

SOCCA 26th Annual Meeting and Critical Care Update

Presented prior to ANESTHESIOLOGY™ 2013

October 11, 2013
Hyatt Regency San Francisco (Embarcadero Center)
San Francisco, California

Syllabus



THE SOCIETY OF CRITICAL CARE ANESTHESIOLOGISTS
WOULD LIKE TO THANK
THE FOLLOWING EXHIBITORS
OF THE
SOCCA 26TH ANNUAL MEETING:

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Target Audience

The SOCCA 26th Annual Meeting and Critical Care Update is designed for anesthesiologists in the clinical and laboratory setting who desire to improve development of anesthesiology teaching methods by engaging in an interchange of ideas as represented in this meeting.

Statement of Need

The Society of Critical Care Anesthesiologists Annual Meeting seeks to optimize outcomes for critically ill patients and their families by providing updates and expert discussion on topics of interest to anesthesiologists practicing critical care and perioperative medicine through advancing knowledge, improving competence and enhancing performance of intensive care teams.

Participation in the SOCCA 26th Annual Meeting

Attendance shall be open to all health practitioners, provided that they have registered for the meeting. CME credit will only be offered to M.D.s, D.O.s or equivalent. A completed Physician Verification of Attendance form must be turned in to SOCCA at the conclusion of the meeting. The form will be available on-site.

Educational Format

CME activities include the following formats: plenary sessions, lectures, and moderated poster discussions.

Accreditation Statement and Credit Designation

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education through the joint sponsorship of the American Society of Anesthesiologists and the Society of Critical Care Anesthesiologists. The American Society of Anesthesiologists is accredited by the ACCME to provide continuing medical education for physicians.

The American Society of Anesthesiologists designates this live activity for a maximum of 7 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Learning Objectives

At the conclusion of this activity the participant should be able to:

- Explain the potential pitfalls of targeting normal physiologic goals in all patients in the intensive care unit.
- Discuss the application and outcome data for the use of extracorporeal life support in patients with acute respiratory failure.
- Debate the relative advantages and disadvantages for the use of different types of intravenous fluids in the resuscitation of critically ill patients.
- Examine new therapeutic techniques for improved outcome following solid organ transplantation.
- Appraise emerging information on the significance of vitamin D in the care of the critically ill and injured.
- Review recent publications of interest to the practicing intensivist.
- Describe opportunities for and barriers to critical care anesthesiologist practice outside of the academic medical center.
- Analyze controversies in the management of patients following cardiac arrest.
- Evaluate the role of multimodal monitoring in the care of patients with neurologic disease and injury.

Faculty Disclosure

The American Society of Anesthesiologists and the Society of Critical Care Anesthesiologists adhere to ACCME Essential Areas, Standards, and Policies regarding industry support of continuing medical education. Disclosures of faculty and commercial relationships will be made known at the activity. Speakers are required to openly disclose any limitations of data and/or any discussion of any off-label, experimental, or investigational uses of drugs or devices in their presentations.

Disclaimer

The information provided at this CME activity is for continuing education purposes only and is not meant to substitute for the independent medical/clinical judgment of a healthcare provider relative to diagnostic and treatment options of a specific patient's medical condition.



Resolution of Conflicts of Interest

In accordance with the ACCME Standards for Commercial Support of CME, the American Society of Anesthesiologists and the Society of Critical Care Anesthesiologists will implement mechanisms, prior to the planning and implementation of this CME activity, to identify and resolve conflicts of interest for all individuals in a position to control content of this CME activity.

Faculty and Program Committee

Jordan Brand, M.D.

Staff Anesthesiologist
San Francisco VA Medical Center, Berkeley, CA

Christofer D. Barth, M.D.

Director of Cardiovascular Critical Care
Aurora St. Luke's Medical Center
Staff Intensivist, Aurora Critical Care Service,
Aurora Medical Group, Milwaukee, WI

Eugene Cheng, M.D.

Chief, Critical Care
Kaiser Permanente San Jose Medical Center
Chair, Biomedical Device Integration Council
Kaiser Permanente Health Plan, San Jose, CA

Carlee A. Clark, M.D.

Assistant Professor
Anesthesia and Perioperative Medicine
Medical University of South Carolina
Charleston, SC

Miguel A. Cobas, M.D.

Associate Professor of Clinical Anesthesiology
University of Miami
Jackson Memorial Hospital, Miami, FL

Steve Deem, M.D.

Physicians Anesthesia Service and Swedish
Medical Group
Clinical Professor of Anesthesiology
University of Washington, Seattle, WA

Charles G. Durbin, Jr., M.D.

Professor of Anesthesiology and Surgery
University of Virginia Health System
Charlottesville, VA

Daniel A. Emmert, M.D., Ph.D.

Assistant Professor
Anesthesiology and Surgery
Washington University School of Medicine
St. Louis, MO

Brenda G. Fahy, M.D., FCCM

Professor of Anesthesiology
Chief of Critical Care Medicine
University of Florida, Gainesville, FL

Eddy Fan, M.D., Ph.D.

Assistant Professor
Respiratory Medicine
Toronto General Hospital
Toronto, ON, Canada

Jane C.K. Fitch, M.D.

Professor and Chair
Department of Anesthesiology
University of Oklahoma Health Sciences Center
Oklahoma City, OK

Andrea Gabrielli, M.D.

Professor of Anesthesiology
Program Director
Division of Critical Care Medicine
University of Florida College of Medicine
Gainesville, FL

Brian P. Kavanagh, M.B.

Staff Physician, Critical Care Medicine
The Hospital for Sick Children
Chair, Department of Anesthesia
University of Toronto
Toronto, ON, Canada

Erik B. Kistler, M.D., Ph.D.

Staff Anesthesiologist
VA San Diego Healthcare System
Assistant Professor
University of California
San Diego, CA

Daryl J. Kor, M.D.

Assistant Professor of Anesthesiology
Department of Anesthesiology
Mayo Clinic College of Medicine, Rochester, MN

John D. Lang, M.D.

Associate Professor
Anesthesiology and Pain Medicine
University of Washington, Seattle, WA

Patricia Murphy, M.D.

Associate Professor
University of Toronto, Toronto, ON, Canada

Mark E. Nunnally, M.D., FCCM

Associate Professor of Anesthesia and Critical Care
University of Chicago, Chicago, IL

Ronald Pauldine, M.D.

Clinical Professor
Department of Anesthesiology and Pain Medicine
University of Washington, Seattle, WA

Sadeq Quraishi, M.D., M.H.A.

Assistant Professor of Anesthesia
Department of Anesthesiology, Critical Care
and Pain Medicine
Massachusetts General Hospital, Boston, MA

Aryeh Shander, M.D., FCCM

Chief of the Department of Anesthesiology,
Critical Care Medicine, Pain Management
and Hyperbaric Medicine
Englewood Hospital and Medical Center
Demarest, NJ

Lori Shutter, M.D.

Visiting Professor
Departments of Critical Care Medicine, Neurology,
and Neurosurgery
University of Pittsburgh, Pittsburgh, PA

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Committee/Faculty

Christofer D. Barth, M.D.

Brenda G. Fahy, M.D., FCCM

Aryeh Shander, M.D., FCCM

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1 - Aurora Health Care

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The following program committee members/faculty have nothing to disclose:

Jordan Brand, M.D.

Eugene Cheng, M.D.

Carlee A. Clark, M.D.

Miguel A. Cobas, M.D.

Steve Deem, M.D.

Charles G. Durbin, Jr., M.D.

Daniel A. Emmert, M.D., Ph.D.

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Jane C.K. Fitch, M.D.

Andrea Gabrielli, M.D.

Brian P. Kavanagh, M.B.

Erik B. Kistler, M.D., Ph.D.

Daryl J. Kor, M.D.

John D. Lang, M.D.

Patricia Murphy, M.D.

Mark E. Nunnally, M.D., FCCM

Ronald Pauldine, M.D.

Sadeq Quraishi, M.D., M.H.A.

Lori Shutter, M.D.

Poster Presenter Disclosures

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Poster Presenter	Poster Disclosures	Poster Presenter	Poster Disclosures
Richard Hotchkiss	4 - MedImmune, LLC, Bristol Myers	Gyorgy Frendl	4 - EarlySense, Inc.
Michael J. Banner	7 - Convergent Engineering	Tal Kap	1 - EarlySense, Inc.
Carl G. Tams	1 - Convergent Engineering	Shiraz Levkovich	1 - EarlySense, Inc.
Neil Euliano	1,2 - Convergent Engineering	Eyal Zimlichman	4 - EarlySense, Inc.

The following poster presenters have nothing to disclose:

Ozan Akca	Marcus DiLallo	Ardeshir Jahanian	Vivek Moitra	Cheromi Sittambalam
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Andre Atoian	Natalie A. Ferrero	Ishaq Lat	Afrin Nuzhad	Leslie M. Terdiman
Alexander F. Bautista	Chris Fjell	Meghan B. Lane-Fall	Edward O. O'Brien	Duraiyah Thangathurai
Kate E. Bennett	Lee A. Fleisher	Alice Y. Li	Michael O'Connor	Miriam Treggiari
Sascha Betler	Robert Fowler	Helene Logginidou	Enrique Pantin	Alex Villafranca
Andrey V. Bortsov	John A. Fox	Rainer Lenhardt	Andrew J. Patterson	Brant M. Wagener
Michael J. Bowling	Christopher M. Franklin	Elizabeth B. Mahanna	Jean-Francois Pittet	Keith Walley
John Boyd	Andrea Gabrielli	Victor L. Mandoff	Jashvant Poeran	Matthias Walz
Angela P. Brandon	Monica Goldklang	Rizwan A Manji	Shaizeel Praptani	Brendan T. Wanta
Andrew Burr	Clairmont E. Griffith	Anatole Daniel Martin	Ferenc Rabai	Peggy A. White
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Timothy Curry	Jessica L. Hobbs	Katie Mieux	Ilona Schmaulffuss	Daniel Yoo
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Thomas Danninger	Joe Hsu	Annette Mizchi	Raghu R. Seethala	David A. Zvara
Sumudu S. Dehipawala	Ryan M.J. Ivie	Nitesh S. Mody	Nigel E. Sharrock	
John T. Denny	Eric Jacobsohn	Mariana Mogos	Ian Shempp	





Awards

Lifetime Achievement Award

Attendees of the SOCCA 26TH Annual Meeting will honor Charles G. Durbin, Jr., M.D. as this year's Lifetime Achievement Award recipient. This award recognizes Dr. Durbin's distinguished service and outstanding contributions to critical care medicine. Dr. Durbin's presentation is entitled *"Four Things I Thought I Knew ..."*

Young Investigator Award

This award is presented annually to the individual whose research exemplifies the Society's mission to educate anesthesiologists in the care of critically ill patients and to foster the knowledge and practice of critical care medicine by anesthesiologists. The recipient of the Young Investigator Award will make an oral presentation of their work at the SOCCA Annual Meeting. SOCCA is proud to announce the 2013 Young Investigator Award recipient as Ryan M.J. Ivie, M.D., Columbia University, for his paper titled *"The Generalizability of Randomized Controlled Trials in Critical Care Medicine."*



SOCCA Subspecialty Panel at ANESTHESIOLOGY™ 2013

“Quality Improvement in Perioperative Care (SOCCA)”

Monday, October 14, 2013, 7:00 - 8:15 a.m.

Moscone Convention Center, Room 301

The SOCCA subspecialty panel will focus on strategies for measuring and improving the quality of care in the perioperative setting. Panelists will focus on different aspects of health care quality, including a survey of successful approaches, strategies for outcome measurement and incremental improvement, and the relevance of Health Information Technology (Health IT).

Objectives

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

1. Review current strategies for perioperative quality improvement;
2. Describe and discuss examples of successful approaches to quality improvement in perioperative care;
3. Describe and explore the relevance of Health IT in facilitating quality improvement.

Presentations

**Lead Speaker-Quality:
A Systems Approach**

Matthias Merkel, M.D.
Oregon Health and
Sciences University
Portland, OR

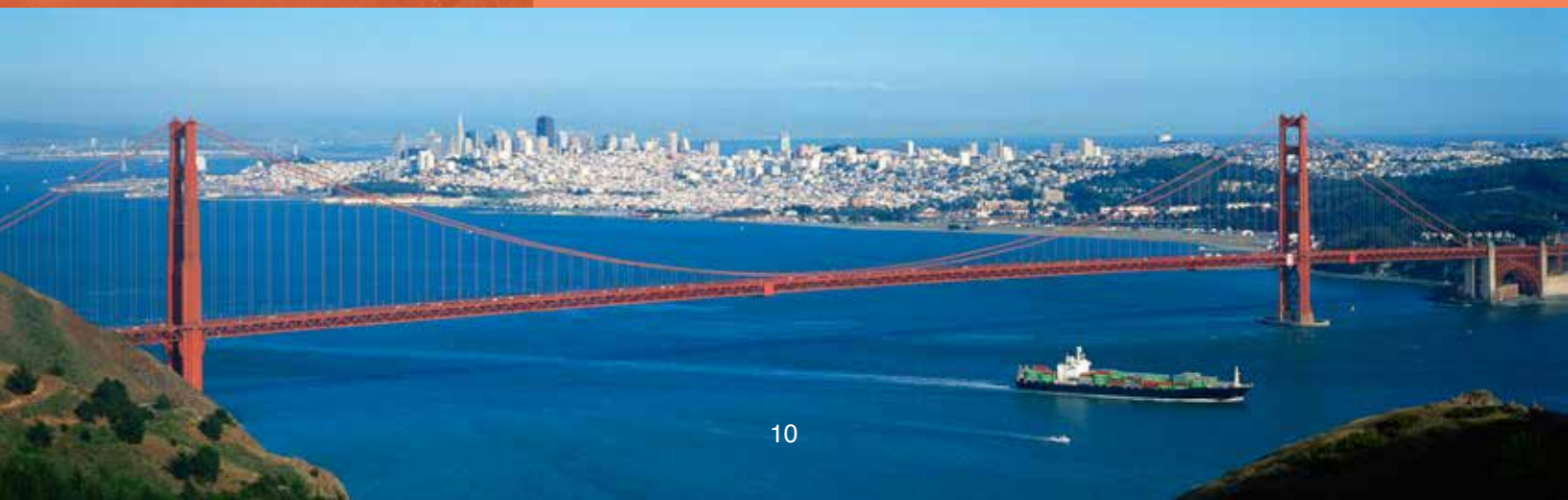
**Speaker-Real World Examples
of Successful Quality
Improvement**

Gregory H. Botz, M.D.
University of Texas MD
Anderson Cancer Center
Houston, TX

**Speaker-Can Health
IT Drive Quality?**

Andrew L. Rosenberg, M.D.
University of Michigan
Ann Arbor, MI

This panel is part of the ANESTHESIOLOGY™ 2013 annual meeting.



SOCCA 26TH ANNUAL MEETING AND CRITICAL CARE UPDATE: 2013 Program

Friday, October 11, 2013

6:30 a.m. - 5:00 p.m.

Registration

7:30 - 8:00 a.m.

Continental Breakfast - Exhibits Open

8:00 - 8:05 a.m.

Welcome and Introduction

Ronald Pauldine, M.D.

Patricia Murphy, M.D.

Content Section I – “Plus Ça Change, Plus C’est La Meme Chose; Everything Old is New Again”

8:05 - 8:35 a.m.

The Fallacy of VAP

Brian P. Kavanagh, M.B.

8:40 - 9:10 a.m.

ECMO for Respiratory Failure

Eddy Fan, M.D.

9:15 - 9:45 a.m.

What is the Ideal Resuscitation Fluid?

Aryeh Shander, M.D.

9:50 - 10:10 a.m.

Break and Visit with Vendors

Content Section II - Off The Beaten Path: From Translational Concepts to Important Publications

10:15 - 10:30 a.m.

Inhaled Therapies for Solid Organ Transplantation

John D. Lang, M.D.

10:35 - 10:50 a.m.

Vitamin D in Critical Care

Sadeq Quraishi, M.D.

10:55 - 11:25 a.m.

Important Publications You Might Have Missed

Miguel A. Cobas, M.D. - Moderator

Daryl J. Kor, M.D.; Eliot Fagley, M.D.;

Mark E. Nunnally, M.D.

11:30 - 11:35 a.m.

Introduction of ASA President Elect

Brenda Fahy, M.D.

11:35 a.m. - Noon

ASA Update

Jane C.K. Fitch, M.D. - ASA President-Elect

12:00 - 1:00 p.m.

Lunch and Presentation by Young Investigator Award Recipient

“The Generalizability of Randomized Controlled Trials in Critical Care Medicine”

Recipient: Ryan M.J. Ivie, M.D.

Content Section III - The Critical Care Anesthesiologists Beyond the Ivory Tower

1:05 - 2:10 p.m.

Realities of Critical Care in Private Practice

Eugene Cheng, M.D. – Panel Chair
Kaiser Permanente Northern California

Steve Deem, M.D.

Physicians Anesthesia Service
and Swedish Medical Center

Jordan Brand, M.D.

San Francisco VA Medical Center

Christofer D. Barth, M.D.

Aurora Health Care

2:15 - 2:30 p.m.

SOCCA-FAER-Hospira Physician Scientist Award Lecture

“The Role of Digestive Enzymes in Circulatory Shock”

Erik Kistler, M.D., Ph.D.

2:35 - 3:15 p.m.

Moderated Poster Session

2:35 - 3:15 p.m.

Break and Vendor Visits

3:20 - 3:50 p.m.

Presentation by Lifetime Achievement Award Recipient

“Four Things I Thought I Knew ...”

Charles G. Durbin, Jr., M.D.

Content Section IV – Controversies in Neurological Care in the Intensive Care Unit

3:50 - 4:20 p.m.

Controversies in Post-Resuscitation Care After Cardiac Arrest

Andrea Gabrielli, M.D.

4:25 - 4:50 p.m.

Update on Neuromonitoring: Emerging Technology, Does It Matter?

Lori Shutter, M.D.

4:55 - 5:00 p.m.

Closing

5:00 - 5:45 p.m.

SOCCA Annual Business Meeting

5:00 - 6:00 p.m.

Resident/Fellow Program

5:45 - 7:00 p.m.

Welcome Reception

Content Section I

“Plus Ça Change, Plus C’est La Meme Chose; Everything Old is New Again”

The Fallacy of VAP

Brian P. Kavanagh, M.B.

ECMO for Respiratory Failure

Eddy Fan, M.D.

What is the Ideal Resuscitation Fluid?

Aryeh Shander, M.D.

The Fallacy of VAP

Brian P. Kavanagh, M.B.

Ventilator-Associated Pneumonia (VAP) is pneumonia that occurs as a result of receiving mechanical ventilation. It contrasts with, for example, aspiration pneumonia (that is thought to have occurred during endotracheal intubation), and with community-acquired pneumonia (occurs long before any contact with ventilation). The definition of VAP has evolved into two sets of consensus criteria, which are widely used.

While the precise pathophysiology of VAP is unclear, much of the problem almost certainly results from the microaspiration into the lungs of oropharyngeal contents, often around the indwelling endotracheal tube.

Two cardinal features of VAP have resulted in its being catapulted into the front lines of healthcare quality metrics. First, many investigators have reported that important associations exist between the presence of VAP and important healthcare outcomes (e.g. length of stay, financial cost and mortality), and several authorities have interpreted these associations as causal. Second, healthcare organizations and medical professional societies have determined that VAP is largely preventable. For these reasons, leaders in the field have suggested that preventing VAP would result in marked patient and institutional benefit, and because prevention is thought to be possible, the rate of VAP -as well as compliance with VAP-prevention measures- should be reported as measures of health care quality. Indeed, many hospitals publically report VAP rates.

It has been clear for some time that many of these assumptions are poorly supported, and some are simply wrong. The criteria for VAP are suited to surveillance, do not confirm the presence of infection (related to ventilation or otherwise) and are screening -not diagnostic- measures. While some measures do appear to reduce the incidence of VAP, many of the standard VAP prevention 'bundles' contain elements that are ineffective or that have no relationship to VAP. Indeed, there are major differences between the UK (NICE) and the US (IHI) in how such measures are weighed and recommended. Finally, prior associations between VAP and either mortality or economic cost appear to be based on oversimplified analyses; the true attributable mortality and financial costs seem low.

References

- O'Grady NP, Murray PR, Ames N. Preventing ventilator-associated pneumonia: does the evidence support the practice? JAMA 307:2534-9, 2012
- Kollef MH, Afessa B, Anzueto A, Veremakis C, Kerr KM, Margolis BD, Craven DE, Roberts PR, Arroliga AC, Hubmayr RD, Restrepo MI, Auger WR, Schinner R; NASCENT Investigation Group. Silver-coated endotracheal tubes and incidence of ventilator-associated pneumonia: the NASCENT randomized trial. JAMA 300:805-13, 2008
- Drakulovic MB, Torres A, Bauer TT, Nicolas JM, Nogué S, Ferrer M. Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. Lancet 354:1851-8, 1999
- Kalil AC, Wiener-Kronish JP. Is the evidence for benefits from ventilator-associated pneumonia bundles reliable enough for implementation in a general hospital? Crit Care Med 40:348-50, 2012
- Klompas M. Eight initiatives that misleadingly lower ventilator-associated pneumonia rates. Am J Infect Control 40:408-10, 2012

Notes: _____

ECMO for Respiratory Failure

Eddy Fan, M.D.

This presentation will cover the following topics:

- Briefly review the Berlin Definition for severe ARDS
- Briefly review the different configurations of ECMO and their relevance in severe acute respiratory failure/ARDS
- Review the evidence for the use of ECMO for acute respiratory failure in adults
- Discuss indications and contraindications for the use of ECMO in acute respiratory failure in adults
- Highlight current controversies, as well as ongoing and future research into the use extracorporeal life support for acute respiratory failure in adults

Key References

1. The ARDS Definition Task Force. Acute respiratory distress syndrome: the Berlin Definition. JAMA 2012;307:2526-2533.
2. Brodie D and Bacchetta M. Extracorporeal membrane oxygenation for ARDS in adults. N Engl J Med 2011;365:1905-1914.
3. Pipeling MR and Fan E. Therapies for refractory hypoxemia in acute respiratory distress syndrome. JAMA 2010;304:2521-2527.
4. Peek G et al., Efficacy and economic assessment of conventional ventilatory support versus extracorporeal oxygenation for severe adult respiratory failure (CESAR): a multicenter randomized controlled trial. Lancet 2009;374:1351-1363.
5. Fan E, Villar J, Slutsky AS. Novel approaches to minimize ventilator-induced lung injury. BMC Med 2013;11:85.
6. Abrams D and Brodie D. Emerging indications for extracorporeal membrane oxygenation in adults with respiratory failure. Ann Am Thorac Soc 2013;10:371-377.

Notes: _____

What is the Ideal Resuscitation Fluid?

Aryeh Shander, M.D.

- Consequences of over and under hydration
- What are the outcomes associated with fluid management in the critically ill patients
- Describe the clinical conditions for the use of fluid resuscitation
- Compartment resuscitation – Intravascular and extravascular
- Describe crystalloid and colloid options for fluid management in peri-operative and critically ill patients
 - Colloid resuscitation – HES vs. HA
 - Describe the effect of fluid resuscitation in septic patients
- How to develop a fluid management strategy for individual patients
- How to monitor fluid response
- Randomized controlled trials and fluid management
- Current guidelines for fluid management (EU)

Notes: _____

Content Section II

Off The Beaten Path: From Translational Concepts to Important Publications

Inhaled Therapies for Solid Organ Transplantation

John D. Lang, Jr., M.D.

Vitamin D in Critical Care

Sadeq Quraishi, M.D.

Important Publications You Might Have Missed

Miguel A. Cobas, M.D. - Moderator

Daryl J. Kor, M.D.; Daniel A. Emmert, M.D., Ph.D.; Mark E. Nunnally, M.D.

Inhaled Therapies for Solid Organ Transplantation

John D. Lang, Jr., M.D.

Ischemia-reperfusion injury (IRI) remains the greatest contributor to graft dysfunction and/or failure in patients undergoing solid organ transplantation resulting in prolonged hospital length of stays and increased costs.¹ While some progress has been made, specific therapies for attenuating IRI remain largely elusive.

Inhalation as a method for the administration of therapeutic agents for other than cardiopulmonary disorders has been relatively under appreciated. Previous work has demonstrated preemptive treatment with inhaled nitric oxide (iNO), carbon monoxide (CO) and hydrogen sulfide (H₂S) can attenuate IRI via modulation of a myriad of inflammatory, cellular and vascular mechanisms in clinically relevant models of organ transplantation.^{2,3,4,5}

Specifically, preemptive administration of iNO (80 ppm) has been demonstrated to significantly attenuate the inflammatory responses in patients undergoing knee surgery associated with tourniquet use, a clinical model of IRI, characterized by reduced expression of CD11b/CD18, P-selectin, and nuclear factor kappa B when compared with a control group. Use of iNO was accompanied by increased plasma levels of nitrate and nitrite and significant reduction in markers of oxidative stress.⁶ Subsequently, when patients undergoing liver transplantation received iNO prior to and during surgery, patients receiving iNO were observed to have enhanced recovery of graft function, significantly reduced hepatocellular necroapoptosis and a significantly reduced hospital length of stay. No detrimental toxic or metabolic effects were observed from iNO when compared to the patients receiving placebo.⁷ In a recent two-center trial in patients undergoing liver transplantation, use of iNO was again associated with enhanced graft recovery and reduced hepatobiliary complication rates at 9-months post-transplantation (manuscript under review). In other clinically relevant models of organ transplantation, use of iNO or NO-related metabolites have been shown to demonstrate superiority when compared to controls.^{8,9,10,11}

In conclusion, inhaled therapies administered with the intent to attenuate IRI are showing remarkable promise. Inhaled nitric oxide in particular appears to be both safe and efficacious in human liver transplantation. Translating this research in an effort to enhance best practices for this complex patient population remains the ultimate goal.

References:

1. Washburn WK, Meo NA, Halff GA, Roberts JP, Feng S (2009) Factors influencing liver transplant length of stay at two large-volume transplant centers. *Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society* 15: 1570-1578.
2. Phillips L, Toledo AH, Lopez-Neblina F, Anaya-Prado R, Toledo-Pereyra LH (2009) Nitric oxide mechanism of protection in ischemia and reperfusion injury. *Journal of investigative surgery : the official journal of the Academy of Surgical Research* 22: 46-55.
3. Ikeda A, Ueki S, Nakao A, Tomiyama K, Ross MA, et al. (2009) Liver graft exposure to carbon monoxide during cold storage protects sinusoidal endothelial cells and ameliorates reperfusion injury in rats. *Liver transplantation : official publication of the American Association for the Study of Liver Diseases and the International Liver Transplantation Society* 15: 1458-1468.
4. Balaban CL, Rodriguez JV, Guibert EE (2011) Delivery of the bioactive gas hydrogen sulfide during cold preservation of rat liver: effects on hepatic function in an ex vivo model. *Artificial Organs* 35: 508-515.
5. Siriussawakul A, Chen LI, Lang JD (2012) Medical gases: a novel strategy for attenuating ischemia-reperfusion injury in organ transplantation? *Journal of Transplantation* 2012: 819382.
6. Mathru M, Huda R, Solanki DR, Hays S, Lang JD (2007) Inhaled nitric oxide attenuates reperfusion inflammatory responses in humans. *Anesthesiology* 106: 275-282.
7. Lang JD, Jr., Teng X, Chumley P, Crawford JH, Isbell TS, et al. (2007) Inhaled NO accelerates restoration of liver function in adults following orthotopic liver transplantation. *The Journal of Clinical Investigation* 117: 2583-2591.
8. Li W, Meng Z, Liu Y, Patel RP, Lang JD (2012) The hepatoprotective effect of sodium nitrite on cold ischemia-reperfusion injury. *Journal of Transplantation* 2012: 635179.
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10. Xue Q, Yuan Z, Chen Z, Hao R, Liu C, et al. (2012) Protective role of nitric oxide induced by ischemic preconditioning on cold ischemic-reperfusion injury of rat liver graft. *Transplantation Proceedings* 44: 948-951.
11. Yagi S, Nagai K, Kadaba P, Afify M, Teramukai S, et al. (2013) A novel organ preservation for small partial liver transplantations in rats: venous systemic oxygen persufflation with nitric oxide gas. *American Journal of Transplantation* 13: 222-228.

Sadeq A. Quraishi, M.D., MHA, MMSc

References:

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Important Publications You Might Have Missed

Miguel A. Cobas, M.D. - Moderator

Daryl J. Kor, M.D.; Daniel A. Emmert, M.D., Ph.D.; Mark E. Nunnally, M.D.

The purpose of this panel is to provide you with an overview of carefully selected topics that might have gotten lost in the enormity of the literature coming out every month.

These are the articles each one of our curators have selected for brief discussion:

Mark Nunnally, MD:

1. Combination antifungal therapy for cryptococcal meningitis.

Day JN, Chau TT, Wolbers M, Mai PP, Dung NT, Mai NH, Phu NH, Nghia HD, Phong ND, Thai CQ, Thai le H, Chuong LV, Sinh DX, Duong VA, Hoang TN, Diep PT, Campbell JI, Sieu TP, Baker SG, Chau NV, Hien TT, Laloo DG, Farrar JJ.
N Engl J Med. 2013 Apr 4;368(14):1291-302. doi: 10.1056/NEJMoa1110404.

2. Treatment of HCV infection by targeting microRNA.

Janssen HL, Reesink HW, Lawitz EJ, Zeuzem S, Rodriguez-Torres M, Patel K, van der Meer AJ, Patack AK, Chen A, Zhou Y, Persson R, King BD, Kauppinen S, Levin AA, Hodges MR.
N Engl J Med. 2013 May 2;368(18):1685-94. doi: 10.1056/NEJMoa1209026. Epub 2013 Mar 27.

Daryl J. Kor, M.D:

1. Efficacy and Safety of a Four-Factor Prothrombin Complex Concentrate (4F-PCC) in Patients on Vitamin K Antagonists Presenting with Major Bleeding: A Randomized, Plasma-Controlled, Phase IIIb Study.

Sarode, R., Milling, T. J., Refaai, M. a, Mangione, A., Schneider, A., Durn, B. L., & Goldstein, J. N. (2013).
Circulation. doi:10.1161/CIRCULATIONAHA.113.002283

2. Relationship between red cell storage duration and outcomes in adults receiving red cell transfusions: a systematic review.

Lelubre, C., & Vincent, J.-L. (2013).
Critical care (London, England), 17(2), R66. doi:10.1186/cc12600

3. Guidelines on the management of anaemia and red cell transfusion in adult critically ill patients.

British journal of haematology, Retter, A., Wyncoll, D., Pearse, R., Carson, D., McKechnie, S., Stanworth, S., Š Walsh, T.
160(4), 44564. doi:10.1111/bjh.12143

Daniel A. Emmert, M.D., Ph.D.:

1. Safety and feasibility of prehospital extra corporeal life support implementation by non-surgeons for out-of-hospital refractory cardiac arrest.

Lamhaut L, Jouffroy R, Soldan M, Phillipe P, Deluze T, Jaffry M, Dagron C, Vivien B, Spaulding C, An K, Carli P.
Resuscitation. 2013 Jul 1. pii: S0300-9572(13)00310-9. doi: 10.1016/j.resuscitation.2013.06.003. [Epub ahead of print]

2. Avalon® Bicaval Dual-Lumen Cannula for Venovenous Extracorporeal Membrane Oxygenation: Survey of Cannula Use in France

Chimot, Loïc*†; Marqué, Sophie*; Gros, Antoine*; Gacouin, Arnaud*; Lavoué, Sylvain,*, Camus, Christophe*; Le Tulzo, Yves*
ASAIO Journal: March/April 2013 - Volume 59 - Issue 2 - p 157–161
doi: 10.1097/MAT.0b013e31827db6f3

3. Time course of haemostatic effects of fibrinogen concentrate administration in aortic surgery.

C. Solomon, C. Hagl and N. Rahe-Meyer
British Journal of Anaesthesia 110 (6): 947–56 (2013)
Advance Access publication 6 February 2013 .
doi:10.1093/bja/aes576

Content Section III

The Critical Care Anesthesiologists Beyond the Ivory Tower

Realities of Critical Care in Private Practice

Eugene Cheng, M.D. Panel Chair

Kaiser Permanente Northern California

Steve Deem, M.D.

Physicians Anesthesia Service and Swedish Medical Center

Jordan Brand, M.D.

San Francisco VA Medical Center

Christofer D. Barth, M.D.

Aurora Health Care

SOCCA-FAER- Hospira Physician Scientist Award Lecture

“The Role of Digestive Enzymes in Circulatory Shock”

Erik Kistler, M.D., Ph.D.

Realities of Critical Care in Private Practice

Eugene Cheng, M.D. – Panel Chair

Kaiser Permanente Northern California

- I. Are there jobs in private practice for Critical Care Trained Anesthesiologists?
- II. Drivers increasing critical care positions in private practice
- III. Panel members presenting personal pathway to private practice and key considerations
 - A. Location
 - B. Practice model – group, solo, multi-specialty, MD only, MD plus MD extenders
 - C. Work time distribution and hours--critical care only, critical care+anesthesia
 - D. Scope of practice – patient demographics, types of ICUs covered, model of care
 - E. Contract model – self-employed, group practice, hospital employee, work hours
 - F. Call structure
 - G. Compensation and benefits
 - H. Partnership track
 - I. Sources available for finding job opportunities
- IV. Q&A

Notes: _____

Physicians Anesthesia Service and Swedish Medical Center

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small margins at the top and bottom. There are no vertical margin lines, and the page is completely blank except for the lines themselves.

San Francisco VA Medical Center

[illegible]

Aurora Health Care

[illegible]

SOCCA-FAER- Hospira Physician Scientist Award Lecture

“The Role of Digestive Enzymes in Circulatory Shock”

Erik Kistler, M.D., Ph.D.

Circulatory shock, encompassing disparate triggering events such as sepsis, hemorrhage, trauma, vascular ischemia, and burn, is a common cause of morbidity and death in the intensive care unit, with a mortality of 30-100%. The mechanisms leading to circulatory shock and cardiovascular collapse are incompletely understood, and in spite of numerous theories no agreement exists for the microvascular and molecular mechanisms that lead to the rapid progression to cell and organ failure in this condition. Likewise, other than source control and supportive care there is no definitive treatment for circulatory shock, which results in high morbidity for those who survive the initial insult. However, it is becoming increasingly clear that the gut, and particular the small bowel, may be the key to understanding shock and its sequelae.

We propose new hypothesis for the mechanisms that lead to cell dysfunction and multi-organ failure in shock with the discovery that pancreatic digestive enzymes in the bowel may play a major role in this pathology. These powerful enzymes are synthesized in the pancreas and transported in the lumen of the small intestine as a requirement for normal food digestion, where they are fully activated and remain compartmentalized by the bowel mucosal barrier. However, in intestinal ischemia or after exposure to inflammatory mediators the permeability of the bowel mucosal barrier increases and pancreatic enzymes escape into the wall of the intestine. Entry of these digestive enzymes into the intestinal wall precipitates an autodigestion process in which structures are destroyed and cell membrane molecules are cleaved, compromising the tight barrier properties of the intestine. Pancreatic enzymes also generate inflammatory breakdown products during autodigestion, including vasoactive peptides and unbound free fatty acids. These digestive enzymes and the breakdown products they generate escape into the systemic circulation where they cause and contribute to remote organ failure.

We present evidence for intestinal blockade of pancreatic digestive enzymes in acute forms of shock as a potential therapeutic intervention. Blockade of digestive enzymes in the intestinal lumen, but not the systemic circulation, may abolish mortality and morbidity normally seen in experimental models of circulatory shock. The “autodigestion” hypothesis has now been tested in a number of acute shock models and different animal species and has demonstrated decreased inflammation, morbidity and mortality in these experimental models. Inhibition of luminal digestive enzymes in critical illness is now the subject of human trials to determine the efficacy of such an approach.

References

1. DeLano, F.A., Hoyt, D.B., Schmid-Schönbein, G.W.: Digestive enzyme blockade in the lumen of the intestine increases long-term survival rate after shock. *Science Translational Medicine*, 5(169):169ra11, 2013.
2. Chang, M., Kistler, E., Schmid-Schönbein, G.W.: Disruption of the intestinal mucin layer during ischemia allows early entry of digestive enzymes into the intestinal wall. *Shock*, 37:297-305, 2012.
3. Kistler, E.B., Hugli, T.E., Schmid-Schönbein, G.W.: The pancreas as a source of cardiovascular cell activating factors. *Microcirculation*, 7:183-192, 2000.
4. Mitsuoka, H., Kistler, E.B., Schmid-Schönbein, G.W.: Generation of in vivo activating factors in the ischemic intestine by pancreatic enzymes. *Proc. Nat. Acad. Sci. U.S.A.*, 97:1772-1777, 2000.

Lifetime Achievement Award

“Four Things I Thought I Knew ...”

Charles G. Durbin, Jr., M.D.

Physicians Anesthesia Service and Swedish Medical Center

How to resuscitate critically ill patients with fluids

The use of fluids in resuscitation evolved from replacing lost blood and other measured fluid losses in the 40's to administering additional, theoretically and calculated, “3rd” space (unmeasured loss) “losses” in the 60's. It was believed that cellular injury from shock or trauma caused the need for additional fluid and electrolytes and this loss could be identified and treated by monitoring and maintaining a normal central venous pressure. This approach of using pressure as a surrogate for cardiac filling was improved by the invention of the flow-directed pulmonary artery catheter in the early 70's. Soon thermodilution cardiac output measurements added to the precision of resuscitation and fluid challenges to determine optimum filling pressures became standard. Ultrasonographic cardiac chamber evaluations confirmed that pressure alone was a poor indicator of cardiac filling, and confounding conditions (i.e., AML) could further degrade identification of optimum fluid management using the PA catheter. Dynamic predictors of fluid responsiveness are replacing pressure-alone guided approaches. The recognition that too much resuscitation/maintenance fluid can make matters worse has been known since the 40's and now use of vasoactive agents are returning to treatment approaches. What kind of fluids-colloids, crystalloids, blood, and blood products to use, continues to revolve and change.

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- Swan HJ, Ganz W, Forrester J, Marcus H, Diamond G, Chonette D. Catheterization of the heart in man with use of a flow-directed balloon-tipped catheter. *N Engl J Med* 283(9):447-51, 1970
- Bartels K, Thiele RH, Gan TJ. Rational fluid management in today's ICU practice. *Crit Care* 17 Suppl 1:S6. Epub 2013 Mar 12.

How to use PEEP in treating ARDS

Positive pressure mechanical ventilators were developed in Europe in the 50's for treatment of mechanical respiratory failure, primarily for treating hypercarbic respiratory failure from polio. In the US, victims of the polio epidemics were supported with negative pressure (tank) respirators. The ventilation devices were relatively simple and only capable of providing controlled volume breaths at a fixed rate or on patient demand. The emergence of hypoxic respiratory failure (often following trauma or sepsis) with a very high mortality required new supportive therapies. Devices capable of providing continuous positive airway pressure were crafted in the workshops of anesthesia departments and applied to critically ill patients clinically. The mortality of this new disease entity was greater than 90%. The use of cardiopulmonary bypass technology to support these patients was found to offer no survival benefit to these patients. An observation during the landmark study of extracorporeal oxygenation trial increased the interest in optimizing CPAP and PEEP in ARDS treatment. Applying PEEP to achieve a low shunt fraction or optimal lung compliance were suggested as therapeutic (rather than supportive) approaches to this lethal entity. Pioneers of this approach reported survival of greater than 90% with average PEEP as high as 35-40 torr with minimal barotrauma (in patients breathing spontaneously). The current treatment has been on reducing tidal volume and peak airway pressures but we have not achieved the high survival rates of the 1980s. A new look at the optimum airway pressure approach directed by compliance is showing promise.

- Ashbaugh DG, Bigelow DB, Petty TL, Levine BE. Acute respiratory distress in adults. *Lancet*, Aug 12;2(7511):319-23, 1967
- Petty TL, Ashbaugh DG. The adult respiratory distress syndrome. Clinical features, factors influencing prognosis and principles of management. *Chest* 60(3):233-9, 1971
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- Gallagher TJ, Civetta JM, Kirby RR. Terminology update: optimal PEEP. *Crit Care Med*; 6(5):323-6, 1978
- Talmor D, Sarge T, Malhotra A, O'Donnell CR, Ritz R, Lisbon A, Novack, V, Loring SH. Mechanical Ventilation Guided by Esophageal Pressure in Acute Lung Injury. *N Engl J Med*; 359:2095-104, 2008

How to use steroids in ARDS and shock

Steroid use in ARDS and sepsis has a long and checkered history. The identification that inflammation is present in ARDS suggested that steroids in large doses could be beneficial and certainly couldn't hurt. 2 grams of Solumedrol® was administered to all patients with this new syndrome of hypoxic respiratory failure and refractory shock in the 60's and 70's. In the 80's we identified many "bad" things that megadose steroids could do including GI bleeding, myopathy, adrenal suppression, all leading to a worse survival. They were generally abandoned. A resurrected interest in use of more "physiologic" doses of steroids occurred in the past decade. Identification of some patients developing adrenal insufficiency who responded to steroid treatment with severe sepsis. Larger, randomized trials have failed to support this initial finding, but the debate and research goes on.

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- Sprung CL, Annane D, Keh D, et al. Hydrocortisone therapy for patients with septic shock. *N Engl J Med*; 358:111-24, 2008.

How to improve patient outcomes as a leader of the ICU team

ICU care IS team care. Team members have unique perspectives, knowledge, and skills. Critically ill patients benefit from different points of view. Teams support their members in this changing environment. Teams can change and improve ICU practice. The best patient care occurs in ICUs with strong teams, led by intensivists, who use proactive problem solving methods. Electronic team members are changing the ICU by improving adherence to care plans and evidence-based practices. The impact of this practice model has not diminished or changed in relevance over the past 50 years.

- Safar P, Grenvik A. Critical care medicine. Organizing and staffing intensive care units. *Chest*; 59(5):535-47, 1971
- Durbin CG Jr. Team model: advocating for the optimal method of care delivery in the intensive care unit. *Crit Care Med*; 34(3 Suppl):S12-7, 2006
- Lilly CM, Cody S, Zhao H, Landry K, Baker SP, McIlwaine J, Chandler MW, Irwin RS
- Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes. *JAMA*; 305(21):2175-83, 2011

Content Section IV – Controversies in Neurological Care in the Intensive Care Unit

3:50 - 4:20 p.m.

Controversies in Post-Resuscitation Care After Cardiac Arrest

Andrea Gabrielli, M.D.

4:25 - 4:50 p.m.

Update on Neuromonitoring: Emerging Technology, Does It Matter?

Lori Shutter, M.D.

Controversies in Post-Resuscitation Care After Cardiac Arrest

Andrea Gabrielli, M.D.

A systematic approach to post-cardiac arrest care after return of spontaneous circulation (ROSC) improves the likelihood of patient survival with acceptable quality of life (ref: Neumar R. et al ILCOR Consensus Statement: Post Cardiac Arrest Syndrome Circulation 2, 2008 vol. 118 no. 23 2452-2483). However, many aspects of post ROSC management still remain controversial. This lecture reviews the most important ones based on evidence collected from the literature.

Post-ROSC as a Syndrome

The unique pathophysiology that follows whole-body ischemia causes global tissue, organ injury and reperfusion injury to be added to the disease that caused the cardiac arrest. Four basic components of post-cardiac arrest syndrome can be identified (1) post-cardiac arrest brain injury, (2) post-cardiac arrest myocardial dysfunction, (3) systemic ischemia/reperfusion response, and (4) persistent precipitating pathology, each contributing to the final outcome in different way between individual and individual and influenced by the time of exposure to the arrest and the care quality of the resuscitation team.

Therapeutic Hypothermia

Therapeutic hypothermia post-ROSC is now recommended as part of a standardized treatment strategy for a selective group of comatose survivors of cardiac arrest. The adoption of a standard post ROSC protocol including hypothermia improves outcome in adults who remained comatose after initial resuscitation from out-of-hospital ventricular fibrillation (VF) (Ref: Sunde et al. K, Implementation of a standardized treatment protocol for post resuscitation care after out-of-hospital cardiac arrest. Resuscitation. 2007; 73: 29–39.) A practical approach of therapeutic hypothermia can be divided into 3 phases: induction, maintenance, and rewarming.

No single method or device used to deliver hypothermia seems to make a decisive difference in outcome. (Ref: Tømte Ø et al.) A comparison of intravascular and surface cooling techniques in comatose cardiac arrest survivors. Crit Care Med. 2011 Mar;39 (3):443-9)

Furthermore, optimal goal temperature or temperature table, time of onset and duration of cooling all remain controversial topics currently being studied. Recent literature would suggest that earlier approach to hypothermia

Syndrome	Pathophysiology	Clinical Manifestation
Post-cardiac arrest brain injury	• Impaired cerebrovascular autoregulation	• Coma
	• Cerebral edema (limited)	• Seizures
	• Postischemic neurodegeneration	• Myoclonus
Post-cardiac arrest myocardial dysfunction	• Global hypokinesia (myocardial stunning)	• Cognitive dysfunction
	• ACS	• Persistent vegetative state
		• Secondary Parkinsonism
Systemic ischemia/reperfusion response		• Cortical stroke
		• Spinal stroke
		• Brain death
Persistent precipitating pathology	• Reduced cardiac output	• Reduced cardiac output
	• Hypotension	• Hypotension
	• Dysrhythmias	• Dysrhythmias
Systemic ischemia/reperfusion response	• Cardiovascular collapse	• Cardiovascular collapse
	• Pyrexia (fever)	• Pyrexia (fever)
	• Hypertension	• Hypertension
Systemic ischemia/reperfusion response	• Impaired tissue oxygen delivery and utilization	• Multiorgan failure
	• Impaired resistance to infection	• Infection
	• Specific to cause but complicated by concomitant PCAS	• Specific to cause but complicated by concomitant PCAS
Persistent precipitating pathology	• Cardiovascular disease (AMI/ACS, cardiomyopathy)	
	• Pulmonary disease (COPD, asthma)	
	• CNS disease (CVA)	
Persistent precipitating pathology	• Thromboembolic disease (PE)	
	• Toxicological (overdose, poisoning)	
	• Infection (sepsis, pneumonia)	
Persistent precipitating pathology	• Hypovolemia (hemorrhage, dehydration)	

Table 1: 4 Key Element of Post Cardiac Arrest Syndrome. Modified from Neumar R. et al ILCOR Consensus Statement: Post Cardiac Arrest Syndrome Circulation 2, 2008 vol. 118

(ROSC ALERT!) similar to stroke or acute coronary syndrome could improve outcome. (Ref: Wolff International J Cardiol 2009 133 (2): 223)

An extension of hypothermia beyond 24 hours seems to be beneficial in animal studies suggesting at least the need to maintain normothermia beyond 24 of cooling in humans. (Ref: Che et al. Critcal Care Medicine 2011; 39(6): 1423-1430)

Finally, induced hypothermia might also benefit unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest or in-hospital cardiac arrest from a non-shockable rhythm including, of course, patients in an anesthetizing stations. (Ref: Dumas F et al. Is hypothermia after cardiac arrest effective in both shockable and nonshockable patients?: insights from a large registry. Circulation. 2011 Mar 1;123(8):877-86.)

Percutaneous Coronary Intervention (PCI) post-ROSC

Between 20% to 30% of OHCA patients who survive to hospital admission have evidence of STEMI (including a new left bundle-branch block) on their presenting ECG. Multiple observational studies support a Class I AHA recommendation to take all post-arrest patients with STEMI for emergency coronary angiography, irrespective of the presence or absence of coma. (Ref: Dumas F et al Long-term prognosis following resuscitation from out of hospital cardiac arrest: role of percutaneous coronary intervention and therapeutic hypothermia. J Am Coll Cardiol. 2012;60:21–27)

There is also increasing evidence that patients with suspected ACS but without clear STEMI on a presenting ECG may benefit from early intervention. An on going AHA effort is aiming to categorize OHCA STEMI-PCI cases separately from other STEMI-PCI. The obvious goal is to encourage skeptical invasive cardiologists to embrace this philosophy without fear of increasing their cath lab mortality and complication rate, a major concern now that hospitals PCI outcomes are of public domain.

(REF: Peberdy et al. AHA Scientific Statement Impact of Percutaneous Coronary Intervention Performance Reporting on Cardiac Resuscitation Centers. A Scientific Statement From the American Heart Association Circulation. 2013; 128: 762-773)

Goal directed post ROSC therapy:

In line with other fields of critical care medicine evidence is accumulating in favor of a goal directed therapy for the key components of post cardiac arrest syndrome (maybe with the exclusion of the ischemia reperfusion response still mostly speculative and experimental). A summary of the goals is available in a recent AHA guideline statement manuscript. (Ref: Peberdy MA et al. Part 9. Postcardiac arrest care: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010; 122 (18 Suppl. 3):S768–S786.)

Neuro prognostication post-ROSC

Early prognostication parameters classically recommended in acute brain damage post-ROSC (Ref: Wijdicks EFM et al. Practice parameter: prediction of outcome in comatose survivors after cardiopulmonary resuscitation (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology 2006; 67:203–210) are now becoming controversial after the widespread introduction of post cardiac arrest hypothermia.

Current prognostic recommendations for patients treated with therapeutic hypothermia acknowledge that the available parameters are less reliable for predicting poor outcome during and post cold/sedated/paralyzed state and that close neuro observation of at least 72 h after the return of spontaneous circulation (ROSC) should be considered before attempting to predict outcome (Ref: Peberdy MA et al. Part 9. Postcardiac arrest care: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2010; 122 (18 Suppl. 3):S768–S786.)

Recent guidelines touch upon prognostication techniques as part of management recommendations. In addition to novel laboratory values, there have been few reports on the use of new clinical parameters, diagnostic imaging techniques, and electrophysiological techniques to assist in prognostication. Despite recent advances in neuromonitoring controversial case reports have suggested the potential reversibility of brain death diagnosis in cardiac arrest patients treated with hypothermia even after documented severe diagnostic exam (myoclonus) or absence of SSEP after rewarming.

Neuroimaging and serum biomarker studies have been trying to fill the knowledge gap. However, the results of these studies confirmed that in the era of therapeutic hypothermia after ROSC, no test or examination can reliably assessment neurological outcome. The phenomenon of self-fulfilling prophecy is described in this case as a clinical decision to withdraw care influenced early post ROSC by

In summary, the introduction of hypothermia after cardiac arrest in the context of a post-resuscitation critical care bundle has dramatically increase the chance of patients' survival with meaningful neurological recovery, but it has also introduced new diagnostic, therapeutic and ethical dilemmas that are currently being intensively studied with controversial interpretation.

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Update on Neuromonitoring: Emerging Technology, Does It Matter?

Lori Shutter, M.D.

Current Neurological Monitoring

CCU	NSICU
SBP, DBP, MAP, CVP, PA, PWP, CO, SVR Sat, O ₂ , CO ₂ , pH, Hg, CK-MB, troponin, EKG, ECHO, Thallium	MAP ICP CPP EEG
200 drugs	4 drugs AEDs

Electrophysiology

cEEG

- **Measures:**
 - Brain electrical activity;
 - Relationship to cerebral metabolism, sensitive to cerebral ischemia & hypoxia (window of reversibility?)
- **Indications:**
 - Status epilepticus; altered mental status to detect non-convulsive status epilepticus; pentobarbital coma
 - Diagnosis of abnormal movements: posturing, spasms, tremors, myoclonus, etc
- **Advantages / Disadvantages:**
 - Dynamic monitoring that can detect changes and provide localization when exam may not
 - Qualitative evaluation; frequent artifacts; interference with head imaging studies

Seizure Incidence in the ICU

- **cEEG in 124 ICU patients¹**
 - Stroke, ICH, seizures, metabolic coma, tumors, trauma
 - Overall seizure rate = 35%.
 - > 75% of these were non-convulsive events or status
- **EEG for AMS or SE w/o further clinical sz (n=198)²**
 - EEG with definite or probable SE in 74 (37%)
 - Altered LOC was only clinical sign in 23 cases, subtle motor activity present in 36 others

Seizure Incidence in the ICU

Prospective trial of cEEG x 48 hours in 55 comatose patients

- Excluded: cardiac arrest, brain death, recognized status epilepticus, anesthesia
- 2 groups:
 - acute structural lesion (31)
 - metabolic abnormality (24)
- Seizures recorded in 20% (11) of patients
 - 32% (10/31) of patients with structural lesions. Only 2 of these had clinically recognized seizures.
 - 4% (1/24) of patients with metabolic disorders
- Retrospective review of 570 patients undergoing continuous EEG in the Neuro-ICU
- All were on prophylactic anticonvulsants
- Indication for monitoring:
 - Unexplained decrease in LOC
 - Detection of subclinical seizures
- Time to 1st seizure:
 - 88% within 24 hrs; 93% within 48 hrs
- Seizure frequency
 - Seizures occurred in 110 patients (19%)
 - 101 of these 110 patients (92%) had only NCSE

Seizure Incidence in the ICU

Diagnosis	N	Any Sz (%)	NCS (%)	NCSE (%)
Epilepsy	51	17 (33)	16 (31)	10 (20)
CNS Infection	35	10 (29)	9 (26)	6 (17)
Brain Tumor	43	10 (23)	10 (23)	5 (12)
SAH	108	20 (19)	19 (18)	14 (13)
TBI	51	9 (18)	9 (18)	4 (8)
↓ LOC (NOE)	105	17 (17)	16 (15)	5 (5)
ICH	45	6 (13)	6 (13)	4 (9)
CVA	56	6 (11)	5 (9)	4 (7)

Claassen J, et al. Neurology 2004; 62:1743-1748

Risk Factors for Seizures

1. Coma
 - 57% of comatose patients had seizures on cEEG
 2. Age < 18
 3. Past history of seizures
 4. Convulsive seizures prior to monitoring
- Incidence of seizure relative to risk factors
 - 2 of 4 = 40%
 - 3 of 4 = 65%
 - 4 of 4 = 88%

Status Epilepticus

- Definition:
 - Traditional: Any type of seizure lasting > 30* minutes, or **2 or more sequential seizures without full recovery of consciousness between them** (JAMA 1993)
 - *Modern: any seizure lasting > 5 minutes
 - Practical: any patient who is still seizing

Does It Matter? Prognosis:

- Mortality: 17-23%^{1,2}
- New disabling neurological deficits: ~10%³
- Some functional deterioration in ~23%
- Predictors of worse outcome
 - Age (higher mortality in elder pts)
 - Etiology (acute symptomatic worst)
 - Long SE duration, continuous szs
 - Nonconvulsive szs; +/-periodic discharges

DeLorenzo RJ, et al. Neurology 1996; 46:1029-35

Hesdorffer DC, et al. Neurology, 1998; 50:735-41

Hirsch LJ, Claassen J. Curr Neurol Neurosci Rep 2002; 2:345-56

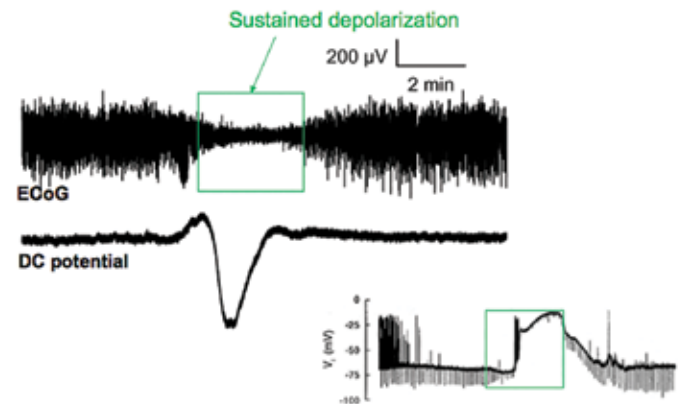
Cortical Spreading Depolarization

- Waves of tissue depolarization that mediate progressive development of cortical infarction
 - Have been seen in both animal models and patients with acute brain injury
- Subdural ECoG strip
 - Often used with other probes
 - PbtO₂, CBF, MD, Surface vs depth EEG electrodes
 - Possible sign of progressive metabolic failure leading to tissue death



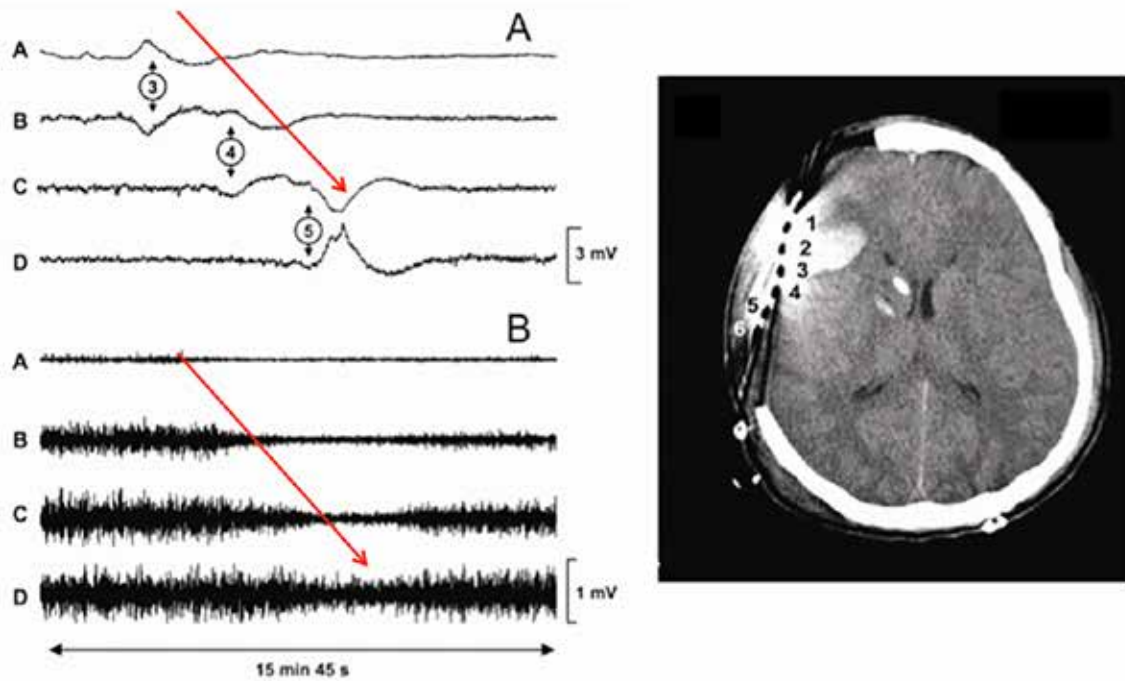
What are Spreading Depolarizations?

Class of pathologic waves characterized by near-complete sustained depolarization of neurons/astrocytes that propagate through gray matter at 1-5 mm/min

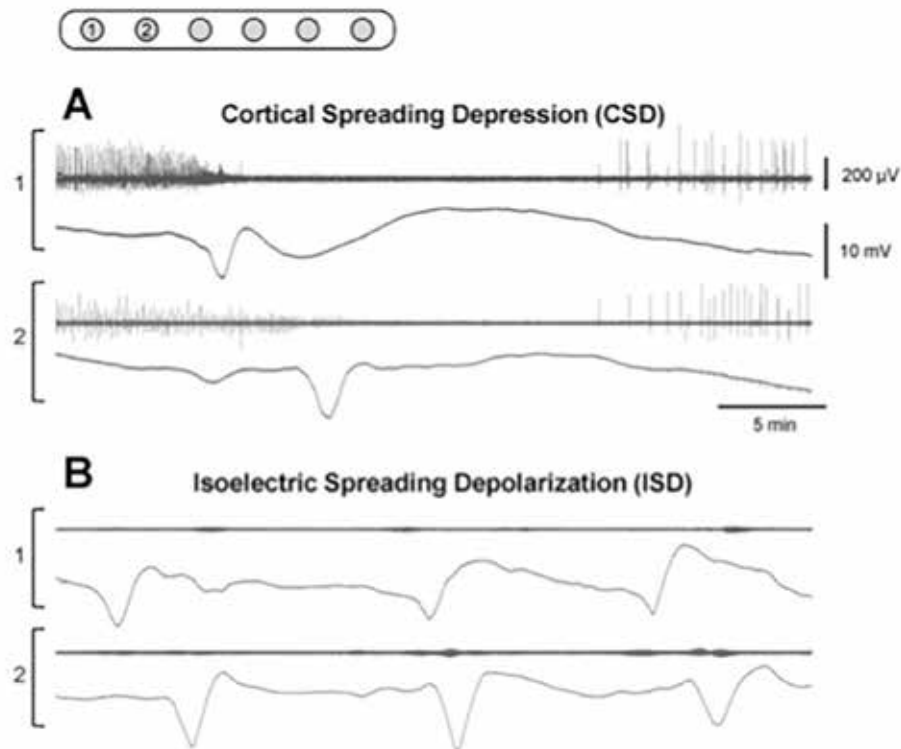


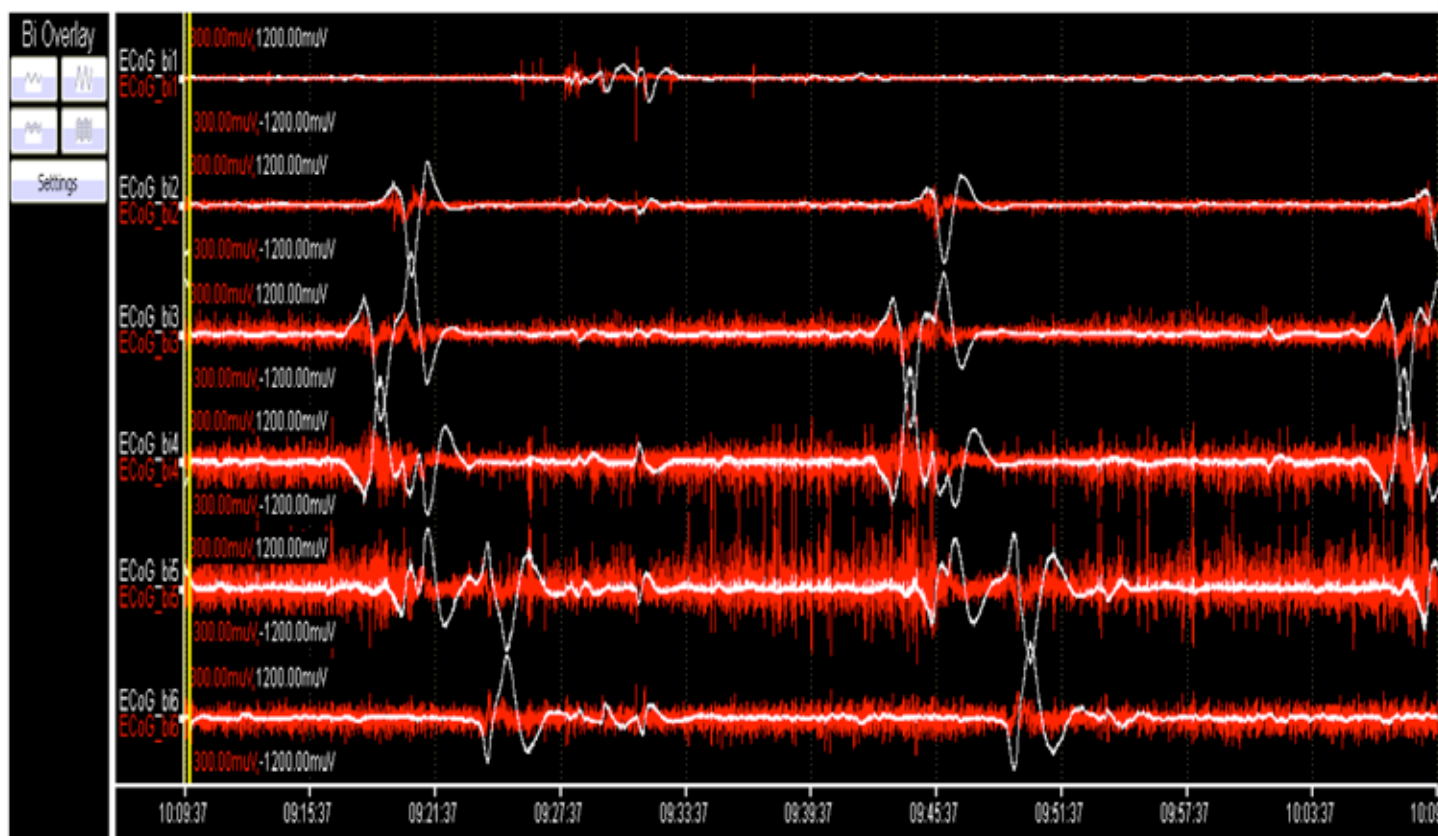
Drier JP. Nature Medicine 2011; 17:439-47

Cortical Spreading Depolarizations



Types of Depolarizations





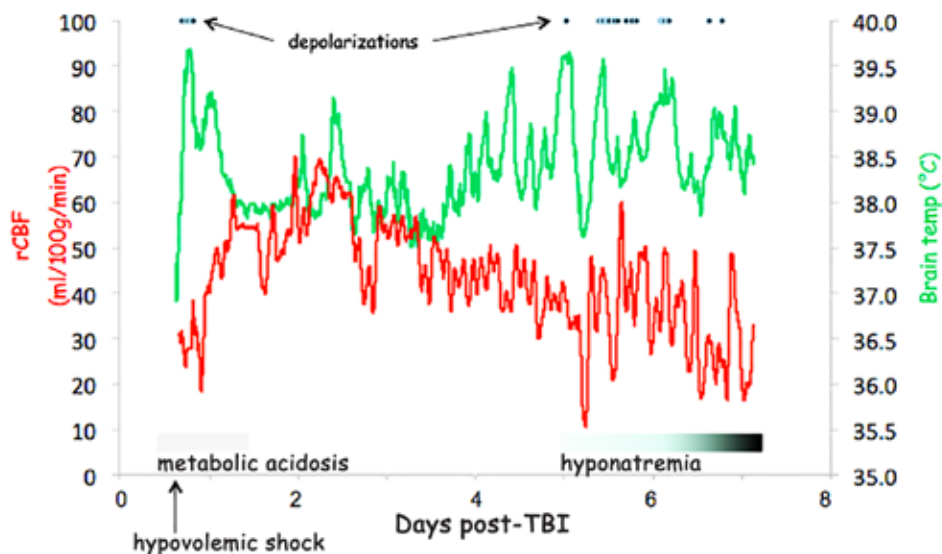
*SD starts at electrode 4, then moves to 3 (ISD) /5, then to 6.
Electrodes 1/2 most likely on hemorrhage or dead cortex.
Slow potentials are white; EEG activity in red.*

TBI Case Example

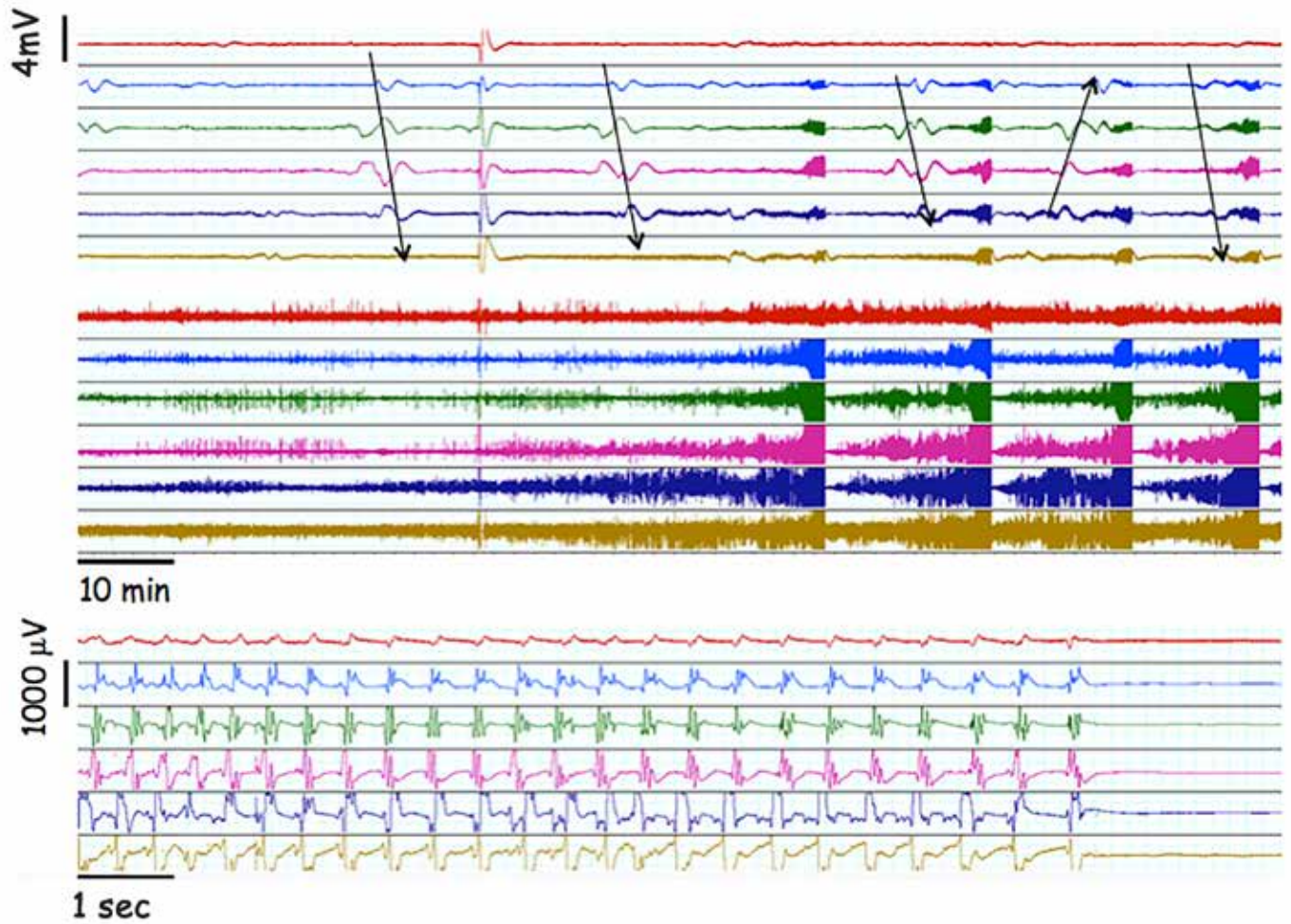
Licor $P_{bt}O_2 > 20$ mm Hg throughout

ICP < 20 mm Hg throughout

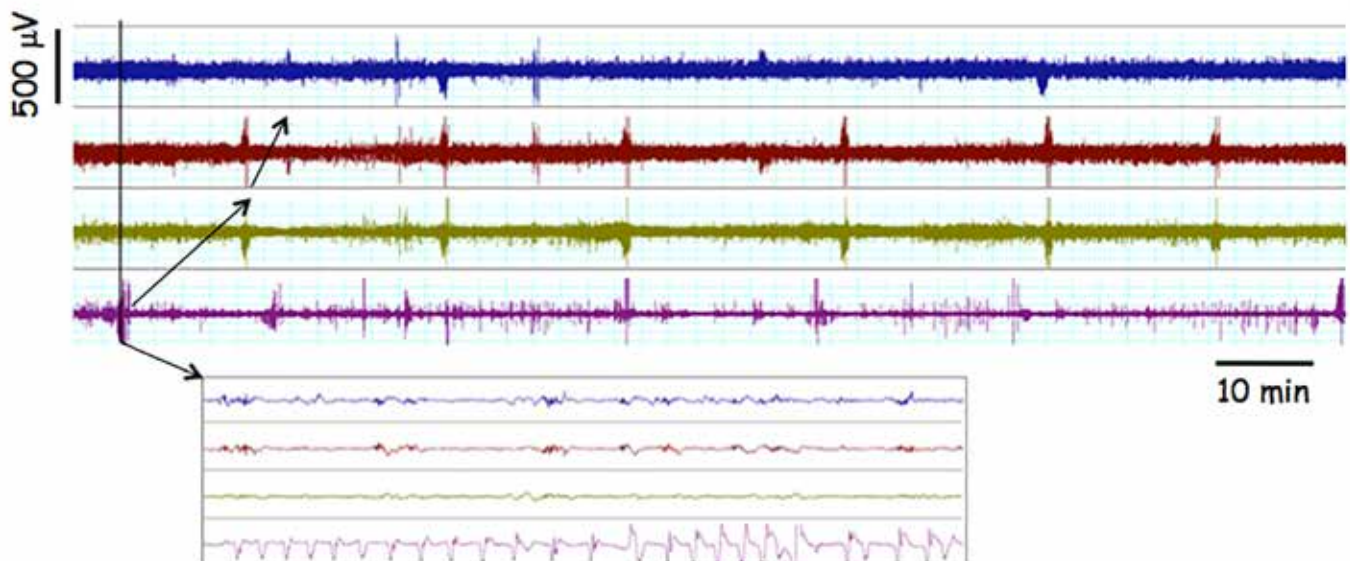
GCS: 7T ☒ 10T



Seizures and Spreading Depolarizations

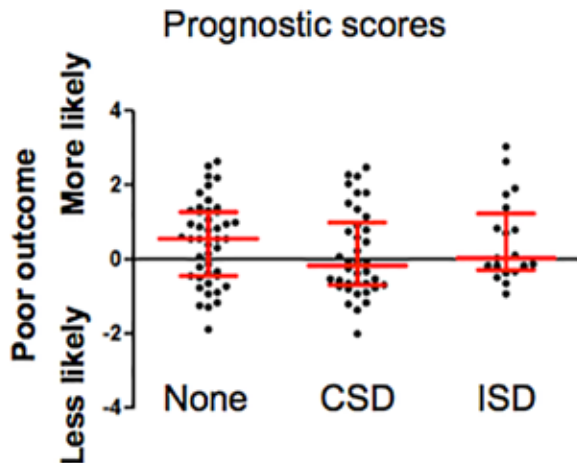


ECoG-detected Seizures (may be focal)

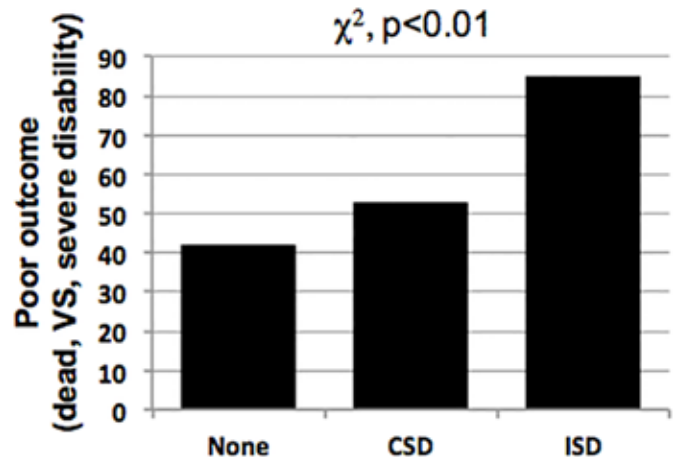


Significance in TBI

No differences in recording durations ($p>0.50$), timing of surgery ($p>0.50$), or prognostic scores ($p=0.34$).



Significant difference in outcome between depolarization categories



Hartings JA, et al. *Lancet Neurol.* 2011; 10:1058-64.

Summary Thoughts on SD

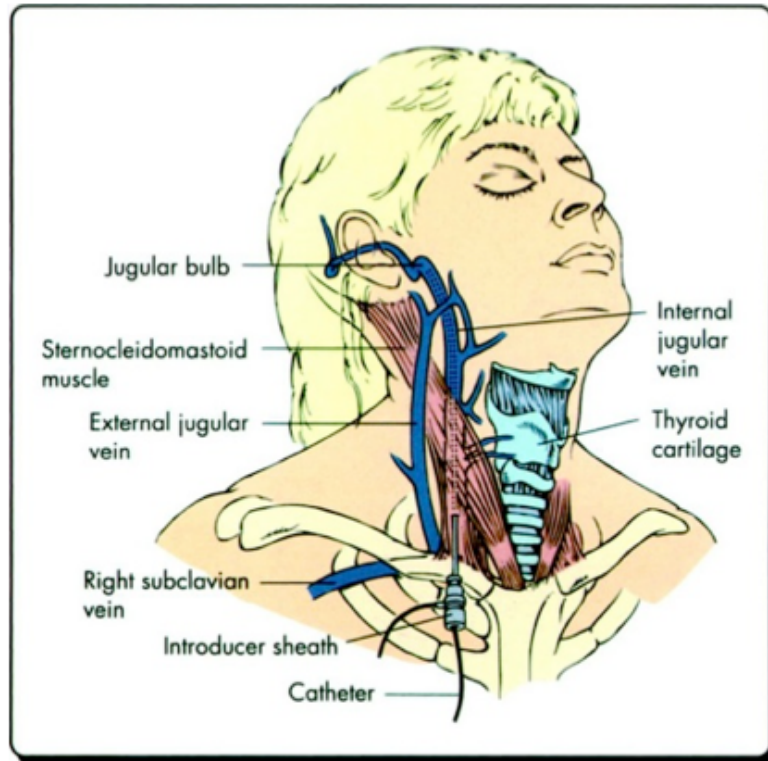
- SD are robustly associated with worse outcomes
 - Independent of baseline outcome predictors
- SD account for 13% of outcome variance beyond that explained by established prognostic factors.
- SD are a causal pathomechanism, with adverse effects on traumatically injured brain.
- The first pathomechanism, with demonstrated clinical relevance, that can be monitored in real-time and targeted in treatment of TBI.
- Medications exist that impact SD.
- Can see SD on cEEG recordings in 60% of patients

Brain Oxygenation

SjVO2

- Measures O_2 saturation of cerebral venous return
 - Estimates global relationship between CBF and metabolism
 - Inversely related to $AVDO_2$; normal level ~ 50 – 75%
 - Interpretation based on assessing balance between cerebral O_2 delivery and $CMRO_2$
 - Elevation suggests hyperemia or decreased $CMRO_2$
 - Low suggests hypoperfusion or increased $CMRO_2$
- Goal
 - Detect cerebral hypoperfusion or hyperperfusion to prevent / treat secondary ischemic brain injury
- Indications:
 - Severe TBI; SAH; diffuse cerebral edema
- Disadvantages:
 - Line sepsis; venous thrombosis; carotid puncture; motion; does not measure regional oxygenation

Figure 1. The jugular bulb is the dilated portion of the jugular vein just below the base of the skull that contains blood with little extracerebral contamination.



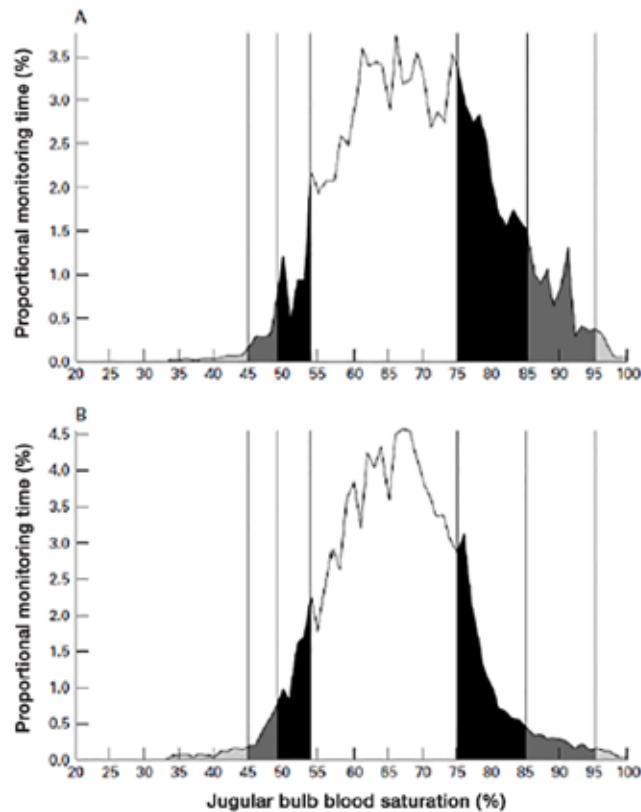
Schell R M , Cole D J *Anesth Analg* 2000;90:559-566

©2000 by Lippincott Williams & Wilkins

Anesthesia & Analgesia

Hyperemia on S_jVO_2 monitoring associated with worsened TBI outcome

Macmillan *JNNP* 2001



Near Infrared Spectroscopy

■ Measures regional brain tissue O_2 saturation (rSO_2)

- Light source generates near-infrared beam, passes through the tissues and detected by distant optodes
- Tissue O_2 saturation and Hgb content are determined by difference in light intensity
- Normal range = 60 – 75%

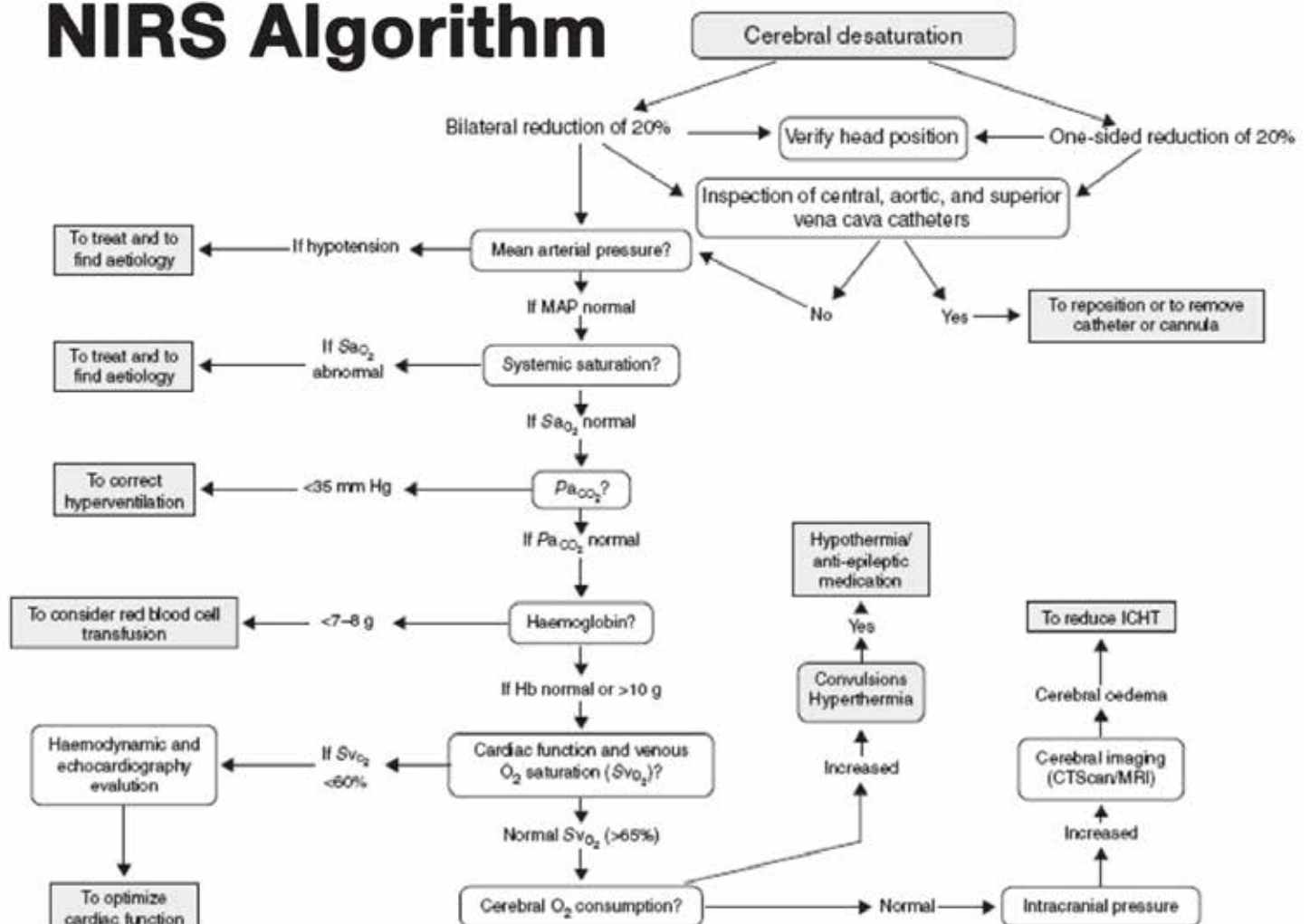
■ Indications:

- Severe TBI; CEA
- Trend monitor; bedside non-invasive assessment of cerebral autoregulation; risk for cerebral ischaemia

■ Disadvantages:

- Sensitivity to extraneous light; motion artifact; signal drift

NIRS Algorithm



Murkin JM & Arango M. *Br J Anaesth* 2009; 103 (Suppl. 1): i3-i13

PbtO₂ Monitoring

Location

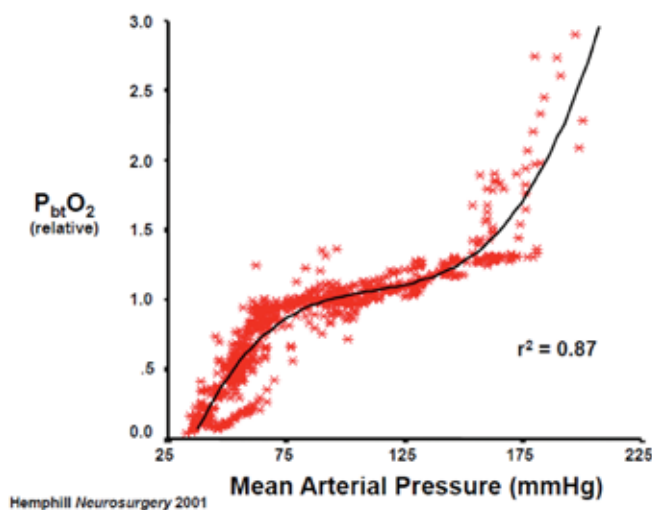
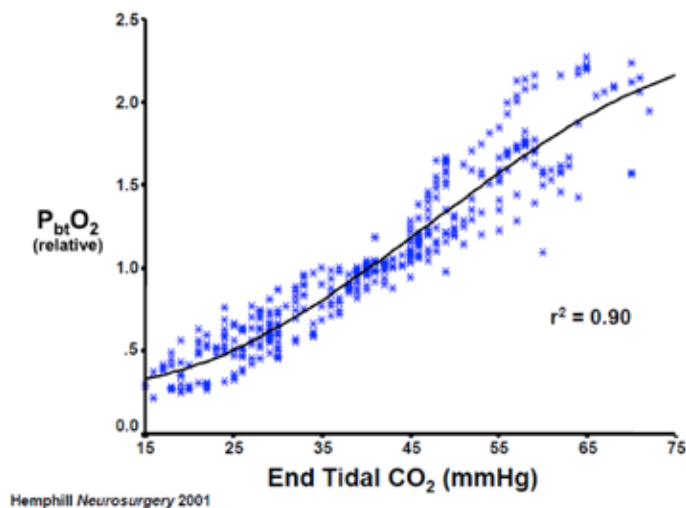
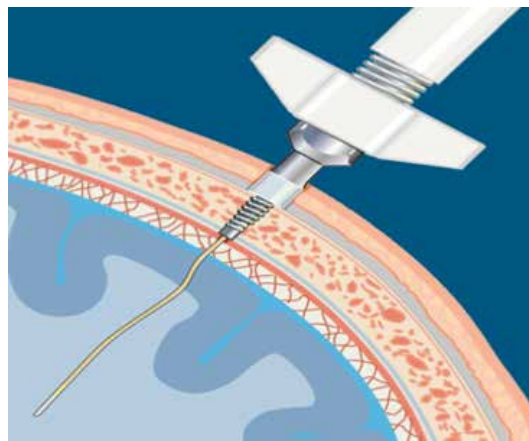
- Placed in white matter (~35mm)
- Normal tissue or pericontusional?

Measures O₂ partial pressure (mmHg) in interstitial space

- What does this represent?
- Thoughts: Total O₂ delivery; cerebral O₂ metabolism; O₂ diffusion; perfusion

Values:

- Normal > 20 mmHg
- Ischemia: 8 - 12 mmHg
- Critical PbtO₂ = 5 - 8 mmHg



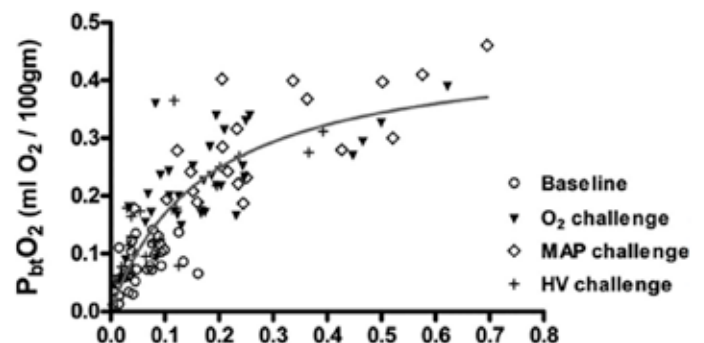
What Does PbtO₂ Represent?

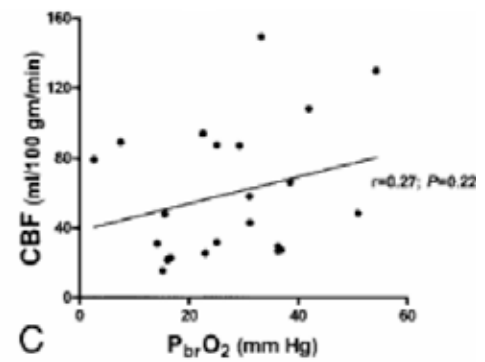
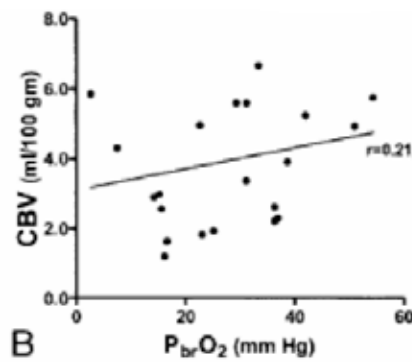
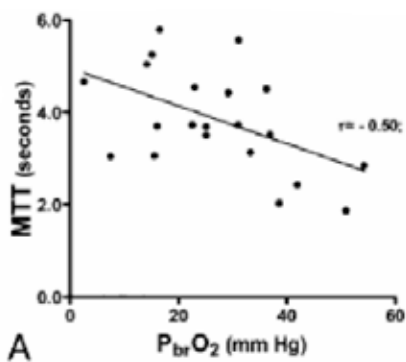
Prospective observation study; n = 14 sTBI

- PbtO₂ & CBF monitoring with FiO₂, MAP, CO₂ challenges
- Measured: PaO₂, CaO₂, PVO₂, CVO₂, AVDO₂, locCMRO₂

Best association: CBF x (PaO₂ - PvO₂)

- Thus may represent the diffusion of dissolved plasma O₂ across the BBB and reflect O₂ accumulation in brain



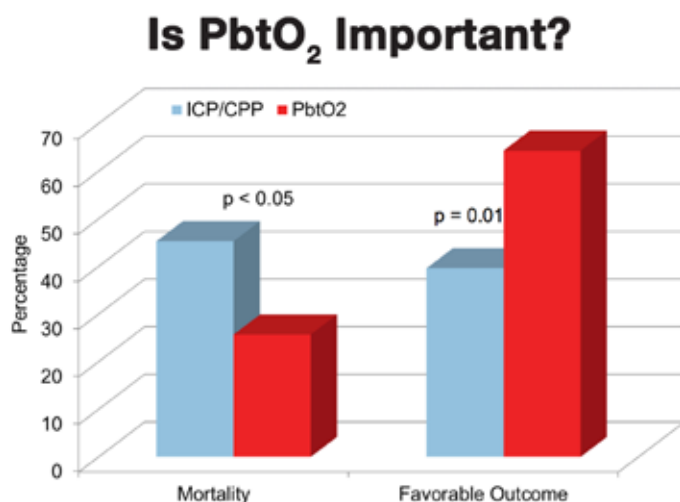


What Does PbtO₂ Represent?

- Observation study; n = 19 (15 TBI)
 - CTP studies = 22
 - Physiologic data: PbtO₂, MAP, CPP, ICP, FiO₂
 - CTP data: MTT, CBF, CBV
- Results
 - Multivariate analysis: PbtO₂ independently associated w/ MTT (p=0.006)

Is PbtO₂ Important?

- Prospective sTBI patients (n = 70) compared to historical controls (n = 53)
 - ICP w/ PbtO₂ vs ICP monitors
 - ICP < 20, PbtO₂ > 20, CPP > 60
- Mean daily ICP / CPP & frequency of elevated ICP or suboptimal CPP episodes were similar
- Results: PbtO₂ patients had
 - Significantly lower mortality rate (26 vs 45%; p < 0.05)
 - Improved short-term outcome (64% vs 40%; p = 0.01)



Splotts AM, et al. J Neurosurg 2010; 113:571-580

SjvO₂ vs PbtO₂ vs NIRS

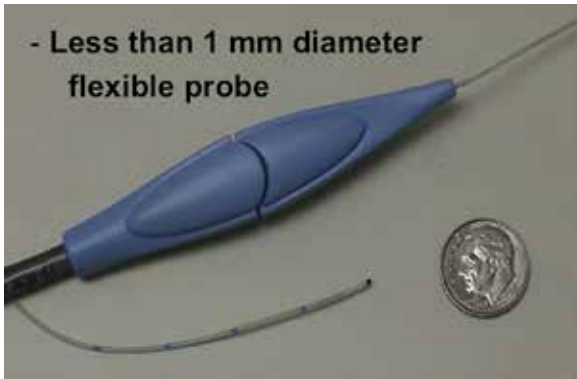
- Difficult to compare, may be complementary
- Benefits
 - Real-time, continuous bedside data
- Concerns
 - PbtO₂ and SjvO₂: invasive, require technical expertise
 - PbtO₂: regional, good quality data with few artifacts
 - SjvO₂: hemispheric, artifacts are a problem
 - NIRS: noninvasive, requires little technical expertise, less well established, lack of standardization / norms
 - PbtO₂ & SjvO₂ correlation has been shown; not w/ NIRS
- Uses
 - Assess pressure autoregulation, optimize CPP, titrate interventions (HV), identify underlying pathophysiological disturbances and direct therapy.

Cerebral Blood Flow

- Xenon-133 clearance
 - Severe TBI; SAH
 - Measures superficial blood flow; unreliable with abnormal blood-brain partition coefficient
- Laser-Doppler flowmetry: LD-rCBF
 - Qualitative value
 - Under study for severe TBI and cerebral edema
 - Probe malfunction requiring replacement
- Thermal diffusion flowmetry: TD-rCBF
 - Regional cerebral cortical blood flow
 - Under study for severe TBI and cerebral edema
 - Infection (low risk); signal distortion; regional monitoring

TD-rCBF Monitoring

- Quantitative CBF intuitively appealing
- Values
 - Normal = 55 ml/100gm/min
 - Ischemic threshold = 18 ml/100g/min
 - Irreversible injury = 10 ml/100g/min



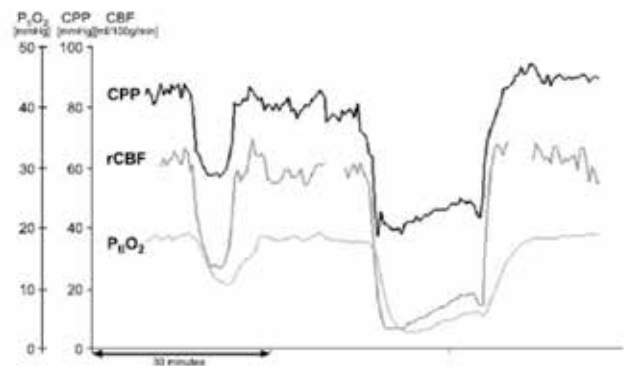
TD-rCBF

- Method
 - Thermistor in tip, temperature sensor 5mm proximal
 - Thermistor heated to 2° C above tissue temperature.
 - CBF calculated mathematically using tissue's ability to transport heat, which depends on tissue perfusion
 - The sample volume is approximately 27mm³.
 - Recalibrates itself every 30 minutes, this takes 2-5 min and interrupts continuity of CBF measurement.
 - System does not allow blood flow measurements if brain temperature > 39.1 C
- Good agreement has been shown when TD-rCBF compared to sXe-rCBF measurements¹

Does It Matter?

- SAH^{1,2,3}
 - TD flowmetry has been shown to reliably detect cerebral vasospasm-associated hypoperfusion
 - SAH & TBI⁴
 - Strong correlation between TD flowmetry & PbtO₂
 - PbtO₂ levels seem to be predominately determined by regional CBF (90% correlation)
- TBI^{5,6}
 - TD flowmetry used to evaluate individual hemodynamic parameters (including vasoreactivity), thus can guide optimal MAP / CPP therapy
 - rCBF Comparison to CPP & PbtO₂

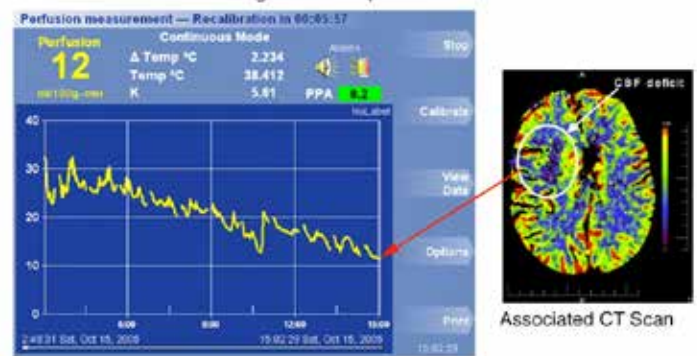
rCBF Comparison to CPP and PbtO₂



*Jaeger M, et al. Acta Neurochir (Wien) 2005; 147:51-56

Early Detection of Vasospasm

BPM Screen Shot during CBF Vasospasm



Courtesy of Stephen B. Lewis, M.D., University of Florida

The Others: Microdialysis & Processed Data

Microdialysis

■ Capillary method

- Measure concentration of brain parenchyma chemicals
 - glucose; lactate; pyruvate; glutamate; glycerol
- Catheter is inserted via burr hole into penumbra of injury or normal tissue; depth ~ 3 cm from dura to catheter tip

■ Goal

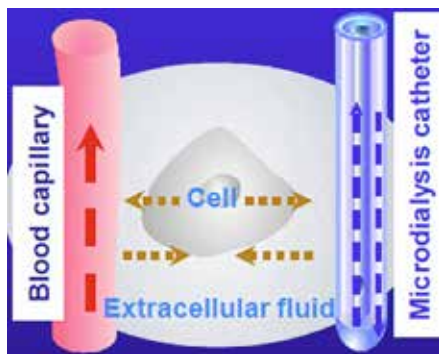
- Detect neurochemical changes of brain injury; trend monitor – relative values rather than absolutes

■ Indications

- Severe TBI; SAH; AIS, epilepsy

■ Disadvantages

- Invasive; may not detect all ischemic regions
- Inherent delay from tissue to measured value (~1 hour)



Microdialysis

- Deprived of oxygen and glucose, anaerobic metabolism leads to a constellation of events
 - ATP levels fall
 - Build up of lactate & hydrogen ions – cellular acidosis
 - Progressive mitochondrial failure
 - ↑ intracellular calcium levels, excitatory neurotransmitter release, proteolysis, lipolysis, free-radical formation, DNA fragmentation, cytoskeletal dissolution, cellular necrosis
 - Progressive inflammation
- Microdialysis may be able to detect these metabolic changes prior to irreversible injury
 - May also be used for administration of therapeutic agents

Cerebral Autoregulation: Pressure Reactivity

Pressure reactivity as a guide in the treatment of cerebral perfusion pressure in patients with brain trauma

Tim Howells, Ph.D., Kristin Elf, M.D., Patricia A. Jones, M.App.Sc., Elisabeth Ronne-Engström, M.D., Ian Piper, Ph.D., Pelle Nilsson, M.D., Ph.D., Peter Andrews, M.D., Ph.D., and Per Enblad, M.D., Ph.D.

Department of Neurosurgery, Uppsala University Hospital, Uppsala, Sweden; Department of Clinical Physics, Southern General Hospital, Glasgow; Child Life and Health, University of Edinburgh and Royal Hospital for Sick Children; and Department of Anesthesiology, Western General Hospital, Edinburgh, Scotland.

■ Comparison of severe TBI patients treated with

- CPP therapy in Edinburgh
- Lund therapy in Uppsala

■ Looked at pressure reactivity (MAP/ICP slope) as measure of intact autoregulation

Findings

- Among patients getting ICP-oriented treatment (Uppsala), pressure-passive patients (MABP/ICP slope >0.13) had better outcomes
- Among patients undergoing CPP-oriented treatment pressure-active patients had better outcomes
- In other words: patients with autoregulation intact did better with CPP therapy and patients with disturbed autoregulation did better with Lund Therapy
 - It turns out that one size does not fit all
 - Everybody was right, just part of the time

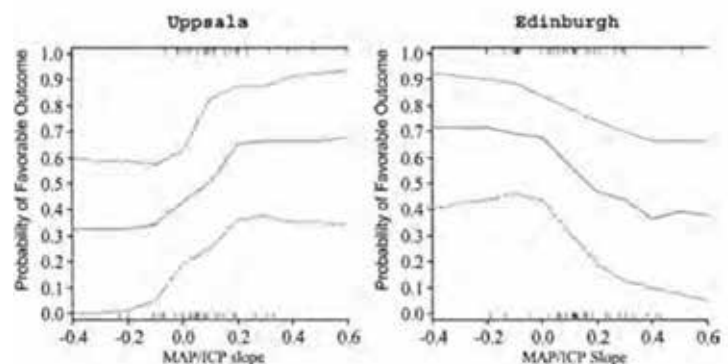


FIG. 6. Graphs demonstrating the probability of a favorable outcome as a function of the slope of MABP/ICP. Pressure-active patients (negative slope) in Edinburgh had a better outcome, whereas pressure-passive patients (positive slope) in Uppsala had a better outcome. Dotted lines represent boundaries of 90% confidence region; solid line represents a maximum likelihood estimate of probability.

Assessing Cerebral Autoregulation

■ Pressure reactivity index (PRx)

- Moving correlation coefficient of MAP and ICP; defines optimal CPP
- Downsides - requires informatics setup; relies on “naturally occurring” fluctuations
- Uses Prx Ranges between -1 and 1

■ Positive Prx indicates loss of autoregulation

- Cut-point? > 0.13 in Edinburgh/ Uppsala study
- > 0.2 as arbitrary cut-point
- > 0.3 associated with increased mortality

■ Optimal CPP is the value at which Prx is minimized

■ Difference between mean CPP and CPP_{opt} associated with outcome

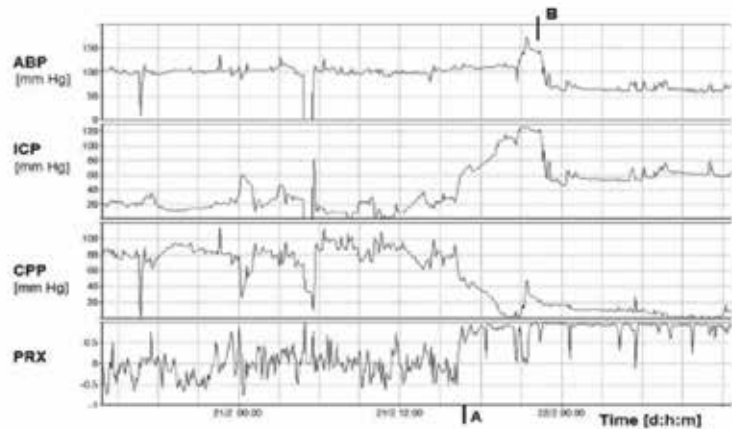
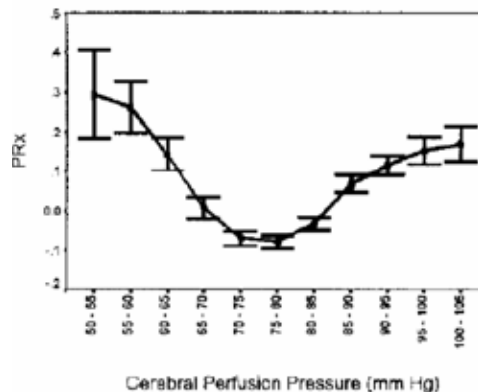


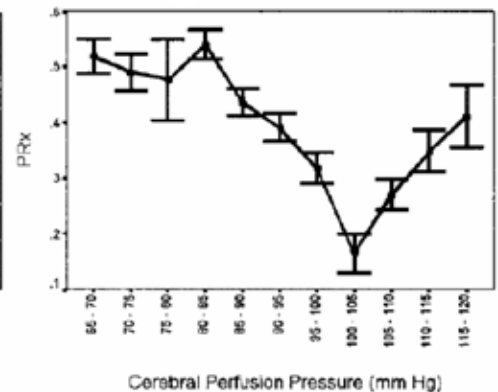
FIG. 3. Example of continuous monitoring of PRx in a patient who died after developing suddenly refractory intracranial hypertension. The value of PRx increased to > 0.5 past point A. Six hours later, brainstem herniation was indicated by drop in ABP (point B). The interval between the switch of PRx to radically positive values and a drop in CPP below 50 mm Hg was 45 minutes.

Zweifel C, et al. *Neurosurg Focus* 2008; 25:E2



Good Outcome

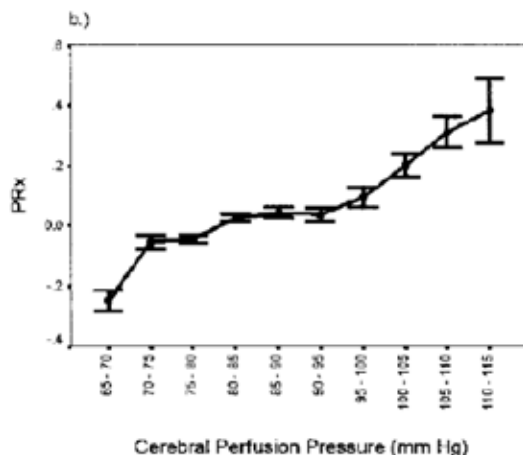
CPP-CPP_{opt}= 3 mmHg



Dead

CPP-CPP_{opt}= -10 mmHg

Steiner LA, et al. *Crit Care Med* 2002; 30:733-8



**CPP_{opt} not obtainable in all patients
(only in 60% in Steiner CCM 2002)**

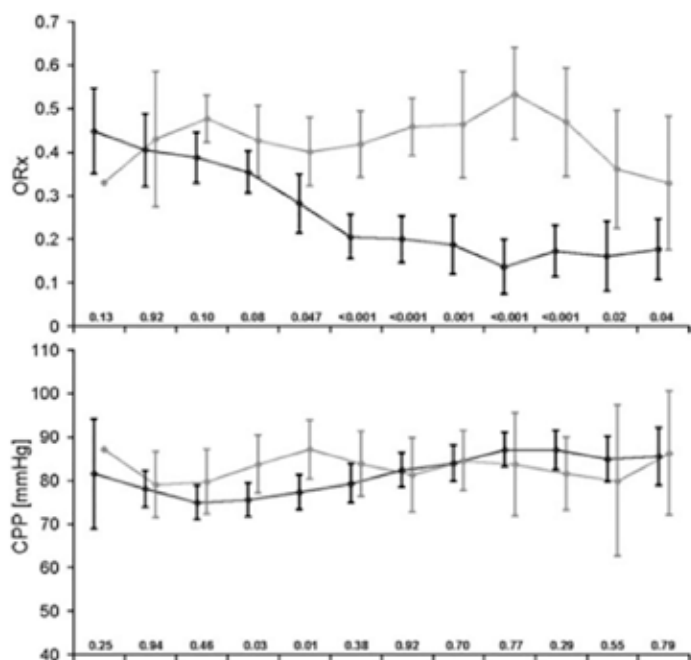
Steiner LA, et al. *Crit Care Med* 2002; 30:733-8

PbtO₂ Autoregulatory Failure

Continuous Monitoring of Cerebrovascular Autoregulation After Subarachnoid Hemorrhage by Brain Tissue Oxygen Pressure Reactivity and Its Relation to Delayed Cerebral Infarction

Matthias Jaeger, M.D., Martin U. Schuhmann, M.D., Ph.D.,
Martin Soehle, M.D., Christoph Nagel, M.D.,
Jürgen Meixensberger, M.D., Ph.D.

- Measure PbtO₂ and assess brain tissue oxygen autoregulation as well as standard measures
 - CPP, ICP, PbtO₂
 - ORx – moving correlation coefficient b/t CPP & PbtO₂



Jaeger M, et al. *Stroke* 2007; 38:981-6

PbtO₂ Autoregulatory Failure

- PbtO₂ autoregulation predicts infarction due to vasospasm
 - CPP, ICP, and absolute PbtO₂ do not

What's in the Future?

- New Monitoring
 - Smart Catheter
 - Multi-modality data collection (Mobius)
- Bio-informatics
- Nanotechnology
 - Non-invasive sensors

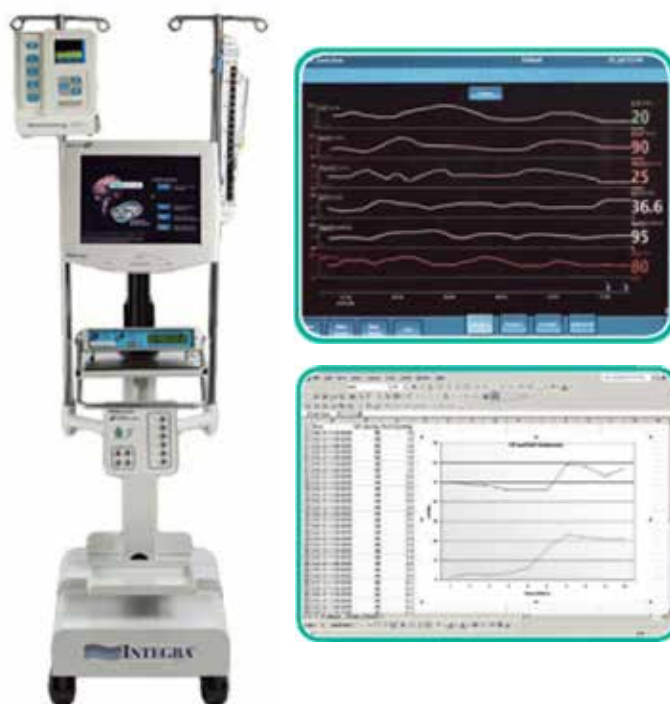


TABLE 2. CPP, ICP, PtiO₂, and ORx Obtained During the Entire Monitoring Period

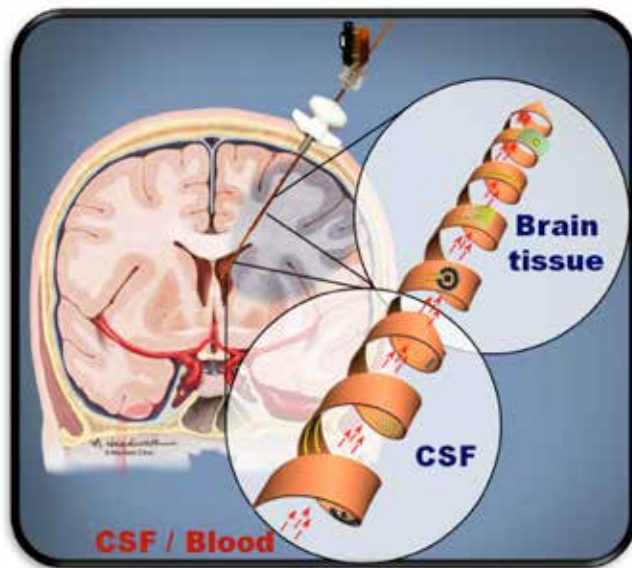
Variable	Noninfarction Group (n=47)	Infarction Group (n=20)	P
CPP, mm Hg	81.1±12.1	82.8±11.4	0.43
ICP, mm Hg	12.2±3.9	14.4±5.2	0.10
PtiO ₂ , mm Hg	23.9±5.8	20.8±5.0	0.06
ORx	0.23±0.14	0.43±0.09	0.0000002

Values are mean±SD.

P for Mann-Whitney U test.

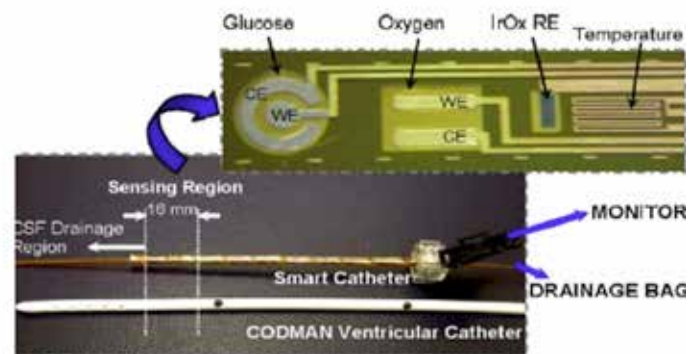
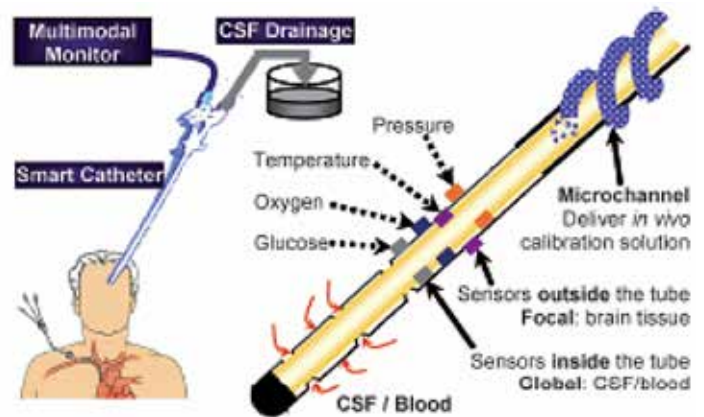
Smart Catheter

- Capable of draining CSF & continuously monitoring multiple physiological / metabolic parameters
- Less invasive
- Minimizes potential trauma
- Cost savings
- Focal & global (CSF/blood) information
- Buried spirally-rolled microchannels deliver calibration solution for biosensors & can allow targeted drug delivery



Deciding What to Use

- Clinical guidelines
- Patient mix
- Who will be managing system?
- Expertise of staff
- Areas of research
- Hospital administration



The Neurointensivist's Holy Grail

- Single system that does it all
 - ICP monitor with drainage; $PbtO_2$; temperature; microdialysis (glucose, sodium, etc); CBF; depth Ecog & EEG; Ability to infuse medications
- Bioinformatics system that
 - Records & displays all parameters simultaneously
 - Selects a CPPopt based on Prx and integrated real-time data from multi-modality monitors
- Automated feedback with IV pumps to infuse pressors or fluids to maintain a CPPopt based on the above



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Cortical Spreading Depolarizations

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Cerebral Microdialysis

Pressure Reactivity

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Smart Catheter

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“The Generalizability of Randomized Controlled Trials in Critical Care Medicine”

Ryan M.J. Ivie, M.D.

Physicians Anesthesia Service and Swedish Medical Center

Introduction: In order to assess the applicability of the conclusions of randomized controlled trials (RCTs) to our critical care patient population, we investigated whether or not our patients would meet the entry criteria for the fifteen most frequently cited RCTs in critical care medicine.

Methods: Using the Ovid Medicine search engine with ranking data from the Scopus Search Engine, the fifteen most frequently cited RCTs from 1998-2010 were identified. At Columbia University Medical Center, New York USA, all patients newly admitted to the medical and surgical intensive care units over a seven-day period were enrolled in the study. At the Sunnybrook Health Science Centre, Toronto CA, all patients newly admitted to the combined medical-surgical intensive care unit over a fourteen-day period were enrolled in the study. Every enrolled patient was screened on each day of ICU admission to determine eligibility for each study. The frequency of patients meeting entry criteria for the RCTs was then calculated and subdivided by timing, location, and primary disease process.

Results: Ninety-three patients were enrolled from three ICUs. Forty-eight of the 93 patients (51.6%) were not eligible for any of the RCTs. Of the 45 patients that were eligible for an RCT, 28 (62.2%) were eligible for only one RCT, 9 (9.7%) were eligible for two RCTs, and 8 (8.6%) were eligible for three RCTs. Of the 1395 possible instances of RCT eligibility (15 RCTs x 93 patients), no exclusion criteria were met 676 times (48.5%) and all inclusion criteria were met only 180 times (12.9%). Eighty-two of the 96 instances of eligibility (85.4%) occurred during the first 24 hour period following admission to the ICU with none occurring after day four of admission. The most common reasons for admission included respiratory failure (17.2%), sepsis (15.1%), trauma (12.9%) and post-surgical monitoring (12.9%). Of the 32 patients with suspected sepsis, only 19 (59.4%) were eligible for at least one sepsis trial and the median number of sepsis trials for which septic patients were eligible was 1 (out of 6 sepsis RCTs). Of the 8 patients with suspected acute respiratory distress syndrome (ARDS), only 4 (50.0%) were eligible for at least one ARDS trial and the median number of ARDS trials for which ARDS patients were eligible was 0.5 (out of 4 ARDS RCTs).

Discussion: The strict eligibility criteria of RCTs impose limitations on the generalizability of their findings. Half of the patients were not eligible for any of the most frequently cited RCTs in critical care medicine. Both the inclusion criteria and exclusion criteria accounted for the low rate of eligibility. Forty percent of patients with sepsis and 50% of patients with ARDS did not meet eligibility criteria for any of the major sepsis and ARDS RCTs. Most patients who met eligibility criteria for a study did so during the first 24-hour period suggesting that screening ICU patients only on the first day after admission may be adequate for recruitment for most RCTs.

Table 1.

Eligibility	N	%
Total Number of Patients	93	
Not Eligible for Any RCT	48	51.6%
Eligible for 1 RCT	28	30.1%
Eligible for 2 RCTs	9	9.7%
Eligible for 3 RCTs	8	8.6%

Inclusion vs. Exclusion Criteria	N	%
Total Possible Instances of RCT Eligibility (15 RCTs x 93 Pt.s)	1395	
Met No Exclusion Criteria	676	48.5%
Met All Inclusion Criteria	180	12.9%
Met All Inclusion Criteria But Met Exclusion Criteria	84	6.0%
Total Instances of RCT Eligibility	96	6.9%

Timing of Eligibility	N	%
Eligible on Day 1	82	85.4%
Eligible on Day >1	14	14.6%

Disease Specific Eligibility	N	%
Sepsis		
Number of Sepsis RCTs	6	
Patients with Suspected Sepsis	32	
Patients Eligible for At Least One Sepsis Trial	19	59.4%
Median Number of Eligible Sepsis Trials Per Patient	1	16.7%
ARDS		
Number of ARDS RCTs	4	
Patients with Suspected ARDS	8	
Patients Eligible for At Least One ARDS trial	4	50.0%
Median Number of Eligible ARDS Trials Per Patient	0.5	12.5%

Demographics†	All ICUs	All RCTs
Age (years)	63	57
BMI (kg/m ²)	26	26
APACHE	21.3	20.4
Female	34.4%	41.9%
White	58.1%	81.3%
Hispanic	18.3%	6.3%
Black	11.8%	15.8%

† mean values, unless otherwise specified

Outcomes	All ICUs	All RCTs
Length of stay (days)	2.7	5.5

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 Department of Anesthesiology, Hospital for Special Surgery, New York, NY¹; Department of Public Health,
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 Department of Anesthesiology, Hospital for Special Surgery, New York, NY¹; Department of Anesthesiology, Perioperative Medicine and Critical Care Medicine, Paracelsus Medical University, Salzburg, Austria²; Department of Anesthesiology, UMass Memorial Medical Center, Worcester, MA³
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Rizwan A. Manji, M.D., Ph.D., FRCSC, MBA¹; Julia Witt, Ph.D.²; Alan H. Menkis, DDS, M.D., FRCSC¹
 I.H. Asper Clinical Research Institute - St. Boniface Hospital¹; University of Manitoba²

POSTER 1

Red Blood Cell Transfusion in Octogenarians: Extrapolation or Real Data?

Alice Y. Li, B.S.; Shamsuddin Akhtar, M.B.B.S.

Department of Anesthesiology, Yale University, New Haven, Connecticut

Introduction: Many guidelines are being published, however, the data on which these guidelines are based, have typically excluded or have minimal representation of octogenarians. The guidelines are typically “extrapolated” to elderly patients, which can potentially be harmful, as many elderly patients have significantly altered physiology and co-morbidities. The purpose of our study was to examine the current literature being published in the field of red blood cell (RBC) transfusions and examine whether octogenarians are well represented in such studies.

Methods: A Pubmed literature search was conducted for primary studies with the following key words: “blood OR erythrocyte”, “transfusion” and “cardiac OR trauma OR critical care” from 2008 to 2012. Only primary publications, such as prospective, retrospective, and clinical trials were included. Each study was examined for data on age, such as mean or median age, standard deviation, and age distribution. The studies were categorized based on type: cardiac, trauma, orthopedic and critical care and further sub-categorized as prospective or retrospective. In order to account for variability in study size, we also determined the number of patients in each study and tabulated them according to mean age (since there was little information on age distribution). Statistical analysis was done by Fisher’s exact test; $P < 0.05$ indicated significance.

Results: Eighty-one studies on RBC transfusion met our inclusion criteria. Of these, 39 (48%) were cardiac, 25 (31%) were trauma, 9 (11%) were orthopedic, and 8 (10%) were critical care studies. The overall mean age distribution categorized by study type is represented in Figure 1. The majority of trauma studies had patients with mean age in the 79 was actually a transcatheter aortic valve replacement study. Additionally, the cardiac papers had a significantly higher proportion of prospective studies compared to trauma (89.7% vs 56%, $P < 0.05$) (Figure 3).

Discussion: Our study shows that elderly trauma patients are not well represented in current literature. The same could be said for octogenarians undergoing cardiac surgery. We recommend that practitioners be aware of this under-representation when applying RBC transfusion guidelines to elderly patients, and we encourage more blood transfusion research to be conducted on the elderly population.

Figure 1.

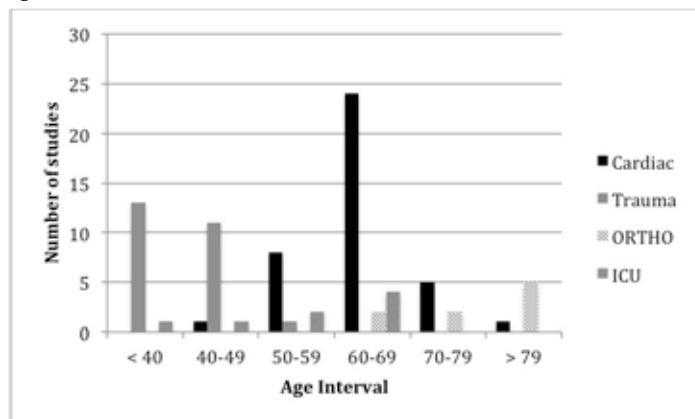


Figure 2.

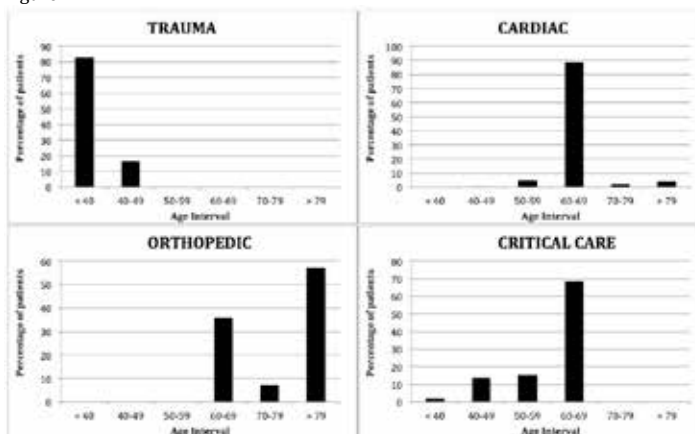
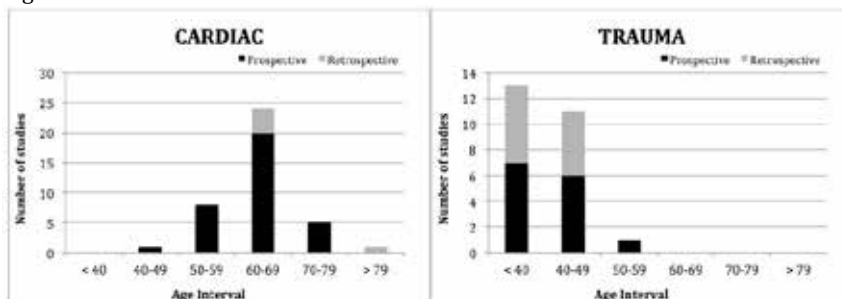


Figure 3.



POSTER 2

SCCM Versus SCA Blood Transfusion Guidelines: A Tale of Two Societies

Alice Y. Li, B.S.; Shamsuddin Akhtar, M.B.B.S.

Department of Anesthesiology, Yale University, New Haven, Connecticut

Introduction: The Eastern Association for Surgery of Trauma (EAST)/ Society of Critical Care Medicine (SCCM)¹ and the Society of Thoracic Surgeons (STS)/Society of Cardiovascular Anesthesiologists (SCA)² have both recently published practice guidelines on blood transfusions. Although these guidelines are based on data accessible to all, each set of guidelines may actually be derived from different types of studies. It is important for practitioners to be aware of the quality of evidence and type of studies used in the development of guidelines. The purpose of this study was to compare the recommendations, evidence and type of studies used in development of the EAST/SCCM and STS/SCA guidelines.

Methods: The two guideline papers, EAST/SCCM 2009 and STS/SCA 2011, were reviewed for: total number of recommendations, grading of evidence and number of references. Each reference was then categorized according to type of study: expert opinion, guidelines, meta-analysis, prospective, randomized controlled trial (RCT), retrospective, and others. Statistical analysis was done with Fisher's exact test; P-value < 0.05 was considered significant.

Results: The EAST/SCCM guidelines had a total of 27 recommendations, and the STS/SCA guidelines had 35 recommendations. Both documents used different criteria for grading recommendations and level of evidence. The EAST/SCCM used the Canadian and US Preventive Task Force method, and the STS used the American Heart Association guideline grading method. The EAST/SCCM guidelines had 3 Level I, 22 Level II and 2 Level III recommendations (Table 1); however, the level of evidence was not included. Compared to the EAST/SCCM guidelines, the STS/SCA guidelines had only 7 Level I recommendations, of which 4 were based on Class A evidence. There were 24 Level II recommendations and 5 Level III. Overall, 13 (37%) recommendations were based on Class A evidence.

Additionally, the EAST/SCCM paper referred to 248 publications, and the STS/SCA paper referenced 404. Both studies had similar proportions of primary studies (prospective, retrospective and RCTs), with 62.5% in the EAST/SCCM guidelines and 59.4% in STS/SCA (P = 0.458). Processed data (reviews, meta-analyses, guidelines) had higher representation in the EAST/SCCM (28.2%) compared to STS/SCA (20.0%, P < 0.05) (Table 2). Since the level of evidence was not included in the EAST/SCCM guidelines, the quality of evidence could not be directly compared between the 2 documents.

Discussion: This study demonstrates that although the total number of references differed among the EAST/SCCM and STS/SCA guidelines, both referenced a similar proportion of primary studies. Interestingly, the EAST/SCCM paper referenced a higher proportion of processed data. This highlights the trend to use more processed data when creating and/or revising clinical guidelines. Practitioners should be encouraged to consider the quality of evidence before applying the recommendations clinically.

Table 1.

	EAST/SCCM	STS/SCA
Total Number of Recommendations	27	35
Level of Recommendation		
Level I	3	7
Level II	22	10 (IIa) 13 (IIb)
Level III	2	5
Level of Evidence		
Class A		13
Class B	N/A	14
Class C		8

Table 2.

Study Type	EAST/SCCM (n = 248)	STS/SCA (n = 404)	P-value
Prospective	70 (28.2%)	66 (16.3%)	< 0.05
Retrospective	50 (20.2%)	71 (17.6%)	0.409
RCT	35 (14.1%)	103 (25.5%)	< 0.05
Review	45 (18.1%)	53 (13.1%)	0.091
Meta-analysis	7 (2.8%)	17 (4.2%)	0.401
Guidelines	18 (7.3%)	11 (2.7%)	< 0.05
Other	23 (9.3%)	83 (20.5%)	< 0.05

References:

1. Napolitano LM, et al: Crit Care Med. 2009; 37(12):3124-57.
2. Ferraris VA, et al: Annals of thoracic surgery 2011, 91(3):944-982.

POSTER 3

Early Radiologic and Clinical Predictors of Post-Traumatic Cerebral Infarction

Elizabeth B. Mahanna, M.D.; Ferenc Rabai, M.D.; Steven Robicsek, M.D., Ph.D.;
Ilona Schmauluss, M.D., University of Florida

Background and Objective: Post-traumatic cerebral infarctions (PTCI) are known secondary injuries following severe traumatic brain injury (sTBI). Computed tomography (CT) classification of TBI was introduced by Marshall based on 4 levels of diffuse injury and mass lesion evacuation. It was modified to the Rotterdam Score by the addition of subarachnoid and intra-ventricular hemorrhage, and further differentiation of mass lesions and basal cistern obliteration. Both models have been validated to have high predictive power of overall prognosis, however, they lack prediction of secondary injury, such as PTCI. Identification of patients at risk for ischemia may be useful in guiding therapy to minimize PTCI extent. The aim of this study was to examine CT images and clinical data for early signs predictive of PTCI. We hypothesized findings of elevated intracranial pressure (ICP) on CT and clinical conditions that decreased oxygen delivery or increased consumption are associated with higher risk of PTCI.

Methods: A prospective convenience controlled cohort study enrolled 131 adult patients with sTBI. Initial CT scans were evaluated for the presence of PTCI, hydrocephalus, and 3rd and contralateral ventricle compression. Incidences of ICP greater than 20mmHg, cerebral perfusion pressure (CPP) less than 70mmHg and systolic blood pressure (SBP) less than 90mmHg were also examined.

Results: 15 of 131 patients (11.4%) developed PTCI; 12 in large vessel, 3 in watershed territories. CT signs predictive of PTCI included contralateral ventricle compression, OR 9.6(2.96,31.4), 3rd ventricle compression OR 15.5(1.98,121.98) and hydrocephalus OR 3.95(1.31,11.94). PTCI patients' ICPs were higher than 20mmHg on average 47.6 times versus an average of 25.8 times for patients without PTCI. There was no difference between the two groups in regard to low CPP or SBP.

Discussion: To our knowledge, specific early radiologic signs predicting PTCI have not been described yet. Our review identified contralateral and 3rd ventricle compression as well as hydrocephalus as early signs predictive of PTCI. Further we found that elevated ICP but not low CPP or SBP is associated with PTCI. PTCI may be caused by large vessel compression during herniation syndromes related to increased ICP. Although this has been well described, many clinicians focus on CPP treatment rather than aggressive ICP control in their therapeutic approaches. Identifying patients at risk for PTCI on initial CT may facilitate early initiation of aggressive therapy towards ICP reduction and subsequent PTCI prevention.

Conclusions: In this retrospective analysis, contralateral and 3rd ventricle compression as well as hydrocephalus were identified as early signs of increased risk for PTCI. We also found elevated ICP but not low CPP or SBP was associated with increased risk of PTCI. Early identification of patients at risk for PTCI via CT imaging, can lead to early initiation of aggressive treatment of ICP and not just CPP to possibly reduce the incidence of PTCI.

References:

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2. Maas AI, et al.: Neurosurgery, 2005, 57(6) 1173-1182
3. Huang YH, et al.: Neurosurgery, 2012, 71(1) 80-85
4. Robicsek S et al.: J Neurotrauma, 2012, 29(10):A43, A94

POSTER 4

Real Time Determinations of Total Resistance, Endotracheal Tube Resistance, and Airways Resistance

Nawar N. Al-Rawas, M.D.¹; Michael J. Banner, Ph.D.¹; Anatole Daniel Martin, Ph.D.¹; Carl G. Tams, Ph.D.²; Neil Euliano, Ph.D.²; Andrea Gabrielli, M.D.¹
University of Florida College of Medicine¹; Convergent Engineering²

Introduction: Increased total resistance (RTOT) frequently occurs in intubated patients with respiratory failure receiving ventilatory support. RTOT is the sum of imposed endotracheal tube resistance (RETT) and physiologic airways resistance (RAW)(1). Real time measurements of intratracheal airway pressure (Ptrach) and Y-piece pressure (PY) are used for determinations of RETT and RAW (2), useful for guiding therapeutic interventions. We hypothesized that RTOT, RETT, and RAW can be accurately determined in real time.

Method: A lung model (TTL test lung, Michigan Instruments) was connected to a ventilator (Esprit, Respironics) via an 8.0 mm endotracheal tube (ETT) which was placed inside an artificial trachea. A catheter was inserted through the ETT and passed to its distal end to measure Ptrach via a transducer. Resistors of 5 and 20 cmH₂O/L/sec, in various combinations, were positioned either proximal to the ETT (simulating partial ETT occlusion and increased RETT) or distal to the ETT (simulating bronchoconstriction and increased RAW) while an inhaled flow rate of 1 L/sec and tidal volume (VT) of 0.5 L were employed. A combined pressure and flow sensor, positioned between the ETT and Y-piece of the ventilator breathing circuit, directed data to a respiratory monitor (NICO, Respironics) for measurements of PY, flow rate, and VT. All data were streamed in real time to a laptop computer with dedicated software (Convergent Engineering). An end inspiratory pause of 0.5 sec was employed for determinations of RTOT, RETT, and RAW using equations. Data were analyzed with ANOVA and cell means contrasts; alpha was set at 0.05 for statistical significance.

Results:

Discussion: Increased values of RTOT are due to increases in RETT and/or RAW as indicated in the above table. Monitoring Ptrach, PY, and inspiratory flow rate allow RTOT and its component parts of RETT and RAW to be determined. These resistance parameters allow differentiation of various types of resistance abnormalities. This information enables clinicians to diagnose specific resistance abnormalities and choose appropriate interventions. For example, with increased RETT - suction ETT and with increased RAW - administer nebulized bronchodilator therapy. Increased RTOT alone cannot provide this vital diagnostic information.

Reference:

1. Intensive Care Med 1994;6:421-4; 2.J Appl Physiol 1994;77:2899-29

Proximal Resistor	Distal Resistor	R _{TOT}	R _{ETT}	R _{AW}
0	0	12.7 ± 0.2	8.1 ± 0.2	4.6 ± 0.1
0	5	15.3 ± 0.1*	8.1 ± 0.2	7.2 ± 0.1*
5	0	15.9 ± 0.1*	11.5 ± 0.1*	4.4 ± 0.1
0	20	28.4 ± 0.7*	7.6 ± 0.2*	20.8 ± 0.6*
5	20	31.4 ± 0.9*	11.1 ± 0.4*	20.3 ± 0.5*
20	0	37.1 ± 0.1*	33.2 ± 0.1*	3.8 ± 0.1

* compared to controls (row 1 data) p < 0.05

POSTER 5

Time to Extubation During Propofol Anesthesia for Spine Surgery with Sufentanil Compared with Fentanyl: A Retrospective Cohort Study

Brendan T. Wanta, M.D.; Arun Subramanian, M.B.B.S.; Timothy Curry, M.D., Ph.D.; James Hannon, M.D.
Mayo Clinic – Rochester

Background and Objective: Pharmacokinetic data suggest that sufentanil should lead to more rapid emergence from anesthesia compared to fentanyl. This study compares time to extubation between patients receiving fentanyl vs. sufentanil infusions in combination with propofol for major spine surgery.

Methods: The institutional total intravenous anesthesia (TIVA) protocol for major spine surgery changed from using fentanyl in 2009 to sufentanil in 2011. With IRB approval, all major spine patients receiving a propofol-based TIVA with fentanyl (2009) were compared to those receiving sufentanil (2011). Time to extubation, defined as the time from surgical closure to tracheal extubation, was the study outcome. Relevant demographic, anthropomorphic, anesthetic and surgical data were collected. Association between type of opioid and time to extubation was tested for statistical significance. Multiple linear regression analysis was used to control for confounders.

Results: 167 patients met inclusion criteria (fentanyl=72, sufentanil=95). There was no statistically significant difference between the two groups in terms of baseline characteristics. Time from surgical closure to extubation in the fentanyl versus sufentanil groups was not statistically different [mean (\pm SD): 40.2 (\pm 26.7) minutes vs. 45 (\pm 36.9) minutes; $p = 0.36$]. On multivariate analysis, total dose of propofol and male sex were associated with increased time to extubation.

Conclusion: The use of sufentanil may not reduce time to extubation compared to fentanyl despite its favorable pharmacokinetic profile. Higher doses of propofol and male sex were associated with prolonged time to extubation and appear to play a greater role than choice of opioid.

Table 1. Multiple linear regression results for time to extubation.

Variable	Beta coefficient	p
Intercept	2.80 (-21.99, 27.59)	0.82
Cumulative dose of propofol (mg/kg) ¹	0.28 (0.02, 0.53)	0.04
Male sex ²	14.01 (3.89, 24.14)	<0.01
Age ³	2.69 (-0.32, 5.70)	0.08
Estimated blood loss ⁴	-0.13 (-0.84, 0.58)	0.71
Opioid (Sufentanil vs Fentanyl) ⁵	8.57 (-3.02, 20.17)	0.15
ASA status (\leq II vs. $>$ II) ⁶	-0.44 (-11.51, 10.63)	0.94
Isoflurane used after TIVA discontinued ⁷	4.23 (-9.98, 18.45)	0.56

1 = for every 1 mg change in propofol administered

2 = minutes delay for male compared to female sex

3 = for every decade change in age

4 = for every 100 cc change in estimated blood loss

5 = change in time to extubation (minutes) when sufentanil used compared to fentanyl

6 = change in time to extubation (minutes) when ASA $>$ II compared to ASA \leq II

7 = change in time to extubation (minutes) when isoflurane used compared to desflurane

Simulation Training Enhances Resident Performance in Transesophageal Echocardiography

Natalie A. Ferrero, M.D.¹; Emily Teeter, M.D.²; Harendra Arora, M.D.²; Andrey V. Bortsov, M.D., Ph.D.²; David A. Zvara, M.D.²; Priya A. Kumar, M.D.²
Maimonides Medical Center¹; University of North Carolina at Chapel Hill²

Introduction: The clinical impact of perioperative transesophageal echocardiography (TEE) is well documented.¹ However, TEE training in residency programs is highly variable and is limited by numerous barriers, including time constraints in the OR, a limited number of appropriate cases, and a lack of experienced teaching faculty. Standardized training via simulation may lead to a more rapid and complete skill set. We hypothesized that simulation training will enhance performance in TEE image acquisition among anesthesia residents.

Methods: A total of 42 anesthesia residents were randomized to one of two groups: a control group, who received traditional PowerPoint-based didactic training, and a simulator group, whose training utilized a TEE-mannequin simulator. Each participating resident was directed to obtain ten standard echocardiographic views on an anesthetized patient. Images were evaluated on a grading scale of 0-10, according to predetermined criteria. Data were assessed using a linear mixed model implemented in SAS 9.3 (SAS Institute Inc, Cary, NC).

Results: Residents in the simulation group obtained significantly higher quality images with a mean total image quality score of 83 (95% CI 74 to 92) versus control 67 (58 to 76). A breakdown of image quality by views showed that the simulator group obtained a higher score for every view with the exception of the midesophageal 4-chamber view (Table 1). On average, 71% (58 to 85) of images acquired by each resident in the simulator group were acceptable for clinical use compared to 48% (35 to 62) in the control. Additionally, the difference in score between training groups was the greatest for the CA-1 residents and for those with no previous TEE experience.

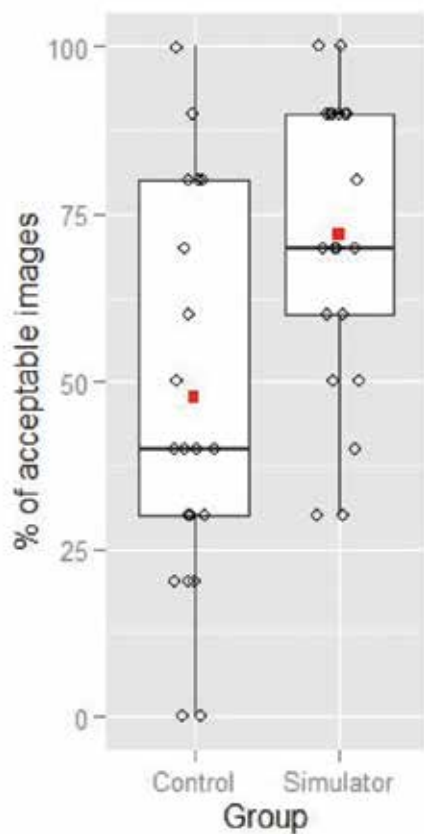
Conclusions: The results of this study show that mannequin-based TEE simulation training substantially improved the ability of residents to obtain ten standard TEE views with better quality and anatomic accuracy than their traditionally trained counterparts. The simulation-trained group outperformed their peers on all but one of the views. The most marked beneficial effect of the simulation training was demonstrated in obtaining the midesophageal right ventricular inflow-outflow, midesophageal bicaval, and deep transgastric views, in which image quality increased between 2.1 to 3 points on a 0-10 point scale. Our results affirm that simulation-based education in TEE enhances the acquisition of technical skills associated with this procedure. Additionally, the simulation-trained CA-1 residents and those with no previous TEE experience demonstrated the most substantial increase in performance compared to controls, suggesting that simulation training may have the greatest impact when implemented early in training. To our knowledge, this is the first prospective randomized study comparing mannequin-based TEE simulation training to traditional teaching methods as assessed by intraoperative performance on actual patients. As the simulation group outperformed controls on all metrics assessed in this investigation, our study supports the adoption of mannequin-based TEE simulation training into residency education.

Reference:

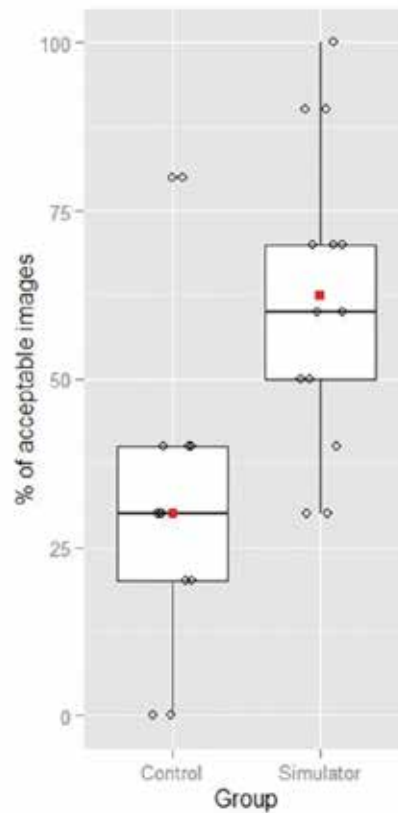
- Guarracino F, Baldassarri R. Transesophageal Echocardiography in the OR and ICU. *Minerva Anesthesiol* 2009; 75:518-29

	Sim Group Score (n=21) (95%CI)	Cntrl Group Score (n=21) (95%CI)	Score Surplus (Sim minus Cntrl)	p-value
Overall Score	83 (74,92)	67 (58,76)	16	0.016
ME Asc Ao SAX	8.1 (6.6,9.6)	6.9 (4.4,7.4)	1.2	0.037
ME 4-Chamber	8.5 (7.6,9.4)	8.6 (7.7,9.6)	-0.1	0.80
ME 2-Chamber	8.8 (7.6,10.0)	7.6 (6.4,8.9)	1.2	0.13
ME AV LAX	7.7 (6.3,9.0)	7.2 (5.8,8.5)	0.5	0.40
ME AV SAX	8.6 (7.5,9.7)	7.0 (5.9,8.1)	1.6	0.049
ME RV Inflow-Outflow	8.6 (7.2,9.2)	6.5 (5.1,7.8)	2.1	0.037
ME Bicaval	8.8 (7.2,10.0)	6.0 (4.4,7.7)	2.8	0.025
TG Midpapillary SAX	7.3 (6.0,8.7)	6.7 (5.4,8.1)	0.6	0.40
TG 2-Chamber	7.7 (6.2,9.1)	5.7 (4.3,7.2)	2.0	0.054
Deep TG LAX	8.4 (6.8,9.9)	5.4 (3.9,7.0)	3.0	0.014
Avg Acceptable Images per Exam (%)	71 (58-85)	48 (35-62)	23.0	0.021

Sim=simulation, 95%CI=95% Confidence Interval, Cntrl=control, ME= Midesophageal, Asc Ao= Ascending Aorta, SAX=short-axis view, AV= Aortic Valve, LAX=long-axis view, RV=Right Ventricle, TG =transgastric, Avg= average



A



B

Percentage of Acceptable Images per resident by study group.

Figure 1. Percentage of Acceptable Images per Exam.

A) All study participants (n=42)

B) Residents with no previous TEE experience (n=24)

A) Percentage of acceptable images per exam obtained by all study participants (n=42); mean 48% in control group versus 71% in simulator group, $P=0.021$.

B) Percentage of acceptable images per exam obtained residents with no previous TEE experience (n=24); mean 30% in control group versus 62% in simulator group, $P=0.038$.

Boxplots indicate minimum, maximum, median, lower and upper quartile.

Red squares indicate the mean for each group.

Vasospasm in a Patient with Sickle Cell Disease

Peggy A. White, M.D.; Daniel A. Hernandez, M.D.
University of Florida

Introduction: Sickle cell disease is characterized by abnormal hemoglobin formation, usually due to an amino acid substitution, valine for glutamate in the codon six position. This substitution causes polymerization of affected hemoglobin in hypoxic conditions. Other physiologic effects that can worsen sickling and complicate the care of a sickle cell patient include; acidosis, intravenous contrast dye, hypothermia and ischemia. Red blood cell deformation and slugging at the capillary level leads to progressive end organ damage. Intracranial complications occur in 25% of sickle cell patients.(1) It is postulated that changes in cerebral arterial vasculature are caused by increased viscosity, turbulent flow and chronic vasoconstriction. These mechanisms cause endothelial thickening, fibrosis, media weakening and infarctions of the vessel wall, all of which may lead to aneurysmal formation. Subarachnoid hemorrhage (SAH) accounts for 2% of the intracranial complications of sickle cell disease. SAH is often complicated by vasospasm, depending on the amount of blood in the subarachnoid space and the patient's neurological deficits. Management of a SAH can become complicated. Many modalities used to treat the aneurysm, open craniotomy for clipping or endovascular coiling both subject the patient to risks of developing a sickle cell crisis. The treatment of vasospasm can be conflicting with the measures used to prevent sickling crisis, i.e. aggressive management of pain could potentially mask altered mental status or subjecting the patient to frequent contrast exposure to directly treat the vasospasm with intraarterial verapamil.

Case Report: We report the case of a 25 year old African American male with history of sickle cell disease diagnosed with subarachnoid hemorrhage, Hunt Hess 2 and Fischer 4. Hematology recommended partial manual exchange transfusion with a goal hemoglobin S of 30% or less. This was achieved with exchange transfusion of 8 units of packed red blood cells (PRBC). On hospital day 2, he underwent a coil embolization of a ruptured left posterior communicating aneurysm. Transcranial Doppler (TCD) was done daily to assess for vasospasm. On bleed day 3 he had a mental status change and stopped following commands. TCD showed increased velocity bilaterally in the anterior circulation. CT angiogram confirmed the diagnosis of vasospasm and he received intraarterial (IA) verapamil. His symptoms resolved with IA verapamil and hypertensive therapy to systolic blood pressures >160.

Discussion: At our institution. Each SAH patient is placed on vasospasm prophylaxis with, seven days of antiepileptics, statin, 21 days of oral nimodipine, and maintenance of euvolemia. TCD is done daily to monitor for the development of vasospasm and when combined with decline in neurological status the diagnosis is confirmed with CT angiogram. Once diagnosed, vasospasm therapy is instituted. This includes, cerebral selective intra-arterial vasodilator therapy and induction of hypertension.(4) The care of this patient was complicated by the risk of precipitating a sickle crisis. Measures to prevent a crisis included, avoiding hypothermia, acidosis, hypoxia and limiting his contrast dye load.

POSTER 8

Predicting Post-Extubation Respiratory Failure by Non-Reassuring Waveforms With a Non-Invasive Piezoelectric Sensor Technology

Gyorgy Frendl, M.D., Ph.D.¹; Tal Kap, M.Sc.²; Shiraz Levkovich, B.Sc.²; Afrin Nuzhad, B.S.¹; Ian Shempp, B.S.¹; Eyal Zimlichman, M.D., M.Sc.¹
Brigham and Women's Hospital¹; EarlySense, Inc.²

Background: Post-extubation respiratory failure (RF) is common (>10%) for critically ill patients. Some breathing patterns (rapid shallow breathing) are ineffective and lead to increased work and RF. The conversion of this observation into a metric (rapid-shallow breathing index) failed to predict weaning failure. We recorded chest wall motion-generated complex waveforms by a continuous, piezoelectric, under-the-mattress sensor plate (EarlySense Inc) to identify respiratory patterns predictive of RF.

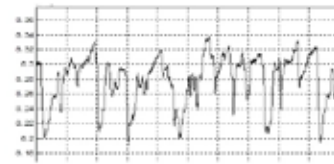
Hypothesis: Patients who fail, despite meeting current clinical criteria for safe extubation, will display unique (non-reassuring) respiratory waveform patterns in their chest wall motion (frequency, amplitude, pauses, regularity), that can be identified by continuous monitoring. We further hypothesized that the non-reassuring respiratory waveforms could be seen before and after extubation and will be less prevalent for those who extubate successfully.

Study design and patient population: Prospective, observational study recording waveforms 24/7 for intubated and mechanically ventilated patients while on PSV and following extubation. Adult critically ill surgical patients (28) or their surrogates were consented for the study.

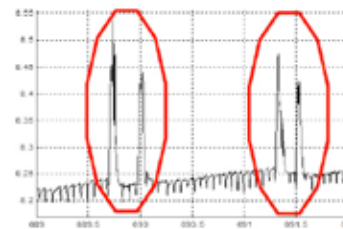
Analysis: Two patient cohorts were studied: those who successfully extubated and those who failed (end-points of failure: reintubation, tracheostomy or death). The periods (6.5-24 hours) prior to extubation and (13-24 hours) following extubation were studied. The recordings were analyzed by an algorithm for abnormal patterns that correlate with respiratory outcomes and confirmed by visual examination of the raw signals.

Non-Reassuring Respiratory Patterns

A: Generalized unorganized respirations



B: Frequent (30-120sec) high amplitude respirations



C: Period of apnea for >20 seconds or more

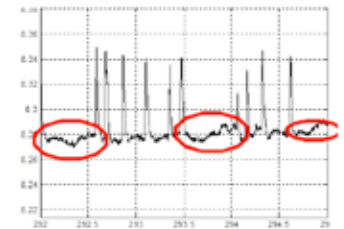


Fig 2

Results: Healthy respiratory pattern (Fig1) is prevalent for those successfully extubated. Non-reassuring respiratory patterns (Figure 2) were seen with those who failed extubation. Positive patients had a cumulative duration of non-reassuring pattern at least twice as long as their periods with normal respiratory pattern during the entire recording period. After extubation, non-reassuring respiratory patterns will identify those patients (Table I) likely to require ventilatory support (91% specificity, 60% sensitivity, PPV:75%, NPV:83%). Similar data on these groups prior to extubation is presented in Table II.

Conclusions: A pattern of unstable respirations (apparent in inconsistent chest wall motion amplitude) has been found to precede and correlate with respiratory failure. For ventilated patients this non-reassuring pattern (seen in PSV mode) may indicate that a patient is not ready for extubation. In the case of recently extubated patients, the pattern may indicate a need for interventions to prevent re-intubation. These conclusions will be tested in a prospective study to further validate their utility for clinical decision making.

Stable (Healthy) Respiratory Amplitude

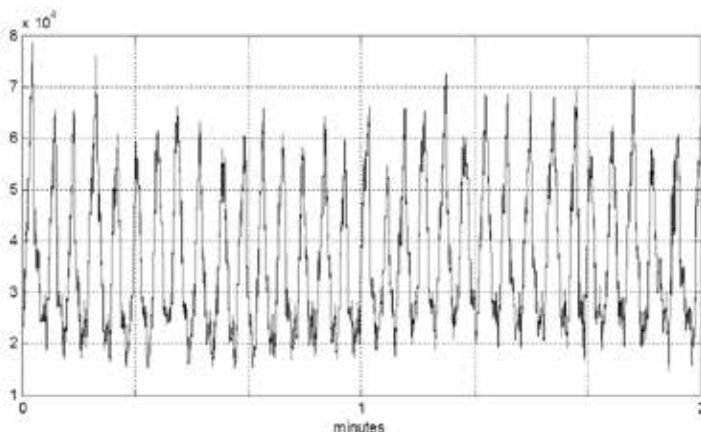


Fig 1

Dexmedetomidine Use in a Patient with Thyroid Storm

Leslie M. Terdiman, M.D.; Helene Logginidou, M.D.; Jarva Chow, M.D., MPH
Department of Anesthesia, Suny Downstate Medical Center, Brooklyn, New York

Introduction: Thyroid storm is a rare, life-threatening condition characterized by severe clinical manifestations of thyrotoxicosis including cardiac decompensation, neurologic, thermoregulatory and gastrointestinal-hepatic dysfunction.^{3,4}

A 41-year-old female with PMH of asthma, presented to the ED with sharp chest pain, nausea, shortness of breath, tachypnea and palpitations. Her vital signs revealed a hyperdynamic state, BP 190/112, HR 110-150's, RR 18-25, SAO₂ 100%, Temperature 98.5 F. Computed tomography angiography showed no evidence of pulmonary embolism (Figure 1). It revealed mixed ground glass alveolar opacities scattered throughout both lungs suspicious for multifocal infectious process, diffuse thyroid enlargement, cardiomegaly and enlarged pulmonary trunk (Figures 2 and 3). Patient was started on IV Propranolol and empiric antibiotic coverage.

Her laboratory results showed significantly elevated Thyroxine (T4) levels, suppressed TSH, high Free T4 and Free T3 levels, elevated Thyrotropin Receptor Antibodies and Thyroid Stimulating Immunoglobulins; negative troponins, and elevated Brain Natriuretic Peptide consistent with thyroid storm. In the ED the patient received a loading dose of Propylthiouracil and Corticosteroids.

Admitted to MICU and endocrinology was consulted. A few hours later the patient became increasingly anxious, irritable, tachycardic and hypertensive. On auscultation she was wheezing and her saturation declined in the low 90's. Levalbuterol and an additional dose of Propylthiouracil was given and Propranolol was discontinued. Dexmedetomidine drip was initiated and titrated to effect. Goal was to relieve patient's hypermetabolic state and neurologic manifestations via it's α_2 A adrenoceptor agonist sympatholytic and anxiolytic effects at the level of locus ceruleus^{3,4} without compromising patient's respiratory status. Soon after initiation of Dexmedetomidine, the patient's hemodynamics and agitation improved, respiratory rate normalized maintaining adequate oxygenation and ventilation.

Thyroid ultrasound revealed right lobe enlarged thyroid gland hypoechoic and hyperemic consistent with Grave's disease (Figure 4).

Transthoracic Echocardiography showed mildly dilated left ventricle with normal systolic function and wall thickness; bi-atrial mild dilation; moderate mitral regurgitation. She was ultimately discharged in euthyroid condition.

Management of patients in thyroid storm can be challenging. It occurs in patients with underlying thyroid disorder subject to a secondary stress. Our patient had a Thyroid Storm Scoring System > 45.¹

In our case Dexmedetomidine through its α_2 A agonism decreased patient's sympathetic activity and release of catecholamines, achieved sedation and relieved patient's agitation without the need of benzodiazepines or narcotics and thus avoiding mechanical ventilation as well as end organ damage.

References:

1. McDermott MT. Hyperthyroidism. Ann Intern Med 2012; 157(1):ITC1-16
2. Carroll R. Ther Adv Endocrinol Metab. 2010 June; 1(3): 139-145.
3. Kamibayashi T, Maze M. Clinical uses of α_2 -adrenergic agonists. Anesthesiology 2000;93:1345-9
4. Nelson. The α_2 -adrenoceptor agonist dexmedetomidine converges on an endogenous sleep-promoting pathway to exert its sedative effects. Anesthesiology 2003;98:42



Figure 1

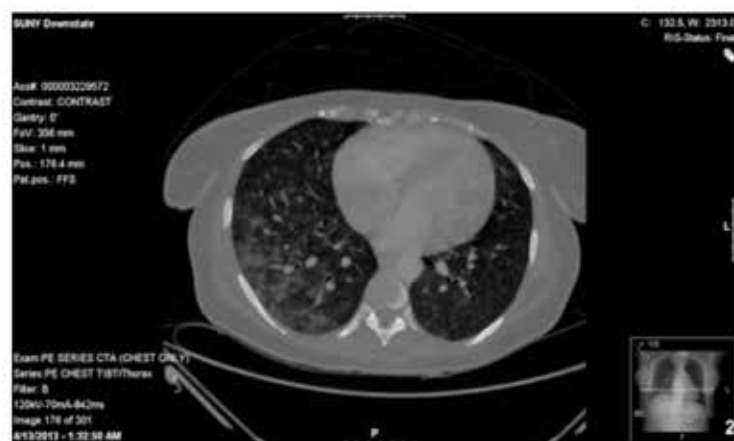


Figure 2

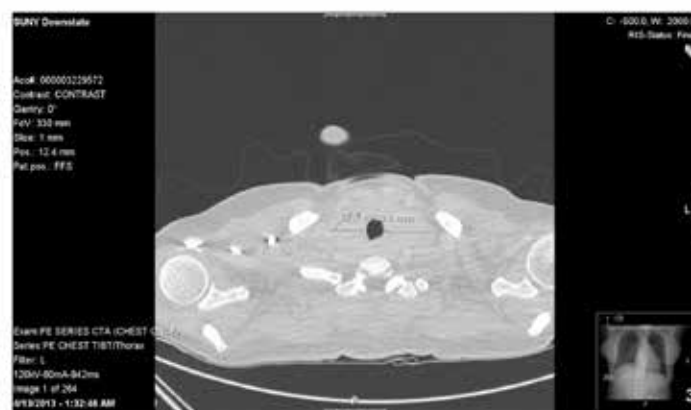


Figure 3

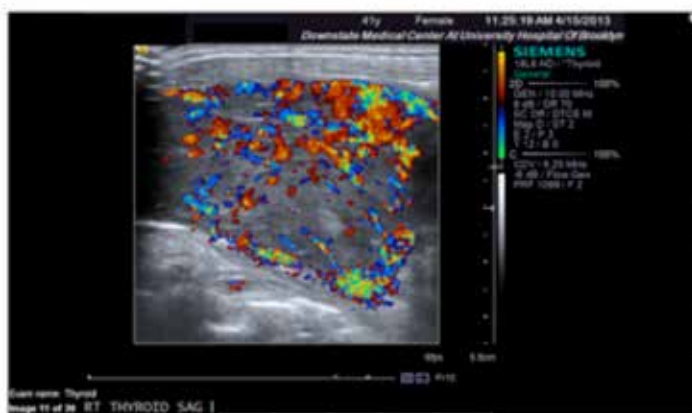


Figure 4

Early Severity Assessment and Mortality Prediction in Neurologically Compromised ICU Patients: A Nomogram to Guide Accelerated Care in the Elderly

Alexander F. Bautista, M.D.¹; Rainer Lenhardt, M.D.¹; Changhong Yu, M.D.²; Edward Mascha, Ph.D.²; Ozan Akca, M.D., FCCM¹

University of Louisville, Department of Anesthesiology and Perioperative Medicine¹;

Cleveland Clinic Foundation Department of Quantitative Health Sciences and Outcomes Research²

Introduction: In 2009, elderly population (age ≥ 65 years) comprised 12.9% of the U.S. population. Age is an independent risk factor for mortality. Moreover, co-morbidities, primary diagnosis, pre-morbid cognitive and functional status are likewise regarded as contributing factors. Stroke, hypertensive and traumatic intracranial hemorrhages are common causes for elderly ICU admissions. Hence, we aimed to establish and validate a model to predict mortality in elderly neurologically compromised ICU patient.

Methodology: After IRB approval, using our ICU database from 2005-2009, we retrospectively reviewed elderly neurologically compromised patients for the training data set. We fit a multivariable logistic regression model predicting in-hospital mortality as a function of age, GCS, WBC, platelets, glucose, BUN, creatinine, temperature, APACHE-III, SOFA Score, sodium, smoking, CHF, aspirin and statin use (y/n). Both linear and non-linear forms of the continuous variables were considered. Backwards variable selection was used and the model with the best BIC was chosen. Internal discrimination was assessed with an optimism-corrected (by 10-fold cross-validation) c-statistic (AUC). Internal calibration was assessed with a plot of observed versus expected mortality. A nomogram was constructed to display the final model and was tested in our ICU patients from the years 2010-2012. In sensitivity analyses, similar discrimination and calibration were achieved when withholding WBC from training and learning data sets. Discrimination was assessed with a c-statistic (AUC). Calibration was assessed with a plot of the observed versus the nomogram predicted mortality probability, and with the Hosmer-Lemeshow test goodness of fit test of predictions versus the observed event rate. Overall prediction was assessed with Scaled Brier's score (range 0 to 1, where 1 is perfect prediction) as well.

Results: Of 913 elderly patients admitted, 537 patients were considered for analysis. Overall mortality was 28%. The final multivariable model prediction mortality from the training set included age, smoking, GCS, WBC, SOFA score, CHF and aspirin use. The training dataset (Figure 1) final model had internal AUC (95% CI) of 0.848 (0.810-0.886) after adjustment for over-fitting indicating excellent discrimination. When applied to the test data, the AUC was 0.878, and Brier's score was 0.414. In-hospital mortality for the training data was 28%. When the model was applied to the test data, the AUC was 0.878 (0.820-0.936) (Figure 2), still excellent discrimination, and the scaled Brier's score was 0.414, indicating moderate overall prediction. Calibration on the test data was acceptable, with Hosmer-Lemeshow goodness of fit $P=0.09$. However, the calibration plot indicated a slight but consistent over-prediction of mortality across the range of predicted scores (Figure 3).

Conclusion: Our prediction model for in-hospital mortality for elderly neuroscience ICU patients had very good discrimination and moderate prediction accuracy when applied to the new data set.

N	537	
	Survivors (n=388)	Non-Survivors (N=149)
DEMOGRAPHICS		
AGE	76.2 \pm 7.4	78.8 \pm 7.3
GENDER		
Male	204	62
Female	184	87
Hospital Days	9.8 \pm 11.9	9.5 \pm 14.2
DIAGNOSIS AND COMORBIDITIES		
Hypertension	173(44.6%)	57(38.2%)
CAD/MI	84(21.6%)	26(17.4)
Congestive Heart Failure	25(6.4%)	21(14.1%)
DM	67(17.3%)	20(13.4%)
COPD	30(7.7%)	11(7.4%)
Smoking History	17(4.4%)	12(8.1%)
Chronic Renal Failure	7(1.8%)	5(3.3%)
History of Cancer	32(8.2%)	11(7.4%)
Aspirin Use	145(42.4%)	41(28.7%)
Statin Use	133(38.9%)	29(20.3%)
PHYSIOLOGIC PARAMETERS		
Glasgow Coma Scale	12.3 \pm 2.8	9 \pm 3.6
APACHE III	41.1 \pm 13.4	50.7 \pm 17.1
SOFA score	3.3 \pm 2.3	5.3 \pm 2.4
Temperature (°F)	99.5 \pm 1.2	100.3 \pm 1.7
LABORATORY PARAMETERS		
White Blood Cell (Thou/mm ³)	12.7 \pm 5.4	14.7 \pm 4.9
Hemoglobin(g/dl)	11.2 \pm 1.9	11.0 \pm 2.0
Hematocrit(%)	34.9 \pm 17.7	33.3 \pm 6.2
Platelet Count(Thou/mm ³)	200.8 \pm 76.8	187.1 \pm 68.8
Sodium (mmol/L)	138.8 \pm 8.6	138.8 \pm 4.8
Creatinine (mg/dl)	1.1 \pm 0.9	1.3 \pm 1.0
BUN(mg/dl)	20.2 \pm 10.9	23.9 \pm 11.5
Glucose (mg/dl)	147 \pm 53.3	170 \pm 56.6

Table 1: Baseline Characteristics of Training Data 2005-2009

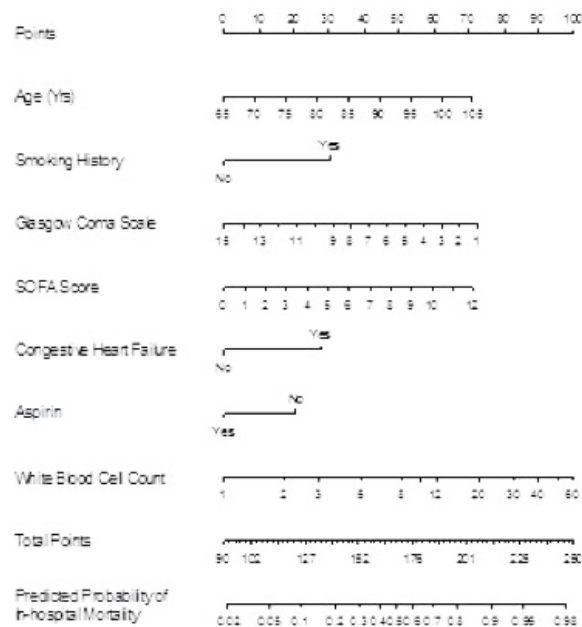


Figure 1: Nomogram for predicting mortality, based on multivariable model fit on variables available at ICU admission from 2005-2009

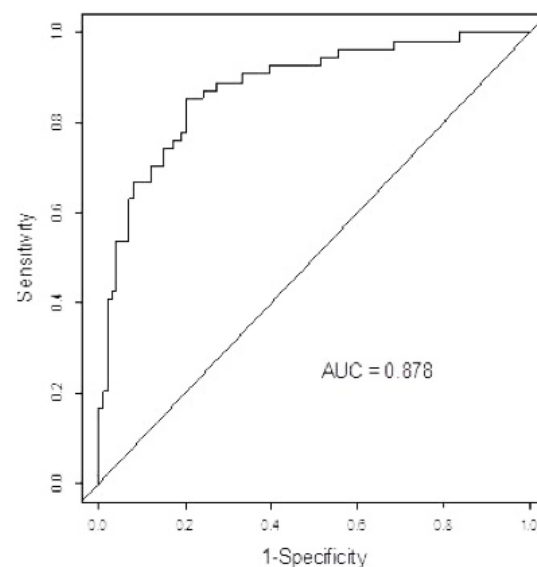


Figure 3: Receiver operating characteristic curve predicting in-hospital mortality on test data (2010-2012) indicates very good discrimination, with area under the curve (95% CI) of 0.878 (0.820-0.936).

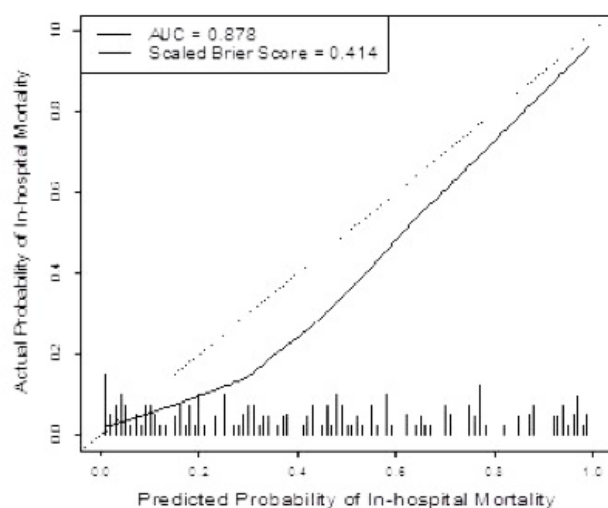


Figure 2: Calibration curve predicting test data (2010-2012) from training data model (nomogram) indicated slight and consistent over-prediction of mortality. Hosmer Lemeshow goodness of fit chi-square = 13.7, P value = 0.09.

POSTER 11

Vasopressin Augments the Decline of Plasma Cytokine Levels in Septic Shock

Andrew J. Patterson, M.D., Ph.D.¹; James A. Russell, M.D.²; Joe Hsu, M.D., MPD¹; John Boyd, M.D.²; Chris Fjell, Ph.D.²; Keith Walley, M.D.²
Stanford University¹; University of British Columbia²

Rationale: Changes in plasma cytokine levels may predict mortality in patients experiencing septic shock. Administration of vasoactive pharmaceuticals may alter plasma cytokine levels early in septic shock.

Hypothesis: 1. Changes in plasma cytokine levels during the first 24 hours after detection of septic shock differ between survivors and non-survivors. 2. Vasopressin has a different effect on plasma cytokine levels than norepinephrine when administered to septic shock patients.

Measurements: 394 patients (of 778 patients enrolled in the Vasopressin and Septic Shock Trial - VASST, Russel et al., NEJM, 2008) were studied. Levels of 39 cytokines were measured at baseline (detection of septic shock) and after 24 hours of therapy. Cytokine levels were compared. Hierarchical clustering and principal component analysis (PCA) were used to evaluate cytokine expression. 28 day mortality was evaluated.

Results: Survivors of septic shock experienced a greater decrease in overall cytokine levels at 24 hours compared to non-survivors ($p < 0.001$). Vasopressin decreased overall 24 hour cytokine concentration more than norepinephrine ($p = 0.037$). Vasopressin decreased IP-10, GCSF, and IL-6 levels more than norepinephrine in less severe septic shock patients. Vasopressin decreased GRO levels more than norepinephrine in more severe septic shock patients. The groups of cytokines identified using hierarchical clustering and PCA did not fit into conventional pro-inflammatory, anti-inflammatory, chemokine, and growth factor groupings.

Conclusions: 1. Immune profiles may be useful for predicting mortality of septic shock patients. 2. Administration of vasopressin may be beneficial early in the treatment of septic shock. 2. Septic shock may be a heterogeneous group of disorders in which different patterns of cytokine expression lead to similar clinical presentations.

Simulator Training for Point-of Care-Cardiac Ultrasound

Thomas Edrich, M.D., Ph.D.; Raghu R. Seethala, M.D.; Annette Mizuguchi, M.D., Ph.D.; Sascha Beutler, M.D., Ph.D.; John A. Fox, M.D.; Gyorgy Frendl, M.D., Ph.D.
Brigham and Women's Hospital

Introduction: Use of bedside transthoracic echocardiography (TTE) by anesthesia critical care providers is finding increased use. Use of simulation may help meet the need for training for both manual acquisition and image recognition skills. Ease of scheduling may enable more effective training for large numbers of physicians than tradition teaching using live volunteers. We enrolled anesthesiologists into a training study under the thesis that simulation training would not be inferior to live training.

Methods: Fifty-eight anesthesiology residents, fellows, and staff received 80 minutes of TTE training using either a simulator or a live volunteer. Preparation occurred before the training day in self-study using a written and video tutorial. Twelve of the participants had prior training in transesophageal echocardiography (TEE). The improvement in manual image acquisition skills was assessed using a practical test performed before and after training. Subjects were allowed 20 seconds to obtain each of 5 standard 2-dimensional images as specified by the FATE protocol. The ability to rapidly obtain high-quality 2-dimensional TTE views was assessed using a novel quantitative scoring system that ranged from 0-15 points. A change of 2 points was defined apriori to be clinically meaningful.

Results: As shown in figure 1, participants without prior TEE training (groups live and sim) showed significant improvements in image acquisition skills after TTE training. Means and 95% confidence intervals are plotted together with the number of subjects enrolled in each group. There were no significant differences between the simulation and live groups. Participants with prior TEE training (groups live+TEE and sim+TEE) also demonstrated improvement, but this did not reach statistical significance. The improvement in group live minus the improvement in group sim was compared to the apriori non-inferiority threshold as shown in figure 2 demonstrating that simulator training is not inferior for trainees without prior TEE training. Likewise the groups with TEE experience were compared, but with the 95% confidence interval crossing the non-inferiority limit.

Conclusions: When providing initial TTE training to anesthesiologists without prior experience in echocardiography, training using a simulator was not inferior to using live volunteers.

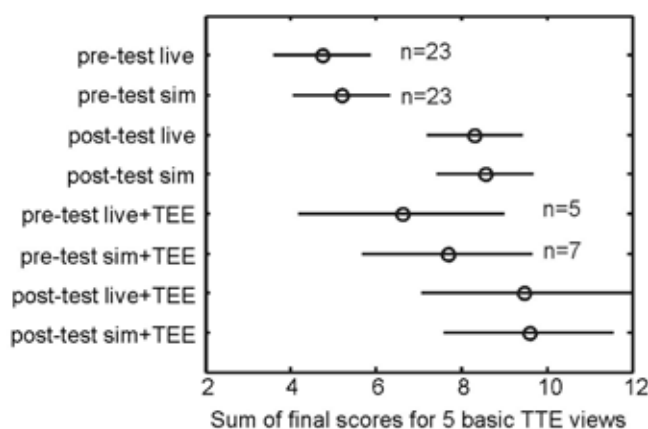


Figure 1

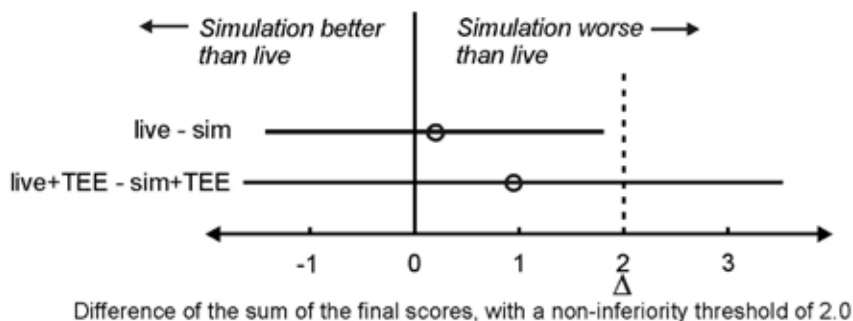


Figure 2

Physician and Nurse Staffing Patterns in Pennsylvania Cardiac Surgery Intensive Care Units

Meghan B. Lane-Fall, M.D., MSHP; Xu He, BA; Kelly L. Wiltse Nicely, Ph.D., CRNA; Lee A. Fleisher, M.D., FACC; Mark D. Neuman, M.D., MSHP
University of Pennsylvania

Background: Physician and nurse intensive care unit (ICU) staffing have been independently linked to patient outcomes, but no studies have simultaneously evaluated physician and nurse staffing since the advent of the Leapfrog Group standards for physician intensivist staffing.

Purpose: Characterize physician and nurse staffing patterns in Pennsylvania cardiac surgery ICUs, including variation in physician presence and nurse-to-patient ratios on night and weekend shifts compared with weekday shifts.

Methods: Telephone and mail survey of all Pennsylvania cardiac surgery ICU nurse managers. Previously validated instruments were modified using physician and nurse administrative experts to create a novel survey instrument. Hospitals performing cardiac surgery in Pennsylvania were identified from the most recent statewide cardiac surgery report issued by the Pennsylvania Health Care Cost Containment Council (PHC4). The nurse manager of each hospital's cardiac surgery ICU was contacted using public hospital directory information. Participants completed a 60-item questionnaire regarding physician and nurse staffing. We compared responders and non-responders with respect to facility-level characteristics using univariate hypothesis tests. Descriptive statistics were used to characterize responding ICUs' staffing patterns and care practices.

Results: 61 hospitals were identified from PHC4 data. Three hospitals no longer performed cardiac surgery. From the remaining 58 hospitals, the nurse managers of 45 hospitals were contacted; 41 completed the survey and 4 declined participation. The final response rate was 41/58, or 70.7%. There were no significant differences between responders and non-responders with respect to bed size, urban versus rural locality, academic affiliation, or Hospital Safety Score (SM). Magnet® status had been achieved by more of the respondents' hospitals (14/41, 34.2%) than the non-respondents' hospitals (1/17, 5.9%, $p=0.045$). Attending physicians were present at night in 25/41 (61.0%) ICUs; 8/25 (32.0%) night attendings were dedicated to the cardiac surgery ICU. On weekends, 28/41 (68.3%) reported having attending physicians present; 14/28 (50.0%) weekend attendings were dedicated to the ICU. 11/41 (26.8%) ICUs did not have attendings present during nights or on weekends. There was no association between night/weekend attending presence and hospital teaching status or night/weekend presence of residents, physician assistants or nurse practitioners. With respect to nursing characteristics, 11/39 (28.2%) ICUs reported that the proportion of nurses with <2 years ICU experience changed from weekdays to nights/weekends; 6/11 (54.5%) had less experienced nurses on nights/weekends. 8/39 (20.5%) of respondents had a change in the proportion of nurses with at least a BSN degree from weekdays to nights/weekends; 4/8 (50.0%) had a higher BSN proportion on nights/weekends.

Conclusions: Pennsylvania cardiac surgery ICUs employ a variety of physician and nurse staffing schemes, with variation apparent in weekday versus nighttime and weekend coverage for both provider types. Additional work is needed to establish whether these staffing models are associated with differential patient outcomes.

POSTER 14

Heparin Induced Thrombocytopenia Complicated by Cardiac Ischemia, Hemothorax, and High Dose Argatroban

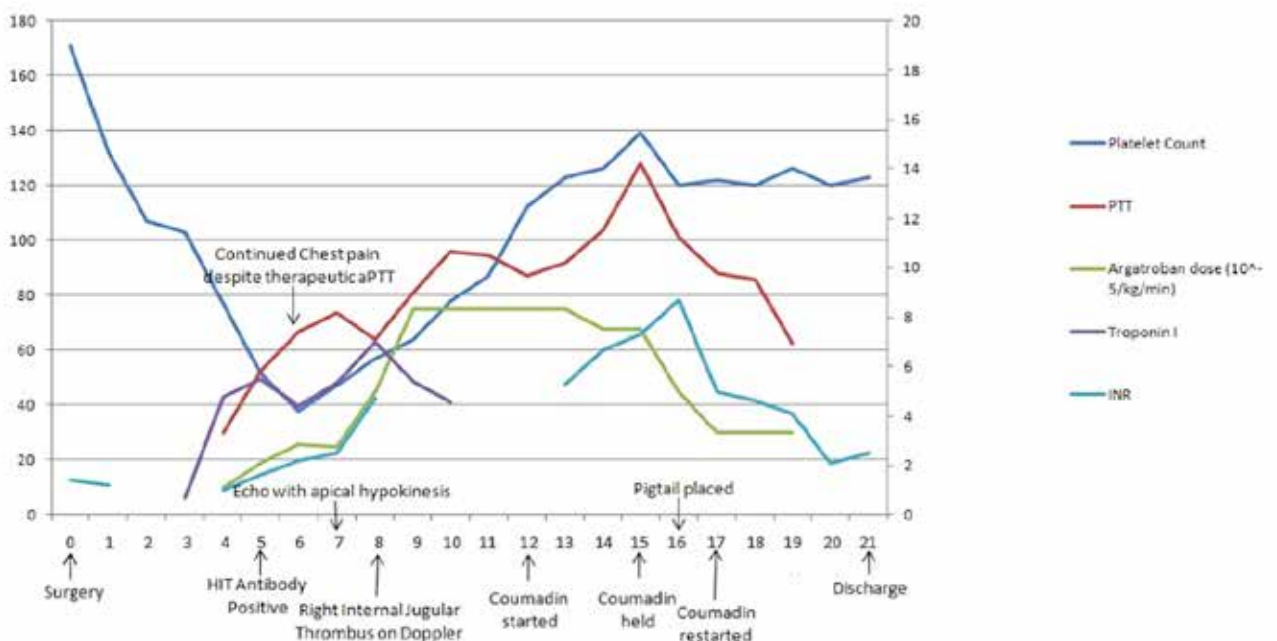
Daltry Dott, M.D.; Joseph Schlesinger, M.D.
Vanderbilt University Medical Center

57 year old male status post coronary artery bypass surgery who developed thrombocytopenia and new onset chest pain on postoperative day 4. Once heparin-induced thrombocytopenia (HIT) was suspected, all heparin products were discontinued, and he was started on an argatroban infusion to reduce the risk of thromboembolic events. Cardiac surgery patients pose a challenge to the diagnosis of HIT because a majority of patients have thrombocytopenia during the first 72 hours postoperatively¹, and to further complicate the diagnosis, 25% to 70% of cardiac surgery patients develop anti-platelet factor 4 (PF4)-heparin antibodies, and as many as 20% test positive by platelet activation assays²⁻⁴. However, only a small number of these patients develop clinical HIT⁵. HIT was diagnosed by positive heparin antibodies and confirmed by a positive serotonin release assay. Our patient required high-dose argatroban (>7.5 mcg/kg/min) to obtain a therapeutic aPTT. Throughout his hospital course he had chest pain that was attributed to ischemia, pericarditis, microvascular thrombi, and anxiety. EKG demonstrated findings of both pericarditis and acute ST-segment elevation myocardial infarction. A repeat echocardiogram demonstrated new onset apical hypokinesis. Argatroban was titrated to an aPTT at which the patient had minimal chest pain and was therapeutically anticoagulated. Once a therapeutic dose had been obtained, dual-anticoagulation therapy with warfarin was started. During dual anticoagulation therapy, he developed an expanding left-sided hemothorax that required drainage. A pigtail catheter was successfully placed while temporarily holding dual anticoagulation, despite the patient's high thrombogenic risk. When transitioning from

dual anticoagulation therapy to warfarin monotherapy after a five day overlap, INR and chromogenic factor X levels were monitored. This case presents a diagnostic challenge of multifactorial chest pain juxtaposed with management of anticoagulation while undergoing procedural intervention and weaning high dose argatroban to warfarin monotherapy while ensuring therapeutic anticoagulation.

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Ventriculopleural Shunt Surgery in a Patient With Multiple Skeletal and Neurodevelopmental Anomalies - A True Perioperative Challenge

Ashish K. Khanna, M.D., FCCP; Ehab Farag, M.D, FRCA; Wael Ali Sakr Esa, M.D.
Cleveland Clinic Foundation-Anesthesiology Institute

Introduction: Surgical management of hydrocephalus commonly entails a shunt procedure with drainage to the peritoneum or right atrium. A ventriculopleural shunt is an uncommon shunt considered for draining CSF in selected patients when conventional sites are not suitable either due to adhesions, infection, thrombosis or obliteration.¹

Case Report: A 42 year old, 125 cm tall 35.5 kg (78 lb 4.2 oz) female with PMH of spina bifida and consequent paraplegia, type II chiari malformation and partial agenesis of corpus callosum, presented with increasing shunt-dependent hydrocephalus. She had a right occipital ventriculoatrial shunt placed around the time of her birth for hydrocephalus, which was revised at age 9 to a ventriculoperitoneal shunt. Recently, she had multiple shunt revisions with dehiscence and breakdown of the anterior chest wall and distal shunt malfunction.

The planned surgical procedure was an internalization of distal shunt revision with ventricular pleural shunt creation via thoracoscopic assistance. Perioperative concerns included right lung collapse in a patient with short stature, dysmorphic skeletal features, severe kyphoscoliosis, restrictive underlying lung disease and multiple neurodevelopmental midline defects.

In the operating room a left radial arterial line and two good wide bore peripheral intravenous access lines were secured awake. After adequate preoxygenation an IV induction of anesthesia was done and a 35 Left Double Lumen Endotracheal tube was placed and the patient was positioned in a left lateral decubitus position. Correct positioning of the tube was confirmed via a bronchoscopic and clinical examination. As the Neurosurgery team tunneled their shunt in, the tunneling device was

visualized thoracoscopically with CO₂ insufflation of the right pleural cavity and catheter placement was then successfully completed by the thoracic surgery team. (Bottom Image) She was transferred intubated to the Post-Anesthesia Care Unit for delayed extubation after full reversal of neuromuscular blockade was confirmed. A small basilar right pneumothorax because of residual CO₂ was present that resolved on serial imaging. Multiple shunt series radiology films afterwards confirmed correct placement of the shunt in the pleural cavity. (Top Image) She made a progressive recovery and was discharged home on POD-1.

Discussion: Ventriculopleural shunt procedures are a challenge for the entire surgical and perioperative team. These patients need good pre-operative optimization, accurate lung isolation and collapse during surgery and vigilant post-operative monitoring in the ICU or PACU. The usual complications (aside from mechanical and functional) include: respiratory insufficiency from pneumothorax, symptomatic pleural effusions, empyema, pneumocephalus from malfunctioning shunt.²

This patient was a special challenge based on the need for lung collapse in a short stature, dysmorphic kyphoscoliotic thoracic cavity with underlying restrictive disease and background neurodevelopmental midline defects.

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Blood Transfusions in Total Hip and Knee Arthroplasty: An Analysis of Outcomes

Thomas Danninger, M.D.¹; Rehana Rasul, MPH, MA²; Jashvant Poeran, M.D.²; Ottokar Stundner, M.D.³; Madhu Mazumdar, Ph.D., M.A., M.S.³; Stavros G. Memtsoudis, M.D., Ph.D., FCCP¹

Department of Anesthesiology, Hospital for Special Surgery, New York, NY¹; Department of Public Health, Division of Biostatistics and Epidemiology, Weill Cornell Medical College, New York, NY²; Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria³

A significant number of patients undergoing total hip and knee arthroplasty (THA and TKA, respectively) receive perioperative blood transfusions. A number of studies have raised concern of worse outcomes in patients receiving blood transfusions compared to those who do not^{1,2,3}. As population based data on how patient characteristics are associated with the need for blood transfusions and how they impact on outcomes are rare, we sought to compare this group to those that did not utilizing a very large patient cohort. As we hypothesized that patients in the former group would be older and have higher comorbidity burden, we attempted to determine the attributable risk of blood transfusions in respect to perioperative outcomes.

Material and Methods: Data from approximately 400 hospitals in the United States were used to identify patients undergoing THA or TKA from 2006 - 2010. Patient and health care system related characteristics as well as perioperative outcomes were compared. Adjusted and unadjusted logistic regression models were created to determine associations between transfusion and the outcomes of combined major complications, cardiac complications, pulmonary complications, mortality within 30 days, renal failure, and utilization of intensive care services. Methodology to determine attributable risk was employed.

Results: We identified a total of 530,089 patients either undergoing THA or TKA. Of those, 18.93% received a blood transfusion during their hospitalization. Patients requiring a blood transfusion were significantly older and had a higher comorbidity burden. When examining outcomes, patients in the blood transfusion group had significantly higher rates of major complications and longer length of hospitalization. The unadjusted model showed that transfused patients were more likely to have an adverse health outcome than non-transfused patients. However, those odds ratios were higher than those found in the adjusted model, indicating significant impact of covariates. Factors associated with the need for blood transfusion could explain 9.51% (95% CI 9.12-9.90) of all major complications while advanced age and high comorbidity burden explained 55.94% (95% CI 52.89-58.80) and 13.40% (95% CI 12.94-13.86) respectively, when controlling for covariates.

Discussion: In this study we were able to show that patients receiving blood transfusions surrounding THA and TKA were older and had higher comorbidity burden. These factors and potentially others may be responsible for worse outcomes and may not be attributable to blood transfusions themselves.

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Persistent ICU Hyponatremia in an Unusual Case of Transurethral Resection of Prostate Syndrome

Sagar S. Mungekar, M.D.; John T. Denny, M.D.

University of Medicine & Dentistry of New Jersey: Robert Wood Johnson

A 62-year-old man was sent to the emergency room for hematuria and progressive dyspnea after having a laser transurethral resection of the prostate (TURP). Sterile water had been used as the irrigant. He was administered normal saline and furosemide for presumed hypervolemic hyponatremia (serum sodium concentration [Na] 127 mEq/L). Initially, the [Na] rose to 132 mEq/L; however soon thereafter, the patient developed gait imbalance, confusion, and transient obtundation with rhythmic shaking of both lower extremities. The repeated laboratory test then revealed a [Na] of 117 mEq/L.

Infusion of hypertonic (3%) saline was begun. Again, we noted an initial rise in the [Na] to 121 mEq/L followed by a paradoxical fall to 118 mEq/L with a clinical picture consistent with hypo-osmolar hypervolemia. A computed tomography scan demonstrated fluid in the bilateral retroperitoneal spaces (Figure), pleural effusions, and pelvic ascites; contrast dye was noted to leak from the posterior wall of the bladder into the extraperitoneal space. We hypothesized that during the procedure, the bladder neck was perforated and the irrigant extravasated into the retroperitoneum creating a depot of several liters of free water. We reasoned that the hypo-osmolar hyponatremic liquid slowly diffused intravascularly, resulting in persistent symptomatic hyponatremia. The serum creatinine concentration later rose; however, nuclear tests demonstrated only moderately damaged kidneys, suggesting that the retroperitoneal depot then contained urine that was being reabsorbed systemically.

The transurethral resection of the prostate (TURP) syndrome is usually fairly rapid in its onset as hypo-osmolar irrigant is directly absorbed through the extensive vasculature of the prostate. A more recently described transurethral resection of bladder tumor (TURBT) syndrome is often caused by an extravasation of the irrigant; however, we find our case unique in that the bladder neck was perforated in a TURP, not a TURBT, and that the resultant extravasation had two consequences: (1) the creation of a retroperitoneal depot of water that steadily expanded the intravascular volume and forced water into other third spaces; and (2) the creation of a semi-closed-loop urinary system whereby moderately functioning kidneys masqueraded as acutely dysfunctional ones as urine was reabsorbed systemically. Rapid recognition of this phenomenon allowed the critical care team to treat the dangerously low serum sodium levels aggressively. Similarly, we avoided subjecting the patient to unnecessary hemodialysis and further surgical interventions. Our patient was discharged home on hospital day 22 with close outpatient follow-up scheduled.

Following manipulations of the urinary organs in which a hypo-osmolar irrigant is used, the anesthesiologist and critical care physician should be alert to the potential electrolyte derangements that follow in the context of the clinical picture. The ABCs of basic management still prevail: airway and circulation compromise must be addressed, followed by the correction of symptomatic hyponatremia. Further management must depend on the intravascular volume status and recognition that extravasated liquids may act as a depot hindering attempts to correct electrolyte abnormalities.

2002; 38:511-4.



FIGURE. Coronal section from a computed tomography scan of the abdomen and pelvis. Extravasated irrigant is seen in the bilateral retroperitoneal spaces. This depot of free water caused persistent symptomatic hyponatremia.

POSTER 18

Risk of Re-Intubation Following the Implementation of an Extubation Safety Algorithm: Findings From the Extubation Safety and Quality Improvement Project (ESQIP)

Jacob E. Sunshine, M.D., M.S.; David Dorsey, M.D.; Aaron Joffe, D.O.; Nita Khandelwal, M.D., MPH; N. David Yanez, Ph.D.; Miriam Treggiari, M.D., Ph.D.
University of Washington

Background: In the intensive care unit (ICU), re-intubation following planned extubation is independently associated with poor outcomes, including ventilator associated pneumonia, increased length of stay and death. In the context of a quality improvement (QI) initiative, we implemented a planned extubation safety algorithm, based on available evidence that accounted for known patient risk factors for extubation failure, to help reduce the occurrence of re-intubation, in a cohort of mechanically ventilated patients admitted to any ICU (medical, surgical, neuroscience and burn) of one large academic medical center.

Methods: The QI intervention consisted of education of designated ICU team leaders (including physicians, respiratory therapists and nursing staff) who then disseminated the intervention across the institution. Training materials, consisting of posters, bedside signage specific to airway classification, and laminated pocket cards illustrating the decision algorithm were also shared. We compared frequencies of re-intubation following planned extubation during the pre-QI and QI-intervention periods and calculated the relative risk of re-intubation.

Results: During the pre-QI period (March 13, 2012 - September 11, 2012), 870 patients met inclusion criteria. A total of 185 patients (21%) required out-of-operating room re-intubation during their hospital course. During the QI-intervention period (September 12, 2012 - February 28, 2013), 903 patients met inclusion criteria. A total of 166 patients (18%) required re-intubation during their hospital course. Comparing the QI-intervention period with the pre-QI period, the relative risk for reintubation was 0.86 (95% CI, 0.71-1.04).

Conclusions: In the ICUs of one large academic medical center, using an extubation safety algorithm led to a trend toward reduced out-of-operating room re-intubations, compared to usual care.

Limitations: Without comparison cohorts that underwent extubation during the same time periods, it cannot be determined definitively if this trend toward improvement is due to the QI-intervention or unrelated, global improvements in extubation practices.

Severe Anion Gap Acidosis of Unknown Origin in a Patient with Mild Confusion

Madiha Syed, M.B, B.S.; Victor L. Mandoff, M.D.
University of Arkansas for Medical Sciences

Metabolic acidosis may present as an acute or chronic disorder, the acute form likely a result of overproduction of organic acids (lactic acid/ ketoacids) whereas chronic forms are likely secondary to bicarbonate wasting or impaired acidification by the kidney. Diagnosis of the cause is imperative in order to reverse the adverse effects of severe acidosis on multiple organ systems, which may range from CNS depression, cardiovascular dysfunction, impaired immunity and compromise of energy production.¹ Chronic acidosis may lead to muscle degradation and abnormal bone metabolism.² We present a case of a 37 year old male with a history of poly substance abuse and suicidal behavior, who was brought to the ED with mild confusion and no recall of recent events. On exam he had a fractured left upper extremity. He appeared to be mildly confused with a GCS of 13 and was hemodynamically stable. ABG on presentation showed a severe anion gap metabolic acidosis (See Table 1) with values as follows: pH 6.90, HCO₃ 9, Anion gap 24, osmolal gap 34 and serum lactate of 10.7. His serum ketones, salicylate, acetaminophen and ethylene glycol levels were negative. The serum alcohol level was 38 mg/dl, which was below the legal limit. He was admitted to surgical ICU and resuscitated with intravenous fluids and bicarbonate infusion with rapid correction of acidosis and improvement of mental status. He underwent uneventful repair of his arm injury and was discharged home in 3 days.

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Table 1 : Arterial blood gas levels during resuscitation

Time	pH	pCO ₂	pO ₂	HCO ₃	BE	SpO ₂
0112	6.9	24	200	9	Not available	95.4
0218	7.18	33	95	12.3	-4.9	95.1
0542	7.34	41	220	22.1	-3.5	96

Airway Development Status-Post Gunshot Wound (GSW) to the Shoulder with Expanding Hematoma and Cartilage Disruption

Kimberly I. McClelland, MPH; Gium D. Hailedingle, M.D.; Clairmont E. Griffith, M.D.
Howard University Hospital

Case: A 60-year-old driver with no known medical history arrived to the ED after being shot twice in the upper back. His car subsequently collided with a pole (restraint status unknown) and he was brought in on a stretcher, wearing a cervical collar, with a GCS of 15, a patent airway, assistance with a non-rebreather mask and intact circulation.

Upon initial exam, one GSW had pierced each of the patients' shoulders, with no exit wounds visible. The patient also had a laceration on his left chin and complained of left shoulder pain, but remained communicative during the evaluation, with no tongue swelling, vocal changes or blood in the oral cavity.

Despite tracheal deviation observed on X-ray, the patient lacked signs and did not communicate symptoms of any form of mass effect or pneumothorax; therefore, he was considered hemodynamically stable and transported to CT, where he remained conversational during the entire encounter and showed no indication of discomfort aside from his shoulder complaint.

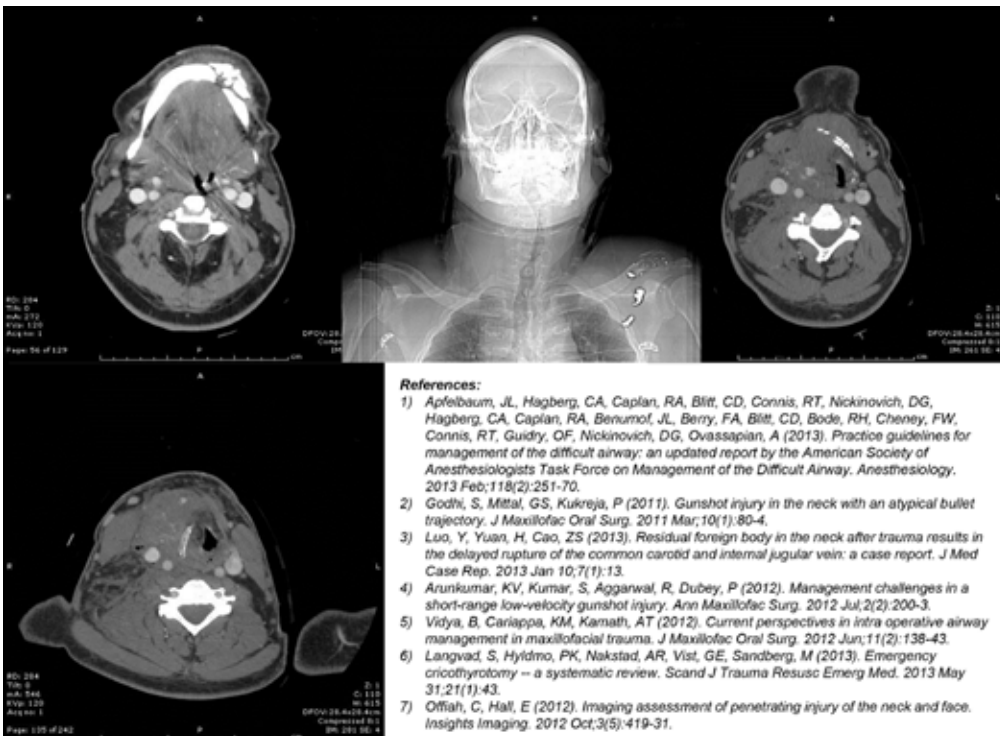
However, during transport from CT, the patient complained of cervical collar tightness, and frantically attempted to remove it. After clearing his cervical spine for injury, the trauma surgeon attempted intubation. However, with the results of the CT now available, the patient was promptly identified as a difficult airway (DA) patient, and Anesthesiology was called to intervene. A GlideScope was used to visualize the patient's airway, which was erythematous and swollen. Intubation was therefore abandoned and cricothyrotomy was successfully performed.

Discussion: One of the primary concerns in the evaluation of a trauma patient is the sufficient preservation of their airway, especially if they require difficult airway management. A difficult airway is classified by the ASA as "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both."¹

Various methods of airway stabilization have been studied in patients in similar scenarios, with maxillofacial and neck injuries^{2,6}, as well as optimal imaging techniques for the more rapid identification of trauma effects (7). However, the added complication of sudden airway constriction and unusual bullet trajectory make this case particularly unique.

According to our radiology dept., the bullet that entered our patient's left shoulder fractured the left clavicle-hence the patient's complaint of left shoulder pain. The bullet that entered the right shoulder traversed Zone II of the neck, fractured the hyoid bone, ricocheted off of the patient's mandible and exited, while creating an actively bleeding hematoma within the neck that slowly expanded to constrict the patient's airway. Additionally, lack of mucosal violation from the bullet trajectory explains the lack of blood in the oral cavity during physical exam.

The fact that this patient remained talkative throughout his primary and secondary surveys proved a misleading sign with respect to anticipating imminent airway patency. The rapid deterioration of our patient's airway was an unexpected consequence of his injuries and provides a valuable clinical lesson with respect to emergency airway management.



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Inhibition of Beta-adrenergic-mediated Stimulation of Alveolar Fluid Clearance in ARDS: Critical Role for IL-8

Brant M. Wagener, M.D., Ph.D.; Angela P. Brandon, B.S.; Jean-Francois Pittet, M.D.
University of Alabama at Birmingham

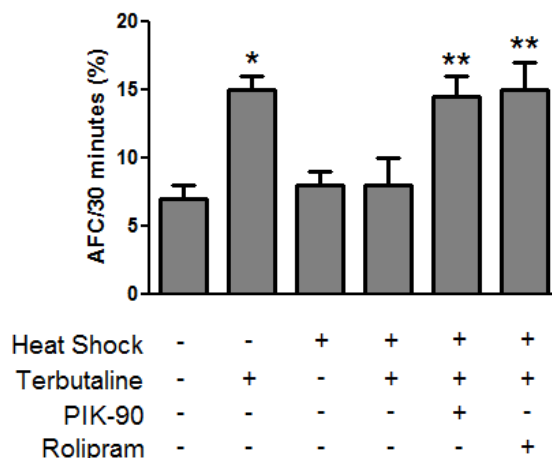
Patients with acute respiratory distress syndrome (ARDS) who retain maximal alveolar fluid clearance (AFC) have better clinical outcomes.¹ Indeed, a multi-center observational study has reported that increased pulmonary edema is the most important predictor of mortality in ICU patients.² Therefore, significant effort has been undertaken to pharmacologically upregulate AFC to reverse progression of lung injury. In particular, experimental and small clinical studies have shown that β 2-adrenergic receptor (β 2AR) agonists enhance AFC via a cAMP-dependent mechanism. However, two multicenter, phase 3 clinical trials failed to demonstrate that β 2AR agonists provide a survival advantage in ARDS patients.³⁻⁴ Our preliminary clinical data suggested that high pulmonary edema fluid levels of IL-8 (> 4,000 pg/ml) collected immediately after onset of mechanical ventilation were associated with impaired AFC in ARDS patients. Thus, we hypothesized that IL-8 may directly antagonize the alveolar epithelial response to β 2AR agonists. Short-circuit current and whole-cell patch-clamping experiments revealed that IL-8, or its rat analog cytokine-induced neutrophil chemoattractant 1 (CINC-1), significantly decreases β 2AR agonist-stimulated vectorial Cl- and net fluid transport across alveolar epithelial type II cells via a reduction in the cystic fibrosis transmembrane conductance regulator activity and biosynthesis. This reduction was mediated by a phosphoinositide 3 kinase-(PI3K)-dependent heterologous β 2AR desensitization, cell membrane downregulation and inhibition of the receptor recycling to the cell membrane in alveolar epithelial cells. Furthermore, IL-8, or its rat analog CINC-1, further reduced c-AMP production in response to β 2AR agonist via a PI3K-

dependent activation of phosphodiesterase 4 (PDE4). Finally, inhibition of CINC-1 (specific antibody), PI3K (PIK90, a specific PI3K inhibitor) or PDE4 (rolipram) restored β 2AR agonist-stimulated AFC in an experimental model of hemorrhagic shock and ARDS in mice (Figure 1) that is associated with a complete inhibition of the β 2AR-mediated stimulation of alveolar fluid clearance.⁵ These results demonstrate a novel role for IL-8 in inhibiting β 2AR agonist-stimulated alveolar epithelial fluid transport via PI3K/PDE4-dependent mechanisms. As specific PDE4 inhibitors are already used in combination with long-acting β 2AR agonists for the treatment of patients with chronic obstructive pulmonary disease, PDE4 inhibitors given in combination with β 2AR agonists could be considered as a new treatment to stimulate AFC during the early phase of ARDS in humans. This therapeutic approach may be preferable for ARDS patients rather than direct inhibition of IL-8 that could adversely affects neutrophil-mediated bacterial clearance in ARDS due to infections.⁶⁻⁷

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Figure 1. Alveolar Fluid Clearance in Hemorrhagic Shock



The mice underwent laparotomy followed by hemorrhage for 1 hour and were resuscitated. AFC was measured in the presence of treatments described.

* β 2-AR agonists activate AFC in the absence of hemorrhage ($p < 0.05$).

** IL-8-mediated inhibition of β 2-AR-dependent AFC is reversed by inhibitors of PI3K and PDE4 ($p < 0.06$).

PIK-90 or rolipram alone do not affect basal alveolar fluid clearance (data not shown).

The Generalizability of Randomized Controlled Trials in Critical Care Medicine

Ryan M.J. Ivie, M.D.¹; Hannah Wunsch, M.D.¹; Monica Goldklang, M.D.¹; Cheromi Sittambalam, M.D.²; Robert Fowler, M.D.²; Vivek Moitra, M.D.¹

Department of Anesthesiology, Columbia University¹; Sunnybrook Health Science Centre²

Introduction: In order to assess the applicability of the conclusions of randomized controlled trials (RCTs) to our critical care patient population, we investigated whether or not our patients would meet the entry criteria for the fifteen most frequently cited RCTs in critical care medicine.

Methods: Using the Ovid Medicine search engine with ranking data from the Scopus Search Engine, the fifteen most frequently cited RCTs from 1998-2010 were identified. At Columbia University Medical Center, New York USA, all patients newly admitted to the medical and surgical intensive care units over a seven-day period were enrolled in the study. At the Sunnybrook Health Science Centre, Toronto CA, all patients newly admitted to the combined medical-surgical intensive care unit over a fourteen-day period were enrolled in the study. Every enrolled patient was screened on each day of ICU admission to determine eligibility for each study. The frequency of patients meeting entry criteria for the RCTs was then calculated and subdivided by timing, location, and primary disease process.

Results: Ninety-three patients were enrolled from three ICUs. Forty-eight of the 93 patients (51.6%) were not eligible for any of the RCTs. Of the 45 patients that were eligible for an RCT, 28 (62.2%) were eligible for only one RCT, 9 (9.7%) were eligible for two RCTs, and 8 (8.6%) were eligible for three RCTs. Of the 1395 possible instances of RCT eligibility (15 RCTs x 93 patients), no exclusion criteria were met 676 times (48.5%) and all inclusion criteria were met only 180 times (12.9%). Eighty-two of the 96 instances of eligibility (85.4%) occurred during the first 24 hour period following admission to the ICU with none occurring after day four of admission. The most common reasons for admission included respiratory failure (17.2%), sepsis (15.1%), trauma (12.9%) and post-surgical monitoring (12.9%). Of the 32 patients with suspected sepsis, only 19 (59.4%) were eligible for at least one sepsis trial and the median number of sepsis trials for which septic patients were eligible was 1 (out of 6 sepsis RCTs). Of the 8 patients with suspected acute respiratory distress syndrome (ARDS), only 4 (50.0%) were eligible for at least one ARDS trial and the median number of ARDS trials for which ARDS patients were eligible was 0.5 (out of 4 ARDS RCTs).

Discussion: The strict eligibility criteria of RCTs impose limitations on the generalizability of their findings. Half of the patients were not eligible for any of the most frequently cited RCTs in critical care medicine. Both the inclusion criteria and exclusion criteria accounted for the low rate of eligibility. Forty percent of patients with sepsis and 50% of patients with ARDS did not meet eligibility criteria for any of the major sepsis and ARDS RCTs. Most patients who met eligibility criteria for a study did so during the first 24-hour period suggesting that screening ICU patients only on the first day after admission may be adequate for recruitment for most RCTs.

Table 1.

Eligibility	N	%
Total Number of Patients	93	
Not Eligible for Any RCT	48	51.6%
Eligible for 1 RCT	28	30.1%
Eligible for 2 RCTs	9	9.7%
Eligible for 3 RCTs	8	8.6%

Inclusion vs. Exclusion Criteria	N	%
Total Possible Instances of RCT Eligibility (15 RCTs x 93 Pt.s)	1395	
Met No Exclusion Criteria	676	48.5%
Met All Inclusion Criteria	180	12.9%
Met All Inclusion Criteria But Met Exclusion Criteria	84	6.0%
Total Instances of RCT Eligibility	96	6.9%

Timing of Eligibility	N	%
Eligible on Day 1	82	85.4%
Eligible on Day >1	14	14.6%

Disease Specific Eligibility	N	%
<i>Sepsis</i>		
Number of Sepsis RCTs	6	
Patients with Suspected Sepsis	32	
Patients Eligible for At Least One Sepsis Trial	19	59.4%
Median Number of Eligible Sepsis Trials Per Patient	1	16.7%
<i>ARDS</i>		
Number of ARDS RCTs	4	
Patients with Suspected ARDS	8	
Patients Eligible for At Least One ARDS trial	4	50.0%
Median Number of Eligible ARDS Trials Per Patient	0.5	12.5%

Demographics†	All ICUs	All RCTs
Age (years)	63	57
BMI (kg/m ²)	26	26
APACHE	21.3	20.4
Female	34.4%	41.9%
White	58.1%	81.3%
Hispanic	18.3%	6.3%
Black	11.8%	15.8%

† mean values, unless otherwise specified

Outcomes	All ICUs	All RCTs
Length of stay (days)	2.7	5.5

Persistent Lymphopenia on Day 3 After the Diagnosis of Sepsis is Associated With Increased Mortality

Anne M. Drewry, M.D.¹; Lee P. Skrupky, Pharm.D.²; Richard S. Hotchkiss, M.D.¹
Washington University School of Medicine¹; Barnes-Jewish Hospital²

Introduction: Sepsis initiates both proinflammatory and anti-inflammatory mechanisms, with many patients progressing to an immunosuppressive state prior to death.¹ Lymphopenia has been well documented in septic patients and has been shown to persist up to 21 days after diagnosis.^{2,3} The aim of this study was to quantify the degree of lymphopenia during the first five days following the diagnosis of sepsis in survivors and non-survivors and to determine if persistent lymphopenia on Day 3 predicted death.

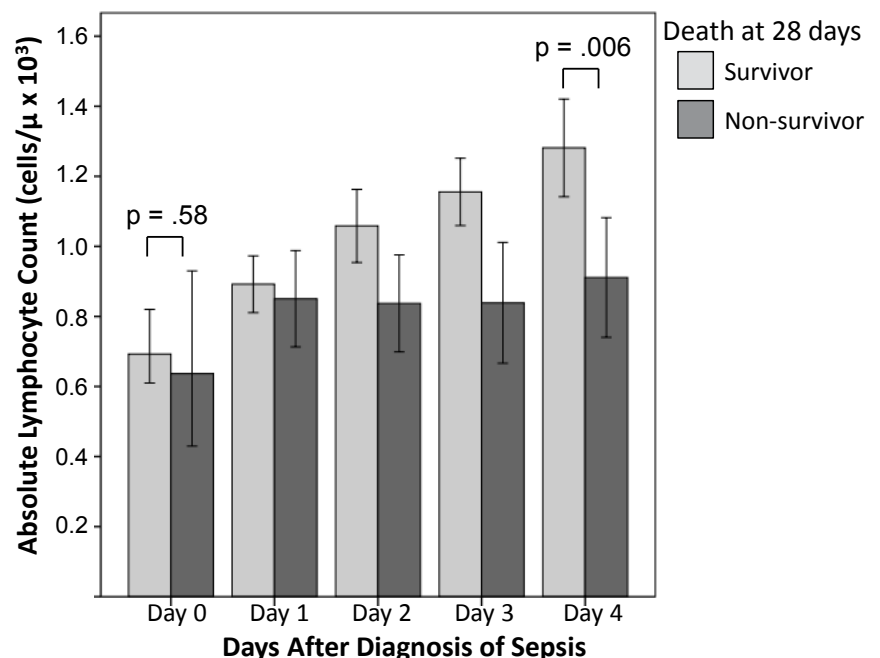
Methods: Single-center, retrospective cohort study of 208 adult patients with sepsis and positive blood cultures admitted to a large academic center from January 2010 through June 2011. Exclusion criteria included hematological disease, treatment with immunosuppressive agents, HIV infection, and death within four days of sepsis diagnosis. All complete blood cell count profiles during the first five days following diagnosis were recorded. Lymphopenia was defined as an absolute lymphocyte count (ALC) less than 1.2 cells/ $\mu\text{l} \times 10^3$.

Results: Forty-nine (23.6%) patients died within 28 days following the diagnosis of sepsis. Lymphopenia was present in survivors (median ALC 0.69 cells/ $\mu\text{l} \times 1000$ [IQR 0.42, 1.11]) and non-survivors (median ALC 0.63 cells/ $\mu\text{l} \times 1000$ [IQR 0.38, 1.16]) at the onset of sepsis, and was not significantly different between the groups ($p = .575$). By Day 4, the median ALC had significantly increased in survivors (1.13 cells/ $\mu\text{l} \times 1000$ [IQR 0.74, 1.66], $p < .001$ compared to Day 0), but had not significantly increased in non-survivors (median 0.80 cells/ $\mu\text{l} \times 1000$ [IQR 0.54, 1.10], $p = .079$ compared to Day 0). Using Cox regression to account for potentially confounding factors (including age, APACHE II score, history of cirrhosis, and hours until appropriate antibiotic coverage), an increase in the ALC to greater than 1.2 cells/ $\mu\text{l} \times 1000$ on Day 3 was independently associated with survival (hazard ratio 0.40 [95% CI 0.23, 0.72], $p = .002$).

Conclusions: Lymphopenia was present in both 28-day survivors and non-survivors on the day of sepsis diagnosis; however, persistent lymphopenia on Day 3 after diagnosis was an independent predictor of death. Given the large number of animal studies showing that prevention of lymphocyte apoptosis improves survival in sepsis¹, a strong rationale exists for clinical trials of immunotherapeutic agents that reverse sepsis-induced lymphopenia. (Grant UL1 TR000448, GM 44118 NIH)

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Dose Dependent Analysis of Thrombotic Events Following the Administration of Recombinant Activated Factor VII in Cardiac Surgery Patients

Allison Dalton, M.D.; Jennifer E. Hofer, M.D.; Michael O'Connor, M.D.; Ishaq Lat, Pharm.D.; Katie Mieure, Pharm.D

Anesthesia and Critical Care, University of Chicago, Chicago, Illinois

Introduction: Recombinant activated factor VII (rFVIIa) has extended use criteria in patients without hemophilia. There are guidelines to help standardize off-label usage, however the ideal dosage to obtain the benefit of hemostasis without the complication of thrombosis has not been confirmed. We hypothesized that there was not an association between rFVIIa dosage and thrombotic events.

Methods: After institutional review board approval, we performed a retrospective chart review of the outcomes of all adult cardiac surgery patients treated with rFVIIa over a 16 month period. Data from the intraoperative course included the timing and dosage of rFVIIa, and the timing and amount of blood product administration. Postoperative data collection included the number of blood products transfused in the intensive care unit and thrombotic events.

Results: We enrolled 50 patients who had previously undergone cardiac surgery including CABG, valve and device placement, all who received rFVIIa. The doses of rFVIIa ranged from 15.2 mcg/kg to 114.8 mcg/kg, which were divided into groups of <30mcg/kg (low dose) and >30mcg/kg (high dose). Of the 50 enrolled patients, 13 patients received a low dose and 37 patients received a high dose of rFVIIa. Three patients in the low dose group had an episode of thrombosis, whereas 5 patients in the high dose group had a thrombotic event ($p = 0.413$). One patient in the low dose and two patients in the high dose group experienced a deep vein thrombosis (DVT) ($p = 1.000$). One patient in the low dose and three patients in the high dose group had a cerebral vascular infarction (CVA) ($p = 1.000$). There were no reported incidences of pulmonary embolus (PE) or arterial thrombosis. There was no statistical significance in the rate of thrombotic events in the high versus low dose rFVIIa groups.

Conclusion: We found that the administration of high dose rFVIIa in cardiac surgery patients was not associated with higher incidences of thrombotic events. This finding suggests that, if necessary to achieve hemostasis, higher dosages of rFVIIa would not incur higher risk of postoperative DVT, PE, CVA and other thrombotic events. Additional study is warranted to determine whether a decrease in transfusion requirements is dependent on the dose of rFVIIa administered.

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Off Label Use of Recombinant Activated Factor VII Decreases Transfusion Rates in Cardiac Surgery Patients

Jennifer Hofer, M.D.; Allison Dalton, M.D.; Michael O'Connor, M.D.; Ishaq Lat, Pharm.D.; Katie Mieure, Pharm.D

Anesthesia and Critical Care, University of Chicago, Chicago, Illinois

Introduction: 96% of recombinant activated factor VII (rFVIIa) is used for off-label treatment of hemorrhaging patients without the diagnosis of hemophilia. These extended criteria cases include management of bleeding from excessive anticoagulation, and treatment of bleeding during surgery and transplantation. Off-label use of the drug is so prevalent that guidelines exist to guide the therapy. We hypothesized that in cardiac surgery patients who received rFVIIa, there would be a significant decrease in transfusion rates after rFVIIa administration.

Methods: After institutional review board approval and informed consent, we performed a retrospective chart review of the outcomes of all adult cardiac surgery patients treated with rFVIIa over a 16 month period. The data collection included patient demographics, established medical diagnoses, and preoperative laboratory studies. Data from the intraoperative course included the timing and dosage of rFVIIa, and the timing and amount of intraoperative blood product administration. Postoperative data collection included the number of blood products transfused in the intensive care unit.

Results: We enrolled 46 patients who had previously undergone cardiac surgery including CABG, valve, and device placement, all who received rFVIIa. The volume of blood products in units, specifically packed red blood cells (PRBC), fresh frozen plasma (FFP), platelets, and cryoprecipitate were measured before and after rFVIIa administration. The doses of rFVIIa varied from < or > 30 mcg/kg dosing. The mean number of PRBC transfused prior to rFVIIa was 8.89 units, the mean number of PRBC units transfused post rFVIIa was 3.15 units ($p < 0.001$). The mean number of units of FFP, platelets, and cryoprecipitate transfused prior to rFVIIa was 7.78, 2.52, and 1.59 units, compared to the mean number of units transfused post rFVIIa which was 2.43, 1.15, and 0.57 respectively, each statistically significant with $p < 0.001$.

Conclusion: We found that the administration of rFVIIa was associated with a statistically significant decrease in blood product transfusion rates. This finding suggests there is a benefit to off-label use of rFVIIa in cardiac surgery patients which is to decrease bleeding, decrease transfusion requirements, and decrease utilization of limited banked blood. Further investigation is needed to elicit whether the benefit of decreasing transfusion requirements is balanced with potential thrombotic complications with off-label rFVIIa administration in cardiac surgery patients.

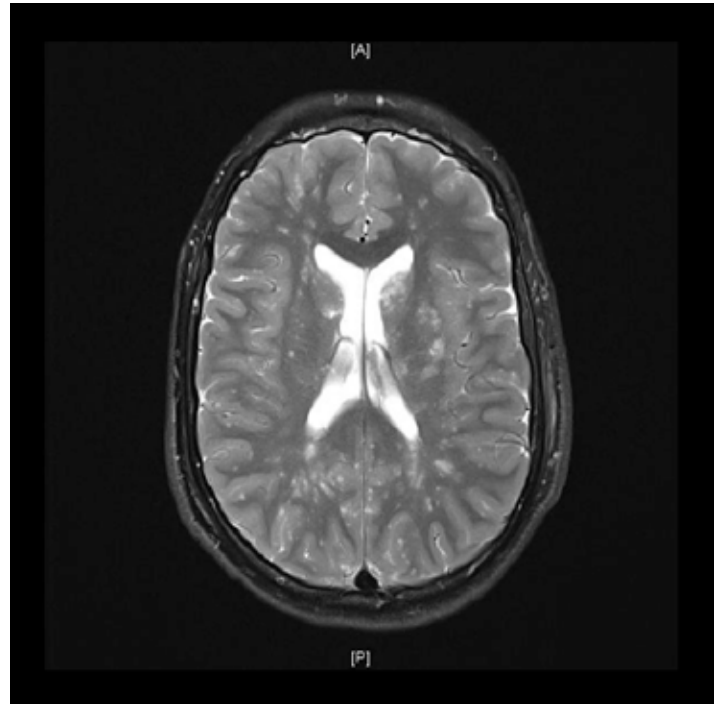
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Fat Emboli Syndrome Diagnosed in a Post-Operative Trauma Patient Following ICU Admission: A Case Report

Kristen E. Dragan, M.D.; Michael J. Bowling, D.O.; Kathrin J. Allen, M.D.
West Virginia University

Fat emboli syndrome (FES) is a rare complication of long bone fractures.¹ The syndrome is poorly understood and a diagnosis of exclusion based on a collection of respiratory, hematological, neurological, and cutaneous symptoms.² A 19 years old Caucasian male involved in a motor vehicle collision presented with a splenic laceration and left open femur and tibial fractures. Initial imaging of the head was negative for intracranial abnormalities, and the patient had a Glasgow Coma Scale score of 15. The patient underwent emergent splenic embolization and intramedullary nailing of his left tibia and femur. Post-operatively he was unarousable and unable to be extubated. Initial metabolic work-up was negative, and repeat computed tomography of the brain was negative. He was placed on continuous electroencephalogram, which showed diffuse encephalopathy. He then underwent magnetic resonance imaging that was concerning for fat emboli syndrome. He subsequently developed pulmonary and cutaneous symptoms. He also developed seizures and neurogenic fevers which were both diagnosed and treated promptly. His neurologic and respiratory status improved slowly over several weeks with supportive treatment. He was ultimately discharged and eventually returned to work. There are many causes of an obtunded patient post-operatively the ICU. A high index of suspicion is needed for prompt diagnosis and treatment of FES. FES patients presenting with diffuse encephalopathy are at high risk of developing pulmonary disease and fever.³ MRI-T2-weighted imaging is the most sensitive technique for diagnosing cerebral fat emboli and correlates well with clinical severity of brain injury.⁴



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The Effect of Postoperative Blood Transfusions on Muscle Tissue Oxygenation After Total Knee Arthroplasty

Thomas Danninger, M.D.¹; Ottokar Stundner, M.D.²; Daniel Yoo¹; Isabelle Kao¹; Matthias Walz, M.D.³; Stavros G. Memtsoudis, M.D., Ph.D.¹

Department of Anesthesiology, Hospital for Special Surgery, New York, NY¹; Department of Anesthesiology, Perioperative Medicine and Critical Care Medicine, Paracelsus Medical University, Salzburg, Austria²; Department of Anesthesiology, UMass Memorial Medical Center, Worcester, Massachusetts³

Introduction: Each year, approximately 13 million units of red blood cells are transfused. Despite this large number of transfusions, it remains unclear what effect transfusions have on tissue perfusion in the perioperative setting. This is important as this parameter is the ultimate goal of a blood transfusion. The aim of our study was to determine the change in muscle tissue oxygenation in response to postoperative blood transfusion.

Material and Methods: Patients aged between 18 and 99 years undergoing total knee arthroplasty were enrolled. Data on demographics (age, gender, ethnicity, comorbidities) were recorded. Muscle oxygenation (SmO₂) was measured by continuous sampling of near-infrared spectroscopy spectra at the deltoid muscle using CareGuide™ NIRS devices (Reflectance Medical, Westborough, MA). Continuous hemoglobin (SpHb) was measured using non-invasive Rainbow® ReSposable™ Pulse CO-Oximeter™ Sensor System (Masimo®; Irvine, CA). Stroke volume (SV) and cardiac index (CI) were measured continuously using a non-invasive bioreactance monitor (NICOM™; Cheetah Medical, Vancouver, WA). In addition, standard hemodynamic parameters including heart rate (HR), invasive mean arterial blood pressure (MAP) and arterial oxygen saturation (SO₂) were obtained. A passive leg raise test was performed before the transfusions were started. SmO₂ and hemodynamic parameters were recorded at different time points: 1) leg raise start time (LR start) 2) leg raise end time (LR end) 3) transfusion start time (trans start, immediately after leg raise end) and 4) transfusion end time (trans end), respectively. The leg raise test was considered positive when change in CI was >10%.

Results: We enrolled 28 patients for analysis. The mean response to leg raise test was non-significant (CI 2.61 vs. 2.71 l/min/m², (SD +/-0.64 and +/-0.72, respectively), p=0.64) as was the change in SmO₂ (SmO₂ 63.82 vs. 64.33%, (SD +/-10.93 and +/-10.73, respectively) p=0.83). The mean CI and SmO₂ were 2.60 l/min/m², SD (+/-0.76) and 63.93%, (SD +/-9.40), respectively at the beginning vs. 2.90 l/min/m² (SD +/-1.00), p=0.258 and 66.64%, (SD +/-8.07), p=0.15, respectively at the end of transfusion. SmO₂ remained elevated five minutes after transfusion. Mean SpHb was 7.95 g/L vs 9.05 g/L, (SD +/-3.48 and +/-3.43, respectively), p=0.0371 at the beginning and end of transfusion.

Discussion: In this study we showed a trend toward increased muscle tissue oxygenation in response to blood transfusion after a blood transfusion. If this finding is related to an increase in oxygen carrying capacity and/or the expansion of intravascular volume remains unclear, however, in the absence of a positive passive leg raise test, the latter contributor may be less likely a factor.

Diastolic Dysfunction and OPCAB Surgery

John Denny, M.D.; Andrew Burr, D.O.; Enrique Pantin, M.D.; Denny Angela, BSN;
Sharon Morgan, MSN, CRNA; Darrick Chyu, M.D.
Rutgers/Robert Wood Johnson Medical School

Introduction: Diastolic dysfunction is a well-described component of coronary artery disease, and is common among cardiac surgery patients. Diastolic dysfunction is reported to occur in 33-66% of patients with congestive heart failure. A change in left ventricular relaxation is common in left ventricular hypertrophy as well as in coronary artery disease, and results in a decrease in the velocity and volume of early diastolic filling as well as an increase in the velocity and volume of later diastolic filling linked with atrial contraction. One portion of diastolic function is mitral inflow velocities measured with Doppler trans esophageal echocardiography (TEE). The E wave or early phase velocity represents flow during the rapid filling phase while the A wave represents trans-mitral flow due to atrial contraction. Off pump coronary artery bypass grafting (OPCAB) remains an optional approach in certain patients requiring coronary artery bypass surgery. The purpose of this study was to delineate E and A waves before and after OPCAB surgery.

Methods: Twelve elective OPCAB patients of the same surgeon were studied following endotracheal intubation after induction with etomidate, fentanyl, and rocuronium. No patient was having active ischemia. Doppler TEE measurements were taken with the Acuson Sequoia C256 using pulse wave Doppler. The sample volume was positioned at the mitral leaflet tips. E and A wave velocities were measured in meters/second.

Results:

Pre OPCAB, mean Post OPCAB, mean
Peak E velocity, m/sec 0.607 0.653
Peak A velocity, m/sec 0.690 0.612
E/A ratio 0.906 1.085

Discussion: Trends toward an increase in the E velocity were seen post OPCAB, but did not reach statistical significance. Likewise, the trend toward a decrease in the A velocity seen post OPCAB did not reach statistical significance. Many variables can affect trans-mitral flow velocities. Increased preload will increase E velocity, while systolic dysfunction or increased afterload will decrease E velocity. This study did not reveal a clear impact of OPCAB surgical technique on mitral inflow velocities. Further study is needed to elucidate the impact of OPCAB on mitral inflow and diastolic function.

POSTER 31

A New Discovery That May Not Be So New: Anti-N-Methyl-D-Aspartate Receptor Encephalitis

Jessica L. Hobbs, M.D.; Christopher M. Franklin, M.D.
University of Maryland Medical Center

Anti-N-methyl-D-aspartate receptor (NM.D.AR) encephalitis is a neurological disorder associated with antibodies against the NM.D.A receptor. Patients suffering from NM.D.AR encephalitis present with psychosis, memory deficits, seizures, and language degeneration. It can progress to a catatonic state associated with abnormal movements, and autonomic and breathing instability. It is often associated with a tumor and, if a tumor is present, patients respond faster to immunotherapy after resection than do patients without a tumor. We describe a 33 yo female with HIV infection who presented with seizure activity that progressed to encephalopathy requiring intubation. The patient was subsequently found to have anti-NM.D.AR encephalitis.

Postoperative Dizziness and Arterial Tone in Patients Undergoing Total Hip Arthroplasty

Thomas Danninger, M.D.; Marcus DiLallo, B.A.; Sumudu S. Dehipawala, B.Sc.; Nigel E. Sharrock, M.D.; Stavros G. Memtsoudis, M.D., Ph.D.

Department of Anesthesiology, Hospital for Special Surgery, New York, New York

Introduction: Patients undergoing total joint arthroplasty frequently experience symptoms of orthostatic intolerance (OI), which represents a major obstacle to early ambulation and functional recovery and may even contribute to an increased fall risk. Recent data controlling for a number of covariates could not explain the very high incidence of OI occurring after total hip arthroplasty (THA). Consequently, other factors might exist that impact on the reactivity of the vascular system, including surgical metabolic injury. This study aims to assess perioperative changes in arterial tone and its relation to clinical signs of OI.

Material and Methods: 100 patients undergoing primary, unilateral THA under neuraxial anesthesia aged 18- 90 years were enrolled. Central blood pressure and arterial augmentation index (AI) were measured non-invasively using the non-invasive PulseCor® device at following time points: (1) holding area immediately preceding surgery (baseline), (2) upon admission to the post-anesthesia care unit (PACU), (3) after resolution of the neuraxial motor blockade as assessed by hip flexion/ extension and (4), approximately every 24 hours thereafter (POD 1, 2, 3, 4), until hospital discharge in supine and seated position. Mean arterial blood pressure (MAP) and mean AI were analyzed. Patients were assessed for symptoms of orthostatic intolerance using the Orthostatic Hypotension Symptom Assessment (OHSA) section of the Orthostatic Hypotension Questionnaire (OHQ) at each time point.

Results: A total of 98 patients were included into the primary analysis. Two patients were excluded (withdrew consent). Mean AI (SD) for the different time points showed a significant reduction from baseline (115.64% (± 42.57), 115.97% (± 53.40), 76.11% (± 36.05), 47.80% (± 28.33), 54.59% (± 27.22), 66.62% (± 34.22) and 67.77% (± 26.55)). No difference in AI was found between values measured at baseline and in the recovery room while the neuraxial anesthetic was in effect ($P=0.9135$). However, the drop in AI became highly significant thereafter and lasted through POD4 ($P<0.0001$) with the nadir on POD 1. MAP measurements showed a significant decline from baseline to PACU admission (average decrease MAP 9.79 mmHG ± 0.71) and a more modest decline thereafter (Fig 1). Concomitantly, a significant difference in mean values for dizziness obtained from the OHSA compared to baseline was seen with a peak on POD 1 (Fig 1).

Discussion: In this study, we were able to show a significant change in AI after THA. The drop in AI did not occur until resolution of the neuraxial anesthetic, suggesting that these effects are not mediated by the neuraxial anesthetic but possibly due to injury related metabolite influence. This was accompanied with a significant change in dizziness peaking on POD1 as measured by the OHSA. The study of total knee arthroplasty patients is ongoing and at this time analysis of our data continues to identify if the use of AI can be used as a predictor for signs of OI. This is important as it would potentially prevent patients from OI associated complications after surgery

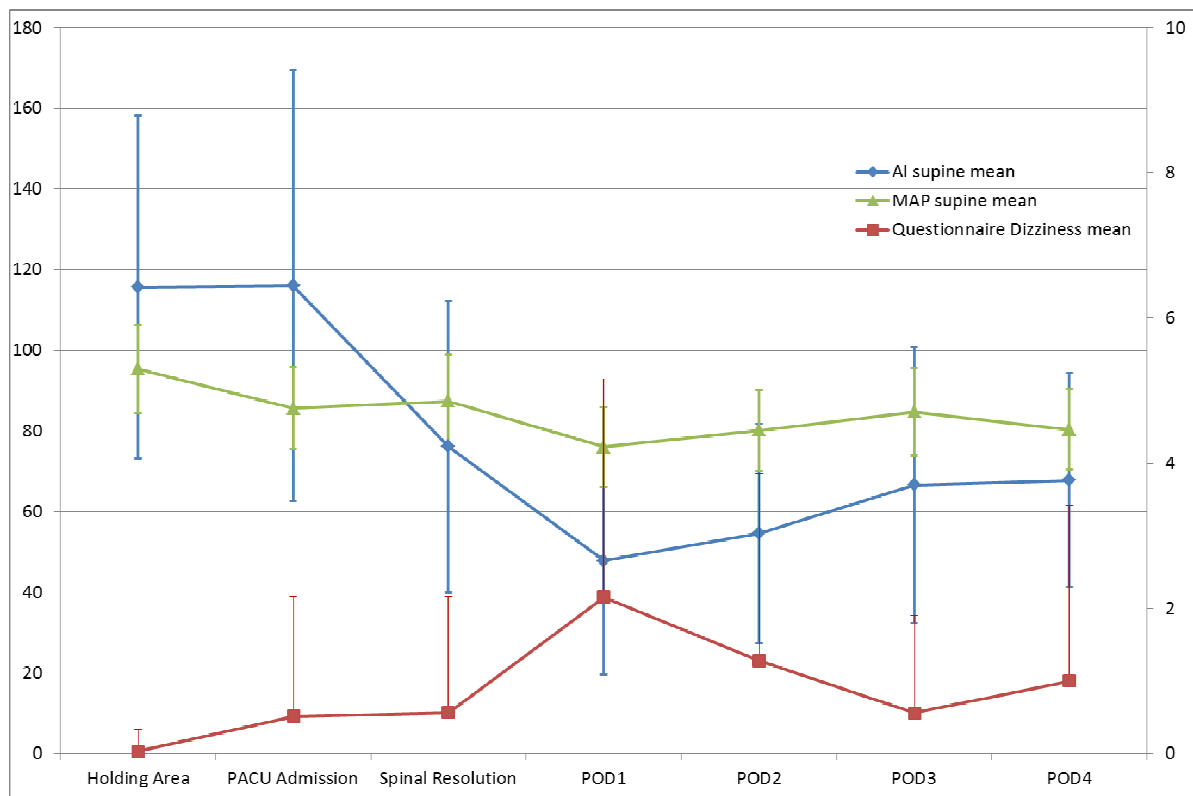


Figure 1: AI, MAP, and OHSA for Dizziness over Time

Demoralization Syndrome in Terminally Ill Patients and Family Members in ICU Settings

Shaizeel Praptani, M.D.; Ardeshir Jahanian, M.D.; Arash Motamed, M.D.; Peter Roffey, M.D.;
Duraiyah Thangathurai, M.D.

Keck School of Medicine of University of Southern California

Patients admitted to the ICU are high risk and often are terminally ill, especially in cancer ICU settings. These patients are prone to develop extreme demoralization and hopelessness. We report our experience of over 30 years in the ICU at our teaching institution.

The concept of demoralization syndrome was described by Jerome Frank as a state of inability to cope with intense feelings of helplessness, hopelessness, and meaninglessness, a sense of incompetence.

Demoralization syndrome in the palliative care setting was originally described by Kissane, et al.¹ Kissane and others distinguish it from the depression associated with medical disease, which is manifested by anhedonia, and associates demoralization syndrome with existential issues, such as loss of dignity and the fear of being a burden.^{2,3} We have noted that the patient's family members also go through this same process to varying degrees, experiencing despair and hopelessness, as well as a sense of loss of meaning and purpose in life.

Physicians, nurses, and other caretakers can significantly contribute to this demoralization syndrome if they do not have a clear understanding of the emotional process the patients and the family goes through. Most ICU nurses and physicians are oriented towards sophisticated technology and machines and the relational aspect of care is ignored. Also, these patients are often managed by multiple consults, and when many physicians are involved in the care it is difficult for the patient to form a strong relationship with any of them. In addition, the palliative care team often becomes involved late in the process, when there is not much time to develop a rapport. Once the palliative team is consulted, many primary physicians distance themselves from the patient and family. However, by this point the patient and family have a relationship with the primary physician and expect them to remain the central figure in the care process. In addition, often in teaching institutions residents remain on their rotations for relatively short periods of time, leading to a lack of continuity of care and weaker doctor-patient relationships. Many institutions have turned to midlevel providers, such as physician assistants, nurse practitioners, and respiratory therapists to provide patient care for economic reasons, which diminishes the quality care by not having a physician with a leadership role.

The ICU team at our institution has expertise in pain management, psychology and ethics. We perform daily rounds and have joined conferences with the nurses and family members addressing their needs, feelings. We have discussions with psychiatrists and involve them in the treatment of depression and anxiety. We also minimize ventilator days which is a major source of anxiety. We feel these are very important steps in order to avoid demoralization syndrome in the ICU.

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Psychophysical Numbness in the ICU

Shaizeel Praptani, M.D.; Janak Chandrasoma, M.D.; Peter Roffey, M.D.; Duraiyah Thangathurai, M.D.
Keck School of Medicine of University of Southern California

Historically, physicians emphasized sensitivity and the value of human life as key components in care. We feel recent trends in medicine may result in “psychophysical numbing,” leading to decreasing the value of human life. These include expanding technology, physician super-specialization, hospital centralization, and protocol-driven care administered to large numbers of patients.

Fetherstonhaugh coined the term psychophysical numbing, stating “people exhibit diminished sensitivity in valuing lifesaving interventions against a background of increasing numbers of lives at risk.”¹ This is applicable to ICUs, where physicians handle a large number of seriously ill patients with life-threatening situations. Previously, Lifton defined “psychic numbness” as “a form of de-sensitization” an incapacity to feel or to confront certain kinds of experience, due to the blocking or absence of inner forms or imagery that can connect with such experience”.² This results from desensitization of neurons in the frontal and parietal cortex related to sympathy and compassion.³ Stanovich described two integrated modes of thinking; one based on intuition and emotion, the other analytical and rational.⁴ The former incorporates compassion, fiduciary relationships, and empathy; however, when facing an issue with a large number of victims, the latter predominates.

Due to great economic pressure, many smaller hospitals are closing, with high-risk patients being admitted to large, centralized hospitals treating a great number of patients. This leads to ICUs with many beds and can have a negative effect on the quality of care given by physicians dealing with life-threatening situations. Historically, hospitals had a maximum of eight to ten ICU beds, with one team responsible for the total care of the patient. Recently hospitals have begun integrating multiple ICUs, with large numbers of patients being managed by multiple teams. This results in disorganized and fragmented care. Because of the large number of patients, physicians may become less sensitive to the needs of individual patients and spend less time with the patient and family.

With super-specialization many consults can be called to treat specific organ issues and often look only at their area of expertise. Protocolized care could potentially lead to mediocrity in care due to a decreased level of physician involvement.

The end result is that patients and their family members often feel abandonment and demoralization. It is important not to ignore the idea of individualized, holistic care, which includes psychological, emotional, social, and spiritual aspects. For optimal care, one needs to balance protocolized care with individualized care based on experience, intuition, compassion, and empathy.

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Characterizing the Epidemiology of Transfusion-Related Acute Lung Injury in Surgical Patients

Leanne Clifford, BM; Qing Jia, M.D.; Hemang Yadav, M.B.B.S.; Subramanian Arun, M.B.B.S.; Darrell R. Schroeder, M.S.; Daryl J. Kor, M.D.
Mayo Clinic, Rochester, Minnesota

Introduction: Transfusion-related acute lung injury (TRALI) is the leading cause of transfusion-related fatalities in the United States. While the burden of this disease has been described in critical care populations, it has been poorly characterized in surgical patients transfused intraoperatively. In order to better inform surgical transfusion practice, and as a first step towards effectively mitigating postoperative TRALI, we must work to better define its incidence and epidemiology. In this study, we present the incidence and patient characteristics of postoperative TRALI/possible TRALI following intraoperative blood product transfusion.

Methods: In this retrospective cohort study, we evaluated all non-cardiac surgical patients aged ≥ 18 years transfused intraoperatively during the calendar years 2004 ($n=1818$) and 2011 ($n=1562$) for the development of TRALI/possible TRALI. Baseline characteristics and data pertaining to the surgical procedure, blood product transfusion, vital signs, laboratory and radiology results was extracted from the electronic medical record. We excluded patients with evidence of preoperative respiratory failure or bilateral infiltrates on chest radiograph as well as those who died intraoperatively or required extra corporeal membrane oxygenation postoperatively. We screened patients' medical records using a previously developed, highly sensitive electronic algorithm for the detection of TRALI/possible TRALI (sensitivity = 92.5% specificity = 93.6%). Thereafter, all screen positive patients' medical records underwent manual review, and two independent physicians' allocated diagnoses. Where disagreement existed, a panel of three senior critical care physicians adjudicated the final outcome.

Results: The overall incidence of TRALI/possible TRALI between 2004 and 2011 was 1.3%. Specifically, the incidence was 1.2% in 2004 compared to 1.4% in 2011 ($p=0.613$). The incidence was comparable in males versus females in both years (1.4% vs. 1.2%, $p=0.764$). Overall, thoracic (3.0%), vascular (2.7%) and transplant surgeries (2.2%) carried the highest rates of TRALI/possible TRALI. Obstetric and gynecological surgical patients had no TRALI episodes during either study year. The rate of TRALI/possible TRALI increased with increasing age ($p=0.041$) and volume transfused ($p < 0.001$ - Table 1).

Conclusions: The incidence of TRALI/possible TRALI in surgical patients was found to be 1.3%. There was no significant change in rates between 2004 and 2011 despite the introduction of various mitigation strategies. This may be the result of our combined outcome of TRALI/possible TRALI with the latter being less responsive to efforts aimed at limiting the transfusion of high-plasma containing products procured from donors at risk of alloimmunization. Future efforts to identify specific risk factors for TRALI/possible TRALI in surgical populations may help to reduce the burden of this life-threatening transfusion-related pulmonary complication.

Table 1 – TRALI Incidence Rates

	<u>2004</u>		<u>2011</u>		<u>Overall</u>		<u>P-values</u>
	N	no. (%)	N	no. (%)	N	no. (%)	
Overall	1818	22 (1.2)	1562	22 (1.4)	3380	44 (1.3)	0.613
<u>Age (years)</u>							0.041
< 49	318	3 (0.9)	277	3 (1.1)	595	6 (1.0)	
50 – 59	296	1 (0.3)	288	3 (1.0)	584	4 (0.7)	
60 – 69	415	4 (1.0)	421	6 (1.4)	836	10 (1.2)	
70 – 79	486	8 (1.6)	370	5 (1.4)	856	13 (1.5)	
≥ 80	303	6 (2.0)	206	5 (2.4)	509	11 (2.2)	
<u>Gender</u>							0.764
Male	858	11 (1.1)	756	11 (1.4)	1614	22 (1.4)	
Female	960	11 (1.3)	806	11 (1.5)	1766	22 (1.2)	
<u>Surgical Specialty</u>							0.066
Abdominal	481	4 (0.8)	463	6 (1.3)	944	10 (1.1)	
OB/GYN	157	0 (0.0)	136	0 (0.0)	293	0 (0.0)	
Neurological	45	1 (2.2)	54	1 (1.9)	99	2 (2.0)	
Orthopedic	401	4 (1.0)	272	3 (1.1)	673	7 (1.0)	
Spine	114	1 (0.9)	135	1 (0.7)	249	2 (0.8)	
Thoracic	59	2 (3.4)	74	2 (2.7)	133	4 (3.0)	
Transplant	81	0 (0.0)	97	4 (4.1)	178	4 (2.2)	
Urology	154	1 (0.6)	125	1 (0.8)	279	2 (0.7)	
Vascular	249	7 (2.8)	127	3 (2.4)	376	10 (2.7)	
Other	77	2 (2.6)	79	1 (1.3)	156	3 (1.9)	
<u>Intraoperative Transfusion Volume (ml)</u>							<0.001
<350	606	2 (0.3)	512	4 (0.8)	1118	6 (0.5)	
351 – 700	635	2 (0.3)	485	5 (1.0)	1120	7 (0.6)	
701 – 1050	201	3 (1.5)	187	2 (1.1)	388	5 (1.3)	
1051 – 1400	130	2 (1.5)	101	2 (2.0)	231	4 (1.7)	
≥ 1401	246	13 (5.3)	277	9 (3.2)	523	22 (4.2)	

Characterizing the Epidemiology of Transfusion Associated Circulatory Overload in Surgical Transfused Patients

Leanne Clifford, BM; Qing Jia, M.D.; Hemang Yadav, M.B.B.S.; Arun Subramanian, M.B.B.S.; Darrell R. Schroeder, M.S.; Daryl J. Kor, M.D.
Mayo Clinic – Rochester, Minnesota

Introduction: Transfusion-associated circulatory overload (TACO) is a leading cause of transfusion related fatalities in the United States. While the burden of this disease has been described in critical care populations, it has been poorly characterized in surgical patients transfused intraoperatively. In order to better inform surgical transfusion practice, and as a first step towards effectively mitigating postoperative TACO, we must work to better define its incidence and epidemiology. In this study, we present the incidence and patient characteristics of postoperative TACO following intraoperative blood product transfusion.

Methods: In this retrospective cohort study, we evaluated all non-cardiac surgical patients aged ≥ 18 years transfused intraoperatively during the calendar years 2004 ($n=2163$) and 2011 ($n=1908$) for the development of TACO. We extracted baseline characteristics and data pertaining to the surgical procedure, blood product transfusion, vital signs, laboratory and radiology results from the electronic medical record. We excluded patients with evidence of preoperative respiratory failure or bilateral infiltrates on chest radiograph, as well as patients who died intraoperatively or required extra corporeal membrane oxygenation postoperatively. First, we screened patients' medical records using a previously developed, highly sensitive electronic algorithm for the detection of TACO (sensitivity = 100%, specificity = 94%). Thereafter all screen positive patients' medical records underwent manual review, and two independent physicians allocated diagnoses. Where disagreement existed, a panel of three senior critical care physicians adjudicated the final outcome.

Results: The cumulative incidence of TACO between 2004 and 2011 was 4.2%. Specifically, we observed a rate of 5.2% in 2004, which decreased to 3.0% in 2011 ($p < 0.001$). The incidence was higher in males versus females in both years (5.7% vs. 4.8% in 2004 and 3.7% vs. 2.2% in 2011, $p = 0.063$). The rates of TACO differed by surgical specialty ($p < 0.001$), with vascular (12.6% and 9.9%), thoracic (9.7% and 5.3%) and transplant (8.0% and 8.6%) consistently experiencing the highest rates in 2004 and 2011 respectively. Overall, obstetric and gynecological patients had the lowest rates of TACO (1.4%). The rate of TACO increased with the volume of blood products transfused ($p < 0.001$) and advancing age ($p < 0.001$). We also observed a steady increase in the rate of TACO with total intraoperative fluid balance ($p < 0.001$), with a sharp increase beyond approximately 7 litres (Table 1).

Conclusions: Incidence rates of TACO in surgical patients are in keeping with previous estimates in non-surgical populations. Our data show a reduction in the rate of TACO between 2004 and 2011; however patterns of incidence are comparable in subgroup analyses even after adjusting for variation in each individual characteristic. Future efforts exploring potential TACO risk factors may help to explain this trend. Furthermore, the identification of pertinent modifiable risk factors specific to surgical populations may help to further mitigate this important transfusion complication.

Table 1 – TACO Incidence Rates

	<u>2004</u>		<u>2011</u>		<u>Overall</u>		<u>P-values</u>	
	N	no. (%)	N	no. (%)	N	no (%)	Characteristic	Year
Overall	2163	113 (5.2)	1908	57 (3.0)	4091	170 (4.2)	N/A	<0.001
<u>Age (years)</u>							<0.001	<0.001
< 49	414	9 (2.2)	365	6 (1.6)	779	15 (1.9)		
50 – 59	345	13 (3.8)	354	10 (2.8)	699	23 (3.3)		
60 – 69	501	21 (4.2)	505	20 (4.0)	1006	41 (4.1)		
70 – 79	572	35 (6.1)	447	14 (3.1)	1019	49 (4.8)		
≥ 80	331	35 (10.6)	237	7 (3.1)	568	42 (7.4)		
<u>Gender</u>							0.063	<0.001
Male	1058	60 (5.7)	966	36 (3.7)	2024	96 (4.7)		
Female	1105	53 (4.8)	942	21 (2.2)	2047	74 (3.6)		
<u>Surgical Specialty</u>							<0.001	0.002
Abdominal	513	25 (4.9)	480	15 (3.1)	993	40 (4.0)		
OB/GYN	157	4 (2.6)	138	1 (0.0)	295	4 (1.4)		
Neurological	45	3 (6.7)	56	1 (1.8)	101	4 (4.0)		
Orthopedic	540	17 (3.2)	465	4 (0.9)	1005	21 (2.1)		
Spine	205	5 (2.4)	199	1 (2.3)	404	6 (1.5)		
Thoracic	62	6 (9.7)	76	4 (5.3)	138	10 (7.2)		
Transplant	88	7 (8.0)	105	9 (8.6)	193	16 (8.3)		
Urology	157	4 (2.6)	128	3 (2.3)	285	7 (2.5)		
Vascular	317	40 (12.6)	181	18 (9.9)	498	58 (11.6)		
Other	79	2 (2.5)	80	2 (2.5)	159	4 (2.5)		
<u>Intraoperative Transfusion Volume (ml)</u>							<0.001	<0.001
<350	682	16 (2.4)	671	6 (0.9)	1353	22 (1.6)		
351 – 700	719	28 (3.9)	560	12 (2.1)	1279	40 (3.1)		
701 – 1050	263	15 (5.7)	225	3 (1.3)	488	18 (3.7)		
1051 – 1400	172	13 (7.6)	117	4 (3.4)	289	17 (5.9)		
≥ 1401	327	41 (12.5)	335	32 (9.6)	662	73 (11.0)		
<u>Intraoperative Fluid Balance (ml)</u>							<0.001	0.005
≤ 2000	187	7 (3.7)	415	5 (1.2)	602	12 (2.0)		
2001 – 4000	682	20 (2.9)	643	9 (1.4)	1325	29 (2.2)		
4001 – 6000	656	31 (4.7)	409	12 (2.9)	1065	43 (4.0)		
6001 – 8000	340	19 (5.6)	218	8 (3.7)	558	27 (4.8)		
≥ 8001	298	36 (12.1)	223	23 (10.3)	521	59 (11.3)		

Case Report of Excess Blood Loss Due to Combined SSRI and SARI Therapy

Kate E. Bennett, M.D., FRCPC, B.Sc.¹; Sean N. Neill, M.B.Ch.B., FRCA²
Wayne State University¹; University of Michigan²

Case Report: The use of selective serotonin reuptake inhibitors (SSRIs) is becoming increasingly commonplace in North America, even in the pediatric populations.¹ Those patients on SSRIs are also more likely to be on other antidepressant medications.² In anesthesiology practice, we should be able to anticipate and treat the side effects associated with the use of these medications, in isolation and when used in conjunction with our perioperative medications. While impossible to keep up to date with all of the considerations, ones that have the potential for impacting patient care are imperative to know.

Of the SSRI's fluoxetine is one of the more commonly prescribed and is the only SSRI approved by the United States Food and Drug Administration (US FDA) for depression in children and adolescents between the ages of 8 and 17 years of age. This medication is often combined with other classes of anti-depressants and sleep aids including other SSRI's, Serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCA's) and serotonin antagonist and reuptake inhibitors (SARIs) such as trazodone.³ Of these trazodone might be the most commonly prescribed dual prescription due to its additional anti-depressant activity, but perhaps its sedative properties that may assist in managing the insomnia often associated with clinical depression.⁴ A recent multicenter retrospective analysis of over five hundred thousand surgical patients showed an increased bleeding risk in surgical patients on these medications²; however, this risk is not widely known in the anesthesia community. Due their frequency of prescription and the concerns with side effects and possible effect on perioperative management a case report of significantly increased intra and perioperative bleeding is presented.

Case: A 14-year-old 57kg male was scheduled for an elective split sagittal osteotomy for maxillary prognathism. Medical history was unremarkable except for a significant depression history and anxiety disorder for which he was maintained on fluoxetine and trazodone therapy. In concert with the attending Oral Surgeon, the plan for the case was made to target a therapeutic hypotensive systolic blood pressure (SBP) of 20% below his baseline of 100mmHg and to incorporate multimodal prophylactic non-opioid analgesia and anti-emetics in this planned outpatient. Due to his severe anxiety disorder his mother was given permission to be in attendance during placement of a pre-induction intravenous catheter and IV induction. Placement of a nasal endotracheal tube was uncomplicated and anesthesia was maintained using desflurane and remifentanyl, which were titrated to the desired mean arterial pressure (MAP). Early in the case ondansetron (4mg) and ketorolac (30mg) were given in addition to the preoperative metoclopramide (10mg) and dexamethasone (8mg) and cefazolin (1g) prescribed by the surgeon. As the case progressed the surgeon repeatedly inquired about the patients' blood pressure, as the blood loss was higher than anticipated for the case. Due to "general oozeiness" of the patient and increased length of time to obtain adequate hemostasis in the OR the surgical duration was almost double the normal length for this procedure (60 vs. 30 minutes of operating time). At the conclusion of the case the estimated blood loss was ~400cc far in excess of the

~150cc usually seen in this procedure. Extubation was uncomplicated and the patient was taken in awake and stable condition to the PACU. The patient continued to have increased oozing in the recovery room, though remained stable for discharge home with his mother. The mother was advised at this time to avoid any platelet inhibiting medications and NSAIDs by the anesthesiologist and surgeon as a precaution, though NSAIDs are normally a component of the routine post-discharge pain management plan in patients undergoing this procedure.

Discussion: Split sagittal osteotomy is an elective, outpatient procedure typically performed for maxillary and mandibular mal-alignment. While some bleeding is typically expected especially when it involves the 'hyper vascular' maxillary region/nasal tissue or posterior maxillary musculature, surgery confined to the much less vascular mandibular field blood loss in excess of 150cc is uncommon, as one would only expect minimal bleed from the cancellous bone, typically in teenage males, since the entire surgery is within the periosteal envelope (with the exception of the access incision which is cautery controlled). We present a case of perioperative blood loss from an unexpected cause.

While different 'approaches' to the administration of general anesthesia, pure volatile vs. total intravenous anesthesia vs. a mixed approach can impact the patient's blood pressure and systemic vascular resistance and thus too the "ooze" during surgery, despite a tightly regulated low systolic and mean BP the patient presented had an unexpectedly increased amount of blood loss. While there is much awareness in our field of the risk for increased bleeding if the patient is on anti-platelet agents such as ASA, NSAIDs, or glucocorticoids, the anesthetic and perioperative literature until the latest on-line publication of a retrospective analysis of surgical patients who were on SSRI's preoperatively² there is little awareness of the hemostatic effects of this class of medication. Previous studies have questioned the occurrence of increased bleeding when these medications are combined with known anti-platelet or anti-thrombotic agents⁵⁻⁷ and there are some evidence in the orthopedic literature that SSRIs are associated with increased need for transfusions⁸ and increased blood loss.⁹

Fluoxetine is member of the selective serotonin reuptake inhibitors (SSRI) class of medications, and it was the first one synthesized. In 1987 it was the first SSRI approved by the United States Food and Drug Administration for treatment of major depression. It is often used as a first line therapy for depression given its safety and efficacy. Patients on SSRI's will often have a high incidence of the co-administration of other anti-depressant medications including an SARI such as trazodone.³ Trazodone is both a 5-HT_{2a} antagonist and a serotonin reuptake inhibitor. If the presumptive method of platelet inhibition with the SSRI class of medications is the depletion of serotonin from platelets resulting from inhibition of serotonin reuptake patients on a combination of these medications will presumptively increase their perioperative bleeding risk although no randomized clinical trials to date have investigated this to date.

Most practitioners are aware of the more common side effects of SSRIs. These include headache, somnolence or insomnia, decreased libido, nausea, anorexia, diarrhea, and xerostomia. With the possible exception of xerostomia none of these are cause for concern in the perioperative setting and would not affect the management of a patient on this therapy. However, while much more rare the increased risk of bleeding is a cause for concern and might impact the choice of anesthetic and analgesic medications. In fact, there are suggestions in the literature that SSRIs should be discontinued as SSRIs may increase the need for transfusion with surgery, perhaps because of their effects on platelet aggregation.¹⁰ Serotonin (5-hydroxytryptamine, 5-HT) and is thought to be a "helper agonist" in potentiating platelet responses to ADP and thrombin thereby increasing their aggregation.¹¹ This effect is mediated by 5-HT_{2A} receptors specifically. Studies have shown that SSRI's decreases the intraplatelet serotonin concentrations considerably¹², reducing platelet plug formation.

The question then becomes whether or not the SSRI or trazodone should be stopped before elective surgery. The recent on-line publication of the largest retrospective review of mortality and morbidity in adult surgical patients showed that even those on these medications had a overall low mortality² while discontinuation can often be associated with a significant discontinuation syndrome. Discontinuation syndrome is often seen with abrupt SSRI withdrawal and can include flu-like symptoms, insomnia, nausea, imbalance, sensory disturbances, and hyperarousal.¹³ These symptoms generally improve gradually over the course of two to three weeks. However, even if patients were seen in the preoperative clinic prior to surgery rarely would they been seen early enough to ensure safe cessation. Tapering, the preferred method of SSRI cessation¹³ would be nearly impossible to do safely and in a timely fashion for even an elective surgical procedure.

If a patient is on SSRI and especially if they are also taking a second agent such as trazodone, which is often the case and up to 8.4% of adult surgical patients will be on both² surgery and anesthesiology teams might consider avoiding or stopping other drugs with adverse effects on hemostasis, especially in surgeries that are higher risk for bleeding. These drugs include aspirin, platelet P2Y₁₂ receptor blockers (e.g. clopidogrel), non-steroidal anti-inflammatory agents (NSAIDs), and while mandibular surgery is not typically associated with an increased bleeding risk, there was a considerable blood loss in this patient. This was most likely multifactorial, (NSAID use, prophylactic glucocorticoid administration) the concomitant use of both fluoxetine (a common SSRI) and trazodone were also probable contributors. In surgeries more commonly associated with higher bleeding risk; coronary bypass surgery, tonsillectomy, prostate surgery, and gynecologic oncology surgery, the awareness of the potential impact of SSRI's, especially when used in conjunction with trazodone on bleeding is paramount. The anesthetic plan could be modified to minimize anti-platelet agents if possible and discussion with surgical colleagues on the importance of rigorous hemostasis and technique. These medications are common in the both the adult and pediatric North American population and will become increasingly so over the next years if the prescribing practices seen today continue. Anesthesiologists and perioperative care physicians need to be aware and familiar with the important, albeit rare, side effects of these medications.

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POSTER 40

ICU Partial Detoxification Using Multimodal Therapy in Drug Dependent Patients

Arash Motamed, M.D., MBA; Janak Chandrasoma, M.D.; Shaizeel Praptani, M.D.; Peter Roffey, M.D.; Mariana Mogos, M.D.; Duraiyah Thangathurai, M.D.
University of Southern California

It is not uncommon for patients to present to the intensive care unit postoperatively with a history of drug dependence, especially to the chronic use of narcotics and benzodiazepines. These patients pose a challenge to the intensivist with regard to adequate pain relief and sedation. This may lead to the use of extremely high doses of opioids, resulting in prolonged intubations and ileus.

Reviewing our IRB database over the last three years, in fifteen patients with opioid and/or benzodiazepine dependence, we have utilized a multimodal approach to pain control to help manage these issues. In addition to the use of an epidural analgesia when appropriate, the combination of medications include an infusion of ketamine that acts as an alternate means of pain control via NM.D.A receptor blockade while decreasing opioid-induced hyperalgesia and tolerance. Moreover, the patients receive an infusion of dexmedetomidine for 24 hours followed by a clonidine patch as well as bolus doses of butyrophenones (droperidol and haloperidol) and atypical antipsychotics such as olanzapine. Gabapentin and antidepressants such as desipramine are also utilized as appropriate. In opioid dependent patients, low-dose fentanyl is added to the ketamine infusion and in certain patients methadone, a long acting narcotic also with NDMA receptor antagonism properties is utilized, as well.

This combination of medications can also be helpful in partial detoxification of the patients. We have found that it decreases the requirements of opioids and benzodiazepines postoperatively, which decreases the incidence of prolonged intubation and ileus and helps to decrease the length of ICU stay.

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Surgical Home Facilitates Early Extubation and Minimizes Ventilator-Associated Complications

Janak Chandrasoma, M.D.; Andre Atoian, M.D.; Peter Roffey, M.D.; Mariana Mogos, M.D.;
Duraiyah Thangathurai, M.D.

Keck Medical Center, University of Southern California

The concept of the “surgical home” is becoming a useful model in patient care, in which the same anesthesia team is highly involved in the preoperative assessment, intraoperative management, and postoperative management of the patient. We have utilized this model for over a decade, especially for the management of high-risk urology patients such as those with various comorbidities undergoing cystectomies, pelvic exenterations, and complex nephrectomies. The team has expertise in anesthesia as well as ICU, and is comprised of residents and faculty.

Our retrospective study appears to indicate that the concept of the surgical home improves patient care by facilitating early extubation and decreasing ventilator-associated complications and ICU stay. This leads to greater overall patient satisfaction and indicates a cost savings for the hospital.

We performed a retrospective study utilizing our IRB-approved database examining the impact of the surgical home on time to extubation. We noted a significantly greater proportion of patients were extubated in the OR in those patients managed in the surgical home model compared to those who were not (37% vs 25%). The difference continued with a shorter time to extubation (0.97 +/- 3.82 vs 1.64 +/- 5.75 days). Early extubation also facilitated a shorter stay in the ICU (2.72 +/- 4.67 vs 4.85 +/- 11.53 days) and minimized respiratory and hemodynamic complications associated with mechanical ventilation as well as sedative requirements. Despite this aggressive extubation strategy, the surgical home patients had a lower rate of re-intubation (1.44 vs 2.22%). This led to higher satisfaction of the patients. This has subsequently enabled a greater number of surgical home patients to be managed in a lower level of care who would have previously required admission to the ICU.

	Post-Operative Events									
	ARF	Readmission†	Reintubation	ICU Stay†	s.d.	Hospital Stay*	s.d.	Ventilation Days†	s.d.	
Traditional	69.72%	15.43%	2.22%	4.85	11.53	10.14	22.57	1.64	5.75	
Surgical Home	65.16%	1.62%	1.44%	2.72	4.67	6.87	16.99	0.97	3.82	

* p<0.01, p<0.001

Diagnosing Heparin Induced Thrombocytopenia Post Cardiac Surgery

Rizwan A. Manji, M.D., Ph.D., FRCSC, MBA; Alex Villafranca, M.Sc.; Hilary Grocott, M.D., FRCPC;
Alan H. Menkis, DDS, M.D., FRCSC; Eric Jacobsohn, M.B.Ch.B., MHPE, FRCPC
I.H. Asper Clinical Research Institute - St. Boniface Hospital

Thrombocytopenia (TcP) is common post cardiac surgery (CS) and may be due to heparin induced thrombocytopenia (HIT). HIT has a high rate of thrombosis necessitating anticoagulation with a non-heparin anticoagulant. Inappropriate anticoagulation for HIT can lead to bleeding/tamponade. Incorrect diagnosis of HIT can lead to morbidity, mortality, and litigation. HIT ELISAs report a positive (pos) or negative (neg) value or an optical density (OD) value. The gold standard to diagnose HIT is a serotonin release assay (SRA) which is done in limited centers. Scoring systems to help diagnose HIT include the 4T score (J Thromb Haemost 2006; 4: 759), with a score of ≥ 4 being an intermediate risk for HIT and the cardiopulmonary bypass (CPB) score (J Thromb Haemost 2004; 2: 1882), with a score of ≥ 2 being a high risk for HIT. We sought to determine the ability of the scoring systems and the ELISA to diagnose HIT in reference to the SRA in patients with tcP post-CS.

Methods: Patients (n=150) were scored using the two systems, and 132 of these with a "pos" HIT ELISA were categorized based on the ELISA OD reading and the SRA values.

Results: Table 1 shows that higher ELISA readings, generally predict higher SRA values; however, there are patients with high ELISA OD readings that did not have high SRA (test is very sensitive). Also, a "pos" ELISA (which all the patients had) does not equate to a high SRA (a high OD generally equates to high SRA). The two scoring systems (Tables 2a/b) were not accurate in predicting HIT but were better at predicting who did not have HIT (specific with high negative predictive value).

Conclusions: The ELISA is sensitive and the scoring systems are specific. ELISAs that provide OD values (rather than a dichotomous pos or neg) should be used. If the ELISA OD is high, then the SRA is likely to be high, justifying the risks of starting a non-reversible, possibly expensive, non-heparin anticoagulant on a patient at reasonable risk for bleeding/tamponade.

Table 1: ELISA Optical Density (OD) Versus Number With SRA \geq 50%

OD Reading	$\geq 50\%$ SRA (True HIT)	Mean SRA %
≥ 0.4000 to ≤ 1.000	2/74 = 2.70%	3.60%
> 1.000 to ≤ 1.500	2/17 = 11.76%	11.35%
> 1.500 to ≤ 2.000	7/14 = 50.00%	46.64%
> 2.000 to ≤ 2.500	2/8 = 25.00%	24.13%
> 2.500	15/19 = 78.95%	75.00%

Table 2a: 4T's Score Versus Number With SRA \geq 50%

4T score	SRA $\geq 50\%$ (True HIT)	SRA $< 50\%$
≥ 4 (intermediate risk)	15	14
< 4	14	107

Sensitivity = 51%

Specificity = 88%

Postive Predictive Value = 52%

Negative Predictive Value = 88%

Table 2b: CPB Score Versus Number With SRA \geq 50%

CPB Score	SRA $\geq 50\%$ (True HIT)	SRA $< 50\%$
≥ 2 (high risk)	20	14
< 2	9	105

Sensitivity = 69%

Specificity = 88%

Postive Predictive Value = 59%

Negative Predictive Value = 92%

What is the Most Cost Effective Method to Prevent Atrial Fibrillation in Patients at Medium to High Risk for Post Cardiac Surgery Atrial Fibrillation?

Rizwan A. Manji, M.D., Ph.D., FRCSC, MBA¹; Julia Witt, Ph.D.²; Alan H. Menkis, DDS, M.D., FRCSC¹
I.H. Asper Clinical Research Institute - St. Boniface Hospital¹; University of Manitoba²

Patients at medium to high risk for post operative atrial fibrillation (POAF) are elderly patients, with poor ventricular function having complex heart surgery on inotropes. POAF increases morbidity, mortality, length of stay and costs; thus prevention is desirable. Amiodarone, steroids, or colchicine have been shown to decrease risk of POAF. There is minimal data on which agent is most cost effective (least cost for best quality adjusted life year - QALY).

Objective: Evaluate the cost-effectiveness (C/E) of steroids (1000mg of hydrocortisone over 72 hrs), colchicine (1mg bid for 1 day and 0.5mg bid for 30 days), or amiodarone (400mg bid for 7 days) to reduce risk of POAF in patients at medium to high risk for POAF considering the adverse effects of POAF (CHF, stroke and anticoagulation related hemorrhage), and drug side effects: amiodarone (pulmonary toxicity, thyroid toxicity), steroids (infection/ GI bleeding), and colchicine (GI upset, myotoxicity, hepatotoxicity, bone marrow toxicity).

Methods: C/E analysis was done using costs and QALYs from the literature, local data (eg. pharmacy), and extrapolation. Sensitivity analysis was undertaken to test robustness of the model.

Results: Colchicine was most C/E at \$6009.45/QALY, followed by steroids at \$7260.82/QALY, no prophylaxis at \$7351.25/QALY and finally amiodarone at \$12,099/QALY. The drivers of cost were the cost of drugs and treatment for side effects of drugs (amiodarone being worst in both out of the three). A sensitivity analysis varying the risk of POAF between 30% and 100% and varying the absolute risk reduction in POAF of the drugs from 10% to 30% still showed colchicine to be most C/E (eg. at 30% risk of POAF and 20% risk reduction in POAF of each drug, colchicine was \$1598.51/QALY vs. \$9188.15/QALY for amiodarone). The C/E of an agent also varied based on the baseline risk of POAF and the absolute risk reduction by using the agent (eg. at a 30% risk of POAF, if colchicine decreased risk by 10%, the cost was \$3065.96/QALY vs. if colchicine decreased risk by 25%, then cost was \$866.11/QALY). Amiodarone was most cost effective if risk of thyroid toxicity and risk of pulmonary toxicity were zero.

Conclusion: Colchicine is the most C/E agent to prevent POAF.