in the "Best of Meeting" sessions and in abstract presentations. A brand-new Cardiovascular Outcomes Research in Perioperative Medicine (COR-PM) Research track will be included in the Annual Meeting and offer high level content for the serious researchers among us. Echocardiography CME hours will be offered in general sessions and workshops, and the true echo-geeks among us will not want to miss the discussion at the SuperEcho session.

Finally, we have a specific program designed for trainees, with unique sessions geared toward the educational and professional development needs of our medical students, residents, and fellows.

Full Program details will be forthcoming but save the date and plan on joining us in Montreal as we come together to share our knowledge and experience in our chosen specialty.

See you there!

Jonathan Ho, MD, FASE
Chair, Scientific Program Committee 2025

Stephanie Ibekwe, MD, MBA, MPH, MS
Vice Chair, Scientific Program Committee 2025

SCA ANNUAL MEETING 2025

Look forward to:

- Amazing content delivered by experts in cardiothoracic anesthesiology, interventional cardiology, and cardiothoracic surgery.
- Experts will provide didactics, small group breakout teaching, and high yield discussions.
- Problem based learning discussions, scientific abstracts, and workshops are planned to optimize attendee learning and connection on critical cardiothoracic anesthesiology topics.
- Attendee networking, idea-sharing, and exhibits

This year, in-person you can:

- Attend live discussion sessions to help you discover up to date practice pathways and innovations in the field
- Register for Workshops and PBLDs tailored for YOUR educational needs
- Network with 1,200 other professionals in anesthesiology as well as thoracic surgeons to help you gain insight into your practice and career
- Connect with industry and exhibiting companies to learn about new products and programs

MEETING VENUE

Montreal Convention Center
159, rue Saint-Antoine Ouest
Montreal, QC, H2Z 1H2

HOTEL INFORMATION

InterContinental Montreal
$299 CAD
Cut-off dates: April 3, 2025

Embassy Suites by Hilton Montreal
$265 CAD
Cut-off Date: April 2

Le Westin Montreal
$311 CAD
Cut-off Date: April 3

ABSTRACT INFORMATION

Abstract Opens
Monday, September 16, 2024

Abstract Closes
Monday, December 2, 2024

Registration Opens December 4, 2024!

SCA NEWS

REMEMBERING SCA'S FIRST PRESIDENT – DR. ROBERT MARINO

Robert (Bob) Marino, MD
March 7, 1946 - July 25, 2024

Robert (Bob) Joseph Marino, MD, died unexpectedly at his home July 25, 2024. He was the first president of the newly formed Society of Cardiac Anesthesia (SCA) in 1979. He and his cardiac anesthesiology colleagues at the Ochsner Clinic including George Burgess, MD and Martin Peuler, MD foresaw the need for anesthesiologists interested in and practicing the rapidly emerging field as needing a forum for education and research. Burgess wrote bylaws and registered the organization in Louisiana to serve the nation in 1978.[1] The first or foundational meeting was held in New Orleans November 16-17, 1979.

Bob can best be described as an affable but committed cardiac anesthesiologist. Being with him, one was never far from a deep bellied laugh and a smile as wide as his face. His unassuming, self-deprecating nature belied his very serious belief in the necessity for better education and the generation of new knowledge in the field he saw as crucial to the development of all anesthesiology and cardiac surgery. **All who worked with him or had the privilege of helping establish the new field of cardiac anesthesiology listened carefully to his ideas and embraced his gentle leadership.**

Bob was born March 7, 1946, in New Orleans and graduated from Loyola College in New Orleans, Louisiana State University School of Medicine in New Orleans, completed his residency at the University of Mississippi School of Medicine in Jackson, MS, under Jim Arens, MD, and then did a fellowship at the Texas Heart Institute under Arthur Keats, MD. Both Arens and Keats themselves made major contributions to anesthesiology, and Bob no doubt learned a great deal about leadership from these two mentors.

The early years of the SCA have been recorded[2] and suffice it to say that Bob became the Godfather of the organization. The bylaws for years specified that the founding President (Marino) and Vice-President (Burgess) be members of the SCA Board of Directors, and his counsel was formally assured. But more than that, especially in the formative years of the Society, he was always a phone call away to offer sage advice to the presidents and board as the organization enjoyed spectacular growth. It is certain that the membership and annual meetings achieved unimaginable success in the first ten or so years – much of it due to the quiet, sustained support of the Godfather.

Among his notable professional contributions at Ochsner Clinic was the founding and medical direction of the Ochsner Flight Care Program. Later he served as the Medical Director of the Outpatient Surgery Center at Ochsner Covington. In his non-professional time he enjoyed photography, sports cars and car racing. He had a life-long interest in animals, particularly dogs and was a supporter of Northshore Humane Society and St. Tammany Parish Department of Animal Services.

Bob is survived by his wife of 56 years, Betsy, and children Jeanne and Robert M who is an anesthesiologist. He has six grandchildren and two great grandchildren. His contributions to the Society of Cardiovascular anesthesia are only surpassed by his love and devotion to his large family – **he will be greatly missed, but his contributions will be forever remembered by a grateful anesthesiology subspecialty.**

Written by:
Jerry Reves, MD
Fred Guidry, MD

1. Burgess, G., SCA Past President - George Burgess, MD, G.P. Gravlee, Editor. 2023, SCA: SCA Website.
2. Reves, J.G., An essay on 35 years of the Society of Cardiovascular Anesthesiologists. Anesth Analg, 2014. 119(2): p. 255-65.

SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS
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SERVE YOUR SOCIETY

Call for Volunteers Coming this Fall!
April 2025 - April 2027 Term Selection

Support your Society's strategic goals and initiatives by serving on one of its 40-plus committees and sub-committees! The Call for Volunteers will be open this October to fulfill the 2025-2027 term. Watch your in-box later this summer for details.

For questions related to the Call for Volunteers, please email committees@scahq.org

The following committees are anticipated to have openings for the 2025-2027 Term:

- Abstract Review Committee
- Acute Kidney Injury (AKI) Sub-Committee
- Artificial Intelligence in Cardiovascular Anesthesia (Task Force)
- Atrial Fibrillation Sub-Committee
- Blood Management Sub-Committee
- Bylaws Committee
- Clinical Practice Improvement Committee
- Diversity, Equity, and Inclusion Committee
- SCA Echo Program Planning Committee
- Economics and Gov. Affairs Sub-Committee
- Enhanced Recovery After Cardiac Surgery Sub-Committee
- Enhanced Recovery After Thoracic Surgery Sub-Committee
- Ethics Committee
- Guidelines and Standards Sub-Committee
- Kaplan Leadership Development Award Sub-Committee
- Mechanical Circulatory Support Sub-Committee
- Member Engagement Committee
- Mobile App Sub-Committee
- Newsletter Sub-Committee
- Online Education Sub-committee
- Quality, Safety and Value Committee
- Research Committee
- Scientific Planning Committee (SCA Annual Meeting)
- Thoracic Anesthesia Symposium Planning Committee

Consider Joining a Committee

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PUF GRANT

NOW OPEN!

PARTICIPANT USER FILE RESEARCH PROGRAM

2024-2025 Participant User File Research Grant

Letter of Intent Submission

The Call for Participant User File (PUF) Research Grant Letter of Intent (LOI) is NOW open. Each selected applicant will be awarded up to $15,000 to apply for and complete an STS Participant User File (PUF) application.

PUF applications being accepted for research projects based on data from the Adult Cardiac Surgery Database, General Thoracic Surgery Database, Congenital Heart Surgery Database, and the INTERMACS Database.

***Please Note:** SCA will not consider applications from primary investigators (PI's) currently receiving SCA research funding. However, they may serve as a co-investigator on a PUF application.*

All STS Database related documents are available after a free registration through the STS website: www.sts.org.

First Step - Letter of Intent Required Documents
(All documents will be required to be uploaded as a PDF):

- The Letter of Intent (LOI) should not be more than two pages.
- The LOI should detail the proposed title of the project and a statement that the PI/applicants checked and verified that their proposed work is not similar to a previously completed or presently active STS approved research proposal.
  - List of active STS research proposals from all programs
  - List of recently published STS research studies based on STS National Database data
- The LOI should describe the roles of the key personnel including PI, co-investigators, cardiac surgeon who are also an active STS member, and a PhD level biostatistician. Their backgrounds/connection to the topic area, the key personnel, and the unique skills or resources they and their institutions bring to the project.
- Details of the proposed study, including background, specific aims, the study design, and target patient population or disease process, along with a description of any translational/mechanistic components.
- Biosketch in the new NIH formatting for the PI.

Award details:

- Total award amount: $60,000 for a total up to 4 grants awarded at $15,000 each.
- Award duration: One time award.
- **Letter of Intent (required) deadline: September 16, 2024.**
- Notification of invitation for full application: October 31, 2024.
- Application deadline for invited applicants: November 25, 2024.
- Award recipients announced: February 2025.
- Click Here for full application requirements.

Click Here TO SUBMIT YOUR LETTER OF INTENT

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AWARDS

Congrats PUF Award Winners!

Congratulations to the Participant User File (PUF) Award Winners!

The winners were awarded for research projects based on data from the Adult Cardiac Surgery Database, General Thoracic Surgery Database, Congenital Heart Surgery Database, and the INTERMACS Database.

2023 Winners

Jiapeng Huang, MD, PhD

University of Louisville

Title: *Deep Interpretable Neural Network-based Perioperative Cardiac Surgery Associated Acute Kidney Injury Risk (CSA-AKI) Prediction and Markov Decision Process for Clinical Treatment Recommendation from STS Database*

Harikesh Subramanian, MBBS, MS

University of Pittsburgh

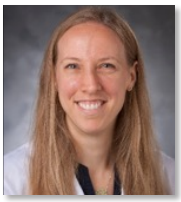
Title: *Association Effects of Social Determinants of Health (Sdoh) on Complications after VAD*

Isaac Y. Wu, MD

University of Rochester

Title: *Association Between Postoperative Cardiac Surgical Outcomes and the Familiarity of the Anesthesiologist-Surgeon Dyad and Composition of the Anesthesia Care Team*

2022 Winners



Anne Cherry, MD

Duke University Medical Center

Title: *Training and Validation of Novel Cardiac Surgical Risk Models Incorporating Right Ventricular Function from the STS Adult Cardiac Surgery Database*

Amanda Kleiman, MD

University of Virginia

Title: *Multimodal Analgesia and Outcomes after Cardiac Surgery: A Retrospective Cohort Study*

Emily MacKay, DO, MSHP

University of Pennsylvania

Title: *Assessment of a Tree-Based, Machine Learning Algorithm to Optimize Intraoperative Transesophageal Echocardiography Allocation for Isolated Coronary Artery Bypass Graft Surgery – A Precision Medicine Application*

Jacob Raphael, MD, FAHA

Thomas Jefferson University

Title: *Perioperative Acetaminophen and Decreased Postoperative Acute Kidney Injury (AKI) After Cardiac Surgery*

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2025 Annual Society Awards Call for Recommendations Submission Window Open August 1 - September 23, 2024

The SCA encourages its members to honor those who have made a significant impact within the Society and the sub-specialty of cardiovascular anesthesiology by recommending them for one of its annual awards.

The Distinguished Service Award

- Honors an individual who has made a meaningful contribution to the ***field of cardiovascular anesthesiology*** through research, education, or service that has produced a significant impact in the field.
- This individual does not have to be an anesthesiologist but must be a member of the SCA.
- To submit a recommendation for this award, click here!

The Presidential Outstanding Service Award

- Honors an individual who has made outstanding, long-term contributions to the ***Society of Cardiovascular Anesthesiologists (SCA).***
- This individual must be an anesthesiologist and a member of the SCA.
- To submit a recommendation for this award, click here!

The John Hinckley Outstanding Service Award

- Honors an individual who has contributed to or advanced the ***field of cardiovascular anesthesiology*** through education, research, or innovative clinical work.
- This individual must be a ***non-physician.*** Membership in the SCA is not required.
  - Examples of possible recipients include perfusionists, blood bank personnel, etc.
- To submit a recommendation for this award, click here!

A listing of past Society awardees may be found here.

2025 Kaplan Leadership Development Award

Accepting Applications Beginning September 13

Applications for the 2025 Kaplan Leadership Development Award will be accepted September 13, 2024 - January 13, 2025. The award is designed to assist cardiothoracic and vascular anesthesiologists in their career by granting funding to further their leadership development through coursework and leadership-specific studies.

The Kaplan Leadership Award will be adjusted accordingly to offer an aggregate of $5,000 to either one recipient or divided among two.

$5,000/$2,500 from the SCA Endowment, with a $5,000/$2,500 match from the applicant's institution to fund a leadership education strategy

Click here Kaplan Leadership Development Award for more information on this award and how to apply.

Questions about the grant and grant application may be emailed to operations@scahq.org.

SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS
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2025 Call for Nominations NOW Open! Apply Today for an SCA Leadership Position

The SCA encourages its members to honor those who have made a significant impact within the Society and the sub-specialty of cardiovascular anesthesiology by recommending them for one of its annual awards. The call will be open September 10 - October 7, 2024. Watch your in-box and the SCA Website for details.

Eligible nominees must be an SCA "Active" Member in good standing.

President-Elect (1 opening)

- Term: 2-year term commencing in April 2025.
- Overview: The President-Elect shall assist in the performance of the President's duties, serves as Chair of the CME Committee, and is responsible for the overall goals of the Society's educational programs. **Candidates for officer positions must have served on the SCA Board of Directors for one full term**. Must attend up to 4 Board meetings per year.

Secretary/Treasurer (1 opening)

- Term: 2-year term commencing in April 2025.
- Overview: The Secretary/Treasurer is charged with monitoring and reporting the financial health of the organization, in addition to assuring the proper record of all formal Society proceedings. **Candidates for officer positions must have served on the SCA Board of Directors for one full term.** Must attend up to 4 Board meetings per year.

Director-at-Large (2 openings)

- Term: 3-year term commencing in April 2025.
- Overview: The Director-at-Large will bring expertise in cardiovascular anesthesiology, governance, and finance to the Board.
- **The ideal candidate will have prior SCA involvement experience.**
- Must attend up to 4 Board meetings per year.

Nominating Committee-at-Large Member (2 openings)

- Term: 2-year term commencing in April 2025.
- Overview: The Nominating Committee assembles a list of the willing and most qualified candidates for positions in the Society leadership. Nominating Committee members should have knowledge of the Society and previous involvement with SCA. Must be able to participate in up to 4 meetings per year.

Continuing Medical Education (CME) Committee Member (1 opening)

- Term: Up to a 4-year term commencing in April 2025.
- Overview: The CME Committee leads and facilitates the independent development of unbiased, scientifically balanced, CME activities.
- **The ideal candidate will have prior SCA involvement experience.**
- Must be able to attend up to 2 CME Committee meetings.

All nominees for any of the positions listed above must submit the following:)

- A self-nomination letter or a letter of nomination from a Society member (for self-nominees, this letter cannot be combined with the statement of intent)
- Two letters from Society members seconding the nomination.
- A statement of intent from the nominee
- The nominee's curriculum vitae
- Biography – **150 words or less** (Those more than 150 words will be returned for revisions)
- A high-resolution, color business photo of the nominee

If you are self-nominating or submitting your application: You will be required to complete the online application. Your SCA username and password is required.

2025 SCA DEI Junior Resident Scholarship

Submission Accepted Beginning in November

The Society of Cardiovascular Anesthesiologists Diversity, Equity, and Inclusion Committee (DEI) Junior Resident Scholar Program provides selected underrepresented minority (URM) anesthesiology residents (CA1) early exposure to cardiovascular anesthesiology by attending the SCA Annual Meeting, presenting a poster and interacting with SCA members and leaders. Applications will be accepted November 1, 2024, through January 19, 2025. Watch your in box for details!

The goals of this scholarship are:

- To expose URM residents to the clinical practice of cardiothoracic anesthesiology by attending the SCA annual meeting.
- To give URM resident scholars early involvement in the SCA through interactions with and mentorship by leaders of the sub-specialty and other cardiothoracic anesthesiologists.

SCHOLARSHIP INFORMATION

Ten scholarships will be awarded in 2025!

REQUIREMENTS

- Nomination of URM resident by the program director or cardiothoracic faculty.
- The nominee must be an academically promising URM CA1 resident in good standing in an ACGME-accredited residency program.
- Each nominee must submit an essay addressing the following (maximum 500 words):
  - Diverse background of the nominee
  - Nominee's understanding of the issues of DEI in Cardiovascular medicine
  - Nominee's interest in CV anesthesia
- A letter of support from the program director and one additional letter of recommendation from a faculty member.
- The CV of the nominee.
- Recipients must be members of the SCA, or agree to become one, to accept the scholarship. Non-members will receive a complimentary, one-year resident/fellow membership to meet this requirement.

FUNDING

$1,000 travel stipend; complimentary basic registration to the 2025 SCA Annual Meeting.

EVALUATION AND SELECTION

Scholarship applications will be reviewed and selected by the Scholarship Review & Selection Sub-Group of the DEI Committee at the SCA. Up to 10 scholarships will be awarded yearly.

Questions? Please write to us at dei-cmte@scahq.org

Application will be accepted November 1, 2024, through January 19, 2025. Watch your in box for details!

Support Your Society through the SCA Endowment

Your donation plays a pivotal role in the Society of Cardiovascular Anesthesiologists' (SCA) ongoing mission to lead, innovate, and excel in the field of cardiovascular anesthesiology. Every contribution is directed towards funding cutting-edge research, supporting educational programs, and developing resources that enhance patient care.

By investing in the advancement of knowledge and treatment strategies, your generosity not only aids in the education and development of current and future anesthesiologists but also contributes to improving the outcomes for patients facing cardiovascular diseases across the globe. In essence, your support empowers the SCA to continue its vital work, ensuring that the most advanced care and groundbreaking research continue to evolve and reach those in need.

The SCA Endowment Fund online donation page is available. Making an online donation is quick, easy, and secure.

To complete the online donation form, **CLICK HERE**

ANESTHESIA & ANALGESIA

A&A Editorial Fellowship Call for Applications

Anesthesia & Analgesia (A&A) is seeking to appoint up to 12 Editorial Fellows annually –directed at current residents, specialty trainees and fellows, or early career researchers across our content spectrum – to join our Journal Editorial Board to shadow and to learn from the work of editors, while also completing a project relevant to the science and practice of scholarly publishing.

Applications are welcome from all countries. Applicants do not need to be current members of the International Anesthesia Research Society (IARS) or A&A journal subscribers, but both are strongly encouraged.

A vital goal of Anesthesia & Analgesia is to foster the global research community by addressing the needs of individuals in the early stages of their clinical and academic careers. Understanding the journal peer review process and acquiring journal editorial skills are essential for academicians and clinical researchers – yet are seldom well addressed during doctoral education and postdoctoral training.

A&A has launched the A&A Editorial Fellowship, which is designed to mentor and to train early career individuals interested in better understanding and more effectively contributing to scholarly publishing.

During this 12-month opportunity, the Editorial Fellow will join our Journal team to acquire skills, gain experience, and receive behind-the-scenes insights into every aspect of journal editorial work. A&A expects that this Editorial Fellowship will strengthen the participants' multidimensional yet interrelated roles as researchers, educators, authors, peer reviewers, and grant applicants.

For more information, please visit the **A&A website.**

Introducing the SCA ARC Question Bank!

ARC Question Bank: You Asked, We Answered!

This question bank of 400+ questions will help you prepare for the ABA's Adult Cardiac Anesthesia Board Examination. All questions were written by cardiac anesthesiologists.

Price

Member: $200 • Non-member: $350

Join the Society of Cardiovascular Anesthesiologists and SAVE on the question bank and receive ARC: A Review Course for the ABA's Adult Cardiac Anesthesia Board Examination for free!

ARC: A Review Course for the ABA's Adult Cardiac Anesthesia Board Examination

SCA's ARC: A Review Course focuses on the Adult Cardiac Anesthesia Board Examination that will be administered by the American Board of Anesthesiology in December 2024.

Our review course embraces the intersection of technology and education and hosts a series of 48 interactive modules that will walk you through the content outline of the ACA exam. These modules contain images, videos, tables, and text from a variety of sources, but have been arranged for members in easy-to-navigate modules. Work through our modules that are rigorously cited and peer-reviewed.

This course is for **FREE** to all SCA members within the SCA University account! If you have not created an account, you will need to do so before you can access. If log in assistance is required, please contact info@scahq.org. For non-members, **you can join** and have access to these interactive modules! ACCESS COURSE

SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS
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Presented by the American Society of Regional Anesthesia and Pain Medicine & The Society of Cardiovascular Anesthesiologists

ASRA PAIN MEDICINE

Register NOW for this Joint Webinar between SCA and ASRA

Pioneering Regional Anesthesia Strategies in Cardiothoracic Surgery: A Multidisciplinary Approach

Wednesday, September 18, 2024 • 7:00 PM – 8:30 PM, ET

Topics & Speakers:

- Regional Anesthesia for Arrhythmias - Kamen Vlassakov, MD
- Blocks in the EP Lab and OR for Devices, Minimally Invasive Cardiac Surgery, and Sternotomy - Himani Bhatt, DO, MPA
- Current Evidence on Regional Anesthesia for Cardiothoracic Surgery - Ban Tsui, MD
- ERAS Protocols: Challenges, Logistics, and Successes - Jessica Brodt, MD
- Analgesia After Median Sternotomy – Pectointercostal Plane Blocks and Beyond – Sina Grape, MD
- Question & Answer Session

REGISTER NOW

SPOTLIGHT

AWEsome Woman Interview

Nadia B. Hensley, MD

Johns Hopkins University School of Medicine

It is a privilege to be interviewed for the AWEsome woman section of the SCA newsletter. I am an Associate Professor of Anesthesiology and Critical Care Medicine (ACCM) at Johns Hopkins Hospital in Baltimore, MD, where I also serve as the Deputy Vice Chair of Quality, Safety, and Service for ACCM.

My childhood was in a small town in western Tennessee. I then graduated from Rhodes College in Memphis, TN. After a period exploring other career opportunities outside of medicine, I attended the University of TN College of Medicine in Memphis. My fascination with taking care of patients with complex disease during their surgery led me to pursue an anesthesiology residency at Virginia Commonwealth University Medical Center in Richmond, VA and serve as chief resident in my final year.

Through experiencing my cardiac anesthesia rotation and performing translational research in perfluorocarbons with Dr. Bruce Spiess, I decided to pursue a cardiothoracic anesthesiology fellowship at Johns Hopkins. After which, I was recruited to be on faculty.

1. What led you to become a Cardiovascular/Thoracic Anesthesiologist?
First, I was drawn to caring for patients with more complex physiology undergoing high-risk surgeries. During medical school I was considering becoming a surgeon since I found immense satisfaction in learning procedural skills, understanding anatomy better and how to perform well in a high stake's environment. When I decided anesthesiology was a better fit, it was the bigger cases with high-risk patients that kept me most engaged and wanting to learn more to ensure the best patient outcomes.

I have been an amateur photographer since a college photography class and I'm drawn to the visual arts, drawing and painting throughout high school. When I was introduced to how skillful TEE imaging was able to inform decision making in cardiac surgical patients, I was hooked. I had the opportunity to moonlight in the cardiac surgical ICUs on the weekends during residency. By being the lone provider throughout the night in the CVSICU, I was deeply challenged which prepared me for being a cardiothoracic anesthesia fellow. Since I thrive on challenge, this experience further solidified my desire to become a cardiovascular anesthesiologist.

2. How did you hear about the SCA?
As a fellow, I attended my first SCA meeting immediately following my oral board exam. I was highly encouraged by faculty at Hopkins to submit an abstract which I was happy to do. I attended the fellows' programmed events, one of which was a panel of academic and private practice cardiovascular anesthesiologists.

Dr. Colleen Koch from the Cleveland Clinic was a panelist, and I was interested to learn about her journey in academic medicine. Twelve years later, I can still hear Colleen's voice describing her mantra of "one paper a year" while she was busy raising her three children. Little did I know that in two years' time, Colleen would become Chair of our department at Hopkins.

As junior faculty, I continued to be encouraged to be an active member in the SCA. Dr. MaryBeth Brady, as recent Chair of the SCA Annual meeting, is highly involved in the SCA and inspired many of us to begin our journey participating on committees and submitting ideas for panel presentations, PBLDs, and workshops.

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In 2017, Dr. Jake Abernathy was recruited to be our new Division Chief. Given his long-term commitment and service to the SCA, his leadership influenced many faculty members, including myself, to further our engagement.

3. What roles have you held for the society?
Starting in 2018, it was an honor to be asked to serve on the scientific program committee. I have thoroughly enjoyed collaborating with those on this committee to create an attractive annual meeting for the previous 5 years. In the same year, I became a member of the quality and safety leadership (QSL) committee and served as the liaison to the scientific program committee. Since the QSL committee was the parent committee for many sub-committees in the prior SCA structure, serving to create panel discussions, pro-con debates and workshop ideas from each sub-committee was a large part of my role.

Beginning in 2021, I became active on the SCA patient blood management (PBM) working group and was asked to serve as Vice Chair. Along with the Chair, Dr. Jacob Rafael, and the fantastic group of fellow members, we have worked on several projects for SCA including creating podcasts for SCA University, writing a clinical practice advisory for patients on direct oral anticoagulants (DOACs) in non-elective surgery, and a clinical practice guideline on preoperative anemia management. I am thrilled and honored to co-lead this committee and work with those that are passionate about PBM.

In 2023, I was excited to be asked to be the research liaison for WICTA interest group. It is wonderful to collaborate with this amazing group of women cardiovascular anesthesiologists to further their research goals. We have created research dyads and triads in which a more experienced mentor can team with a mentee through a research project for publication. I have a strong interest in creating opportunity for growth for other women as I have benefited immensely from those willing to invest in me.

4. What is one of your greatest achievements as a Cardiovascular/Thoracic Anesthesiologist?
One of my greatest achievements have been collaborating with medical students, residents, and fellows on research projects, including the forming the hypothesis, analysis, abstract submissions, abstract presentations, writing manuscripts, responding to reviewers, through to final publication. It is a joy to celebrate a publication in a respected journal with those trainees after the long process.

I have had the pleasure of working with fantastic trainees and always learn a great deal from them each time. Their enthusiasm is contagious and when they decide they will become an anesthesiologist, apply for the research track in residency, or choose to do a cardiovascular anesthesiology fellowship, it is another positive reinforcement of why I enjoy working in academic medicine.

5. Do you have any advice for fellows and residents?
Try to remember that your career is long. Although a year of fellowship in the area you are most interested in is an investment in both time and salary, your return on investment will be high if it will allow you to practice over a long career in the area you are most passionate about.

6. Have you experienced any difficulties as a woman in the field?
Early in my career, I had to ensure that I was assertive with surgeons who may not know me. I would call them by their first name so they would understand my role as the attending anesthesiologist. I also had to be confident in approaching male colleagues who excluded me from research discussions, whether inadvertently or not, to demonstrate I was interested and willing to put in the time and work. At the same time, I needed to balance humility with confidence, while acquiring new research skills.

Women tend to be questioned more about why they may be in a certain position. A few years ago, Dr. Sasha Shillcutt moderated the opening plenary session of the SCA Annual Meeting, and I was honored to be asked to speak along with Dr. Amanda Fox and others. During our session, there were online comments posted that were bullying and mean spirited. The virtual moderators removed those inappropriate comments quickly. Sometimes it is necessary to ignore the noise and focus on the positive and why you deserve to be there instead of starting down a path of imposter syndrome and self-doubt.

7. Do you have any advice for other women in the field?
Do not be afraid to take risks during your career. I have learned so much more from my failures than when everything went smoothly. It is also never too late to acquire new skills, take courses, and expand your capabilities. Having a growth mindset makes most things more fun. Finding the right mentor for you may take some time, but it is good to keep trying different mentors. Your mentorship needs may evolve over time depending on your interests. I have been fortunate enough to have excellent male and female mentors and sponsors who have been crucial to my professional development.

Along with taking risks, get comfortable with being uncomfortable. Early in my career as I was asked to be an administrative leadership role in our department, I attended hospital meetings in quality. We met in the historic hospital in a beautiful room with a long table and several seats outside of the table. I noticed several women sitting in these outside seats. I decided, although it felt uncomfortable since I did not know other leaders yet, I was going to take a seat at the table.

8. How do you balance work and personal life?
When my kids were very young, I was not as engaged as I am now in research, applying for grants, or writing many manuscripts. As junior faculty, I was focused on quality, safety, and service work, including taking courses (far from Baltimore) that would give me a greater depth of understanding in this area of healthcare.

Like many women in academic medicine, as my kids became closer to school age, I had more time to evaluate what was invigorating to me and prioritize how to accomplish my academic goals. During the COVID pandemic, I suddenly found myself with the time and interest to begin grant writing and writing more manuscripts. Since I am an extrovert, the pandemic gave me the solitude I needed to turn to more internal pursuits such as writing.

It is vital to me to strike the right balance. I find joy in being engaged in my kids' activities. Even simple tasks such as taking them to school on my post-call day or volunteering to be their soccer coach are highly important to me. When we are balanced, we are much more productive in our work lives which leads to greater satisfaction.

9. What is something you enjoy doing outside of work?
I have been a lifelong runner since high school and in the last year, started racing again. I am currently training for my first marathon in 17 years and enjoying the process. I have met a great group of runners in a community running club and this has made training much more fun.

10. Would you change anything about the path you took to get to where you are now?
If I had known I would be as involved in clinical research as I currently am now, I would have completed early research training by completing a Masters in Statistics or Health Science. Having the skills earlier that I needed for optimizing research analyses would have been crucial for future professional development.

11. What was the best piece of advice you received?
It is important to be your authentic self as a leader as this fosters trust. Building trusting relationships at work is vital to being an effective leader.

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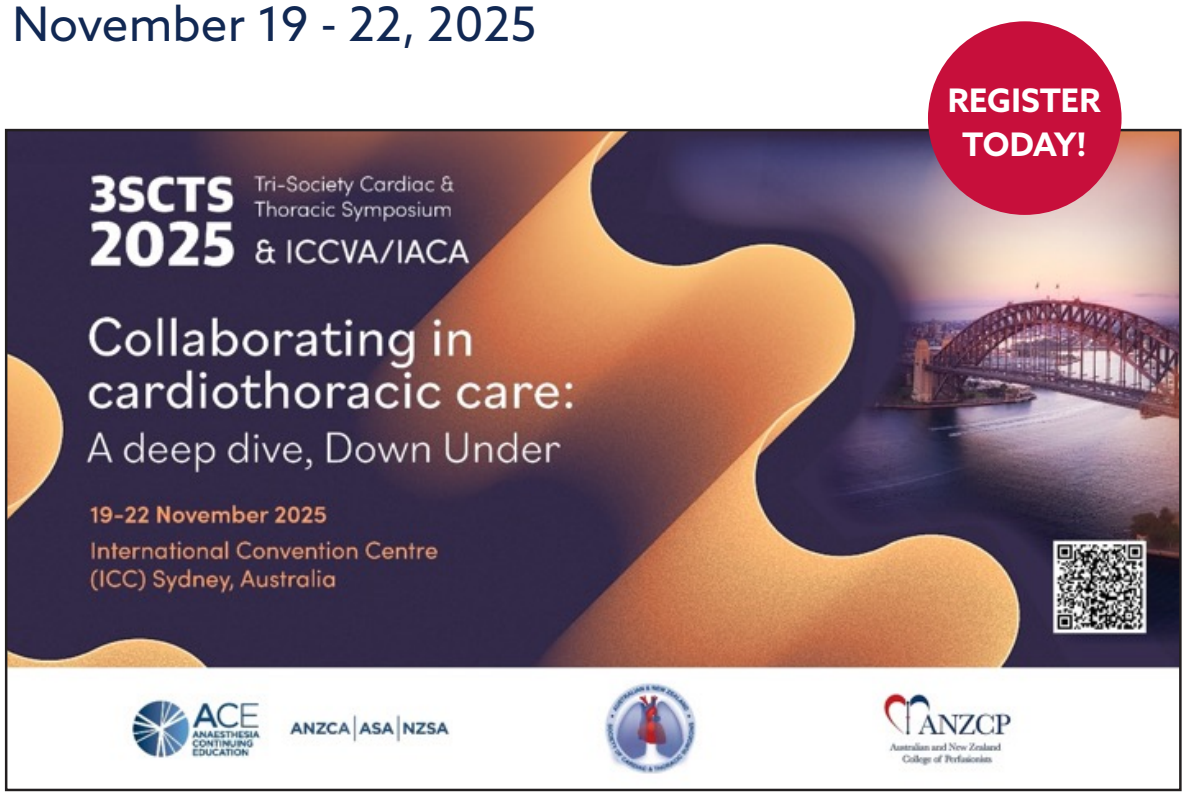

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CLINICAL REVIEWS

Associations Between Nonanemic Iron Deficiency and Postoperative Outcomes in Cardiac Surgery

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Anesthesia & Analgesia. 2024 July; 139 (1) 47-57. DOI: 10.1213/ANE.0000000000006822. PMID: 38241670

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Background

Non-anemic iron deficiency (NAID) in heart failure patients is associated with reduced functional capacity and quality of life, both of which improve with iron repletion.[0] This raises the possibility that treatment of NAID may also contribute to improved outcomes in cardiac surgery patients. Multiple guidelines and societies recommend testing and treatment for iron deficiency in the prior to cardiac surgery.[2,3,4]

While anemia is associated with inferior post-operative outcomes in elective cardiac surgery, the association between NAID and postoperative outcomes is less well-understood.[2,5,6] The authors of this study performed a systematic review, meta-analysis, and meta-regression of existing evidence to evaluate the association between NAID and adverse outcomes following cardiac surgery, and to determine if preoperative NAID screening should be recommended.

Methods

The authors performed a comprehensive search of observational studies through December 9, 2022, comparing iron-deficient vs iron-replete adults undergoing cardiac surgery. In included studies, iron deficiency was defined by ferritin concentrations and/or transferrin saturation (TSAT) levels. Anemia was defined as a hemoglobin concentration <130 g/L in men and <120 g/L in women.

The primary outcome was hospital length of stay (LOS). Secondary outcomes included days alive and at home on post-operative days 30 and 90, blood transfusion requirements, ICU LOS, all-cause complications, infection, readmission, and mortality.

Statistical analysis involved comparing binary outcomes with adjusted odds ratios (OR) and continuous outcomes with mean differences (MD), using random-effects inverse variance modeling and the I2 statistic for heterogeneity assessment. Univariate meta-regression was used to explore relationships between patient factors and NAID.

Results

Eight studies with a total of 2,683 patients were included in the analysis; of these, 1,130 patients (42.1%) were iron deficient and 1,553 (57.9%) were iron replete. Nearly all studies defined iron deficiency as ferritin < 100 ug/L or ferritin between 100 and 300 ug/L and TAT < 20%. Seven of the eights' studies involved patients undergoing coronary artery bypass grafting and/or cardiac valve surgery; the remaining study was limited to surgical aortic valve replacements.

There was no significant difference in the primary outcome of mean hospital LOS for patients with NAID versus patients without iron deficiency (9.77 days v 8.84 days: mean difference [MD] 0.54 days, 95% CI -0.04 to 1.13, P = 0.07). NAID patients were significantly more likely to receive a blood transfusion compared to non-iron deficient patients (OR 1.39, 95% CI 1.16 to 1.68, P < 0.01). However, there was no evidence of an association with the number of units transfused (MD 0.13 units, 95% CI -0.1 to +0.35 units, P = 0.27).

No significant differences were observed in other secondary outcomes, including ICU length of stay (LOS) (MD 3.43 hours, 95% CI -1.37 hours to +8.23 hours, P = 0.16), mortality (OR 1.48, 95%

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CI 0.51 to 4.26, P = 0.47) rates of post-operative complications (OR 1.42, 95% CI 0.86 to 2.34, P = 0.17) including infection (OR 1.06, 95% CI 0.78 to 1.44, P = 0.32), or days alive and at home on post-operative day 90 (DAH-90) (MD 0.04 days, 95% CI -0.43 to +0.34, P = 0.82).

Of note, quality of evidence was deemed "low" DAH-90, and "very low" for all other outcomes.

Discussion

This systematic review and meta-analysis explored the association between nonanemic iron deficiency (NAID) and postoperative outcomes in patients undergoing cardiac surgery, compared to non-iron-deficient patients. Iron levels are crucial for heme synthesis, blood oxygen carrying capacity and mitochondrial function, and screening and treatment of NAID are broadly recommended for prospective cardiac surgery patients.[1,2,7,8]

Despite the biological plausibility of an association between iron deficiency and inferior post-operative outcomes, this study did not find a significant difference in the primary outcome or most of secondary outcomes between NAID and non-iron deficient patients undergoing cardiac surgery. Although there was a significant difference in the binary outcome of blood transfusion between NAID and non-iron deficient patients, there was no correlation with the number of units of blood transfused between the two groups.

The authors of this study suggest that a more restrictive definition of iron deficiency such as the definition used by the World Health Organization may yield more conclusive evidence.[8]

The findings of the study are limited by the observational nature of all included studies. In addition, the quality of evidence was ated"low" or "very low," due in part to the lack of control for surgical risk prediction score and lack of information about the time lag between iron testing and the index operation.

Although the current study observed reduced transfusion risk in "iron replete" patients, it did not evaluate differences in outcomes following treatment for NAID. NAID treatment has previously been shown to reduce the risk of blood transfusion, as in a double-blind, randomized, placebo-controlled trial that found that a single dose of IV iron reduced RBC transfusion requirements in NAID patients.[9]

Given the complications associated with blood transfusions and, at times, scarcity of donor blood, treatment of NAID may be beneficial. However, further research is needed to determine if routine testing and treatment for NAID is warranted in pre-operative cardiac surgery patients.

Conclusions

In the current study, NAID was associated with increased transfusion requirements, but not with the primary outcome of hospital LOS or with other secondary outcomes, including mortality and postoperative complications. Current evidence does not strongly support routine preoperative screening for NAID to improve postoperative outcomes in cardiac surgery patients. Further research is necessary to establish more definitive guidelines.

References

1. von Haehling S, Jankowska EA, van Veldhuisen DJ, Ponikowski P, Anker SD. Iron deficiency and cardiovascular disease. Nat Rev Cardiol. 2015;12:659–669.
2. Guinn NR, Schwartz J, Arora RC, et al; Perioperative Quality Initiative (POQI-8) and the Enhanced Recovery After Surgery-Cardiac Society (ERAS-C) Investigators. Perioperative quality initiative and enhanced recovery after surgery-cardiac society consensus statement on the management of preoperative anemia and iron deficiency in adult cardiac surgery patients. Anesth Analg. 2022;135:532–544.
3. Kotzé A, Harris A, Baker C, et al. British Committee for Standards in Haematology Guidelines on the identification and management of pre-operative anaemia. Br J Haematol. 2015;171:322–331.
4. Muñoz M, Acheson AG, Auerbach M, et al. International consensus statement on the peri-operative management of anaemia and iron deficiency. Anaesthesia. 2017;72:233–247.
5. Muñoz M, Laso-Morales MJ, Gómez-Ramírez S, Cadellas M, Núñez-Matas MJ, García-

Erce JA. Pre-operative haemoglobin levels and iron status in a large multicentre cohort of patients undergoing major elective surgery. Anaesthesia. 2017;72:826–834

6. Padmanabhan H, Siau K, Curtis J, et al. Preoperative anemia and outcomes in cardiovascular surgery: systematic review and meta-analysis. Ann Thorac Surg. 2019;108:1840–1848
7. Muñoz M, Gómez-Ramírez S, Besser M, et al. Current misconceptions in diagnosis and management of iron deficiency. Blood Transfus. 2017;15:422–437
8. Ward DM, Cloonan SM. Mitochondrial Iron in Human Health and Disease. Annu Rev Physiol. 2019;81:453–482.
9. Friedman, Tom, et al. "Intravenous iron administration before cardiac surgery reduces red blood cell transfusion in patients without anaemia." British Journal of Anaesthesia 131.6 (2023): 981-988.

CLINICAL REVIEW

Machine Learning Multicenter Risk Model to Predict Right Ventricular Failure After Mechanical Circulatory Support

The STOP-RVF Score

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JAMA Cardiol. 2024;9(3):272-282. doi:10.1001/jamacardio.2023.5372

Published online January 31, 2024.

Reviewer:

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Background

The recent years, use of the Left Ventricular Assist Device (LVAD) has become frequent for surgical management of advanced heart failure, either as a destination therapy or as a bridge to transplant. Right ventricular failure (RVF), either as progression of preexisting right ventricular dysfunction or as a new onset in the perioperative period, occurs in as high as 15-40% of patients after LVAD implantation, and is associated with increased morbidity and mortality.[1-5] Prediction of the patients at high risk to develop RHF after LVAD implantation is important for appropriate patient selection and management.

Early treatment of RVF with a planned assist device is associated with improved outcomes compared to late implementation as rescue.[6,7] Patients who receive LVAD as destination therapy have worse outcomes if they develop RHF and may need pharmacologic or other long-term support.[8]

In this study the investigators examined the question whether patients at high risk of developing RHF after LVAD implantation can be identified in advance. Data derived from pre and during implantation values and patient characteristics were used to develop an RVF risk calculator which was then validated.

Existing proposed models for prediction of RVF have several methodologic problems such as: single center studies, varying RVF definitions, older generation LVADs so limited applicability today, non-inclusion of intraoperative data and most importantly poor performance with external validation.[5,9-13]

Methods

The study was a hybrid prospective-retrospective cohort of consecutive heart failure patients who received advanced heart failure therapy with continuous flow LVAD between 4/2008 and 7/2019. The University of Utah, Intermountain Medical Center, and the George E Wahlen VAMC contributed patients prospectively between 4/2008-7/2019 and the Inova Heart and Vascular Institute and the Henry Ford Hospital contributed retrospectively between 1/2015-7/2019, total of 798 patients which constituted the derivation cohort. The 327 consecutive patients with severe heart failure who received an LVAD at Stanford University, during the same study period, served as the independent external validation cohort.

RVF was defined as use of inotropic support for at least 14 days postoperatively and/or percutaneous or implanted right sided mechanical support within 30 days post LVAD implantation.

Baseline data were collected within 24 hours prior to LVAD and included: demographics, comorbidities, laboratory values and medications. Hemodynamic data were collected from the last assessment prior to LVAD implantation and included pulmonary artery (PA) pulsatility index (PAPi)

and PA pulse pressure (PAPP), as well as echocardiographic assessment. Intraoperative values including duration of surgery and CPB, blood transfusion requirements, arterial blood gases were also collected.

Primary outcome: RVF.

Secondary outcome: 3 days, 6 months, and 12 months all-cause mortality.

The variables collected were compared between patients of the derivation cohort who developed RVF and those who did not, to identify risk factors predisposing to RVF.

AI machine learning techniques, bootstrap imputation and adaptive least absolute shrinkage were used for the development of the predictive model named STOP RVF score, an RVF risk calculator. The RVF risk calculator was derived from variables of the derivation cohort and externally validated in the validation cohort and compared with previously published RVF risk scoring systems.[5,12]

Results

From the 798 patients of the derivation cohort and 327 patients of the validation cohort 193 (24.2%) and 107 (32.7%) respectively developed RVF.

Derivation cohort, characteristic values of patients who did vs did not develop RVF:

	RVF	non RVF
Non ischemic cardiomyopathy	66.3%	57.7%
INTERMACS 1	27.4%	10%
Preop inotropes	86 %	73.6%
Temp support/ impella	23.8%	7.6%
Received centrifugal LVAD	76.7%	58.4%
BUN	34.1 mg/dL	29.7 mg/dL
Na	132.9 mEq/L	134.9 mEq/L
Albumin	3.38 g/dL	3.6 g/dL
Preoperative HR	93.4 BPM	87.9 BPM
Mean RA pressure	13mmHg	11mmHg
RA/PCWP ratio	0.58	0.46
PAPP	25.57	27.03
RV stroke work index	6.39 g/m²/beat	7.19 g/m²/beat
PAPi	2.75	3.75
CPB duration	102 min	85 min
Peak lactate	3.53 mmol/L	2.47 mmol/L
Hgb	8.77g/dL	9.43 g/dL
PRBC	2.48 units	1.31 units

Echocardiographic measurements were not different between patients with or without RVF.

The BI-BL variable selection method identified the following 11 parameters, associated with postoperative RVF which were included in the STOP-RVF score: Non ischemic cardiomyopathy, IABP, Impella or ECMO, LVAD configuration, INTERMAX profiles 1 to 2, RA/PCWP, use of ACEIs, platelet count, Na, Albumin and Creatinine.

When tested in the derivation cohort the model showed high discriminative performance with ability to predict RVF c-statistic 0.75. Independently tested in the validation cohort, it showed high discriminative performance with c-statistic 0.73, outperforming previous studies: Kormos5 0.58 and Drakos12 0.62.

When applying the RVF risk score to all-cause mortality, in the derivation and validation cohorts, survival rate was higher when the postoperative course was not complicated by RVF. Lower risk patients were less likely to develop RVF and had better survival.

Discussion

In this large multicenter cohort of over 1000 patients, of which approximately one quarter developed RVF, associated with worse outcomes. Better prediction of the patients at risk to develop RVF can guide management and improve outcomes. The machine generated STOP-RVF score identified patients at risk of developing post LVAD RVF better than previous models, which can improve outcomes.

References

1. Slaughter MS, Rogers JG, Milano CA, et al; Heart Mate II Investigators. Advanced heart failure treated with continuous-flow left ventricular assist device. N Engl J Med. 2009;361(23):2241-2251. doi:10.1056/NEJMoa0909938
2. Rogers JG, Pagani FD, Tatooles AJ ,et al. Intrapericardial left ventricular assist device for advanced heart failure. N Engl J Med.2017;376(5): 451-460. doi:10.1056/NEJMoa1602954
3. Dang NC, Topkara VK, Mercando M, et al. Right heart failure after left ventricular assist device implantation in patients with chronic congestive heart failure. J Heart Lung Transplant. 2006;25(1):1 6. doi:10.1016/j.healun.2005.07.008
4. Potapov EV, Stepanenko A, Dandel M, et al. Tricuspid incompetence and geometry of the right ventricle as predictors of right ventricular function after implantation of a left ventricular assist device. J Heart Lung Transplant. 2008;27(12):1275-1281. doi:10.1016/j.healun.2008.08.012
5. Kormos RL, Teuteberg JJ, Pagani FD, et al; Heart Mate II Clinical Investigators. Right ventricular failure in patients with the Heart Mate II continuous-flow left ventricular assist device: incidence, risk factors, and effect on outcomes. J Thorac Cardiovasc Surg. 2010;139(5):1316-1324. doi:10.1016/j.jtcvs.2009.11.020
6. Fitzpatrick JR III, Frederick JR, Hiesinger W, et al. Early planned institution of biventricular mechanical circulatory support results in improved outcomes compared with delayed conversion of a left ventricular assist device to a biventricular assist device. J Thorac Cardiovasc Surg. 2009;137(4):971 977. doi:10.1016/j.jtcvs.2008.09.021
7. Shah P, Ha R, Singh R, etal. Multicenter experience with durable biventricular assist devices. J Heart Lung Transplant. 2018;37(9):1093 1101. doi:10.1016/j.healun.2018.05.001
8. Molina EJ, Shah P, Kiernan MS, et al. The Society of Thoracic Surgeons INTERMACS 2020 Annual Report. Ann Thorac Surg. 2021;111(3):778-792. doi: 10.1016/j.athoracsur.2020.12.038
9. Fitzpatrick JR III, Frederick JR, Hsu VM, et al. Risk score derived frompre-operative data analysis predicts the need for biventricular mechanical circulatory support. J Heart Lung Transplant. 2008; 27(12):1286-1292. doi:10.1016/j.healun.2008.09.006
10. Matthews JC, Koelling TM, Pagani FD, Aaronson KD.Therightventricular failure risk score a preoperative tool for assessing the risk of right ventricular failure in left ventricular assist device candidates. J Am Coll Cardiol. 2008;51(22):2163-2172. doi:10.1016/j.jacc.2008.03.009
11. Atluri P, Goldstone AB, Fairman AS, etal. Predicting right ventricular failure in the modern, continuous flow left ventricular assist device era. Ann Thorac Surg. 2013;96(3):857-863. doi:10.1016/ j.athoracsur.2013.03.099
12. Drakos SG, Janicki L, Horne BD, et al. Risk factors predictive of right ventricular failure after left ventricular assist device implantation. Am J Cardiol. 2010;105(7):1030-1035. doi:10.1016/j. amjcard.2009.11.026
13. Soliman OII, Akin S, Muslem R, et al; EUROMACS Investigators. Derivation and validation of a novel right-sided heart failure model after implantation of continuous flow left ventricular assist devices: The EUROMACS (European Registry for Patients with Mechanical Circulatory Support) right-sided heart failure risk score. Circulation. 2018;137(9):891-906. doi:10.1161/CIRCULATIONAHA. 117.030543

CLINICAL REVIEW

Volatile Anesthetic Use Versus Total Intravenous Anesthesia for Patients Undergoing Heart Valve Surgery: A Nationwide Population-Based Study

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Anesthesia & Analgesia 139(1):p 114-123, July 2024

Reviewer:

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Background

Cardiac surgery carries a high rate of major organ injury and postoperative mortality as compared with many other types of surgery.[1] Anesthetic agents have demonstrated organ-protective effects in preclinical work. Volatile agents exert cardioprotective effects through mediating inflammation and pre-conditioning via mimicking ischemic conditions.[2,3] Alternatively, propofol-based total intravenous anesthesia (TIVA) has also been proposed to have anti-inflammatory and antioxidant effects, although the science remains in the pre-clinical phase with a focus on the kidney.[4-6] To date there have been no definitive studies to suggest benefit of either volatile or TIVA based techniques.

The Mortality in Cardiac Surgery Randomized Controlled Trial of Volatile Anesthetics (MYRIAD) did not demonstrate a mortality benefit after coronary artery bypass grafting (CABG) when volatiles were used as compared to TIVA. This has been the largest prospective randomized trial on this topic, at 5,400 subjects. Criticisms of this study include non-standard use of volatiles with washout or wash-in volatile periods, instead of whole case use.[7] However, more recently, meta-analyses that have included the MYRIAD trial have suggested that there are benefits of volatile agents. One demonstrating benefit in long-term mortality, and secondary outcomes including myocardial protection.[8] The other finding no mortality or myocardial protection benefits but did find shorter ICU and hospital stays with volatile use.[9]

Therefore, this study attempted to expand on the work of MYRIAD by evaluating outcomes based on anesthetic technique in valve surgery patients.

Methods

This study analyzed claims from the national Korean database of Healthy Insurance Review and Assessment of Korea, where data for all Korean residents are mandated to be reported. Patients over the age of 18 undergoing aortic, mitral, or tricuspid surgery without concomitant CABG or aortic surgery were included in this study. Patient pre-operative demographics were captured via ICD-10 codes. Data was analyzed as intention to treat.

The primary outcome was 1-year all-cause mortality and secondary outcomes included all-cause mortality in-hospital, and at 30 days, 90 days, and 1 year or beyond. The primary outcome was analyzed using cox proportional hazards regression analysis with adjustment via stabilized inverse probability of treatment weighting (IPTW). Notably there were significant differences in baseline characteristics with volatile patients having increased rates of chronic pulmonary disease, having surgery at institutions with less case volume per year, and with significant differences in years where the surgery was performed as defined by the authors absolute standardized mean difference threshold of > 0.1. These differences did not meet significance after IPTW.

A post hoc sample size justification was performed, using a weighted sample size estimate based on IPTW. With the adjusted sample size, the observed 1-year mortality of 8.5% and a 90% power, the minimum hazard ratio detectable was 0.14 from 1 (>1.15 or < 0.87).

Results

In the unadjusted analysis volatile anesthetics had a significantly increased 1 year mortality at 8.9% compared to TIVA 7.6%. Volatiles also had a significantly increased mortality at every time point analyzed for secondary outcome.

In the adjusted analysis, where all covariates were balanced, there were no statistically significant differences between groups in any primary or secondary outcome.

No subgroup analysis displayed intergroup differences that were statistically significant. Subgroups that had the largest, albeit not significant differences, included sex, extracardiac arteriopathy, surgery type and institutional case volume. Subgroups that favored volatile use, although not significant statistically, included older, male, non-diabetic, those with recent myocardial infarction, those with extracardiac arteriopathy, those with pulmonary disease, undergoing primary aortic valve surgery, and at lower volume institutions.

Discussion

This study differs from prior work in its form (cohort, large sample size), study population (valve surgery, east Asian population) and execution (intention to treat, volatile vs. TIVA, and long term follow up, median 4.8 years).

The advantage of this study includes its clinically relevant anesthetic plans, whole case TIVA or volatile as compared to MYRIAD. Adjustments were made for potential confounders such as institutional case volume.

The disadvantages include, as this was not randomized, anesthetic prescription was up to provider discretion, therefore there may be subject to provider or systemic bias. Additionally, post-operative sedation with propofol may limit differences seen. No information of dose of anesthetics delivered was available for study. Notably anesthetic preconditioning may have dose dependency in cardio protection.[10] No investigation into cardiac assessments via echocardiography or cardiopulmonary bypass related data was analyzed.

Conclusion

Based on the analysis presented by the authors there appears to be no significant benefit in using volatile anesthetics over TIVA for heart valve surgery.

However, despite extensive statistical weighting, the starting differences between groups studied may allow for unmeasured confounders. Further large scale prospective randomized work may be called for to definitively answer the question at hand.

New Issues Here

Added heart VALVE surgery
Previous results inconclusive

Questions

Stabilized inverse probability of treatment weighting
Overall incidence of 1 year mortality 8.5%

References

1. Conrad C, Eltzschig HK. Disease mechanisms of perioperative organ injury. Anesthesia & Analgesia. 2020;131(6):1730-1750.
2. De Hert SG, Turani F, Mathur S, et al. Cardioprotection with volatile anesthetics: mechanisms and clinical implications. Anesthesia & Analgesia. 2005;100(6):1584-1593.
3. Pagel PS. Myocardial protection by volatile anesthetics in patients undergoing cardiac surgery: a critical review of the laboratory and clinical evidence. Journal of cardiothoracic and vascular anesthesia. 2013;27(5):972-982.
4. Rodríguez-López JM, Sánchez-Conde P, Lozano FS, et al. Effects of propofol on the systemic inflammatory response during aortic surgery. Canadian Journal of Anesthesia. 2006;53(7):701.

5. Sánchez-Conde P, Rodríguez-López JM, Nicolás JL, et al. The comparative abilities of propofol and sevoflurane to modulate inflammation and oxidative stress in the kidney after aortic cross-clamping. Anesthesia & Analgesia. 2008;106(2):371-378.
6. Irwin M, Chung C, Ip K, et al. Influence of propofol- based total intravenous anaesthesia on peri- operative outcome measures: a narrative review. Anaesthesia. 2020;75:e90-e100.
7. Landoni G, Lomivorotov VV, Nigro Neto C, et al. Volatile anesthetics versus total intravenous anesthesia for cardiac surgery. New England Journal of Medicine. 2019;380(13):1214-1225.
8. Bonanni A, Signori A, Alicino C, et al. Volatile anesthetics versus propofol for cardiac surgery with cardiopulmonary bypass: meta-analysis of randomized trials. Anesthesiology. 2020;132(6):1429-1446.
9. Beverstock J, Park T, Alston RP, et al. A comparison of volatile anesthesia and total intravenous anesthesia (TIVA) effects on outcome from cardiac surgery: a systematic review and meta-analysis. Journal of cardiothoracic and vascular anesthesia. 2021;35(4):1096-1105.
10. Kehl F, Krolikowski JG, Mraovic B, et al. Is isoflurane-induced preconditioning dose related? The Journal of the American Society of Anesthesiologists. 2002;96(3):675-680. mechanical circulatory support results in improved outcomes compared with delayed conversion of a left ventricular assist device to a biventricular assist device. J Thorac Cardiovasc Surg. 2009;137(4):971 977. doi:10.1016/j.jtcvs.2008.09.021
7. Shah P, Ha R, Singh R, etal. Multicenter experience with durable biventricular assist devices. J Heart Lung Transplant. 2018;37(9):1093 1101. doi:10.1016/j.healun.2018.05.001
8. Molina EJ, Shah P, Kiernan MS, et al. The Society of Thoracic Surgeons INTERMACS 2020 Annual Report. Ann Thorac Surg. 2021;111(3):778-792. doi: 10.1016/j.athoracsur.2020.12.038

CLINICAL REVIEW

Article Review: Association Between Loop Diuretics and Mortality in Patients with Cardiac Surgery–Associated Acute Kidney Injury

Reviewer:
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Atrium Health Wake Forest Baptist

Overview

AKI is a frequent complication post-cardiac surgery, with varying reported incidence. It leads to prolonged hospital and ICU stay, increased mortality and morbidity and subsequently higher healthcare costs. There is a lack of specific pharmacological interventions routinely used to prevent AKI post-cardiac surgery due to limited and sometimes conflicting evidence. This study explores the relationship between the use of loop diuretics (LDs) and mortality rates in patients who developed acute kidney injury (AKI) following cardiac surgery (CS-AKI). Utilizing a retrospective cohort design, the researchers aimed to clarify the effectiveness of LDs in improving patient outcomes in this context.

Study Goals

To determine if LD use is effective in reducing in-hospital and ICU mortality in patients with CS-AKI. To address the limitations of previous studies, such as small sample sizes and inconsistent definitions of AKI and LD exposure.

Methodology

Data from the Medical Information Mart for Intensive Care III (MIMIC-III) database were used. Patients who underwent cardiac surgery and developed AKI during their ICU stay were included. The primary outcomes measured were in-hospital and ICU mortality rates. Inverse probability weighting (IPW) was utilized to minimize bias.

Results

The study included 5478 patients, with a significant proportion of women. Patients who received LDs had significantly lower in-hospital and ICU mortality rates compared to those who did not. Adjusted hazard ratios indicated a significant reduction in both in-hospital and ICU mortality for patients treated with LDs.

The benefits of LD use varied with the patients' fluid balance and other co-existing medical conditions, suggesting a need for personalized management.

Conclusions

LD use is associated with reduced hospital and ICU mortality in CS-AKI patients. The study suggests that while LDs can be beneficial, individual patient factors should be considered to ensure optimal outcomes.

Strengths

Large sample size and robust methodology, including the use of IPW to adjust for potential confounding variables. Clear identification of the study population and comprehensive outcome measures. Detailed statistical analyses supporting the findings.

Implications

This study provides valuable insights into the potential benefits of LDs for patients with CS-AKI, highlighting the importance of personalized medical management. Clinicians should consider individual patient factors, such as fluid balance, when prescribing LDs to optimize outcomes.

The findings contribute to the ongoing discussion about the best practices for managing AKI in cardiac surgery patients and forming future guidelines and clinical practices.

Overall, the article presents a significant contribution to understanding the role of LDs in managing postoperative complications in cardiac surgery patients, emphasizing the importance of tailored treatment approaches.

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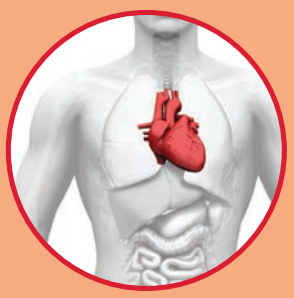

ECHO REVIEW

Quantification of Mitral Regurgitation in Mitral Valve Prolapse by Three-Dimensional Vena Contracta Area: Derived Cutoff Values and Comparison with Two-Dimensional Multiparametric Approach

J Am Soc Echocardiogr.
Fiore G, Ingallina G, Ancona F, Gaspardone C, Biondi F, Margonato D, Morosato M, Belli M, Tavernese A, Stella S, Agricola E.
2024 Jun;37(6):591-598. doi: 10.1016/j.echo.2024.03.009. Epub 2024 Mar 24. PMID: 38522488.

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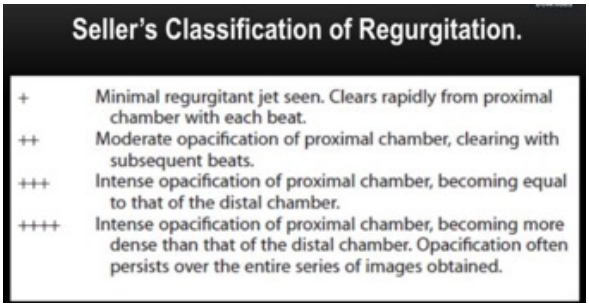
The assessment of mitral regurgitation is anything but clear. Early, quantification was limited to angiographic and two-dimensional echocardiographic data. In time, three-dimensional data was introduced and verified using two-dimensional data. Subsequently, three dimensional analyses by echocardiography and/or cardiac magnetic resonance imaging (CMR) is now considered the preferred method and now used to demonstrate the inaccuracies of two-dimensional analyses. When all is considered, the current MR severity determination began with 2D assessments which was subsequently used to validate the more advanced 3D assessments. Subsequently, the 3D imaging has now described the limitations of 2D assessments.[1] As highlighted in the review by Grayburn, all the assessment modalities have their limitations and range of error.[2]

How did we get to the current criteria for severe mitral regurgitation?? In 1997, Dujardin et al prospectively evaluated 180 patients with mitral regurgitation.[3] The reference measure of MR severity was based on a four-grade angiographic assessment described in 1964 by Sellers et al.[4]

Table 1: Angiographic grading of regurgitant severity of mitral valve

Grade	Mitral regurgitation
1+	Contrast refluxes into the left atrium but clears on each beat
2+	Left atrial contrast density gradually increases but **never equals** left ventricle density
3+	The density of contrast in the atrium and ventricle equalize after **several** beats
4+	The left atrium becomes **as dense as** the left ventricle on the first beat and contrast is seen refluxing into the pulmonary veins



Using echocardiography, mitral regurgitation was quantified using the continuity equation and flow convergence (Proximal Isovelocity Surface Area) technique. Regurgitant volume (RVol), regurgitant fraction (RF), and effective regurgitant orifice area (EROA) were calculated with each technique and compared to angiographic assessment, which was considered the standard.[3] Severe mitral regurgitation (grade 4) was associated:

1. EROA 0.4cm2
2. Regurgitant volume 60 ml/beat
3. Regurgitant fraction 50%

The effective regurgitant orifice measured using PISA-EROA was found to be an independent determinant of survival. Compared to those with a PISA-EROA < 20mm2, patients with an

effective regurgitant orifice of > 40 mm2 had an increased risk of death from any cause, death from cardiac causes, and major adverse cardiac events including cardiac surgery, the latter of which was associated with improved survival.[5] The authors concluded that patients with an effective regurgitant orifice of at least 40 mm2 should promptly be considered for cardiac surgery. Anotoine et al evaluated patients with degenerative mitral regurgitation (DMR) who were managed medically and surgically.[6] Compared with general population mortality, excess mortality appears for moderate DMR (EROA ≥20 mm2), becomes notable at EROA ≥30 mm2, and steadily increases with higher EROA levels > 40 mm2.[6]

In recognizing the benefits and availability of echocardiography, as well as the difficulties in analyzing flow convergences, a number of relatively simpler echocardiographic data have been studied and, per 2017 Guidelines, are incorporated into a 'Multiparametric Approach' toward quantifying MR as mild, moderate, and severe shown below.[7]

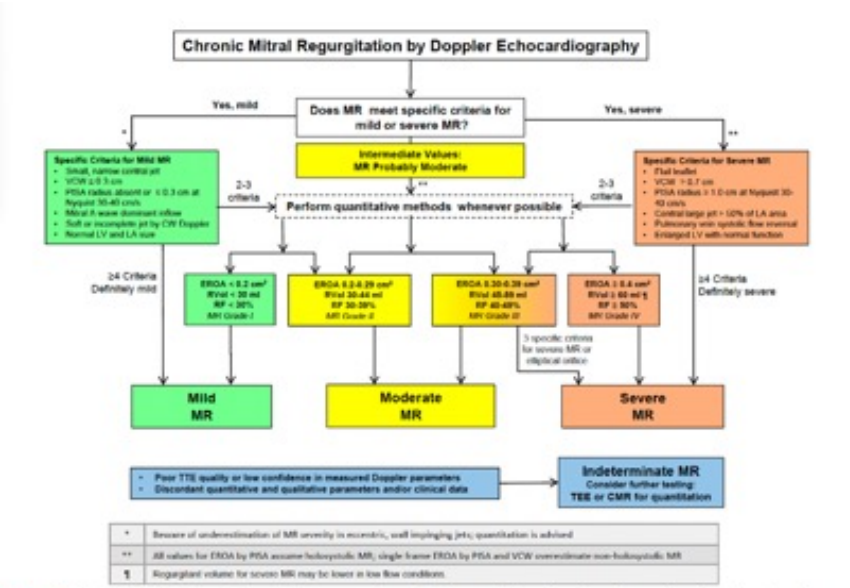
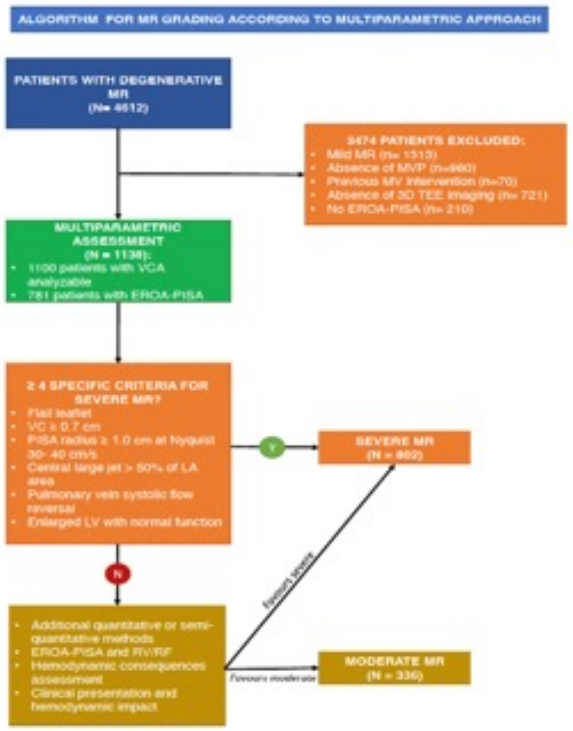


Figure 18 Algorithm for the integration of multiple parameters of MR severity. Good-quality echocardiographic imaging and complete data acquisition are assumed. If imaging is technically difficult, consider TEE or CMR. MR severity may be indeterminate due to poor image quality, technical issues with data, internal inconsistency among echo findings, or discordance with clinical findings.



Study

The study by Fiore et al measured 3D vena contracta area (3D VCA) using 3D color Doppler during transesophageal imaging in 1138 patients with moderate or greater MR due to mitral valve prolapse.[8] These data were compared to 'guideline suggested multiparametric approach' severity determination of mitral regurgitation.[7] Secondarily, the 3D VCA data were compared to the effective regurgitant orifice area estimated by proximal isovelocity surface area (EROA-PISA).[6]

The authors focus on mitral valve prolapse because of the variability in regurgitant orifices recognizing the challenges for echocardiographic imaging.

1. Jet eccentricity
2. Multiple regurgitant jets and multiple orifices
3. Non circularity of regurgitant orifices
4. Regurgitant flow variability during systole

The authors hypothesized that 3D VCA should overcome limitations of 2D EROA-PISA.

Patients underwent both TTE and TEE. Left heart volumes and LVEF were quantified during TTE using biplane modified Simpson's method. Three-dimensional color Doppler datasets were obtained using multi-beat acquisition to achieve a minimum temporal resolution of 12 Hz. Using the guideline multiparametric approach, severe mitral regurgitation was determined by the presence of more than 3 of the following:

1. Flail leaflet
2. Vena contracta width > 7 mm
3. Pulmonary venous systolic flow reversal
4. PISA radius > 1; Nyquist limit 30-40m/s
5. > 50% of the left atrial area
6. Enlarged left ventricle with normal function

Less than or equal to three or a discrepancy of the above findings resulted in a listing of moderate regurgitation, unless additional quantitative or semi-quantitative methods suggested that severe mitral regurgitation was present. Two echocardiographers were involved in determining MR severity.

Calculation of the effective regurgitant orifice area was accomplished using the PISA method. The view and frame were selected by the largest flow convergence zone (Nyquist 30-40cm/s). From this same view a two-dimensional vena contracta width was also measured.

A volumetric analysis was performed by comparing flow across the left ventricular outflow tract to that across the mitral annulus. Mitral annular and LVOT areas were determined using 3D analyses. Pulsed wave Doppler flow profiles were assessed at the mitral annular and LVOT sites respectively

Left ventricular total stroke volume (3D SV) = MAVTI x 3D MAarea
Mitral regurgitant volume (3D RV) = 3D SV – (LVOTVTI x 3D LVOTarea)
Mitral regurgitant fraction (3D RF) = 3D RV/3D SV

The three-dimensional VCA was measured from the volumetric data set using multiplanar reconstruction with Nyquist limit 50-70cm/sec. If multiple jets were involved each was individually cropped and measured, the sum of the equaling the final 3D-VCA.

Not surprisingly, those determined to have severe mitral regurgitation had larger LA and LV volumes, larger EROA-PISA, 2D and 3D vena contracta. Based on guidelines, using multiparametric approach to differentiate severe from moderate MR optimal cutoffs using receiver operating characteristic curves are:

3D VCA 0.45cm2 (Spec 0.87; Sens 0.90)
EROA-PISA 0.37cm2 (Spec 0.94; Sens 0.85)
VCA 6.25mm (Spec 0.87; Sens 0.78)

The correlation and agreement between the 3D VCA and EROA-PISA:

$r = 0.62$; $p < 0.001$
+0.14+/-0.24 cm2
Limits of Agreement -0.33 to +0.61cm2

An EROA-PISA of 0.4 cm2 was considered equivalent to a 3D VCA of 0.5 cm2. Finally, in the subgroup of 126 patients with 3D quantitative Doppler analysis a 3D RF > 50% was associated with a 3D VCA of 0..45 cm2 (Sens 0.78; Spec 0.83), which was significantly greater than the EROA-PISA (0.37 cm2).

Discussion

A number of findings in the study are important. The regurgitant orifice may not be circular nor singular, especially so for patients with degenerative mitral regurgitation with either prolapse or flail leaflet. Reliance on 2D assessment is potentially limiting and may underestimate the total regurgitant orifice area, regurgitant volumes, and regurgitant fraction when compared to 3D volumetric data analysis.

The authors made it a point to describe the machine settings with some emphasis on the temporal resolution (Frame rate) during 3D imaging/analysis. A minimum frame rate of 12 Hz was selected, however, there are no standard guidelines for this. The balance between temporal, lateral, and elevational resolutions produce a more complete interrogation of the regurgitant jet will be. This is critical toward the study since the authors focused on the time of the cardiac cycle when the flow convergence was largest.

The issues regarding identifying severe mitral regurgitation remain. While the present study suggests moving the EROA 'north' from 0.4cm2 to 0.5cm2 it does so based on the initial possible flawed presumption that a EROA of 0.4-0.5cm2 is considered severe. Certainly, one cannot ignore the negative outcome data associated with larger EROA especially when > 0.4cm2 or > 0.5cm2, as well as the potential benefits of surgery.[5,6,8] While this EROA may or may not represent severe mitral regurgitation, it does present a need for me detailed evaluation of the patho-anatomy and etiology of dysfunction that should either be closely observed, managed with goal directed medical therapies, and/or considered for invasive therapeutic options including both percutaneous and surgical approaches toward corrected dysfunction.[5,6,8]

As for the optimal assessment of mitral regurgitation, the establishment of a 'multiparametric approach' alone recognizes the limitations of published data reporting 2D and 3D volumetric, volumetric Doppler flow, and color Doppler analyses.[2,7] It is intuitive that 2D analyses are limited by not appreciating the non-circularity and non-singularity of the ERO(s), which may be overcome with 3D imaging. Perhaps even better is the 3D volumetric flow data as reported by Fiore et al.[8] Volumetric analysis eliminates issues surrounding the irregularity of the ERO.[8,9] However, and not discussed by the authors, a singular 3D assessment of the mitral annulus may not reflect the average annular area during diastole and may overestimate transmitral flow. To confuse the issue more, recent CMR data highlights the underestimation of EROA with 2D analysis.[10,11,12,13,14,15] Although 3D echocardiographic measures of VCA and volumetric data may agree better with CMR, data sill show discordance.[10,11,12,13,14,15] All these data are based on the acceptance that an EROA > 0.4-0.5cm2 is diagnostic of severe mitral regurgitation.

Although EROA analyses, whether by 3D color Doppler VCA or by 3D volumetric analysis may predict what 'will be', it does not necessarily predict the present state of patient, which is more specifically related to hemodynamic consequences of the regurgitant jet i.e., pulmonary edema and reduced cardiac output. It is still not clear that an EROA of 0.4-0.5cm2 is diagnostic of severe mitral regurgitation or just predictive of adverse events. Whether or not severe mitral regurgitation should be determined by the EROA, hemodynamic changes and consequences, or both. While EROA is important, it is possible that a simpler approach to identify clinically severe mitral regurgitation may is best done using Doppler to assess presence of pulmonary vein systolic flow reversal[16,17] or to rule out severe mitral regurgitation by the presence of A-wave dominance on transmitral flow.[18,19] Interestingly, the presence of pulmonary venous flow reversal and failure of medical or invasive therapy to improve it is independently associated with worse outcome.[17,20,21] The limitations of the paper by Fiore et al are similar to that of other like papers in that there is an absence of a single metric that defines clinically severe mitral regurgitation. The combination of both EROA data and hemodynamic data are critical toward assessing the clinical impact of mitral regurgitation.

References

1. Penicka M, Vecera J, Mirica DC, Kotrc M, Kockova R, Van Camp G. Prognostic Implications of Magnetic Resonance-Derived Quantification in Asymptomatic Patients with Organic Mitral Regurgitation: Comparison with Doppler Echocardiography-Derived Integrative Approach. Circulation. 2018 Mar 27;137(13):1349-1360. doi: 10.1161/CIRCULATIONAHA.117.029332. Epub 2017 Dec 21. PMID: 29269390.
2. Grayburn PA, Weissman NJ, Zamorano JL. Quantitation of mitral regurgitation. Circulation. 2012 Oct 16;126(16):2005-17. doi: 10.1161/CIRCULATIONAHA.112.121590. PMID: 23071176.
3. Dujardin KS, Enriquez-Sarano M, Bailey KR, Nishimura RA, Seward JB, Tajik AJ. Grading of mitral regurgitation by quantitative Doppler echocardiography: calibration by left ventricular angiography in routine clinical practice. Circulation. 1997 Nov 18;96(10):3409-15. doi: 10.1161/01.cir.96.10.3409. PMID: 9396435. In.
4. Sellers Rd, Levy Mj, Amplatz K, Lillehei Cw. Left Retrograde Cardioangiography In Acquired Cardiac Disease: Technic, Indications And Interpretations In 700 Cases. Am J Cardiol. 1964 Oct;14:437-47. Doi: 10.1016/0002-9149(64)90027-X. PMID: 14215054.
5. Enriquez-Sarano M, Avierinos JF, Messika-Zeitoun D, Detaint D, Capps M, Nkomo V, Scott C, Schaff HV, Tajik AJ. Quantitative determinants of the outcome of asymptomatic mitral regurgitation. N Engl J Med. 2005 Mar 3;352(9):875-83. doi: 10.1056/NEJMoa041451. PMID: 15745978.
6. Antoine C, Benfari G, Michelena HI, Maalouf JF, Nkomo VT, Thapa P, Enriquez-Sarano M. Clinical Outcome of Degenerative Mitral Regurgitation: Critical Importance of Echocardiographic Quantitative Assessment in Routine Practice. Circulation. 2018 Sep 25;138(13):1317-1326. doi: 10.1161/CIRCULATIONAHA.117.033173. PMID: 29853518.
7. Zoghbi WA, Adams D, Bonow RO, Enriquez-Sarano M, Foster E, Grayburn PA, Hahn RT, Han Y, Hung J, Lang RM, Little SH, Shah DJ, Shernan S, Thavendiranathan P, Thomas JD, Weissman NJ. Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation: A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance. J Am Soc Echocardiogr. 2017 Apr;30(4):303-371. doi: 10.1016/j.echo.2017.01.007. Epub 2017 Mar 14. PMID: 28314623.
8. Fiore G, Ingallina G, Ancona F, Gaspardone C, Biondi F, Margonato D, Morosato M, Belli M, Tavernese A, Stella S, Agricola E. Quantification of Mitral Regurgitation in Mitral Valve Prolapse by Three-Dimensional Vena Contracta Area: Derived Cutoff Values and Comparison with Two-Dimensional Multiparametric Approach. J Am Soc Echocardiogr. 2024 Jun;37(6):591-598. doi: 10.1016/j.echo.2024.03.009. Epub 2024 Mar 24. PMID: 38522488.
9. Shekel E, Shuvy M, Danenberg H, Planer D, Gilon D, Leibowitz D, Beeri R. Mitral Regurgitation Severity Assessment after Transcutaneous Edge-to-Edge Mitral Valve Repair: Recommended Integration versus Volumetric Assessment Guidelines. J Clin Med. 2023 Oct 3;12(19):6347. doi: 10.3390/jcm12196347. PMID: 37834991; PMCID: PMC10573124.
10. Shanks M, Siebelink HM, Delgado V, van de Veire NR, Ng AC, Sieders A, Schuijf JD, Lamb HJ, Ajmone Marsan N, Westenberg JJ, Kroft LJ, de Roos A, Bax JJ. Quantitative assessment of mitral regurgitation: comparison between three-dimensional transesophageal echocardiography and magnetic resonance imaging. Circ Cardiovasc Imaging. 2010 Nov;3(6):694-700. doi: 10.1161/CIRCIMAGING.110.947176. Epub 2010 Sep 1. PMID: 20810848.
11. Marsan NA, Westenberg JJ, Ypenburg C, Delgado V, van Bommel RJ, Roes SD, Nucifora G, van der Geest RJ, de Roos A, Reiber JC, Schalij MJ, Bax JJ. Quantification of functional mitral regurgitation by real-time 3D echocardiography: comparison with 3D velocity-encoded cardiac magnetic resonance. JACC Cardiovasc Imaging. 2009 Nov;2(11):1245-52. doi: 10.1016/j.jcmg.2009.07.006. PMID: 19909927.

12. Zeng X, Levine RA, Hua L, Morris EL, Kang Y, Flaherty M, Morgan NV, Hung J. Diagnostic value of vena contracta area in the quantification of mitral regurgitation severity by color Doppler 3D echocardiography. Circ Cardiovasc Imaging. 2011 Sep;4(5):506-13. doi: 10.1161/CIRCIMAGING.110.961649. Epub 2011 Jul 5. PMID: 21730026; PMCID: PMC3224848.

]13. Spampinato RA, Lindemann F, Jahnke C, Paetsch I, Fahr F, Sieg F, von Roeder M, Noack T, Hilbert S, Löbe S, Strotdrees E, Hindricks G, Borger MA. Quantification of regurgitation in mitral valve prolapse with automated real time echocardiographic 3D proximal isovelocity surface area: multimodality consistency and role of eccentricity index. Int J Cardiovasc Imaging. 2021 Jun;37(6):1947-1959. doi: 10.1007/s10554-021-02179-2. Epub 2021 Feb 22. PMID: 33616785; PMCID: PMC8255267.

14. Uretsky S, Gillam L, Lang R, Chaudhry FA, Argulian E, Supariwala A, Gurram S, Jain K, Subero M, Jang JJ, Cohen R, Wolff SD. Discordance between echocardiography and MRI in the assessment of mitral regurgitation severity: a prospective multicenter trial. J Am Coll Cardiol. 2015 Mar 24;65(11):1078-88. doi: 10.1016/j.jacc.2014.12.047. PMID: 25790878.

15. Uretsky S, Argulian E, Narula J, Wolff SD. Use of Cardiac Magnetic Resonance Imaging in Assessing Mitral Regurgitation: Current Evidence. J Am Coll Cardiol. 2018 Feb 6;71(5):547-563. doi: 10.1016/j.jacc.2017.12.009. PMID: 29406861

16. Castello R, Labovitz AJ. Evaluation of mitral regurgitation by Doppler echocardiography. Echocardiography. 1991 Nov;8(6):699-711. doi: 10.1111/j.1540-8175.1991.tb01035.x. PMID: 10149282.

17. Pu M, Griffin BP, Vandervoort PM, Stewart WJ, Fan X, Cosgrove DM, Thomas JD. The value of assessing pulmonary venous flow velocity for predicting severity of mitral regurgitation: A quantitative assessment integrating left ventricular function. J Am Soc Echocardiogr. 1999 Sep;12(9):736-43. doi: 10.1016/s0894-7317(99)70024-6. PMID: 10477418.

18. Quader N, Katta P, Najib MQ, Chaliki HP. Effect of mitral inflow pattern on diagnosis of severe mitral regurgitation in patients with chronic organic mitral regurgitation. J Cardiovasc Ultrasound. 2013 Dec;21(4):165-70. doi: 10.4250/jcu.2013.21.4.165. Epub 2013 Dec 27. PMID: 24459563; PMCID: PMC3894367.

19. Thomas L, Foster E, Schiller NB. Peak mitral inflow velocity predicts mitral regurgitation severity. J Am Coll Cardiol. 1998 Jan;31(1):174-9. doi: 10.1016/s0735-1097(97)00454-3. PMID: 9426037.

20. Yedidya I, Stassen J, Butcher S, van Wijngaarden AL, Wu Y, van der Bijl P, Marsan NA, Delgado V, Bax J: The prognostic value of changes in pulmonary vein flow patterns after surgical repair for primary mitral regurgitation. International Journal of Cardiology 2024;414; November 1 132414. https://doi.org/10.1016/j.ijcard.2024.132414

21. Bohra, C, Asch, F, Lerakis, S. et al. TCT-334 Pulmonary Venous Flow Pattern as a Predictor of Outcomes in Patients with Secondary Mitral Regurgitation: The COAPT Trial. JACC. 2022 Sep, 80 (12_Supplement) B134–B135.https://doi.org/10.1016/j.jacc.2022.08.392.

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ECHO CORNER

Identifying a Regurgitant Lesion After an Aortic Valve Replacement

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CASE REPORT

A 60-year-old woman with history of a calcified bicuspid aortic valve (Sievers 1) with moderate aortic stenosis, ascending aorta aneurysm (5.5 cm), and moderate tricuspid regurgitation scheduled for a surgical aortic valve replacement (Inspiris bioprosthetic 23 mm), replacement of the ascending aorta (30 mm straight graft), and tricuspid ring valvuloplasty (28 mm).

Question 1

Post cardiopulmonary bypass echo demonstrated the following findings (Videos 1 and Video 2). What is the most likely pathology?

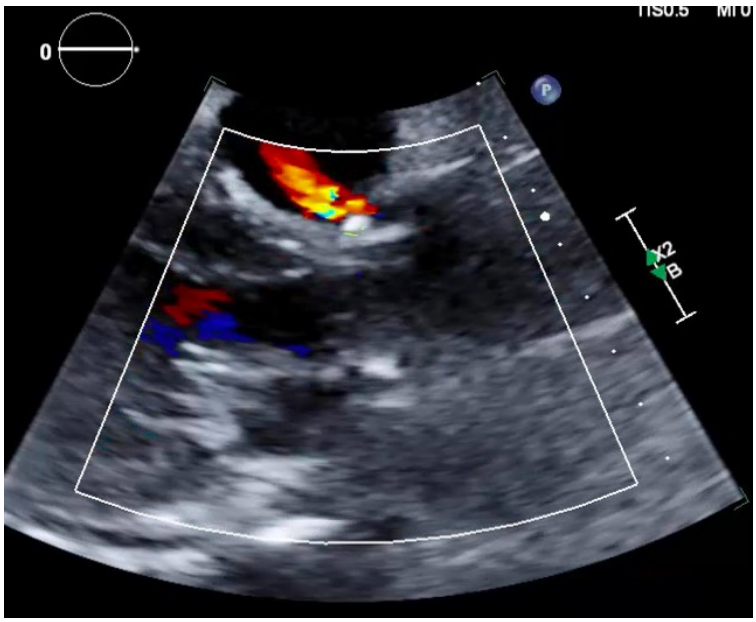
a. Mild pulmonic regurgitation
b. Ventricular septal defect between the LVOT and the RVOT
c. Aorto-ventricular fistula
d. Paravalvular leak

WATCH VIDEO 1 WATCH VIDEO 2

Question 2

Three weeks following discharge the patient presented to the hospital with persistent dyspnea. A TTE was completed with normal biventricular function and demonstrated the below finding (image below). What is the next diagnostic modality for the pathology demonstrated?

a. Transthoracic echocardiography
b. Transesophageal echocardiography
c. Heart catheterization
d. Cardiac magnetic resonance imaging



Identifying a Regurgitant Lesion After an Aortic Valve Replacement

Question 3

Inspiris bioprosthetic valves may have transient diastolic regurgitant jets...

a. True
b. False

Question 4

Which quantitative data suggests a moderate to severe paravalvular leak and would necessitate return to cardiopulmonary bypass for repair?

a. Vena contracta area of 0.2 cm2, circumferential extent < 10%, absent diastolic flow reversal, regurgitant volume 12 mL, EROA < 0.5 cm2
b. Untraceable vena contracta, regurgitant fraction 10%, EROA < 0.1cm2
c. Vena contracta area 0.3 cm2, circumferential extent 22%, pressure half time 380 ms
d. Vena contracta 0.3 cm, absent flow convergence, pressure half time 400 ms, regurgitant fraction20%, EROA 0.8 cm2

Question 5

After trialing a course of diuretics, the patient no longer is having dyspnea. Her follow up TTE demonstrated normal right ventricular function with a normal RVSP. What is the next best course of action in her care?

a. Percutaneous closure device
b. Continue medical management
c. Surgical closure

ANSWERS

Answer 1

C. The most likely pathology is an aorto-ventricular fistula with a continuous flow by color flow Doppler into the RV or RVOT. Continuous flow throughout the cardiac cycle is common with fistulae and ventricular septal defects. Paravalvular leak with aortic prostheses are predominantly characterized with diastolic flow that will be localized within the aortic root. Our media demonstrate extension beyond the root and into the right ventricular cavity. Risk factors for fistula formation after AVR include severe calcification of the coronary cusps, sub annular calcification, and concurrent aortic root intervention.[1]

Answer 2

D. On this transthoracic parasternal long axis view there is a regurgitant jet that traverses the aortic annulus into the right ventricle, which is most consistent with fistula. Though echocardiography was the initial means of diagnosis for this patient. A standard is cardiac MRI, which has proven to be superior in quantification of shunt fraction when compared to echocardiography and computed tomography. Sensitivity of cardiac MRI to detect these anomalies is comparable to angiocardiography.[2]

Answer 3

A. Inspiris valves are uniquely constructed, specifically prosthetics between 19 to 25 mm, which contain lasered stenciled marking holes with an expandable band on the wire frame allowing for frame expansion for future ViV TAVR. The laser stenciled holes are present on the wire frames at each of the three stent posts (12 o'clock, 4 o'clock, and 8 o'clock). The holes allow for diastolic flow from the aortic root through the core-out numbered etching below the coaptation point and into the LVOT.[3] The jet is localized to the valve stent post and can be a single jet or up to three jets. This prosthetic insufficiency is normally transient and frequently resolves after protamine administration.

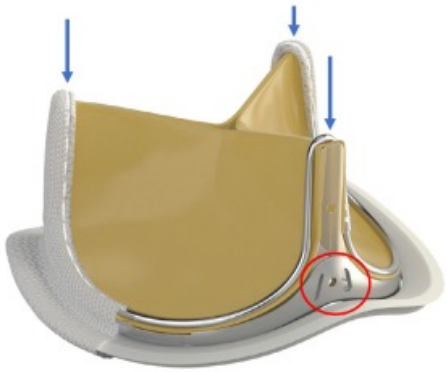


Fig 1. Inspiris valve design. The Inspiris valve is a stented (*blue arrows*), tri-leaflet, bioprosthetic aortic valve. A unique feature is the laser-etched hole in the wire frame (*red circle*), allowing size identification under fluoroscopy. In this image, the "1-9" etching indicates a 19-mm valve. Images reproduced with permission from Edwards Lifesciences.

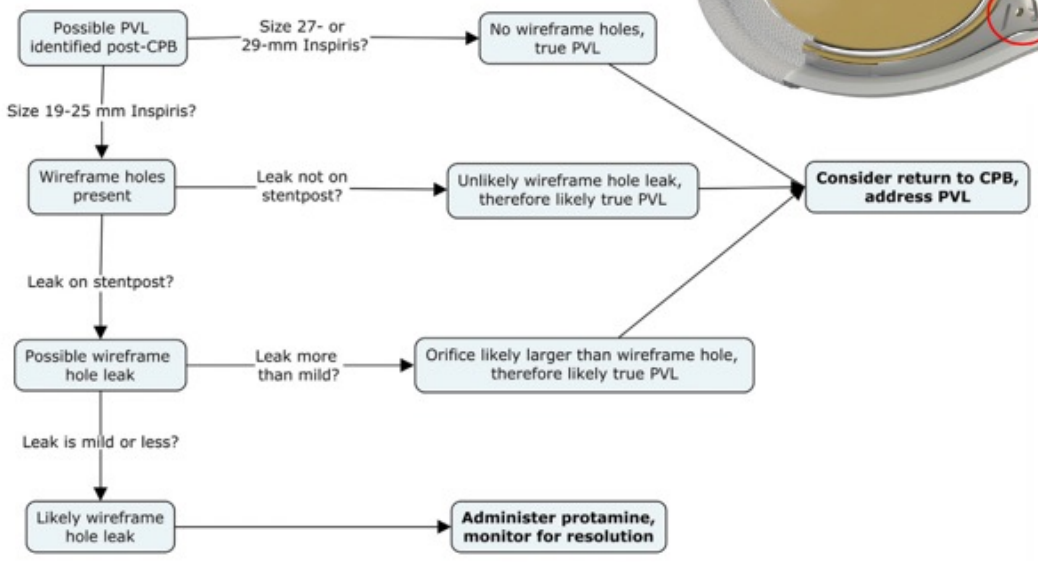


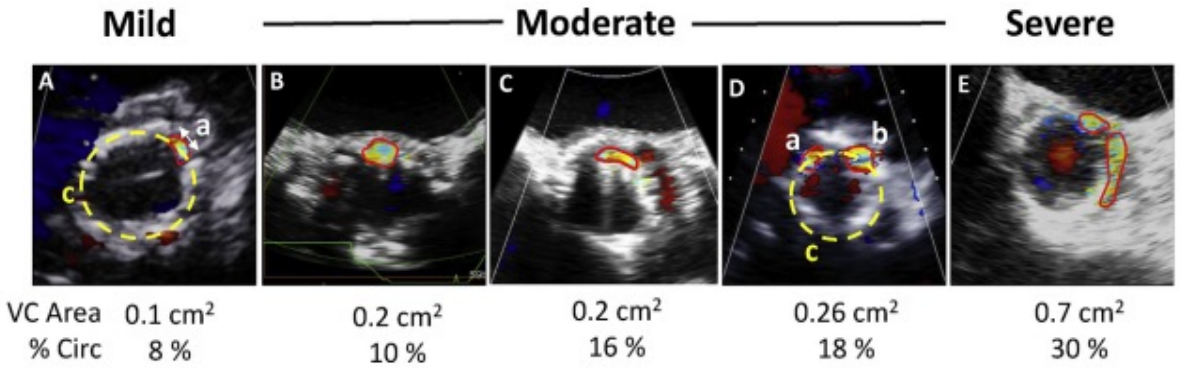
Fig 5. Proposed algorithm assessing for post-bypass leak of Inspiris valve. CPB, cardiopulmonary bypass; PVL, paravalvular leak.

ANSWERS

Answer 4

C. Quantifying aortic paravalvular leak requires assessment of flow convergence, vena contracta/vena contracta area, pressure half time, diastolic flow reversal in the descending aorta, circumferential extent of PVL (%Circ), regurgitant volume, regurgitant fraction, and EROA. Severe paravalvular leak is defined by flow convergence is present, vena contracta is > or = to 0.6 cm, pressure half time is < 200 ms, there is holodiastolic flow reversal in the descending aorta, circumferential extent > or = to 30%, RVol > or = 60 mL, regurgitant fraction > or = 50%, or EROA 0.3 cm2.

"Rocking" can be due to hypermobility of a prosthetic with adjacent tissues. Rocking that accompanies a paravalvular leak Is likely due to dehiscence.[4,5]



Echocardiography: TTE and/or TEE			
Structural parameters			
Position of prosthesis	Usually normal	Variable	Frequently abnormal
Stent and leaflet morphology	Usually normal	Variable	Frequently abnormal
Doppler Parameters			
Qualitative			
Proximal flow convergence (CD)	Absent	May be present	Often present
AR velocity waveform density (CWD)	Soft	Dense	Dense
Diastolic flow reversal (PWD) in - Proximal descending aorta[†‡] - Abdominal aorta	- Brief, early diastolic - Absent	- May be holodiastolic - Absent	- Holodiastolic (end-diastolic velocity ≥20 cm/s) - Present
Semi-quantitative			
Vena contracta width (cm) (CD)	<0.3	0.3-0.6	>0.6
Vena contracta area (cm^2)[§] (2D/3D CD)[§]	<0.10	0.10-0.29	≥0.30
Circumferential extent of PVR (%) (CD)[‖¶]	<10	10-29	≥30
Jet deceleration rate (PHT, ms)[#] (CWD)	Variable Usually >500	Variable 200-500	Steep Usually <200[**]
Quantitative			
Regurgitant volume (mL)	<30	30-59[††]	>60[††] (May be lower in low flow states)
Regurgitant fraction (%)	<30	30-49	≥50
EROA (cm^2)[‡‡]	<0.10	0.10-0.29[††]	≥0.30[††]

ANSWERS

Answer 5

B. Continuing with the current medical management is appropriate. She has no evidence of right ventricular volume or pressure overload or systolic dysfunction. Small shunts with Qp:Qs < 2 can normally be managed conservatively. Large shunts with increasing RVSP or symptoms of right heart failure warrant repair. Surgical repair is first line, though there is developing literature for percutaneous closure with TEE guidance for high-risk patients. Closure with a percutaneous closure device can be complex if the fistula tract is small and nonlinear.[1]

References

1. Coelho B, Ng M, Naoum C, Banoub M, Saad I, Salama A. Iatrogenic Aorto-Right Ventricular Fistula: A Rare Complication of Transcatheter Valve Implantation. CASE (Phila). 2023 Mar 13;7(5):197-204. doi: 10.1016/j.case.2023.01.002.
2. Foster TJ, Amin AH, Busu T, Patel K, Farjo P, Hallak AA, Ali N, Alkhouli M. Aorto-cardiac fistula etiology, presentation, and management: A systematic review. Heart Lung. 2020 May-Jun;49(3):317-323. doi: 10.1016/j.hrtlng.2019.11.002.
3. Vanneman MW, Dalia AA. Perioperative and Echocardiographic Considerations for the Inspiris Resilia Aortic Valve--Current and Future. J Cardiothorac Vasc Anesth. 2020 Oct;34(10):2807-2812. doi: 10.1053/j.jvca.2020.03.056
4. Zakieh AR, Basile M, Passen EL. The Key Role of Color-Flow and Continuous-Wave Doppler Echocardiography in Diagnosis of Aortic Root to Right Ventricle Fistula Complicating Transcatheter Aortic Valve Implantation. J Am Soc Echocardiogr. 2023 Apr;36(4):441-442. doi: 10.1016/j.echo.2022.12.002.
5. Pysz P, Wojakowski W, Smolka G. Paravalvular Leak Echo Imaging before and during the Percutaneous Procedure. J Clin Med. 2022 Jun 1;11(11):3155. doi: 10.3390/jcm11113155.

PRO CON

INTRODUCTION TO PRO CON DISCUSSION

Regarding Drug Testing in the Workplace

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PRO/CON DEBATE

SOCIETY OF CARDIOVASCULAR ANESTHESIOLOGISTS
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The views expressed in this article are those only of the author and do not necessarily represent the views of the Department of Justice or the United States.

The legal landscape for workplace drug testing in the United States involves a complex interplay of federal and state statutes and regulations, constitutional considerations, and evolving societal norms. Private employers routinely implement drug testing policies and navigate a patchwork of legal frameworks that vary significantly across jurisdictions to do so.

In general, at the federal level, there is no comprehensive legislation or regulatory framework that governs workplace drug testing for private employers, with a few significant exceptions discussed below. And while some states do have rules that govern the process of drug testing, very few place any limits on employers' ability to make employment decisions based on drug test results. Courts have repeatedly recognized that private employers have broad discretion to set conditions for employment, including that employee be drug-free through drug testing during the application process and during employment. The result is private employers enjoy wide discretion to drug test both applicant pre-hire and their employees after hire.

By contrast, public and government employers must comply with the limits of the Fourth Amendment to the United States Constitution, which limits the ability of governments--federal, state, and local--to engage in unreasonable searches and seizures. The United States Supreme Court has held that drug testing by a public employer constitutes a search for purposes of Fourth Amendment analysis. Therefore, whenever a government employer wishes to engage in a drug testing process, it must act consistently with the Fourth Amendment. While these rulings do not directly apply to private employers, they have influenced employers' understanding of when drug testing might be justified. These decisions have generally supported drug testing programs when there are significant safety concerns or when employees are in sensitive positions.

For example, in Skinner v. Railway Labor Executives' Association, 489 U.S. 602 (1989) the Supreme Court approved of Federal Railroad Administration regulations that require drug and alcohol testing of any train crew members involved in an accident, even without any particularized suspicion that any of the crew members had been using drugs or alcohol. The Supreme Court concluded that there were "special needs" involved, including the government's desire to protect the safety of the traveling public, that outweighed the employees' privacy concerns and justified an exception to the particularized suspicion requirement. Importantly, the Supreme Court also found that the privacy expectations covered employees were diminished because of their participation in an industry that is regulated pervasively to ensure safety.

In a companion case to Skinner, National Treasury Employees Union v. Von Raab, 489 U.S. 656 (1989), the Court similarly permitted warrantless drug testing without particularized suspicion of drug use for U.S. Customs Service employees seeking promotion to positions involving drug interdiction or carrying firearms. Using the same "special needs" test, the Court concluded that the government's interest in ensuring that drug interdiction employees, and those in positions where they may employ deadly force, are physically fit, and have unimpeachable integrity and judgment. Von Raab also illustrates the limits of the "special needs" test: for a third category of employees, those seeking positions requiring only the handling of classified information, the Court concluded it did

not have enough information to assess the reasonableness of drug testing and remanded the case for further fact finding. While it credited government's compelling interest in protecting truly sensitive information from those who might compromise it, the Court found that the categories of employees subjected to testing was too broad for it to determine whether they all were in fact likely to gain access to sensitive information that could justify testing.

It is important to emphasize that none of these decisions involves workplace drug testing in the private sector, as such testing generally does not involve state action and thus doesn't implicate the Fourth Amendment. Private sector drug testing is primarily governed by state laws.

Federal law is not entirely absent from this space: the Drug-Free Workplace Act of 1988 ("DFWA") requires that certain federal contractors and grantees maintain drug-free workplace policies, educate employees about the dangers of drug abuse in the workplace, and impose sanctions on or require rehabilitation for employees convicted of workplace drug offenses. See 41 U.S.C. §§ 8101-06. Notably, the DFWA does not require drug testing, focusing instead on policies and education to discourage drug use. Though the DFWA does not directly regulate private employers who are not engaged in federal contracts or grants, it has played a significant role in shaping the legal and cultural landscape for employers, serving as a model for many workplace drug policies and contributing to the broader trend of drug-free workplace initiatives.

The second federal law directly affecting private sector drug testing is the Omnibus Transportation Employee Testing Act of 1991. See 49 U.S.C. §§ 5331, 31306. This law codifies earlier Department of Transportation regulations requiring the drug testing of employees in the transportation industry. It also adds the requirement of random alcohol testing for the six million covered employees, including commercial motor vehicle operators, airline employees, and other transportation employees.

Turning to the states, there is significant variation in state laws regarding workplace drug testing, ranging from permissive approaches that largely defer to employer discretion, to more restrictive regimes that impose procedural safeguards and limit the circumstances under which testing can occur. In general, though, these state standards allow employers to conduct drug testing of applicants who are notified that a drug test is part of the hiring process, if the drug test is administered after an offer is made, and tests are conducted by state-certified or approved facilities. Only two states, Montana, and Oregon, further restrict the testing of applicants by private employers. See Mont. Code § 39-2-206 et seq.; Or. Rev. Stat. § 438.435. Like federal law, very few states limit the ability of an employer who decides to require drug testing to decide not to hire an applicant who tests positive.

The most unsettled area of workplace drug testing law concerns marijuana. A growing number of states have legalized marijuana, both for medical and recreational use, creating significant tensions with federal law, which continues to classify marijuana as a Schedule I controlled substance. This discrepancy has led to a variety of state-specific protections, especially for medical marijuana users, challenging employers to reconcile their drug-free workplace policies with emerging legal and societal norms.

As the legal, social, and scientific understanding of drug use continues to evolve, so too does the regulatory environment surrounding workplace drug testing. Against this background, healthcare providers are weighing the pros and cons of a post-incident drug testing, which would mirror the federal railroad standards the Supreme Court authorized in Skinner, as part of a broader approach to ensuring patient safety and quality of care. Healthcare facilities must balance these requirements with other legal and policy considerations, including varying and evolving state laws and privacy concerns.

Post-Incident Urine Drug Screening – Diving Deeper Into the 'Human' Factor of Medical Error

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Cardiac anesthesiology is a medical specialty that prides itself on a safety-centric approach, drawing parallels with the aviation industry's stringent safety focus. The specialty is distinguished by its management of a complex patient demographic, often in critical condition, with advanced interventions such as cardiopulmonary bypass (CPB) and mechanical cardiovascular support (MCS). The cardiac operating room (OR) environment is characterized by multiple teams, high case complexity, extensive use of cognitive aids, and proactive risk assessments to foster a culture of safety commensurate with the high-risk nature of cardiac procedures. The demanding nature of cardiac anesthesiology and a small margin for error makes it a safety-sensitive critical field that requires anesthesiologists to exhibit exceptional precision and cognitive acuity. Procedural time-outs are mandated before the start of a procedure. Checklists are employed throughout cases to ensure the completion of essential tasks. Emergency manuals are accessible to guide responses to rare crises. The aviation industry's diligent application of similar safety protocols has been credited with reducing annual commercial fatalities to fewer than 200 per year.[1] However, preventable medical deaths in the United States, though reduced, still exceed 20,000 annually.[2] Some suggest higher numbers.

The operational safety similarities between aviation and anesthesiology diverge in several respects.[1] Aviation accidents trigger immediate investigations by national agencies, whereas medical incidents typically undergo local investigations adhering to institution-specific practice. Furthermore, aviation incidents often attract media attention and public scrutiny, leading to widespread dissemination of investigation findings to improve safety and meet the public expectation of accountability, a level of transparency not commonly seen in medical practice. Another significant divergence pertains to post-accident protocols, specifically regarding mandatory drug and alcohol testing. The Federal Aviation Administration (FAA) stipulates that such testing is compulsory "if an employee's performance either contributed to an accident or cannot be completely discounted as a contributing factor" (FAA 14 CFR Part 120), with the expectation that testing occurs within 32 hours of the incident. However, testing may be waived if evidence suggests the employee's performance was not a factor in the accident. This requirement for other branches of the transportation industry is mandated by the Omnibus Transportation Employee Testing Act of 1991.[3,4]

The call has been made to consider implementing drug testing after critical events in medicine.[5] Critical events with severe consequences are considered sentinel events. The Joint Commission defines such events as "a patient safety event that results in death, permanent harm, or severe temporary harm".[6] The challenge is that the outcome of an event may not be readily apparent until much later and that death or severe harm does not necessarily imply poor or negligent care. Many errors in medicine though are associated with deviations from standards of care or prevailing safe practice. These events are often referred to as 'never events' and are defined as 'serous, largely preventable patient safety incidents that do not occur if relevant preventative measures have been put in place'.[7,8] Such

events which may be directly attributed to anesthesia practice include, but not limited, to wrongly-prepared high-risk medication, IV administration of an epidural medicine, errant administration of potassium or insulin, transfusion of ABO incompatible blood, massive air embolism via an IV, failure to respond to hypoxemia, or misidentification of a patient.[8] Never events have been described as a "dirty little secret" in anesthesiology.[9] Other performance characteristics may not result in harm but reveal truly unacceptable divergence from our bioethical obligation to prevent harm including sleeping in the operating room, intoxication, patient abandonment, inability to locate while providing care, and clear evidence of assault. These are the events may indicate the impairment by substances.

The first question the medical system needs to address is, why perform post-event drug testing in anesthesia?

The foremost reason to implement post-event testing is to establish a culture of comprehensive critical evaluation of safety events as well as investigation into professional lapses which may be an indicator of hidden patterns. Mandatory post-incident drug testing would force our system to develop formal consistent protocols not only for performing a test but for intervening when concerns arise about a colleague.

Exploration of medical errors over the past 20 years has largely focused on the notion that adverse outcomes are not the result of a single action by an individual but due to several events that pass through different barriers in a system to ultimately cause patient harm.[10]

Errors may be due to problems with the system (latent) or directly attributable to an action (active). Multiple articles, studies, and editorials address the concept of "human error". Often these address types of errors or soft human factors such as fatigue, nutrition, and emotional stress, but virtually never address hard factors such as substance use, physical or mental illness, unexplainable deviations from expected practice, or truly preventable neglect. We fail to adequately explore, the 'human' factor. Post-incident drug testing can be a first step.

Many arguments are made against mandatory post-accident or post-sentinel event drug testing for medical personnel. These include low rates of involvement of substances in critical or sentinel events, risk of false positive results, inconvenience and impact on morale, and the lack of evidence that the presence of substances accurately indicates impairment.

Substance use disorders among physicians have not decreased over time, and much like the rate of use in society, it may be increasing. The abuse of alcohol among all physicians remains higher than drugs with 12.9% of males and 21.4% of females meeting the criteria for abuse or dependence.[11] The rate of substance use disorders (SUD) among anesthesiologists remains at 1 – 2% excluding alcohol.[12,13] A recent study on the use of cannabis among physicians showed that 8% used the substance in the past month and 0.1% noted daily use.[14] Although there was a decrease in cannabis use from 1990 to 2005, use has since rebounded with the highest rates among young males in the West. This is likely due to increased medical and recreational legality. It is reasonable to expect that use will continue to increase.

The absence of routine post-incident urine drug screening in medicine has resulted in a lack of data on the impact of SUD on adverse events and thus warrants consideration of protocols like other safety-sensitive industries, especially aviation. The most comprehensive investigation into the rate of drug involvement in aviation accidents in the United States revealed a post-accident positive rate of 1.82%, surpassing the random drug testing positive rate of 0.62%.[15] This study ascertained that 1.2% of aviation accidents during the examined period were attributable to violations of the use of illicit substances. Cannabis emerged as the predominant substance, accounting for 63% of the illicit substances detected in aviation events.

Harm to patients directly tied to the use of substances by healthcare providers has occurred. The most extreme example may be that of Dr. Christopher Duntsch.[16] Dubbed "Dr. Death," his long-standing addiction led to the deaths of two patients and severe injuries to 31 others, resulting in his unprecedented life sentence for medical malpractice. An ophthalmologist was allowed to continue practicing despite performing cataract surgery while under the influence, exhibiting shaking hands and slurred speech.[17] A family practitioner tested positive for poly-substance use (alcohol, marijuana, cocaine, etc.) seven times from 1990 to 2001, yet was given multiple opportunities to continue practicing, causing harm to patients and eroding public trust.[18] The practitioner's license was suspended by a state's medical board four times but was given multiple chances to continue practicing, to the continued harm of patients and public trust. The integrity of the medical profession is constantly under attack and scrutiny, and public trust in medicine has been declining over the years. In a similar case, a traveling healthcare worker who injected himself with patients' pain medications and refilled the syringes with saline caused the third hepatitis outbreak since 2009 linked to medical professionals, infecting at least 46 people, mostly in New Hampshire.[19] Similar events are not uncommon.

In fact, from 1985 to 2018, the CDC documented 13 outbreaks where healthcare providers transmitted infectious diseases to patients.[20] These cases demonstrate that a system based solely upon self-policing, for even the most egregious violations of care, often fails. A recent large study revealed that 6% of patients suffered preventable harm of which 12% were severe or fatal. Preventable harm was more common in advanced specialties including surgery.[21] Extrapolation of data from substance involvement in aviation events at a rate of 1.2% would indicate that 242 patients are injured a year directly related to substances.

Mandatory post-incident testing, as a policy, is predicated on the notion that the protocol of routine drug testing after an event can significantly alter the behavior of healthcare professionals. The deterrent effect of drug testing is well-documented in sectors such as the military and aviation, where the introduction of drug testing protocols has led to marked reductions in the consumption of illicit substances. Studies by Bray[22] and Meadows[23] provide empirical support for this claim, suggesting that anticipation of testing can influence behavior and reduce the incidence of drug use. The healthcare sector may see similar outcomes, with the knowledge that a drug test will follow any significant adverse event where significant deviation from accepted practice occurs. The possibility of testing may discourage physicians from engaging in substance use before duty, thereby enhancing patient safety and care quality. The threat of drug testing also serves as a warning against protocol violation.

Beyond its deterrent effect, mandatory post-incident testing could identify physicians who may be struggling with substance use disorders. The early stages of such disorders often go unnoticed, with the affected individuals continuing to practice, potentially endangering patient safety. By instituting mandatory testing following incidents, healthcare institutions may identify those in need of support, although if only tied to significant events associated with patient harm, career damage may already be done. Regardless, testing opens avenues for support, rehabilitation, and recovery or career redirection.

False positive results are often cited as a weakness of post-incident medical testing. Federal regulations provide multiple safeguards to ensure accuracy and bolster confidence in the results.[24] These measures include dual-sample collection, confirmatory GC/MS analysis following initial ELISA positives, impartial assessment by an independent medical review officer (MRO), and the option of repeat testing should a preliminary result be positive or indeterminant. The final precaution should involve a professional intervention to discuss the findings with the provider in question to determine if there is a plausible reason for a test result.[25] If repeated measures consistently detect an illicit

substance without a valid explanation including the intervention, the test is deemed positive, necessitating consideration of the substance's role in the incident. Typically, unexpected positives arise from undisclosed prescriptions, and most physicians immediately acknowledge the results and where necessary, seek assistance after secondary tests verify the presence of the substance.[25]

After the argument regarding the potential for false positives in the aftermath of a significant event, a critical issue emerges: a positive test result merely indicates substance use but does not confirm impairment. This concern has validity. It is important to note that urine toxicology screens typically detect metabolites for variable durations from a day to several days or longer after use.[26] In the context of cannabis consumption, the detection window for its presence in the body varies significantly based on usage patterns and THC concentration. Individuals who consume cannabis on an occasional basis may yield positive test results for up to three days post-consumption.26 Moderate users can test positive for a duration ranging from five to seven days, whereas chronic users may exhibit detectable levels for 30 days or longer.[26]

The acute effects of cannabis consumption include compromise of inhibitory control, and working memory, in addition to fostering impulsivity and risk-taking. Immediate deficits in attention, concentration, and information processing are also observed.[27] These are the executive functions that may impact a provider's delivery of anesthesia the most. One function that does not appear to be impacted is verbal fluency. Some chronic users may demonstrate improvement in certain tasks during the acute phase when they use cannabis indicating that abstinence or withdrawal can impact cognition.[27]

Residual or "next day" effects are those that manifest from 7-24 hours after use.[28] The impact during this time frame is less clear but is where the risk may be highest for patients as users may assume they are unaffected. Conversely, chronic users experience the most significant impact on executive functions, with the severity of impairment contingent upon the specific compound consumed, dosage, duration of usage, and periods of abstinence.[29-30]

Post-incident testing may have benefits for the anesthesiologist. Testing that is mandatory for all individuals in defined situations removes the bias associated with selected testing. Post-incident testing is likely to yield a low positive predictive value (PPV) and a high negative predictive value (NPV) because of the current prevalence of substance use among anesthesiologists. Therefore, a primary advantage of post-incident testing is in its NPV: a negative result effectively eliminates concerns about physician impairment at the time of the event, absolving the physician from allegations of substance-induced impairment. Mandatory testing after incidents may also help maintain long-term recovery for impaired physicians. Frequent testing is a key component of recovery through Physicians Health Programs, but only usually occurs for the duration of a recovery contract.[31] Required post-incident testing would essentially maintain this important factor for the duration of a career. An additional incidental benefit from testing is the time results take to return. Testing commonly takes 3-7 days for results to return. Physicians should not work while awaiting results. The time can serve as a built-in "time-out" for the physician to process the event while emotionally recovering.

The key purposes of post-incident drug testing are to safeguard the welfare of patients and uphold the integrity of the medical profession. The bioethical principle of nonmaleficence dictates that medical professionals should not cause harm to their patients. Post-incident drug testing is a critical component of a program designed to identify and address instances of obvious deviations from expected practice, signs of impairment during the delivery of clinical care, or the occurrence of a "never event".

This, in turn, helps to maintain public trust and confidence that the medical profession is fully committed to joining the ranks of safety-sensitive professions. The COVID-19

pandemic led to a temporary increase in trust, but it appears that confidence in the medical profession has resumed its decline, similar to public schools, banks, and television.[32] Post-incident drug testing can serve as a signal to the public that their health and well-being are a top priority for the healthcare system. The testing process requires hospitals to enhance their investigation procedures, ensuring that testing and review adhere to the strictest protocols and national standards.

Post-incident drug testing should be implemented as an additional tool for a complete investigation into critical medical events that cause immediate patient harm and are accompanied by evidence of obvious practice deviation from the standards of care. It is time for the tool which is used so effectively in the most safety-sensitive lay industries be implemented in medicine so that we fully investigate the 'human' factor.

References

1. Kapur N, Parand A, Soukup T, Reader T, Sevdalis N. Aviation and healthcare: a comparative review with implications for patient safety. JRSM Open. 2015 Dec 2;7(1):2054270415616548. doi: 10.1177/2054270415616548. PMID: 26770817; PMCID: PMC4710114.
2. Rodwin BA, Bilan VP, Merchant NB, Steffens CG, Grimshaw AA, Bastian LA, Gunderson CG. Rate of preventable mortality in hospitalized patients: a systematic review and meta-analysis. Journal of General Internal Medicine. 2020;35:2099-2106.
3. Fiorentino DD, Shannahan R, Bergoffen G. Operator Drug-and Alcohol-testing Across Modes. vol 23. Transportation Research Board; 2011.
4. Omnibus Transportation Employee Testing Act of 1991
5. Pham JC, Pronovost PJ, Skipper GE. Identification of physician impairment. JAMA. 2013;309:2101-2102.
6. The Joint Commission. Sentinel Event., 2024. https://www.jointcommission.org/resources/sentinel-event/. Accessed March 29, 2024
7. National Quality Forum. List of Serious Reportable Events. https://www.qualityforum.org/Topics/SREs/List_of_SREs.aspx. Accessed April 2, 2024
8. Adyanthaya SS, Patil V. Never events: an anaesthetic perspective. Continuing Education in Anaesthesia, Critical Care & Pain. 2014;14:197-201
9. Green J, Butterworth J. "Never" events: anesthesiology's dirty little secret. Anesth Analg 2013;117:1-2
10. Reason J. Human error: models and management. BMJ. 2000;320:768-770.
11. Oreskovich MR, Shanafelt T, Dyrbye LN, Tan L, Sotile W, Satele D, West CP, Sloan J, Boone S. The prevalence of substance use disorders in American physicians. Am J Addict 2015;24:30-38.
12. Gravenstein J, Kory W, Marks R. Drug abuse by anesthesia personnel. Anesth Analg. 1983;62:467-472.
13. Booth JV, Grossman D, Moore J, Lineberger C, Reynolds JD, Reves J, Sheffield D. Substance abuse among physicians: a survey of academic anesthesiology programs. Anesth Analg 2002;95:1024-1030
14. Naillon P-L, Flaudias V, Brousse G, Laporte C, Baker JS, Brusseau V, Comptour A, Zak M, Bouillon-Minois J-B, Dutheil F. Cannabis Use in Physicians: A Systematic Review and Meta-Analysis. Medicines (Basel). 2023;10:29
15. Li G, Baker SP, Zhao Q, Brady JE, Lang BH, Rebok GW, DiMaggio C. Drug violations and aviation accidents: findings from the US mandatory drug testing programs. Addiction. 2011;106:1287-1292
16. Dyer O. US neurosurgeon deliberately botched spine operations, prosecutors allege. BMJ. 2015;351:h4739. doi: 10.1136/bmj.h4739. PMID: 26341983

17. Leibert M. Performance of state medical boards: implications for hospitals and health systems. Hosp Top 2010;88:107-15. 2010;88(4):107-115

18. Thompson CW, Sunday A. "Medical boards let physicians practice despite drug abuse". Washington Post. April 10, 2005

19. Rousseau RR. Drug Diversion in the Health Care System: Cultural Change via Legal and Policy Mechanisms. Am J Law Med. 2020;46:446-468

20. Berge KH, Dillon KR, Sikkink KM, Taylor TK, Lanier WL. Diversion of drugs within health care facilities, a multiple-victim crime: patterns of diversion, scope, consequences, detection, and prevention. Mayo Clin Proc. 2012;87:674-82

21. Panagioti M, Khan K, Keers RN, Abuzour A, Phipps D, Kontopantelis E, Bower P, Campbell S, Haneef R, Avery AJ, Ashcroft DM. Prevalence, severity, and nature of preventable patient harm across medical care settings: systematic review and meta-analysis. BMJ. 2019 Jul 17;366:l4185. doi: 10.1136/bmj.l4185. PMID: 31315828; PMCID: PMC6939648.

22. Bray RM, Marsden ME, Rachal JV, Peterson MR. Drug and alcohol use in the military workplace: findings from the 1988 worldwide survey. NIDA Res Monogr. 1990;100:25-43.

23. Meadows SO, Engel CC, Collins RL, Beckman RL, Cefalu M, Hawes-Dawson J, Doyle M, Kress AM, Sontag-Padilla L, Ramchand R, Williams KM. 2015 Department of Defense Health Related Behaviors Survey (HRBS). Rand Health Q. 2018 Oct 11;8:5.

24. Health and Human Serivces Department. Mandatory Guidelines for Federal Workplace Drug Testing Programs. Updated 10/12/2023. 88 FR 70768. https://www.federalregister.gov/documents/2023/10/12/2023-21734/mandatory-guidelines-for-federal-workplace-drug-testing-programs. Accessed April 2, 2024

25. Lange WR, Cabanilla BR, Moler G, Bernacki EJ, Frankenfield DL, Fudala PJ. Preemployment drug screening at the Johns Hopkins Hospital, 1989 and 1991. Am J Drug Alcohol Abuse. 1994;20:35-46.

26. Moeller KE, Lee KC, Kissack JC. Urine drug screening: practical guide for clinicians. Mayo Clin Proc. 2008 Jan;83(1):66-76. doi: 10.4065/83.1.66. Erratum in: Mayo Clin Proc. 2008;83;66-76.

27. Crean RD, Crane NA, Mason BJ. An evidence based review of acute and long-term effects of cannabis use on executive cognitive functions. J Addict Med. 2011;5:1-8.

28. McCartney D, Suraev A, McGregor IS. The "Next Day" Effects of Cannabis Use: A Systematic Review. Cannabis Cannabinoid Res. 2023 Feb;8(1):92-114. doi: 10.1089/can.2022.0185. Epub 2022 Dec 6. PMID: 36475998; PMCID: PMC9940812.

29. Wieghorst A, Roessler KK, Hendricks O, Andersen TE. The effect of medical cannabis on cognitive functions: a systematic review. Syst Rev 2022;11:210.

30. Cuttler, C, Petrucci, AS, LaFrance, E.M. Cognitive test performance in chronic cannabis flower users, concentrate users, and non-users. Sci Rep 2023;13: 8068

31. Dupont RL, Skipper GE. Six lessons from state physician health programs to promote long-term recovery. J Psychoactive Drugs. 2012 Jan-Mar;44(1):72-8. doi: 10.1080/02791072.2012.660106. PMID: 22641968.

32. Blendon RJ, Benson JM. Trust in medicine, the health system & public health. Daedalus. 2022;151(4):67-82

Post Incident Drug Testing Should Not Be Mandatory

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IN 1973, THE AMERICAN MEDICAL ASSOCIATION WROTE:[1]

It is a physician's ethical responsibility to take cognizance of a colleague's inability to practice medicine adequately by reason of physical or mental illness, including alcoholism or drug dependence. Ideally, the affected physician himself should seek help when difficulties arise. Often, however, he is unable or unwilling to recognize that a problem exists. When exhortations by family and friends are ineffective and when the physician is unable to make a rational assessment of his ability to function professionally, it becomes essentially the responsibility of his colleagues to make that assessment for him, and to advise him whether he should obtain treatment and curtail or suspend his practice.

The "sick doctor statute" defines the inability of a physician to practice medicine with reasonable skill and safety to his patients, because of one or more enumerated illnesses.....The defined inability can be the result of organic illness, mental or emotional disorders, deterioration through the aging process, or loss of motor skill.

Further, the inability can arise from excessive use or abuse of narcotics, drugs and chemicals, alcohol, or similar types of material.

Around this time and thereafter drug and alcohol (DAT) testing for health care professionals has been subject to intense debate. Proponents pointed toward federal laws regulating multiple industries, while pointing out failed 'self-reporting' policies in the healthcare sector.[1,3] Drug testing had its legal start with the Drug-Free Workplace Act of 1988[4] and the Omnibus Transportation Employee Testing Act of 1991,[5] making possible both routine and random drug testing utilized in the military, public transportation systems, nuclear power, law enforcement, and the aviation industries.[4,6] Support for drug tests was partly based on the purported reduction in opioid use in military servicemen after the initiation of DAT.[6] Workers in the afore mentioned industries regularly submit to government-mandated drug testing as a condition of employment.[7,8,9] While testing may or may not be credited with reduction in overall drug usage there is yet to be conclusive data connecting substance use with military and/or industry specific accidents.

Supporters for mandatory testing in healthcare emphasize the similarities between anesthesia and the aviation industry, specifically regarding and the contribution of human error to adverse events. It is suggested that pre-hire and random alcohol and drug testing (RDAT) would reduce substance use and subsequently reduce adverse outcomes.[10,11,12] More recently, testing after an adverse incident has been proposed to help determine if an outcome was the result of substance use disorder (SUD) and physician impairment.[13,14,15] Drug testing is thought to supplement a 'speak up policy' described above by the AMA, or to make up for its failure.[1,13,14,15]

In the aviation industry it is estimated that 60-80% of accidents resulting in severe harm or death is at least partly due to human error including inadequate experience, poor training, poor planning, inattention, and fatigue. Li et al reported a 0.65% positivity with general random testing in the aviation industry and a positivity of 1.82% after an incident (16). The authors reported an odds ratio of 2.90 for positive tests of employees involved in an incident with an estimated attributable risk of 1.2%. However, when analyzed for causality the following is concluded[16]:

1. Drug violations play an exceedingly small role in aviation accidents.

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2. One should not infer causality between a positive test and the accident since it does not mean that the employee was under the influence of the drug at the time of accident.

3. Drugs may still be detected days or months after usage and its use may have occurred well before the accident

4. The rarity of aviation accidents and the low prevalence of drug violations 'makes data too sparse for us to assess the relationship between drug violation and the risk of accident involvement.'

Although RDAT might have reduced the number of positive drug tests, to date, there is no data showing causality between drug use and adverse outcomes in the aviation industry.[17]

"We could not draw definitive conclusions regarding the effectiveness of RDAT for employees in safety-sensitive occupations or with safety-sensitive job functions." (Els et al)

Overall, worldwide aviation fatalities have declined since 2006 due to introduction and implementation of new guidance and safety technology, training and education, and regulations on equipment and industry.[17,18] Despite the implementation of drug testing in the trucking industry, positive tests have increased approximately 5% over the from 2009 to 2016 with greater increases in positive tests for amphetamine (0.6% testing positive) and marijuana (now up to 0.8% testing positive), while positive test rates for cocaine and opiate use (both 0.2% testing positive) remain unchanged and low.[19] By comparison truck accidents and associated fatality have increased nearly 50% over the last 10 years from 21 per 100 million-large-truck-miles in 2008 to 37 per 100 million-large-truck-miles in 2022.[20] The cause of most truck accidents includes issues vehicular problems, environmental conditions, unfamiliarity with the roadway, and a number of driver related conditions including fatigue and inattention, job performance pressure, poor driving skills, and distractions.[21] In nearly all cases, proper preparation, education, and training would have prevented the accident. Illegal drugs and alcohol were associated with <3% of cases and causality was not described.[21]

Nevertheless, the Federal Aviation Administration rules DAT requires employees involved in an accident which results in 'death or serious injury' must present for alcohol tests within 2-8 hours and drug testing within 32 hours.[22] Since the 1980s Ronald Reagan "Just say no" to drugs, Executive Order 12564 which made drug abstinence a condition for federal employment, and the 1988 and 1991 federal laws drug testing has grown into a multi-billion-dollar industry requiring testing for anybody in 'safety-sensitive positions', i.e., aviation, trucking, train, and busing industries.[4,5,23] Drug testing now includes many other parts of societies to include it as a prerequisite toward being considered for employment across many industries.[24]

Companies/CEOs may embrace drug testing but not because it improves outcome but because federal contracts depend on its existence under the Drug-Free Workplace of 1988.[25]

While the federal government has mandated drug testing without showing a related positive impact on outcome, data for the aviation and trucking industries do show that safety and accident prevention rests in the improvement of education and training, the management of fatigue, and the implementation of safety equipment and technology. There is no data that RDAT or post incident drug testing has increased safety.

Without doubt, there is concern for patient safety and outcome, however, drug testing in healthcare has yet to be connected with reduction of adverse events. The drive for drug testing comes from different directions. There remains a barrier, and therefore a failure of the 'speak-up policy' where impaired physicians and/or their colleagues would come forward to point out alcohol and drug abuse due to concerns over a punitive environment.[2,10,26] Advocates of DAT have played on public concerns by painting an untruthful picture widespread drug use within the healthcare industry and poor self-regulation.

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An author from a Los Angeles Times article wrote[27]:

"Humans in distress have always reached for relief close at hand. In the case of doctors, that's often prescription medicine. A 2013 study in the Journal of Addiction Medicine revealed that 69% of doctors abused prescription medicine....to relieve stress and physical or emotional pain."

The author misrepresented a 2013 article written by Merlo et al, in which 69% of 55 physicians with known drug use monitored by their state board of health, reported a history of misusing prescription drugs 1) to manage physical pain, 2) to manage emotional/psychiatric distress, 3) to manage stressful situations, 4) for recreational purposes, and 5) to avoid withdrawal symptoms.[28] This is a far cry from '69% of doctors abused prescription medicine'.

In 2010 Desroches et al co-authored an article surveyed the reporting of impaired and incompetent [physician] colleagues.[2] Of 1891 responding to the survey, 'seventeen percent (n=309) of physicians had direct personal knowledge of a physician colleague who was incompetent to practice medicine in their hospital, group, or practice. Of those with this knowledge, 67% (n=204) reported this colleague to the relevant authority'.[2] While the authors concluded that a system relying on physicians to report incompetent and/or impaired physicians is flawed and not adequate and that reliance on this system is exposing patients to 'unacceptable levels of risk',[2] one internet site concluded that[29]:

A physician who knowingly protects a colleague who is unfit to safely treat patients should be considered equally incompetent.

Lucian L Leape, a professor at the Harvard School of Public Health wrote in a review article that:

"One-third of all hospital admissions experience a medical error" and "physician impairment seems to be a possible contributor to patient harm".[3]

"at least one-third of all physicians will experience, at some time in their career, a period during which they have a condition that impairs their ability to practice medicine safely".[3] '

'At some time in their career.....have a condition that impairs' lacks any specific data regarding time, duration, frequency (i.e., a day, weekend, week, month, or year), nor defines the cause of impairment or whether it not any physician was factually impaired while caring for patients.[3,11,14,30,31] Having 'a condition' or 'impairment' does not equate to drug and alcohol abuse or even use but is more likely refers to other illnesses including mental, emotional, or physical fatigue, and/or intellectual incompetence, all of which are significantly more common than drug use and even more so compared to drug abuse.[2,3] Neither **Leape et al or Desroches et al** present any data on causality or link impairment to patient outcome.[2,3] However, based on their articles/lectures and the opinions of others it is thought that Alcohol and Drug testing 'may considerably reduce serious medical error'.[3,32] These statements without clarification, should not form a basis for any drug testing policy.

There are significant differences, however, between substance use, abuse, and impairment. The latter two are most concerning, are less frequent, and without specifics regarding degree and duration of impairment.[11,14,15,30] Although 8-15% of physicians have reported that they may have experienced an episode of substance use in their career, it does not mean 15% are abusing drugs at any one time.[13,31,33,34] The reports lack how substance abuse is defined and do not actually associate substance use with clinical duties or outcomes.[13,31,33,34] The actual reported incidence of substance uses ranges from 1-2% for anesthesia faculty and residents.[14,30] The absence of data connecting a positive DAT and an adverse event can be at least partly explained by the duration of time between drug use and the ability to detect in a test.[35] Despite a positive drug test, the person may not have been impaired.

TABLE Drug Testing:[35]

Length of Time Drugs of Abuse Can Be Detected in UrineDrug	Time
Alcohol	7-12 h
Amphetamine	48 h
Methamphetamine	48 h
Barbiturate	
Short-acting (eg, pentobarbital)	24 h
Long-acting (eg, phenobarbitol)	3 wk
Benzodiazepine	
Short-acting (eg, lorazepam)	3 d
Long-acting (eg, diazepam)	30 d
Cocaine metabolites	2-4 d
Marijuana	
Single use	3 d
Moderate use (4 times/wk)	5-7 d
Daily use	10-15 d
Long-term heavy smoker	30 d
Opioids	
Codeine	48 h
Heroin (detected as morphine)	48 h
Hydromorphone	2-4 d
Methadone	3 d
Morphine	48-72 h
Oxycodone	2-4 d
Propoxyphene	6-48 h
Phencyclidine	8 d

-- Mayo Clinic Proc. 2008; 83(1)66-76

Anesthesia related complications are uncommon. In over one million cases reviewed, the perioperative mortality was 0.53% from which anesthesia was responsible in < 1:10,000 and implicated in 1:1700 cases.[36,37] The authors did not cite alcohol, drugs, or an impaired physician as contributory;[36,37,38] Without dismissing the contribution of human error and errors in judgement, the likelihood that post incident DAT will find a connection between drug use, reported to be 1-2%, and an adverse outcome is extremely low, e.g., < 0.02%.[14,30,39,40,41] The likelihood of showing causality between abuse/impairment and an adverse outcome is even lower.

When establishing policies and penalties it is critical for decision-makers to scrutinize the data and consider the implications on not only patients but also practitioners.[2,10,42] The impact of a positive test on the caregiver is underappreciated, especially without showing a causal relationship with an incident. Results can damage individual careers and challenge departmental stability.[43] In a report, 60% of physicians feel testing is an infringement, 38% lack confidence in the tests, 20% would negatively rank a program based on testing, up to 10% would refuse the test, and up to 10% would consider filing a lawsuit.[42] Testing can spawn an environment of distrust for administration highlighted fear of suspension, firing, and license revocation.[42] Considering the possibility of false positives, cross reactivity with over-the-counter medications, and a questionable or absent association between positive tests and adverse event, implementation of DAT may create a negative environment and also risk legal actions.[15,42,43] In supporting DAT Desroches et al questions the process of and willingness to identify oneself or colleagues who might be impaired. However, a distrustful and punitive environment will have a totally opposite effect than intended.[2] Without outcome and causality data, implementation of drug testing whether random or post-incident is not supported and may have an overall negative impact.[42,44]

We do not dismiss the impact of an unwell or impaired physician who experiences emotional and physical deterioration, and whose expressive patterns may include withdrawn and depressed, frustration, or even anger and frustration.[13,45,46,47] Morbidity and mortality amongst substance abusers is high.[51] Of residents with SUD, despite attempts to rehabilitate 43% have at least one relapse in approximately 9 years and 7.3% die during their residency/training.[48] However, only 1-2% of anesthesia residents and faculty report substance USE, which would yield a much smaller number who might have a substance abuse problem associated with impairment.[14,30] Random drug testing or post-incident testing would be expected to have and very low yield to detect abuse or impairment.

The CDC defines impairment as 'a significant difference or absence in a person's mental functioning, body, structure, or function'.[13,26,49] These patterns are not detected by isolated post incident drug tests nor RDAT.[42] Impairment is a sickness that leads to absenteeism, burnout, and an overall inability of the individual and the group to satisfy the healthcare mission.[13,26,49] However, coupled with a punitive system and the negative impact is magnified.[13,26,49] An important step toward healing and one that is likely to be 'friendlier' and supportive for the impaired physician or colleague is to treat impairment as an illness and assure confidentiality. This would facilitate detection, evaluation, and presentation without fear of reprisal but instead a chance to heal.[2,11,50,51] For the impaired physician coming forward confidentially without fear of reprisal would be associated with comprehensive rehabilitation and follow-up services.[52,53] For those with substance abuse and impairment >75% have positive outcomes and >70% return back to work within the healthcare profession.[52,53]

With regard to patient care, considering the data of anesthesia related adverse events and incidence of drug use, the likelihood of finding a causal association between and isolated event and a positive test would be unlikely. The health care industry would be better served by establishing preventative strategies including surveilling behavioral patterns and patient outcomes. Like both the aviation and trucking industries the causes of anesthesia related are multiple including human error, mental or physical fatigue, lack of training and preparation, lack of education, and for some, incompetence. Resources are better directed toward overall safety and support. For the aviation and trucking industry, training, education, the implementation of new safety technology, and support have been associated with improved work environments and outcomes. This is no different for the medical profession and especially for the world of anesthesiology where training, education, and technology have benefitted patient care greatly.[54,55,56,57,58]

"Wellness" is critical for the individual physician as well as the department. Workplace wellness is associated with reductions of injury, physician sickness, absenteeism, suspensions, burnout, and early retirement.[13,42,49] A study comparing 261 non health care companies enrolled in a drug-free workplace was compared to 20,500 non-intervention companies.[59] The authors found a small but significant reduction in worker injury in the construction services.[59] Whether the benefits are related to drug testing or just an improvement in the overall environment is not concluded. It is likely that drug testing was accompanied by multiple other changes. Undoubtedly, workplace wellness is an important contributor to professional success of a group and the medical profession is no exception. The more supportive a department is, the more likely that impaired physicians can be cared for.

Conclusion:

All stakeholders in this debate want the same outcome – a safe, respectful working environment that provides high-quality care to the public and compassionate support to health care providers (60,61). Being a physician is inherently stressful, especially for the anesthesiologists whose day-to-day activities involves life or death situations. That kind of responsibility has significance, and sometimes consequences. How each of us deals with adverse events will vary. Resources should be directed toward building a stronger,

healthier, and supportive department. Physicians should be given the opportunity to confidentially seek help for themselves or colleagues without fear of reprisal. A confidential supportive environment in which SUD is seen as a disease state that can be treated is better than considering it a crime to be punished.[52,53] Encouraging a 'speaking up' policy to detect impairment, or even potential impairment. This has the best chance of preventing any critical events that might be related to an impaired healthcare provider. Since impairment is not definitively related to drug use it is unlikely that any kind of DAT will be effective.[10]

References

1. AMA: The sick physician. Impairment by psychiatric disorders, including alcoholism and drug dependence. JAMA. 1973 Feb 5;223(6):684-7. PMID: 4739202.
2. DesRoches CM, Rao SR, Fromson JA, Birnbaum RJ, Iezzoni L, Vogeli C, Campbell EG. Physicians' perceptions, preparedness for reporting, and experiences related to impaired and incompetent colleagues. JAMA. 2010 Jul 14;304(2):187-93. doi: 10.1001/jama.2010.921. PMID: 20628132.
3. Leape LL, Fromson JA. Problem doctors: is there a system-level solution? Ann Intern Med. 2006 Jan 17;144(2):107-15. doi: 10.7326/0003-4819-144-2-200601170-00008. PMID: 16418410.
4. Tichy GJ:. The Drug-Free Workplace Act of 1988. Cath. Law. 1991 34, 363.
5. Coughlin L: H.R.3361; Omnibus Transportation abuse. Employee Testing Act of 1991". https://www.congress.gov/bill/102nd-congress/house-bill/3361
6. Riley TL: Toward a Drug Free Military. Crim. Just., 1990; 5, 10-15: 1990
7. Durbin, N., Moore, C., Grant, T., Fleming, T., Hunt, P., Martin, R., ... & Toquam, J. (1991). Fitness for duty in the nuclear power industry (No. NUREG/CR-5784; PNL-7795; BHARC-700/91/025). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Inspection and Safeguards; Battelle Human Affairs Research Center, Seattle, WA (United States); Pacific Northwest National Lab. (PNNL), Richland, WA (United States).
8. Couper FJ, Pemberton M, Jarvis A, Hughes M, Logan BK. Prevalence of drug use in commercial tractor-trailer drivers. Journal of forensic sciences. 2002 May 1;47(3):562-7.
9. Daley DM, Ellis CL:. Drug screening in the public sector: A focus on law enforcement. Public Personnel Management, 1994;23(1), 1-18.
10. Merlo LJ. Drug testing of health care professionals to improve overall wellness and patient care. Am J Bioeth. 2014;14(12):38-41. doi: 10.1080/15265161.2014.964990. PMID: 25369414.
11. Fitzsimons MG, Baker KH, Lowenstein E, Zapol WM. Random drug testing to reduce the incidence of addiction in anesthesia residents: preliminary results from one program. Anesth Analg. 2008 Aug;107(2):630-5. doi: 10.1213/ane.0b013e318176fefa. PMID: 18633044.
12. Carpenter CS. Workplace drug testing and worker drug use. Health Serv Res. 2007 Apr;42(2):795-810. doi: 10.1111/j.1475-6773.2006.00632.x. PMID: 17362218; PMCID: PMC1955359.
13. Wallace JE, Lemaire JB, Ghali WA. Physician wellness: a missing quality indicator. Lancet. 2009 Nov 14;374(9702):1714-21. doi: 10.1016/S0140-6736(09)61424-0. PMID: 19914516.
14. Fitzsimons MG, de Sousa GS, Galstyan A, Quintão VC, Simões CM. Prevention of drug diversion and substance use disorders among anesthesiologists: a narrative review. Braz J Anesthesiol. 2023 Nov-Dec;73(6):810-818. doi: 10.1016/j.bjane.2023.07.008. Epub 2023 Jul 28. PMID: 37517585; PMCID: PMC10625155.

15 Fitzsimons MG, Ishizawa Y, Baker KH. Drug testing physicians for substances of abuse: case report of a false-positive result. J Clin Anesth. 2013 Dec;25(8):669-71. doi: 10.1016/j.jclinane.2013.05.009. Epub 2013 Aug 27. PMID: 23988805.

16 Li G, Baker SP, Zhao Q, Brady JE, Lang BH, Rebok GW, DiMaggio C. Drug violations and aviation accidents: findings from the US mandatory drug testing programs. Addiction. 2011 Jul;106(7):1287-92. doi: 10.1111/j.1360-0443.2011.03388.x. Epub 2011 Apr 7. PMID: 21306594; PMCID: PMC3391734.

17 Els C, Jackson TD, Milen MT, Kunyk D, Wyatt G, Sowah D, Hagtvedt R, Deibert D, Straube S. Random drug and alcohol testing for preventing injury in workers. Cochrane Database Syst Rev. 2020 Dec 27;12(12):CD012921. doi: 10.1002/14651858.CD012921.pub2. PMID: 33368213; PMCID: PMC8130990.

18 https://www.statista.com/statistics/263443/worldwide-air-traffic-fatalities/#:~:text=Published%20by%20Statista%20Research%20Department,the%20operation%20of%20the%20aircraft.

19 https://www.ttnews.com/articles/positive-drug-test-rate-7-year-high-dot-says

20. https://injuryfacts.nsc.org/motor-vehicle/road-users/large-trucks/#:~:text=In%202022%2C%205%2C837%20large%20trucks,in%20the%20last%2010%20years.

21. https://www.fmcsa.dot.gov/safety/research-and-analysis/large-truck-crash-causation-study-analysis-brief

22 https://www.faa.gov/faq/what-constitutes-post-accident-test-what-definition-accident#:~:text=For%20post%2Daccident%20drug%20testing,32%20hours%20after%20the%20accident.

23. https://www.archives.gov/federal-register/codification/executive-order/12564.html#:~:text=Drug%2DFree%20Workplace.,not%20suitable%20for%20Federal%20employment.

24.Costantinou M. The Drug Testing Industry Is a Multibillion Dollar Profit Center. 2001. San Francisco Chronicle August 12

25. https://www.govinfo.gov/content/pkg/USCODE-2009-title41/pdf/USCODE-2009-title41-chap10.pdf

26 Banja J. Alcohol and drug testing of health professionals following preventable adverse events: a bad idea. Am J Bioeth. 2014;14(12):25-36. doi: 10.1080/15265161.2014.964873. PMID: 25369412.

27. https://www.latimes.com/opinion/op-ed/la-oe-grinspoon-addicted-doctors-20160605-snap-story.html

28 Merlo LJ, Singhakant S, Cummings SM, Cottler LB. Reasons for misuse of prescription medication among physicians undergoing monitoring by a physician health program. J Addict Med. 2013 Sep-Oct;7(5):349-53. doi: 10.1097/ADM.0b013e31829da074. PMID: 24089039; PMCID: PMC3790148.

29. https://ethicalnag.org/2010/07/15/reporting-impaired-incompetent-doctors/

30 Rice MJ, Grek SB, Swift MD, Nance JJ, Shaw AD. The Need for Mandatory Random Drug Testing in Anesthesia Providers. Anesth Analg. 2017 May;124(5):1712-1716. doi: 10.1213/ANE.0000000000001796. PMID: 28207591.

31 Arnetz BB. Psychosocial challenges facing physicians of today. Soc Sci Med. 2001 Jan;52(2):203-13. doi: 10.1016/s0277-9536(00)00220-3. PMID: 11144776. Arnetz BB. Psychosocial challenges facing physicians of today. Soc Sci Med. 2001 Jan;52(2):203-13. doi: 10.1016/s0277-9536(00)00220-3. PMID: 11144776.

32 Pham JC, Pronovost PJ, Skipper GE. Identification of physician impairment. JAMA. 2013 May 22;309(20):2101-2. doi: 10.1001/jama.2013.4635. Erratum in: JAMA. 2013 Jul 10;310(2):208. PMID: 23629590.

33 Baldisseri MR. Impaired healthcare professional. Crit Care Med. 2007 Feb;35(2 Suppl):S106-16. doi: 10.1097/01.CCM.0000252918.87746.96. PMID: 17242598

34 Center C, Davis M, Detre T, Ford DE, Hansbrough W, Hendin H, Laszlo J, Litts DA, Mann J, Mansky PA, Michels R, Miles SH, Proujansky R, Reynolds CF 3rd, Silverman MM. Confronting depression and suicide in physicians: a consensus statement. JAMA. 2003 Jun 18;289(23):3161-6. doi: 10.1001/jama.289.23.3161. PMID: 12813122

35 Moeller KE, Lee KC, Kissack JC. Urine drug screening: practical guide for clinicians. Mayo Clin Proc. 2008 Jan;83(1):66-76. doi: 10.4065/83.1.66. Erratum in: Mayo Clin Proc. 2008 Jul;83(7):851. PMID: 18174009.

36 Aitkenhead AR. Injuries associated with anaesthesia. A global perspective. Br J Anaesth. 2005 Jul;95(1):95-109. doi: 10.1093/bja/aei132. Epub 2005 May 20. PMID: 15908453.

37 Boonmak P, Boonmak S, Sathitkarnmanee T, Chau-In W, Nonlhaopol D, Thananun M. Surveillance of anesthetic related complications at Srinagarind Hospital, Khon Kaen University, Thailand. J Med Assoc Thai. 2005 May;88(5):613-22. PMID: 16149677.

38 Auroy Y, Narchi P, Messiah A, Litt L, Rouvier B, Samii K. Serious complications related to regional anesthesia: results of a prospective survey in France. Anesthesiology. 1997 Sep;87(3):479-86. doi: 10.1097/00000542-199709000-00005. PMID: 9316950.

39 Fabri PJ, Zayas-Castro JL. Human error, not communication and systems, underlies surgical complications. Surgery. 2008 Oct;144(4):557-63; discussion 563-5. doi: 10.1016/j.surg.2008.06.011. Epub 2008 Aug 8. PMID: 18847639.

40 Steadman J, Catalani B, Sharp C, Cooper L. Life-threatening perioperative anesthetic complications: major issues surrounding perioperative morbidity and mortality. Trauma Surg Acute Care Open. 2017 Aug 28;2(1):e000113. doi: 10.1136/tsaco-2017-000113. PMID: 29766107; PMCID: PMC5887586.

41 Jones CPL, Fawker-Corbett J, Groom P, Morton B, Lister C, Mercer SJ. Human factors in preventing complications in anaesthesia: a systematic review. Anaesthesia. 2018 Jan;73 Suppl 1:12-24. doi: 10.1111/anae.14136. PMID: 29313908.

42 Donohoe M. Urine trouble: practical, legal, and ethical issues surrounding mandated drug testing of physicians. J Clin Ethics. 2005 Spring;16(1):85-96. PMID: 15915849.

43. MACDONALD, S. Work-place alcohol and other drug testing: a review of the scientific evidence. Drug and Alcohol Review,1997; 16: 251-259. https://doi.org/10.1080/09595239800187431

44 Berge KH, McGlinch BP. The Law of Unintended Consequences Can Never Be Repealed: The Hazards of Random Urine Drug Screening of Anesthesia Providers. Anesth Analg. 2017 May;124(5):1397-1399. doi: 10.1213/ANE.0000000000001972. PMID: 28426583.

45 Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. Ann Intern Med. 2002 Mar 5;136(5):358-67. doi: 10.7326/0003-4819-136-5-200203050-00008. PMID: 11874308.

46 Fahrenkopf AM, Sectish TC, Barger LK, Sharek PJ, Lewin D, Chiang VW, Edwards S, Wiedermann BL, Landrigan CP. Rates of medication errors among depressed and burnt out residents: prospective cohort study. BMJ. 2008 Mar 1;336(7642):488-91. doi: 10.1136/bmj.39469.763218.BE. Epub 2008 Feb 7. PMID: 18258931; PMCID: PMC2258399.

47 Panagopoulou E, Montgomery A, Benos A. Burnout in internal medicine physicians: Differences between residents and specialists. Eur J Intern Med. 2006 May;17(3):195-200. doi: 10.1016/j.ejim.2005.11.013. PMID: 16618453.

48 Warner DO, Berge K, Sun H, Harman A, Hanson A, Schroeder DR. Substance use disorder among anesthesiology residents, 1975-2009. JAMA. 2013 Dec 4;310(21):2289-96. doi: 10.1001/jama.2013.281954. PMID: 24302092; PMCID: PMC3993973.

49 Fortner, N. A., Martin, D. M., Esen, S. E., & Shelton, L. (2011). Employee drug testing: study shows improved productivity and attendance and decreased workers' compensation and turnover. J Global Drug Policy Prac, 5, 1-22.

50 Fitzsimons, M. G., Baker, K., Malhotra, R., Gottlieb, A., Lowenstein, E., & Zapol, W. M. Reducing the incidence of substance use disorders in anesthesiology residents: 13 years of comprehensive urine drug screening. Anesthesiology, 2018;129(4), 821-828.

51 Boisaubin EV, Levine RE. Identifying and assisting the impaired physician. Am J Med Sci. 2001 Jul;322(1):31-6. doi: 10.1097/00000441-200107000-00006. PMID: 11465244.

52 DuPont RL, McLellan AT, Carr G, Gendel M, Skipper GE. How are addicted physicians treated? A national survey of Physician Health Programs. J Subst Abuse Treat. 2009 Jul;37(1):1-7. doi: 10.1016/j.jsat.2009.03.010. PMID: 19482236.

53 Rose JS, Campbell M, Skipper G. Prognosis for Emergency Physician with substance abuse recovery: 5-year outcome study. West J Emerg Med. 2014 Feb;15(1):20-5. doi: 10.5811/westjem.2013.7.17871. PMID: 24696748; PMCID: PMC3952884.

54 Chilkoti G, Wadhwa R, Saxena AK. Technological advances in perioperative monitoring: Current concepts and clinical perspectives. J Anaesthesiol Clin Pharmacol. 2015 Jan-Mar;31(1):14-24. doi: 10.4103/0970-9185.150521. PMID: 25788767; PMCID: PMC4353146.

55 Gaba DM. Anaesthesiology as a model for patient safety in health care. BMJ. 2000 Mar 18;320(7237):785-8. doi: 10.1136/bmj.320.7237.785. PMID: 10720368; PMCID: PMC1117775.

56 Gaba DM, Maxwell M, DeAnda A. Anesthetic mishaps: breaking the chain of accident evolution. Anesthesiology. 1987 May;66(5):670-6. PMID: 3578880.

57 Webster CS, Mahajan R, Weller JM. Anaesthesia and patient safety in the socio-technical operating theatre: a narrative review spanning a century. Br J Anaesth. 2023 Aug;131(2):397-406. doi: 10.1016/j.bja.2023.04.023. Epub 2023 May 18. PMID: 37208283; PMCID: PMC10375501.

58 Ippolito M, Einav S, Giarratano A, Cortegiani A. Effects of fatigue on anaesthetist well-being and patient safety: a narrative review. Br J Anaesth. 2024 Jul;133(1):111-117. doi: 10.1016/j.bja.2024.03.017. Epub 2024 Apr 19. PMID: 38641516.

59 Wickizer TM, Kopjar B, Franklin G, Joesch J. Do drug-free workplace programs prevent occupational injuries? Evidence from Washington State. Health Serv Res. 2004 Feb;39(1):91-110. doi: 10.1111/j.1475-6773.2004.00217.x. PMID: 14965079; PMCID: PMC1360996.

60 Ayers, C. M.. Constitutional Issues Implicated by Public Employee Drug Testing. Wm. Mitchell L. Rev., 1988;14, 337.

61 Peters, G., & Woolley, J. T. Executive Order 12564: Drug-Free Federal Workplace (1986)(Ronald Reagan). Drugs in American Society, 1986. 1024.