*Scientific Session*

# 47th Annual Resident and Fellow Trauma Paper Competition

*Presented during the*

**102nd ANNUAL MEETING**
of the American College of Surgeons
Committee on Trauma

Thursday, March 7, 2024
Chicago, IL

ACS Committee on Trauma
American College of Surgeons

*The content and opinions expressed in these papers and presentations are those of the individual participants and not necessarily those of the American College of Surgeons.*



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Chicago, IL 60611-3211

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*Scientific Session*

# 47th ANNUAL RESIDENT and FELLOW TRAUMA PAPER COMPETITION

## 102nd ANNUAL MEETING
of the American College of Surgeons
Committee on Trauma

MODERATORS:

Warren C. Dorlac, MD, FACS
*(Chair, Regional Committees on Trauma)*
Ashley Williams, MD, FACS
Matthew A. Bank, MD, FACS

Thursday, March 7, 2024
Chicago, IL

## *Acknowledgements*

The American College of Surgeons gratefully acknowledges the generous support from the following individuals and organizations for the 47th Resident and Fellow Trauma Paper Competition between March 1, 2023, and January 31, 2024:

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Trauma and Critical Care Educational Foundation (Kenneth L. Mattox, MD, FACS)

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**Accreditation**

The American College of Surgeons is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians

***AMA PRA Category 1 Credits™***

The American College of Surgeons designates this live activity for a maximum of **4.50** *AMA PRA Category 1 Credits*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Of the *AMA PRA Category 1 Credits*™ listed above, a maximum of 4.50 hours meet the requirements for Trauma*.

***The content of this activity may meet certain mandates of regulatory bodies. Please note that the ACS has not and does not verify the content for such mandates with any regulatory body. Individual physicians are responsible for verifying the content satisfies such requirements.***

PROGRAM OBJECTIVES:

- Discuss current research in patient care for trauma injuries
- Evaluate new methods for treatment of trauma patients

DISCLOSURE INFORMATION

In accordance with the ACCME Accreditation Criteria, the American College of Surgeons must ensure that anyone in a position to control the content of the educational activity has disclosed all relevant financial relationships with any commercial interest. All reported conflicts are managed by a designated official to ensure a bias-free presentation. Please refer to the disclosure list online for our meetings.

*Continuing Medical Education Credit Information, cont.*

| Speakers / Authors | Nothing to Disclose | Disclosure | | |
|---|---|---|---|---|
| | | Company | Role | Received |
| Jose Aldana, MD | X | | | |
| Stas Amato, MD | X | | | |
| Tej D. Azad, MD, MS | X | | | |
| Maraya Camazine, MD | X | | | |
| Sophia Engel, MD, MSc | X | | | |
| Lauren Gallagher, MD | X | | | |
| Kelly E. Harrell, DO | X | | | |
| Lisa Kurth, MD | X | | | |
| Armaan K. Malhotra, MD | X | | | |
| Jennifer Munley, MD | X | | | |
| Emily Myers, MD | X | | | |
| Sahil Patel, MD | X | | | |
| Adam D. Price, MD | X | | | |
| María Agustina Reyes, MD | X | | | |
| Christopher Sum Hiu Fung, MBBS | X | | | |
| Luis Tinoco-Garcia, MD | X | | | |
| Sally Trout, MD | X | | | |

| Planning Committee / Editorial Committee | Nothing to Disclose | Disclosure | | |
|---|---|---|---|---|
| | | Company | Role | Received |
| Warren C. Dorlac, MD, FACS | | Decisio Health<br>Zibrio<br>Aspen Medical | Investor for Decisio Health and Zibrio, Consultant for Aspen Medical | Nothing received from Decisio Health or Zibrio, salary received from Apsen Medical |
| Raymond Fang, MD, FACS | X | | | |
| Naisan Garraway, MD, FACS | X | | | |
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| Thomas J. Schroeppel, MD, FACS | X | | | |
| Douglas J. E. Schuerer, MD, FACS | X | | | |
| Elizabeth N. Turner, MD, FACS | X | | | |

| Discussants / Co-Moderators | Nothing to Disclose | Disclosure | | |
|---|---|---|---|---|
| | | Company | Role | Received |
| Matthew A. Bank, MD, FACS | X | | | |
| Galinos Barmparas, MD, FACS | X | | | |
| David P. Blake, MD, MPH, FACS | X | | | |
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| Juan C. Duchesne, MD, FACS | X | | | |
| Thomas K. Duncan, DO, FACS | X | | | |
| Brian J. Eastridge, MD, FACS | X | | | |
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| Peter E. Fischer, MD, FACS | X | | | |
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| Matthew E. Kutcher, MD MS FACS | X | Intuitive Surgical, Inc., Zimmer Biomet Holdings, Inc., Access Pro Medical, LLC | Consultant | Food, Beverage, and Lodging |
| Stephanie N. Lueckel, MD, FACS | X | | | |
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| Douglas J. E. Schuerer, MD, FACS | X | | | |
| Kevin M. Schuster, MD, MPH, FACS | X | | | |
| Elizabeth N. Turner, MD, FACS | X | | | |
| Ashley Williams, MD, FACS | X | | | |

*Resident and Fellow Trauma Paper Competition –*
*Past Winners*

| Year | 1st Place | Runner(s) Up |
|---|---|---|
| 1978 | John A. Weigelt | Mary H. McGrath |
| 1979 | Joseph V. Boykin | Christopher C. Baker<br>Frank D. Manart |
| 1980 | Robert Tranbaugh | Gary M. Gartsman<br>John B. Moore |
| 1981 | Kenneth Kollmeyer | Kenneth A. Kudsk<br>James Hammesfahr |
| 1982 | Raj K. Narayan | George S. Fortner<br>Hani Shennib |
| 1983 | Mark DeGroot | Gregory Luna<br>Mercedes Dullum |
| 1984 | Ronald B. O'Gorman | Louis Ostrow<br>Frederick A. Moore |
| 1985 | Lawrence Reed | Frank Shannon<br>M. Rebot |
| 1986 | Richard S. Downey | Richard Kiplovic<br>Wiley W. Souba |

| Year | Basic Laboratory Science | Clinical Research |
|---|---|---|
| 1987 | 1. Nicholas B. Vedder<br>2. B. Timothy Baxter | 1. Eric DeMaria<br>2. John D.S. Reid |
| 1988 | 1. Gary Fantini<br>2. David H. Livingston | 1. Christoph Kaufmann<br>2. Tomasso Bochicchio |
| 1989 | 1. David K. Magnuson<br>2. Matthew L. Cooper | 1. Bradley Reeves<br>2. Danielle Desloges |
| 1990 | 1. William J. Mileski<br>2. Gary A. Gelfand<br>2. Jon C. Walsh | 1. Miguel Lopez Viego |
| 1991 | 1. Roy W. Hong<br>2. Benjamin O. Anderson | 1. Karl Illig<br>2. Carson Agee |
| 1992 | 1. Michael O'Reilly<br>2. David Bensard | 1. William S. Hoff<br>2. Juan Manuel Sarmiento-Martinez |
| 1993 | 1. Thomas T. Sato<br>2. Paul A. Taheri<br>2. Alastair C.J. Windsor | 1. Patricia Yugueros |
| 1994 | 1. James T. Wilson<br>2. Robert F. Noel Jr. | 1. Stefan J. Konasiewicz<br>2. Paul J. Gagne |
| 1995 | 1. Donald W. Pate<br>2. Carol J. Cornejo | 1. Russell R. Lonser<br>2. John J. Keleman |

| Year | Basic Laboratory Science | Clinical Research |
|---|---|---|
| 1996 | 1. Kenneth E. Drazan<br>2. Carlton C. Barnett Jr. | 1. Peter D. Wearden<br>2. Nicholas Namias |
| 1997 | 1. Randy J. Irwin<br>2. Molly M. Buzdon | 1. Preston R. Miller<br>2. Katharina Pellegrin |
| 1998 | 1. Geoffrey Manley<br>2. Gregory J. McKenna | 1. E. Lynne Henderson<br>2. Juan P. Carbonell |
| 1999 | 1. Andrew Kramer<br>2. D. Kirk Lawlor | 1. Garret Zallen<br>2. Avery B. Nathens |
| 2000 | 1. Philip P. Narini<br>2. George D. Oreopoulos | 1. Joseph T. Rabban<br>2. Avery B. Nathens |
| 2001 | 1. Deepa Soni<br>2. Daron C. Hitt | 1. John-Paul Veri<br>2. Moishe Lieberman |
| 2002 | 1. Jonas Gopez<br>2. Steven Casha | 1. Ram Nirula<br>2. Seong K. Lee |
| 2003 | 1. Eve C. Tsai<br>2. Katherine Barsness | 1. Steven Fox<br>2. David J. Schultz |
| 2004 | 1. Rachel G. Khadaroo<br>2. Manuel B. Torres | 1. Matthew Rosengart<br>2. Carlos V. R. Brown |
| 2005 | 1. John M. Hwang<br>2. Aaron M. Cheng | 1. Felicia Ivascu<br>2. Stephanie P. Acierno |
| 2006 | 1. Preya Ananthakrishnan<br>2. Jessica Deree | 1. Alexander L. Eastman<br>2. David O. Francis |
| 2007 | 1. Alexander Q. Ereso<br>2. Sagar S. Damle | 1. Alexandra Mihailovic<br>2. Heather F. Pidcoke |
| 2008 | 1. Jason M. Seery<br>2. Elizabeth A. Sailhamer | 1. Joseph F. Golob Jr.<br>2. Sherene Shalhub |
| 2009 | 1. Elizabeth A. Sailhamer<br>2. Reed B. Kuehn | 1. Alexios A. Adamides<br>2. Joseph DuBose |
| 2010 | 1. Angela L. F. Gibson [Reg 5]<br>2. Arash Farahvar [Reg 2] | 1. Barbara Haas [Reg 12]<br>2. Thomas M. Schmelzer [Reg 4] |
| 2011 | 1. Laura E. White [Reg 6]<br>2. Marlene Mathews [Reg 2] | 1. Levi D. Procter [Reg 4]<br>2. Matthew D. Neal [Reg 5] |
| 2012 | 1. Laura E. White [Reg 6]<br>2. Alex Cuenca [Reg 4] | 1. Kristin Cook [Reg 2]<br>2. Jennifer Roberts [Reg 5] |
| 2013 | 1. Abubaker A. Ali [Reg 5]<br>2. Isaiah R. Turnbull [Reg 7]<br>2. Kristin L. Long [Reg 4] | 1. Eiman Zargaran [Reg 11]<br>2. David A. Hampton [Reg 10] |
| 2014 | 1. Michaela C. Kollisch-Singule [Reg 2]<br>2. Matthew W. Ralls [Reg 5] | 1. Hunter B. Moore [Reg 8]<br>2. Vanessa J. Fawcett [Reg 10] |
| 2015 | 1. Simone M. Langness [Reg 9] | 1. Deepika Nehra [Reg 10] |

## *Resident and Fellow Trauma Paper Competition – Past Winners*

| Year | Basic Laboratory Science | Clinical Research |
|---|---|---|
| | 2. Michaela C. Kollisch-Singule [Reg 2] | 2. Cherisse Berry [Reg 3] |
| 2016 | 1. Rachel M. Russo [Reg 13]<br>2. Sarah Ogle [Reg 9] | 1. James P. Byrne [Reg 12]<br>2. Lynn Hutchings [Reg 15] |
| 2017 | 1. Teresa C. Rice [Reg 5]<br>2. Theresa Chan [Reg 9] | 1. Stephanie A. Mason [Reg 12]<br>2. Sabrina Balakrishnan, MBBS [Reg 16] |
| 2018 | 1. Michael Valliere [Reg 7]<br>2. Theresa Chan [Reg 9] | 1. Luke R. Johnson [Reg 13]<br>2. Jarred R. Gallaher [Reg 4] |
| 2019 | 1. Elliott Williams [Reg 9]<br>2. Patricia Martinez-Quinones [Reg 4] | 1. Hope Villiard [Reg 7]<br>2. Parin Boonthum [Reg 16] |
| 2020 | 1. Julia R. Coleman [Reg 8]<br>2. Amanda M. Chipman [Reg 3] | 1. Alexandra Dixon [Reg 10]<br>2. Jetan H. Badhiwala [Reg 12] |
| 2021 | 1. Julia R. Coleman [Reg 8]<br>2. Zachary A. Matthay [Reg 9] | 1. Max Marsden [Reg 15]<br>2. Eric Walser [Reg 12] |
| 2022 | 1. Jessie W. Ho [Reg 5]<br>2. Mark Berry [Reg 9] | 1. Luis I. Ruffolo [Reg 2]<br>2. Mary Bokenkamp [Reg 1]<br>2. Jeongyoon (Jenny) Moon [Reg 12] |
| 2023 | 1. Terry (TJ) R. Schaid [Reg 8]<br>2. Jennifer A. Munley [Reg 4] | 1. Karan K'Souza [Reg 11]<br>2. Ann Polcari [Reg 5] |

*Look ahead at the 2025 Competition –*

*Deadline* for regional submission of region winners - *December 5, 2024!*

Abstracts selected for presentation will be announced *mid-December*

All selected presenters will be required to *submit a submission-ready manuscript by February 1, 2025*; the manuscript will be considered part of the final winner selection in March

*Prizes to be awarded* will recognized the overall First, Second, and Third Place Winners, regardless of classification as either basic science or clinical research paper

*Inclusion of "Achieving Excellence in Surgery through Equity" prize*

For detailed information on next year's competition, please refer to the Resident and Fellow Trauma Paper Competition website at:
https://www.facs.org/quality-programs/trauma/committee-on-trauma/trauma-papers-competition/

## *2024 Regional Winners*

Region 1 Stas Amato, MD
University of Vermont Medical Center, Burlington, VT
"Comparing Risk Adjusted Trauma Mortality Between Systems with Different Resource Availability: MGAP is a More Appropriate Adjustment Score"

Region 2 Sally Trout, MD
North Shore University Hospital, Manhasset, NY
"Immediate Weight-Bearing for Distal Femur Fractures Fixed with a Lateral Locking Plate Leads to Decreased Short-Term Complications without Increased Failure Rates"

Region 3 Tej D. Azad, MD, MS
Johns Hopkins Hospital, Baltimore, MD
"Challenging Neurosurgical Futility — Traumatic Subdural Hematoma Evacuation is Associated with Favorable Discharge Disposition in Patients with Poor Neurologic Examination"

Region 4 Jennifer A. Munley, MD
University of Florida, Gainesville, FL
"Post-Injury Pneumonia Induces a Unique Blood Microbiome Signature"

Region 5 Adam D. Price, MD
University of Cincinnati, Cincinnati, OH
"Hypobaria During Aeromedical Evacuation Increases Systemic Inflammation Following Porcine Traumatic Brain Injury"

Region 6 Maraya Camazine, MD
University of Arkansas for Medical Sciences, Little Rock, AR
"Standard ROTEM Protocols May Fail to Identify Coagulopathy in Hypothermic Trauma Patients"

Region 7 Jose Aldana, MD
Washington University in Saint Louis, Saint Louis, MO
"Prolonged Hourly Neuro Exams are Associated with Increased Delirium and No Discernible Benefit in Mild/Moderate Geriatric TBI"

Region 8 Lauren Gallagher, MD
University of Colorado, Denver, CO
"Platelet Releasates Mitigate the Endotheliopathy of Trauma"

Emily Myers, MD
University of Colorado, Aurora, CO
"Neighborhood Disadvantage in the Pediatric Trauma Population: Relationship Between Injury Mechanism, Severity, and Outcomes"

Region 9 Lisa Kurth, MD
University of California San Diego, San Diego, CA
"Weight-Based Enoxaparin Dosing After TBI"

Sahil Patel, MD
UCSF-East Bay, Oakland, CA
"A Novel 4D Volumetric M-Mode Ultrasound Scanning Technique to Support Automated Hemorrhage and Physiologic Monitoring during Prolonged Damage Control Resuscitation"

Region 10 Luis Tinoco-Garcia, MD
Oregon Health and Science University, Portland, OR
"Swine Bone Marrow Mesenchymal Stem Cells Do Not Produce Hypercoagulability in a Swine Model of Uncontrolled Hemorrhagic Shock"

Region 12 Armaan K. Malhotra, MD
University of Toronto, Toronto, ON, Canada
"Influence of Health Insurance Status on Timing of Mortality After a Withdrawal of Life Sustaining Treatment Decision for Adults with Isolated Severe Traumatic Brain Injury"

Region 13 Kelly E. Harrell, DO
The University of Texas Health Science Center at San Antonio, TX
"From Brothers to Heroes in Arms: Expanding Walking Blood Banks to Include Women Donors Leading to the Potential for More Lives Saved"

Region 14 María Agustina Pienovi Reyes, MD
Hospital de Clínicas "Dr. Manuel Quintela", Mdeo, Uruguay
"Drugs of Abuse and its Relation with Trauma and its Severity"

Region 15 Sophia Engel, MD, MSc
Oslo University Hospital, Oslo, Norway
"Patterns of Opioid use Among Trauma Patients: A National Cohort Study"

Region 16 Sum Hiu Fung Christopher, MBBS
Queen Mary Hospital, Hong Kong
"Implementation of an Institutional CT Head Decision Rule to Reduce Radiation Exposure in Paediatric Neurotrauma"

*Institution and location current at time of Paper/Abstract submission*

## *2024 Presentation Order*

Region 13 Kelly E. Harrell, DO - The University of Texas Health Science Center at San Antonio, TX
"From Brothers to Heroes in Arms: Expanding Walking Blood Banks to Include Women Donors Leading to the Potential for More Lives Saved"
*Discussant: Raymond Fang, MD, FACS*

Region 5 Adam D. Price, MD - University of Cincinnati, Cincinnati, OH
"Hypobaria During Aeromedical Evacuation Increases Systemic Inflammation Following Porcine Traumatic Brain Injury"
*Discussant: Brian J. Eastridge, MD, FACS*

Region 8 Emily Myers, MD - University of Colorado, Aurora, CO
"Neighborhood Disadvantage in the Pediatric Trauma Population: Relationship Between Injury Mechanism, Severity, and Outcomes"
*Discussant: Peter E. Fischer, MD, FACS*

Region 10 Luis Tinoco-Garcia, MD - Oregon Health and Science University, Portland, OR
"Swine Bone Marrow Mesenchymal Stem Cells Do Not Produce Hypercoagulability in a Swine Model of Uncontrolled Hemorrhagic Shock"
*Discussant: Matthew E. Kutcher, MD, MS, FACS*

Region 16 Sum Hiu Fung Christopher, MBBS - Queen Mary Hospital, Hong Kong
"Implementation of an Institutional CT Head Decision Rule to Reduce Radiation Exposure in Paediatric Neurotrauma"
*Discussant: Krista L. Kaups, MD, MSc, FACS*

Region 9 Sahil Patel, MD - UCSF-East Bay, Oakland, CA
"A Novel 4D Volumetric M-Mode Ultrasound Scanning Technique to Support Automated Hemorrhage and Physiologic Monitoring during Prolonged Damage Control Resuscitation"
*Discussant: Kevin M. Schuster, MD, FACS*

Region 2 Sally Trout, MD - North Shore University Hospital, Manhasset, NY
"Immediate Weight-Bearing for Distal Femur Fractures Fixed with a Lateral Locking Plate Leads to Decreased Short-Term Complications without Increased Failure Rates"
*Discussant: David P. Blake, MD, FACS*

Region 15 Sophia Engel, MD, MSc - Oslo University Hospital, Oslo, Norway
"Patterns of Opioid use Among Trauma Patients: A National Cohort Study"
*Discussant: Lacey N. LaGrone, MD, FACS*

Region 7 Jose Aldana, MD - Washington University in Saint Louis, Saint Louis, MO
"Prolonged Hourly Neuro Exams are Associated with Increased Delirium and No Discernible Benefit in Mild/Moderate Geriatric TBI"
*Discussant: Thomas J. Schroeppel, MD, MS, FACS*

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*There will be a 25–30-minute break before continuing with the next presentation*

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Region 8 Lauren Gallagher, MD - University of Colorado, Denver, CO
"Platelet Releasates Mitigate the Endotheliopathy of Trauma"
*Discussant: Juan C. Duchesne, MD, FACS*

Region 14 María Agustina Pienovi Reyes, MD - Hospital de Clínicas, Mdeo, Uruguay
"Drugs of Abuse and its Relation with Trauma and its Severity"
*Discussant: Thomas K. Duncan, DO, FACS*

Region 6 Maraya Camazine, MD - University of Arkansas for Medical Sciences, Little Rock, AR
"Standard ROTEM Protocols May Fail to Identify Coagulopathy in Hypothermic Trauma Patients"
*Discussant: Stephanie L. Bonne, MD, FACS*

Region 3 Tej D. Azad, MD, MS - Johns Hopkins Hospital, Baltimore, MD
"Challenging Neurosurgical Futility — Traumatic Subdural Hematoma Evacuation is Associated with Favorable Discharge Disposition in Patients with Poor Neurologic Examination"
*Discussant: Elizabeth N. Turner, MD, FACS*

Region 4 Jennifer A. Munley, MD - University of Florida, Gainesville, FL
"Post-Injury Pneumonia Induces a Unique Blood Microbiome Signature"
*Discussant: Stephanie N. Lueckel, MD, FACS*

Region 12 Armaan K. Malhotra, MD - University of Toronto, Toronto, ON, Canada
"Influence of Health Insurance Status on Timing of Mortality After a Withdrawal of Life Sustaining Treatment Decision for Adults with Isolated Severe Traumatic Brain Injury"
*Discussant: Babak Sarani, MD, FACS, FCCM*

Region 1 Stas Amato, MD - University of Vermont Medical Center, Burlington, VT
"Comparing Risk Adjusted Trauma Mortality Between Systems with Different Resource Availability: MGAP is a More Appropriate Adjustment Score"
*Discussant: Galinos Barmparas, MD, FACS*

Region 9 Lisa Kurth, MD - University of California San Diego, San Diego, CA
"Weight-Based Enoxaparin Dosing After TBI"
*Discussant: Douglas J. Schuerer, MD, FACS*

*Institution and location current at time of Paper/Abstract submission*

## *Region 13 – Clinical Research*

# From Brothers to Heroes in Arms: Expanding Walking Blood Banks to Include Women Donors Leading to the Potential for More Lives Saved

Kelly E. Harrell, DO

**Background:**
Prehospital combat casualty care focusing on hemorrhage control and transfusion has reduced preventable deaths. Walking blood banks (WBB) use fresh whole blood (FWB) from personnel for immediate use. In November 2021, *Military Medicine* published details of the Ranger O Low-Titer (ROLO) whole blood transfusion program. ROLO is a far forward-walking blood bank, using prescreened male-only low-titer O-positive whole blood (LTOWB) donors for use at point of injury. In 2014, the Association for the Advancement of Blood and Biotherapies published a strategy to reduce the risk of transfusion-related acute lung injury (TRALI), which occurs most frequently after transfusions from female donors with human leukocyte antigen (HLA) antibody (Ab) positivity (+). Since, not all female donors demonstrate HLA Ab +, the purpose of our current research was to determine if we could expand the potential donor pool by including women in our regional LTOWB donor program.

**Study Design:**
A whole blood consortium was created by an urban level 1 trauma center, its affiliated local blood supplier, and the regional trauma advisory council. This consortium developed a transfusion program which preidentified LTOWB (<256 Anti-A, Anti-B antibody) male donors who solely donated LTOWB for resuscitation from hemorrhagic shock. To maximize mass casualty incident (MCI) preparedness, the consortium expanded to screen women as LTOWB donors (see Figure 1). By this current process, O-positive females are screened based upon response to the question: “Have you ever been pregnant?” If the woman has not been pregnant, then their blood is processed like male donors. If previously pregnant, the local blood center performs additional HLA Ab testing. If the result of this assay is negative, women donors can now safely donate LTOWB.

**Results:**
Since January 2023, 1097 O-positive females have been identified. Of those 1097, 771 or 70% were considered lower titer. Of the 771 low-titer females, 146 or 19% answered “yes” to prior pregnancy. When tested for HLA Ab positivity, only 20 or 14% tested positive, which means 126 or 86% are eligible for enrollment. In all, 69% of the 1097 women identified are eligible for enrolled and 86% of previously pregnant females qualified for the program. In the last nine months, 134 women have donated and there have been no reported adverse reactions in recipients.

**Conclusions:**
Automatically excluding female donors results in a significant reduction of potential donors. Low titer, O-positive, never-pregnant women and previously pregnant HLA Ab negative females should be eligible for whole blood donation. This program provides a model that could be adapted to far-forward environments and inclusion of previously pregnant females into programs like ROLO. Thus, the addition of women to LTOWB donor programs for early resuscitation in hemorrhagic shock serves to increase the potential donor pool and potentially more lives being saved.

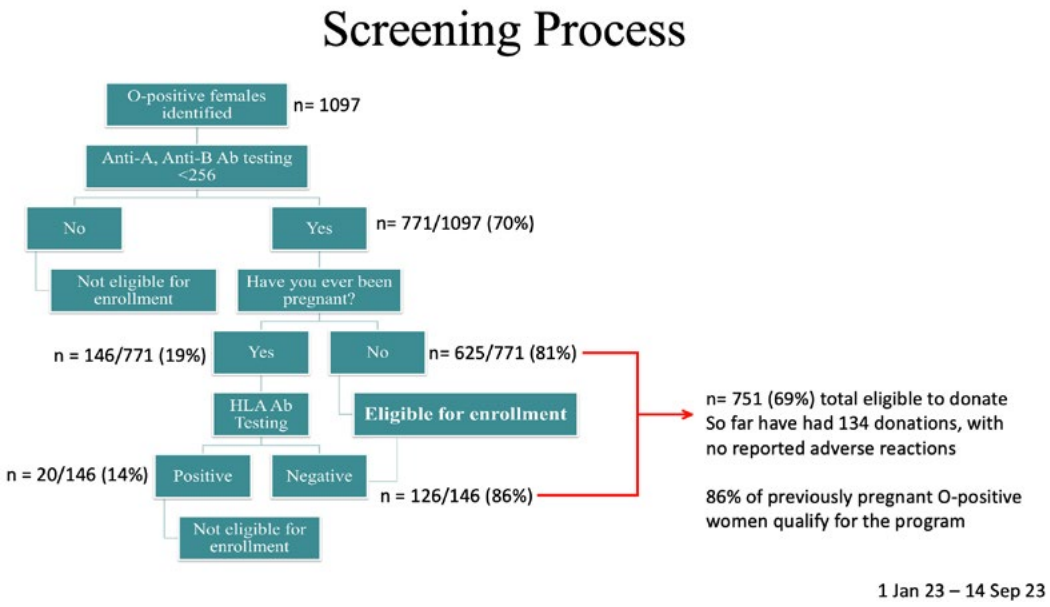

Screening Process
O-positive females identified
n= 1097
Anti-A, Anti-B Ab testing <256
No
Yes
n= 771/1097 (70%)
Not eligible for enrollment
Have you ever been pregnant?
n = 146/771 (19%)
Yes
No
n= 625/771 (81%)
HLA Ab Testing
Eligible for enrollment
n = 20/146 (14%)
Positive
Negative
n = 126/146 (86%)
Not eligible for enrollment
n= 751 (69%) total eligible to donate
So far have had 134 donations, with no reported adverse reactions
86% of previously pregnant O-positive women qualify for the program
1 Jan 23 – 14 Sep 23

Figure 1

## *Region 5 – Basic Science*

# Hypobaria During Aeromedical Evacuation Increases Systemic Inflammation Following Porcine Traumatic Brain Injury

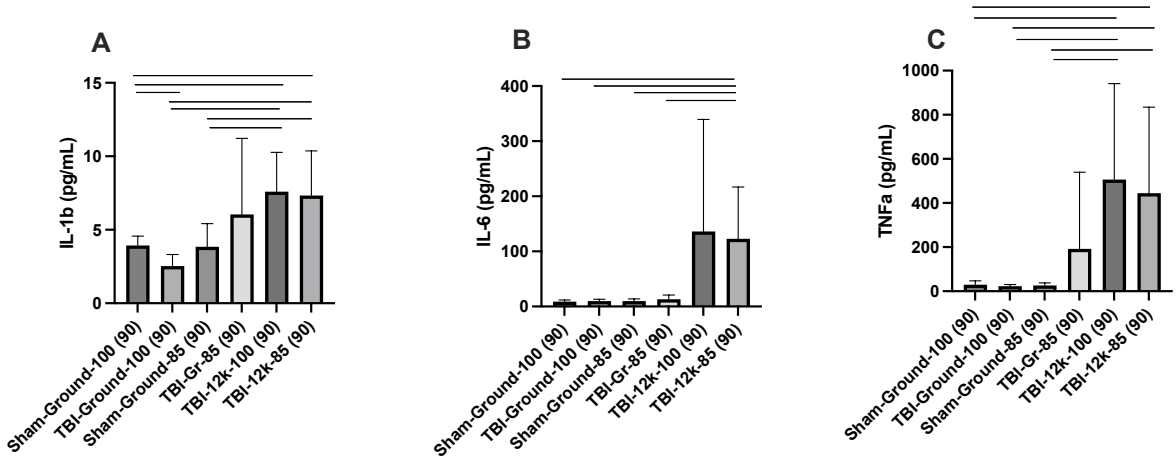
Adam D. Price, MD, Matthew R. Baucom, MD, Ellen R. Becker, MD, Chad M. Archdeacon, BS, Chelsea Caskey, RVT, Rebecca Schuster, MS, Thomas C. Blakeman MS, RRT, Richard Strilka MD, PhD, Timothy Pritts MD, PhD, Michael D. Goodman, MD

Introduction:
Traumatic brain injury (TBI)-related morbidity is caused by a primary insult occurring at the time of injury followed by secondary damage caused by hypoxia, excessive sympathetic drive, and uncontrolled inflammation. Aeromedical evacuation (AE) is routinely utilized by the military for the rapid transport of wounded warriors to higher levels of care. The military AE system may expose the injured soldier to hypobaric, hypoxic conditions inherent to flight that worsen secondary injury associated with TBI. In this study, we hypothesized that both hypobaric and hypoxic conditions would contribute to more severe TBI-related secondary injury in a porcine model.

Methods:
Thirty-six female Yorkshire pigs were divided into 6 groups (n=6 per group) to test TBI vs. TBI sham, hypoxia vs. normoxia, and hypobaria vs. ground conditions. TBI was induced by controlled cortical injury via right-sided craniotomy, hypobaric conditions were established in an altitude chamber set to a pressure of 12,000 feet for 90 minutes, and hypoxic conditions were induced to 85% $SpO_2$ while at altitude, followed by an observation period of 4 hours. Serum cytokines and ubiquitin c-terminal hydrolase L1 (UCHL-1) were analyzed via ELISA. Following euthanasia, the brain was analyzed at the anterior cortex and hippocampus from both the injured and uninjured sides. These sections were stained for glial fibrillary acidic protein (GFAP) and phosphorylated tau (p-tau) and quantified via image deconvolution and cell counts. Data are reported as mean±SD.

Results:
Serum IL-1b, IL-6, and TNF$\alpha$ were each significantly elevated following TBI in pigs exposed to altitude-induced hypobaria/hypoxia compared to ground level/normoxia immediately post-flight ($p<0.05$, Figure 1). This difference persisted to 4 hours of observation with serum IL-6 still elevated at 4 hours TBI+hypobaria/hypoxia compared to TBI+ground/normoxia (20.9±9.0 pg/mL vs. 11.2±1.6 pg/mL). Following this 4hr observation period, no difference persisted between these groups in serum IL-1$\boldsymbol{\beta}$ or TNF$\alpha$. Further, there was no significant difference in serum UCH-L1 following TBI or from exposure to hypobaric and hypoxic conditions. There were no significant differences in brain tissue accumulation of GFAP or p-tau when comparing the most different conditions of sham TBI+ground/normoxia to the TBI+hypobaria/hypoxia group.

Conclusions:
The hypobaric environment of AE can induce a nonspecific elevation in systemic inflammatory signaling following TBI. This acute inflammatory state may play a role in exacerbating secondary injury associated with TBI and could contribute to worse neurocognitive outcomes. Measures should be taken to minimize barometric and oxygenation changes during AE following TBI.


A
IL-1b (pg/mL)
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IL-6 (pg/mL)
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TBI-12k-85 (90)
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Sham-Ground-85 (90)
TBI-Gr-85 (90)
TBI-12k-100 (90)
TBI-12k-85 (90)

## *Region 8 – Clinical Research*

# Neighborhood Disadvantage in the Pediatric Trauma Population: Relationship Between Injury Mechanism, Severity, and Outcomes

Emily Myers, MD

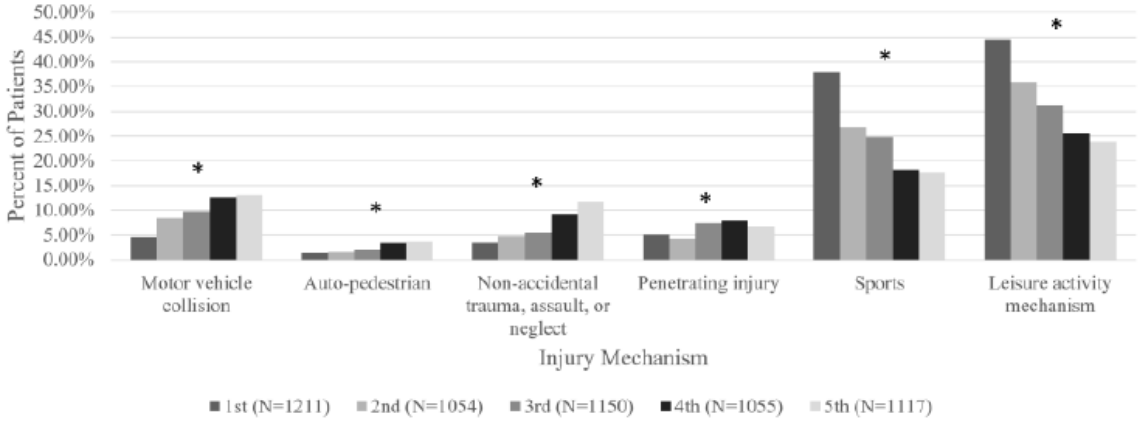
Background:
The impact of unintentional injuries, the leading cause of mortality in children, is not distributed equitably. Previous work has focused on the impact of isolated factors (race, ethnicity, insurance status) on outcomes, with little focus given to neighborhood disparities. This study utilizes the Area Deprivation Index (ADI), a validated composite measure of neighborhood-level disparity, to explore the link between neighborhood disadvantage and pediatric trauma. We hypothesized that higher ADI (i.e., higher neighborhood disadvantage) correlates with injury mechanisms, severity, and outcomes in pediatric trauma patients.

Study Design:
We performed a retrospective review of all pediatric trauma patients aged 0-18 admitted to a single Level I Pediatric Trauma Center from 2016-2021, examining the relationship between ADI, injury mechanism, severity, and outcomes. Subset analysis of the most severely injured patients (injury severity score ([ISS] ≥15) was performed. The national ADI percentile was obtained from the Neighborhood Atlas database using home address at the time of injury. Patients were stratified into ADI quintiles (higher quintile equals higher neighborhood disadvantage). Group differences were analyzed via t-test or Kruskal-Wallis test for continuous variables and Chi-Squared tests or Fisher's Exact tests for categorical variables. Logistic regression was used to obtain pairwise odds ratio (OR) estimates with 95% confidence intervals (CI) of various categories of injury mechanism for different ADI quintiles. All regressions were adjusted for sex, age, race, ethnicity, and insurance status. A Bonferroni correction was used to set the significance level for the overall comparisons at 0.05/8 = 0.00625.

Results:
5,587 patients were included (726 in the severe injury cohort). The mechanism of injury varied with ADI. Patients in the highest ADI quintile experienced different mechanisms of injury than those in the lowest ADI quintiles (Figure 1). Similar trends existed in the most severely injured cohort ($p$=0.001). The adjusted odds of being injured in a motor vehicle collision (OR = 1.89, 95% CI 1.48-2.41; $p$<0.0001), auto-pedestrian collision (OR = 1.99, 95% CI 1.16-2.7), and non-accidental trauma/assault/neglect (OR = 1.53, 95% CI 1.15-2.02) were higher in the 5th ADI quintile and the adjusted odds of sports-related injury were lower in the 5th quintile (OR = 0.63, 95% CI 0.56, 0.72; $p$<0.0001), compared to the 1st quintile. Injury severity increased with increasing ADI, but the need for operation varied inversely with ADI quintile (Figure 2). Among the severely injured cohort, none of the five Need for Trauma Intervention criteria varied with ADI quintile nor did the rate of adverse outcomes including infectious complications, discharge to a rehabilitation facility, mortality, 30-day emergency department visit or 30-day readmission. There were three deaths in the cohort (0.4%).

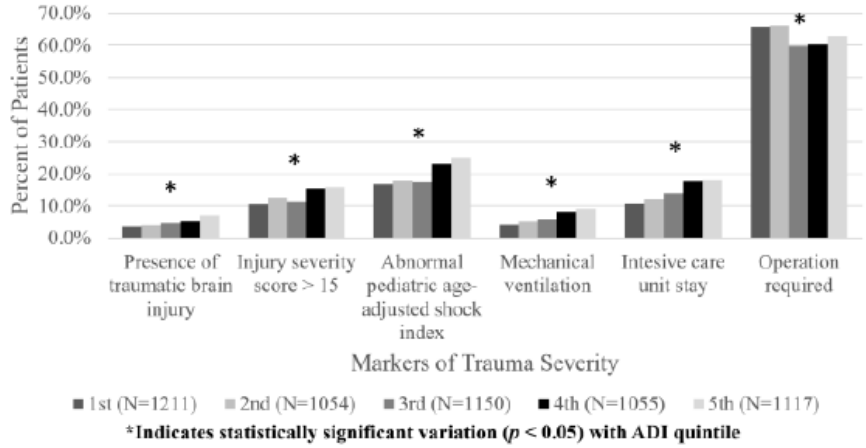
Conclusion:
Children who live in neighborhoods with a high level of disparity experience different injury mechanisms and more severe injuries than those in neighborhoods with low disparity. Despite variations in mechanisms and severity with neighborhood disparity, outcomes did not differ, indicating care received was equitable across ADI quintiles. Understanding drivers of disparities is crucial for targeting injury prevention to areas of high need, with the goal of reducing the disproportionate burden of severe injuries in neighborhoods with high deprivation.

**Figure 1) Injury mechanisms by ADI quintile**




***Indicates statistically significant variation ($p<0.05$) with ADI quintile**

**Figure 2) Markers of trauma severity by ADI quintile**




***Indicates statistically significant variation ($p < 0.05$) with ADI quintile**

## *Region 10 – Basic Science*

# Swine Bone Marrow Mesenchymal Stem Cells Do Not Produce Hypercoagulability in a Swine Model of Uncontrolled Hemorrhagic Shock

L. Tinoco-Garcia MD, L. Buzzard, BS, S. Smith, MD, MBA, A. Dixon, MD, J. Kenny, MD, MS, M. Appleman, PhD, S. Subramanian, MD, A. Goodman; J. Murphy, MD, B. McCully, PhD, A. Kanlerd, MD, B. Miyazawa, BS, A. Trivedi, PhD, S. Pati, MD, PhD, M. Schreiber, MD, FACS

Introduction:
Mesenchymal Stem Cells (MSCs) have been studied for use in many disease processes, including acute respiratory distress syndrome, orthopedic injuries, degenerative conditions, inflammation, autoimmunity, and immune rejection.[1–4] However, concerns have been raised about their safety. MSCs may produce variable amounts of procoagulant tissue factor, which can produce thrombotic adverse events if patients have not been anticoagulated.[5] One study identified bone marrow-derived MSCs as being less procoagulant than adipose-derived MSCs.[6] However, bone marrow-derived MSCs can still have procoagulant activity, as evidenced by Liao, et al.'s study demonstrating micro-thrombi found in multiple mouse organs after injection with bone marrow-derived MSCs.[7] Liao, et al. found the procoagulant effect of bone marrow-derived MSCs was also present in large mammals.[7] While many studies have found that MSCs are safe from a coagulation perspective, it is believed that the rate of adverse thrombotic events attributable to MSCs is underreported. This study was a secondary, retrospective analysis designed to examine the effects of swine MSCs (sMSCs) on coagulation.

Methods:
83 juvenile female Yorkshire crossbred swine were randomized to injury groups including pulmonary contusion (PC) alone, PC plus liver injury, a control group, and treatment groups including LR, swine fresh frozen plasma (FFP), prothrombin concentrate (PCC), and swine MSCs. Blood samples for TEG were collected at baseline as well as at 1 hour, 3 hours, 6 hours, and every subsequent 6 hours until 48 hours post-injury. Treatment groups were chosen to provide a positive control for hypercoagulability with Kcentra and negative controls with LR and sFFP. Effects were analyzed in R with unbalanced repeated measures two-way ANOVA and Tukey HSD test.

Results:
Two subjects were excluded due to early deaths unrelated to the models. Among PC injured subjects, KCentra produced significantly lower reaction times (R times) compared to swine MSCs ($p = 0.005$), Control ($p = 0.007$), LR ($p = 0.04$), and swine FFP ($p = 0.02$) while R times in the swine MSC group were not significantly different from LR, or swine FFP. There were no other significant differences between groups with respect to alpha angle, maximum amplitude or lysis at 30 minutes, 1 hour, 3 hours, 6 hours, and at each subsequent 6-hour period for 48 hours.

Conclusion:
This study found that treatment with PCC resulted in significantly lower R times compared to LR, sFFP, and sMSCs among PC subjects suggesting that PCC is associated with hypercoagulability and sMSCs are not. The finding that PCC is associated with a decreased R value is consistent with its mechanism of increasing soluble coagulation factor function which would also be expected if MSCs produced pro-coagulant tissue factor. The results of this study suggest that sMSCs are a safe intervention with respect to not producing a hypercoagulable state.

# Implementation of an Institutional CT Head Decision Rule to Reduce Radiation Exposure in Pediatric Neurotrauma

Christopher Hiu Fung Sum, MBBS

Background:
Pediatric neurotrauma is an important global health issue. Despite a low absolute risk, the population-level risk of radiation-induced malignancy is non-negligible, especially that it is iatrogenic.
Clinical decision rules (CDRs) help determine the need for CT in children with head trauma. However, rule-specific applicability varies, and clear recommendations may be lacking in certain scenarios such as the PECARN-intermediate group. We aimed to evaluate the diagnostic performance of our institution's CDR against PECARN, CATCH, and CHALICE. Additionally, the pre- and post-implementation CT rates and compliance were evaluated. Future perspectives on further improvement of these CDRs were discussed.

Study Design:
A prospectively maintained trauma database from an university-affiliated tertiary center was interrogated to collect data from children and adolescents aged <18 years with head injury and a Glasgow Coma Scale score of 14 or 15 admitted to the accident and emergency department between 2014 and 2019. Our developed algorithm ("QMH algorithm") has been implemented as a practice guideline since January 2017. The primary outcome was clinically important traumatic brain injury (ciTBI), defined as fulfilling either one of the following: 1) death from TBI, 2) need for neurosurgical intervention, 3) intubation greater than 24 hours for TBI, or 4) hospitalization for 2 nights or more for TBI. Sensitivity and specificity analyses studied the rule-specific diagnostic performance.

Results:
We analyzed data from 696 patients, with CTs performed overall on 353 (50.7%). Mean age was 66.6 months. CiTBI occurred in 67 (9.6%), and 15 (2.3%) underwent neurosurgical operation. For CiTBI, the QMH algorithm had a sensitivity of 91.0 % (95% CI 81.5%-96.6%), which was lower than the CHALICE's 92.3% (95% CI 86.9%-99.0%) and PECARN's 95.2% (95% CI 86.7%-99.0%). However, it carried the highest specificity of 82.4% (95% CI 79.1%-85.3%). Two-thirds of the PECARN-intermediate group would be classified as low risk according to our criteria. PECARN, CHALICE and QMH algorithm all had excellent sensitivity (>99%) in predicting neurosurgical intervention.

Implementation of our CDR led to a decline in CT rate from 0.68 scan/patient to 0.48 scan/patient ($p$=0.006) with a corresponding 36% reduction in non-indicated scans ($p$=0.07). Overall rule compliance was 73.6%. After applying the rule-specific inclusion and exclusion criteria, applicability was the highest in QMH algorithm, followed by PECARN, CHALICE and finally CATCH.

Conclusion:
Compared with the other three CDRs in a large cohort, the QMH algorithm carried greater specificity for ciTBI while maintaining an excellent safety profile, with clear recommendation for each risk category. It also had the highest rule-specific applicability when used as designed. This study forms the statistical basis for application and further validation of this rule. Future addition of biomarkers (e.g., S100B) could lead to additional safe reduction in unnecessary CT scans.

## *Region 9 – Basic Science*

# A Novel 4D Volumetric M-Mode Ultrasound Scanning Technique to Support Automated Hemorrhage and Physiologic Monitoring

Sahil Patel, MD

**Introduction**:
Prompt intravascular volume assessment and monitoring is critical in numerous settings including hemorrhagic shock, trauma, burn injury, surgery, and sepsis. Point of care ultrasound (POCUS) is a relatively low-cost and widely available technology that is suitable for rapid intravascular volume assessment (e.g., inferior vena cava ([IVC] POCUS) but is limited by poor intra- and inter-operator reproducibility and the need for trained personnel. We devised a novel 4-dimensional (4D) volumetric M-mode (VMM) US scanning technique that allows for IVC measurement and heart and respiratory rate monitoring over time to aid in early diagnosis of hypovolemia/hemorrhage and guide resuscitation.

**Methods/Technical Approach**:
Swine model assessment –7 animals underwent a previously published swine model of pressure-controlled hemorrhagic shock with fluid resuscitation. Ultrasound scans were performed at least once per protocol phase (baseline, hemorrhage, or resuscitation). 4D VMM technique was used, which expands upon the spatial coverage of standard M-mode scanning (depth v time) by including lateral image direction. The scan was run for a minimum of 1 to 2 minutes, with slow repeated tilting of the scanhead from side to side. The 2D ultrasound images were then formatted in a 3D volume to provide a time series that captured the changes in vessel size with respiration and volume status changes. Planes were then extracted from the volume at multiple lateral locations and at multiple depths to find and track the target of interest. Three longitudinal slices of the IVC were obtained over the three time points during the swine hemorrhagic shock protocol. The vessel walls were manually traced to identify maximum and minimum diameter during the respiratory cycles. Horizontal planes (lateral vs. time) were selected to extract respiratory and cardiac cycle data. MATLAB (The MathWorks, Inc., MA, USA) was used to extract and measure traced vessel walls. Mean IVC diameter was calculated at each measurement time point in the shock/resuscitation protocol. IVC collapsibility was calculated using the equation $CI = 100*[(D_{max}-D_{min})/D_{max})]$ to measure the respiratory variation of the IVC diameter. ΔIVC was calculated as Dmax-Dmin.

**Results**:
There was a statistically significant difference in mean IVC diameter between protocol phases (baseline, hemorrhage, resuscitation) as demonstrated by one-way ANOVA ($F(2, 11) = 5.23$, $p = 0.025$). A Tukey post hoc test showed that the mean IVC diameter in the baseline phase was significantly greater than in the hemorrhage phase ($p=0.020$) and that there was no significant different in mean IVC diameter between baseline and resuscitation ($p = 0.064$) or hemorrhage and resuscitation phases ($p = 0.531$). There was no statistically significant difference in mean collapsibility or ΔIVC between protocol phases. Heart rate and respiratory rate were measured by detecting cyclic horizontal tissue shifts in the horizontal plane data, and these corresponded with available swine monitoring values. The respiratory rate, measured using VMM images, was 13.0864 breaths per minute and was consistent with the known ventilator rate of 13 breaths per minute. The heart rate measured using VMM images showed an increase in heart rate after hemorrhage and decrease in heart rate after a period of resuscitation.

**Conclusion:**
4D VMM identified IVC changes corresponding to blood loss and resuscitation during hemorrhagic shock as well as heart and respiratory rates. This multi-dimensional US approach has potential to reduce operator variability and provide important and actionable information during treatment of shock. Further studies are underway to quantify differences in 4D VMM parameters throughout stages of hemorrhagic shock and resuscitation.

## *Region 2 – Clinical Research*

# Immediate Weight-Bearing for Distal Femur Fractures Fixed with a Lateral Locking Plate Leads to Decreased Short-Term Complications without Increased Failure Rates

Sally Trout, MD

Background:
Distal femur fractures are challenging injuries to treat. Historically, after operative fixation, 1-to-3 months of non- or partial-weight bearing is prescribed. Allowing immediate weight-bearing , particularly in elderly patients, is desirable due to the well-known benefits of early mobilization. This study aims to compare the clinical and radiographic outcomes of full versus modified weight bearing of distal femur fractures treated with lateral locked plating.

Study Design:
Data was retrospectively analyzed for all patients who underwent lateral locked plate fixation for an acute distal femur fracture at one of four area hospitals between October 2011 and April 2022. All surgeries were performed by a fellowship-trained orthopaedic trauma surgeon. AO/OTA Class 33-A, B, C and periprosthetic fractures with well-fixed components were included. Patient demographics, comorbidities, weight-bearing status, 30-day complications (readmission, return to operating room, myocardial infarction, pulmonary embolism, deep vein thrombosis, cerebrovascular accident, surgical site infection, pneumonia, mortality), and 1-year mortality were recorded. Hardware displacement, fracture displacement, implant failure, malunion, nonunion, and time to union were assessed for all patients with an adverse event, 3-month event-free follow-up, or follow-up to fracture union. Statistical analysis was performed using heteroscedastic t-tests and Chi-squared or Fisher's Exact tests. Binary logistic regression and multiple linear regression were used to determine the relationship between covariates and radiographic and clinical outcome measures.

Results:
124 patients met inclusion criteria. Immediate weight-bearing was permitted in 76 patients (61.3%) (WBAT). The WBAT group was older (83.2 ± 10.5 vs. 68.9 ± 15.8 years, $p < 0.001$) and had a lower body mass index (28.1 ± 6.4 vs. 30.8 ± 7.9, $p = 0.016$) than the restricted weight-bearing group (RWB). There were more peri-implant fractures in the WBAT group (64.4% vs. 41.6%, $p = 0.013$). All open fractures were in the RWB group (12.5% vs 0%, p = 0.003). Intra-articular fractures were significantly more likely to be RWB (55.2% vs 20.0%, p < 0.001). The incidence of any complication within 30 days was lower in the WBAT group (7.9% vs. 25.0%, $p = 0.008$) but there was no difference in the types of complications encountered. There was no difference between RWB and WBAT for 30-day (6.3% vs. 2.6%, p = 0.374) or 1-year mortality (18.9% vs. 25.5%, 0.468), hardware displacement, implant failure, fracture displacement, malunion, nonunion, or time to union (10.5 ± 3.2 vs. 11.3 ± 3.5 weeks, 0.381). Binary logistic regression found that age at time of fracture (OR = 0.885, p = 0.049) and Charlson Comorbidity Index (CCI) (OR 0.478, p = 0.012) significantly predicted mortality at 1 year. Patients who were WBAT (OR 0.207, p = 0.041) and those with lower body mass index (BMI) (OR 1.095, p = 0.040) had significantly lower 30-day complications while CCI (OR 1.547, p = 0.023) predicted increased rates of complications.

Conclusion:
Immediate weight-bearing after fixation of distal femur fractures with a lateral locking plate is associated with fewer early complications than restricted weight-bearing. Weightbearing status, increasing BMI, and higher CCI were independent predictors of 30-day complications. Immediate weight-bearing was not associated with an increase in fixation failure.

# Patterns of Opioid Use Among Trauma Patients: A National Cohort Study

Sophia Engel, MD, MSc

Background:
Previously, high rates of opioid use among trauma patients have been reported, with up to one-fifth utilizing such medication long-term (≥ 90 days). Due to an increasing awareness of potential hazards posed by long-term opioid use (LTU), opioid prescription practices have been challenged, potentially altering these figures. Additionally, previous LTU definitions are inconsistent and simplistic, disregarding important aspects like dispensation dose and consumption consistency. Using recent European trauma data and an improved definition of LTU, the present study aimed at describing peritraumatic patterns of opioid use, and elucidating reasons for LTU.

Study Design:
A population-based retrospective cohort study using 2015-2018 data from the Norwegian Trauma Registry (n=26562), encompassing all injured patients treated at trauma-receiving hospitals in Norway. Opioid dispensations (Anatomical Therapeutic Chemical groups N02A and N07BC) for the year preceding and two years following injury were retrieved from the Norwegian Prescription Database, which covers all prescription drugs dispensed in Norway. Patients with ≥ 2 opioid dispensations 91-180 days apart and receiving ≥900 Morphine Milligram Equivalents (MME) during days 0-90 were classified as long-term opioid users from day 90 onwards. All other opioid use was considered short-term (STU). Opioid dispensations of all patients with LTU during the first year after trauma were screened for chronic pain and palliative care reimbursement codes, as well as preparations typically used in opioid substitution treatment (OST).

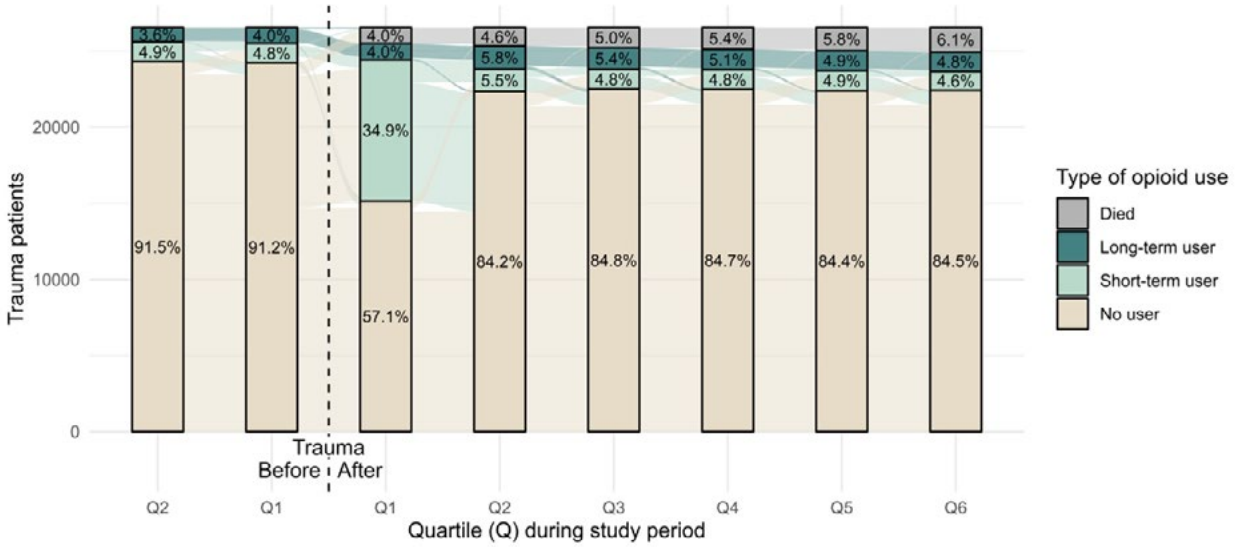



Fig1. Flow diagram visualizing changes in patterns of opioid use from 6 months before to 18 months after trauma. Death rates per quarter are displayed as a relevant competing event.

Results:
About 9% of patients used opioids in the six months preceding trauma. STU increased significantly during the first quarter after injury but returned to pre-trauma levels within the two subsequent quarters. Posttraumatic increases in LTU were less pronounced and regressive. Only few patients changed from LTU to STU or no opioid use (Fig.1). Moreover, for any quarter, median MME's dispensed per day were significantly higher for LTU compared to STU ($p < .001$). Of patients exhibiting LTU during the first year following injury, 36.4% (n=694) were reimbursed opioids for chronic pain, 6.0% (n=114) for palliative care and, 13.3% (n=254) dispensed preparations typically used in OST.

Conclusion:
Most Norwegian trauma patients do not dispense opioids after trauma. Of those who do, about 70% discontinue such treatment within six months from injury. LTU appears largely consistent, with rather small and regressive posttraumatic increases. Importantly, for over 50% of LTU medical indications could be identified, highlighting a strong need for chronic pain treatment. As the clinical viability of long-term opioid therapy for chronic pain is highly debated, alternative treatments and preventive efforts limiting LTU among trauma patients are urgently needed.

# Prolonged Hourly Neuro Exams are Associated with Increased Delirium and No Discernible Benefit in Mild/Moderate Geriatric TBI

Jose Aldana, MD

Introduction:
The current standard of care for traumatic brain injury (TBI) is to monitor them with serial Neurologic Examinations (NE) for evidence of progression. There is limited data about the efficacy of frequent NE, and their effects on sleep-wake cycles predispose patients to an increased delirium rate.
We hypothesized that geriatric TBI patients undergoing hourly (Q1) NE for prolonged periods would have an increased incidence of delirium.

Methods:
Patients >65 years admitted to the ICU from 2019 to 2020 with mild/moderate acute TBI (GCS>9) and orders for serial NE were included. We excluded patients with AIS Score >2 in any anatomical region other than the head. Cohorts were stratified by the duration of exposure to continuous Q1-NE,into Prolonged (≥24h) and Not Prolonged (<24h). We evaluated delirium [Confusion Assessment Method (CAM-ICU positive)], radiological deterioration from baseline images, neurological deterioration(new focal neurological deficit, abnormal pupillary exam, or GCS decrease by >2), and neurosurgical procedures.

Results:
A total of 255 patients with a mean age of 79.6(±8) were included. 75 (29.4%) received prolonged Q1-NE. The prolonged Q1-NE group had higher ISS [17±8.1 vs 13.8±6.1, p0.005] with similar AIS Head [2.8±1.4 vs 2.6±1.2, p0.273], significantly higher delirium rate [61.3% vs 35%, p< 0.001], and a longer Hospital/ICU length of stay [9.7±8.7 vs 5.7±4.9; 4.6±3.8 vs 2.8±2.3, p< 0.001] when compared to the Not Prolonged Q1-NE group. 15 patients (5.9%) had neurosurgical procedures performed. None of these were the direct result of findings on NE. Multivariate logistic regression showed prolonged Q1-NEas the only independent risk factor associated with a 2.7-fold increase in delirium rate (p0.002, CI 1.45-4.96). Based on these findings, the Number Needed to Harm for prolonged Q1-NE was 3.8 patients.

Conclusion:
Geriatric patients with mild/moderate TBI exposed to hourly neurological examination for periods longer than 24 hours had nearly a 3-fold increase in ICU-Delirium rate. In this population, 1/5 patients exposed to a prolonged Q1-NE is harmed by the development of delirium. No patients were found to directly benefit as a result of more frequent neurological examinations.

*There will be a 20–30-minute break before continuing with the next presentation*

## *Region 8– Basic Science*

# Platelet Releasates Mitigate the Endotheliopathy of Trauma

Lauren Gallagher, MD

Introduction:
Impaired hemostasis, altered endothelial barrier function, and dysregulated inflammation are all drivers of thromboinflammatory complications after trauma which take the form of hemorrhagic shock, multi-organ failure and infection/sepsis. Although platelets are well known for their roles in hemostasis, they also play a key role in thromboinflammatory pathways as regulators of endothelial health by promoting endothelial barrier protection and stimulating angiogenesis. When activated, platelets degranulate releasing multiple active substances for promoting angiogenesis, accelerating healing, and mediating host defense. We hypothesized that the soluble environment formed by trauma platelet releasates (TPRs) attenuates thromboinflammation via mitigation of trauma induced endothelial permeability and omic reprogramming.

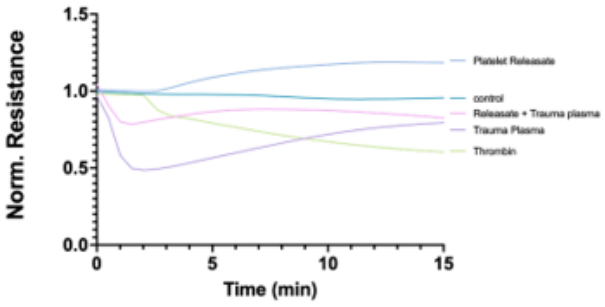
Methods:
Blood was collected from injured patients and centrifuged to create platelet-rich plasma (PRP) to which acid-citrate-dextrose was added. The PRP was recentrifuged to form a platelet rich pellet after discarding the supernatant. The platelet rich pellet was resuspended in calcium to induce platelet activation and degranulation generating TPRs. Trauma plasma (TP) from injured patients was collected in parallel. Human umbilical vein endothelial cells were treated independently and with various combinations of TPR and with 10% TP. Permeability was assessed via resistance measurement by Electric Cell-substrate Impedance Sensing (ECIS) and quantified by the areas under their curves (AUC).

Results:
TP induced endothelial permeability whereas TPR decreased endothelial permeability when compared to untreated cells (control). When TP and TPR from injured patients were mixed *ex vivo*, TPR mitigated TP-induced permeability (Figure 1A), with significant increase in AUC when compared to TP alone (15.16 vs. 10.27 $p < 0.001$, Figure 1B). Overall, TP resulted in decreased AUC and TPR resulted in significantly greater AUC of normalized transendothelial electrical resistance on ECIS compared to TP (Figure 1B).

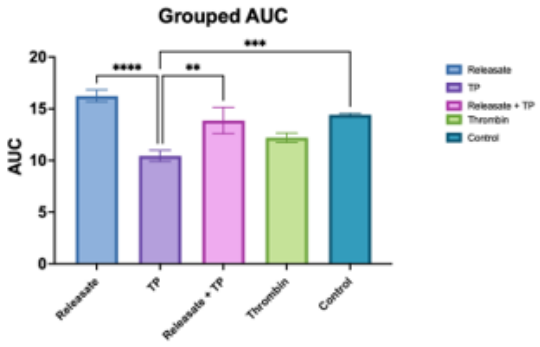
Conclusion:
TPRs provide endothelial barrier protection against TP-induced endothelial permeability. Our findings highlight a potential beneficial action of activated platelets on the endothelium in injured patients. Ongoing work in our lab is examining the proteomics and metabolomics of TPRs on endothelial cells exposed to TP for a comprehensive analysis of this biological matrix. Clinical implications of this study suggest that the soluble contents from platelet degranulation may represent a mechanism of platelets which mitigates the endotheliopathy of trauma, and that activated platelets may prove a promising therapeutic target in the complex integration of thrombosis, endotheliopathy, and inflammation in trauma.

**Figure 1**

**A)**


Norm. Resistance
1.5
1.0
0.5
0.0
0
5
10
15
Time (min)
Platelet Releasate
control
Releasate + Trauma plasma
Trauma Plasma
Thrombin

**B**


Grouped AUC
AUC
20
15
10
5
0
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Releasate
TP
Releasate + TP
Thrombin
Control

## *Region 14 – Clinical Research*

# Drugs of Abuse and Its Relation with Trauma and Its Severity

María Agustina Pienovi Reyes, MD, Edward Delgado, MD, FACS, Marcelo Pontillo, MD, Santiago Dardanelli, MD, Julio L. Trostchansky, MD, FACS, Fernando Machado, MD, FACS

Introduction:
Multiple international articles describe trauma as a growing pandemic and its severity is related to the use of substances of abuse. Uruguay is not left out of this internationally known situation. Besides, it has little national evidence to create new decisions and public policies.

Objectives:
To characterize the relationship between trauma, its severity, and the consumption of drugs of abuse in patients assisted in the Emergency Department of the Hospital de Clínicas Materials and methods: descriptive cross-sectional study; the population studied included all the patients assisted for any traumatic event that involved transmission of kinetic energy in the emergency service of the Hospital de Clínicas from July to September 2022. Closed-question forms were used to collect information using the variables included in the study. Blood samples were requested to detect alcohol, marijuana and cocaine in urine. The severity of the trauma was assessed using the Injury Severity Score (ISS).

Results:
310 patients were included in the study; 36% had at least one positive drug and 27% of all study patients had severe trauma. 36.7% of the patients included suffered a traffic accident. A statistically significant association was found between the consumption of substance abuse and the occurrence of a severe traumatic event ($p = 0.000$). However, no relation was found between the concentration of the substance in plasma or urine and the occurrence of a traumatic event with a higher ISS.

Conclusion:
Consuming a substance of abuse regardless of its level in plasma or urine is linked to the occurrence of severe trauma, associated with greater healthcare requirements.

Key words: trauma, ISS, drugs of abuse, traffic accidents, zero tolerance law.

# Standard ROTEM Protocols May Fail to Identify Coagulopathy in Hypothermic Trauma Patients

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Background:
Hypothermia causes dysregulation of the coagulation cascade, which is often amplified in trauma patients experiencing major blood loss. Rotational thromboelastometry (ROTEM) is commonly used to measure coagulopathy; however, samples are warmed to 37 degrees Celsius during analysis. We aim to compare ROTEM samples at standard protocol (37C) to hypothermic protocol (patient's native temperature at time of collection).

Study Design:
Prospective, single-center study in hypothermic (core temperature <35C) trauma patients. Paired ROTEM samples were obtained and analyzed using standard and hypothermic protocol. Wilcoxon tests were used to compare samples.

Results:
Twenty-four paired ROTEMs from 12 patients were analyzed. Median age was 48 (38-59), and 50% were male. The average temperature of hypothermic ROTEM assay was 34.2C. Clot Formation Times (CFT) were prolonged within the hypothermic assay by an average of 45.4 seconds (EXTEM) and 51.3 seconds (INTEM), $p<0.01$ for both (Figure 1). Maximum Clot Firmness (MCF) was decreased by an average 3.0 mm (EXTEM, $p=0.01$) and 3.3 mm (INTEM, $p<0.01$). EXTEM and INTEM A10 and A20 values additionally showed decreased amplitude using the hypothermic protocol (all $p<0.01$). Using local ROTEM-directed transfusion guidelines, 25% of patients who did not meet platelet transfusion criteria based on standard protocol results, met transfusion criteria based on hypothermic protocol results.

Conclusion:
ROTEM results differed between protocols, with abnormal platelet function parameters more frequently seen using the hypothermic protocol. This data indicate that ROTEMs conducted at a native hypothermic temperature may better guide coagulopathy correction compared to standard warm assay protocols. More extensive studies are needed to validate temperature thresholds to perform hypothermic ROTEM assays and how hypothermic ROTEM-directed resuscitation impacts blood product utilization and outcomes.

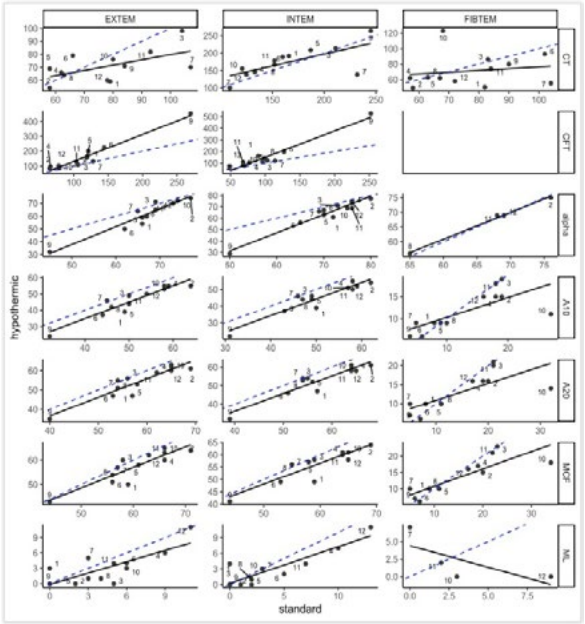


Figure 1: ***Standard vs Hypothermic Measures***. *Blue dashed line represents line of identity.*

## *Region 3 – Clinical Research*

# Challenging Neurosurgical Futility — Traumatic Subdural Hematoma Evacuation Is Associated with Favorable Discharge Disposition in Patients with Poor Neurologic Examination

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Background:
Early neurologic exam guides neurosurgical decision-making among patients with traumatic subdural hematoma (SDH). Poor neurologic exam at presentation may result in a lower likelihood of operative neurosurgery due to perceived futility. We hypothesized that operative neurosurgery for SDH is associated with favorable discharge disposition, even among patients with poor neurologic exam and at the extremes of age.

Study Design:
Data for adult patients with traumatic SDH and midline shift ³5 mm (MLS) due to blunt severe TBI (GCS <8) were derived from the NTDB (2017-19). Patients that died in the ED, with advanced directives limiting care, or nonsurvivable injury (AIS=6) were excluded. The study exposure was operative neurosurgery, defined as burr hole evacuation, craniotomy, or craniectomy. The primary outcome was favorable discharge disposition, defined as discharge to home or inpatient rehabilitation (as opposed to death or long-term care). Hierarchical logistic regression was used to measure the association between operative neurosurgery and favorable discharge disposition, adjusting for patient baseline and injury characteristics. We tested for effect modification to determine if the observed association varied by pupillary response, a common means of prognostication (2R, both reactive; 1R, one reactive; 0R, neither reactive). Subgroup analyses included patients with worst-case neurologic exam (GCS 3 and 0R) and across quartiles of age (<35, 36-55, 56-75, >75 years).

Results:
We identified 13,569 patients with traumatic SDH presenting with MLS and GCS <8. 0R pupillary response was present in 47% of patients and 66% presented with GCS 3. Operative neurosurgery was pursued in 39% of patients. Favorable discharge was achieved in 23%, while 62% died. As expected, patients that received neurosurgery tended to be younger, with more favorable presenting GCS and pupillary exam. Conversely, patients with 0R pupils (vs. 2R) were significantly less likely to undergo neurosurgery (33% vs. 50%) or have favorable discharge (10% vs. 39%). After risk adjustment, operative neurosurgery was associated with two-fold increased odds of favorable discharge (OR 1.9; 95% CI 1.8–2.1). While this effect was modified by pupillary reactivity (*P* for interaction <0.05), neurosurgical intervention was associated with higher probability of favorable discharge in all groups (Figure 1). Among patients with 0R pupils, neurosurgery was associated with an increase in likelihood of favorable discharge from 3.8% (95% CI 3.2–4.4%) to 12% (95% CI 11–14%). In subgroup analysis of patients with GCS 3 and 0R pupils (N = 4,984), neurosurgery was strongly associated with higher odds of favorable discharge (OR 2.9; 95% CI 2.3–3.7). While neurosurgery was associated with improved likelihood of favorable discharge across all ages, this potential benefit was significantly diminished among the eldest (>75 years) with poor pupillary exam. Specifically, neurosurgical intervention provided an increase in probability of favorable discharge from 6.5% to 12% among patients >75 years old with 2R pupils, but only from 1.2% to 2.2% among those with 0R pupils.

Conclusion:
Among patients with severe TBI and MLS due to SDH, operative neurosurgery is associated with a significantly improved likelihood of favorable discharge. Operative neurosurgery should be offered to all young patients with SDH regardless of presenting neurologic examination. However, this recommendation cannot be made in elderly patients with poor neurological findings owing to an exceedingly low probability of favorable outcome.

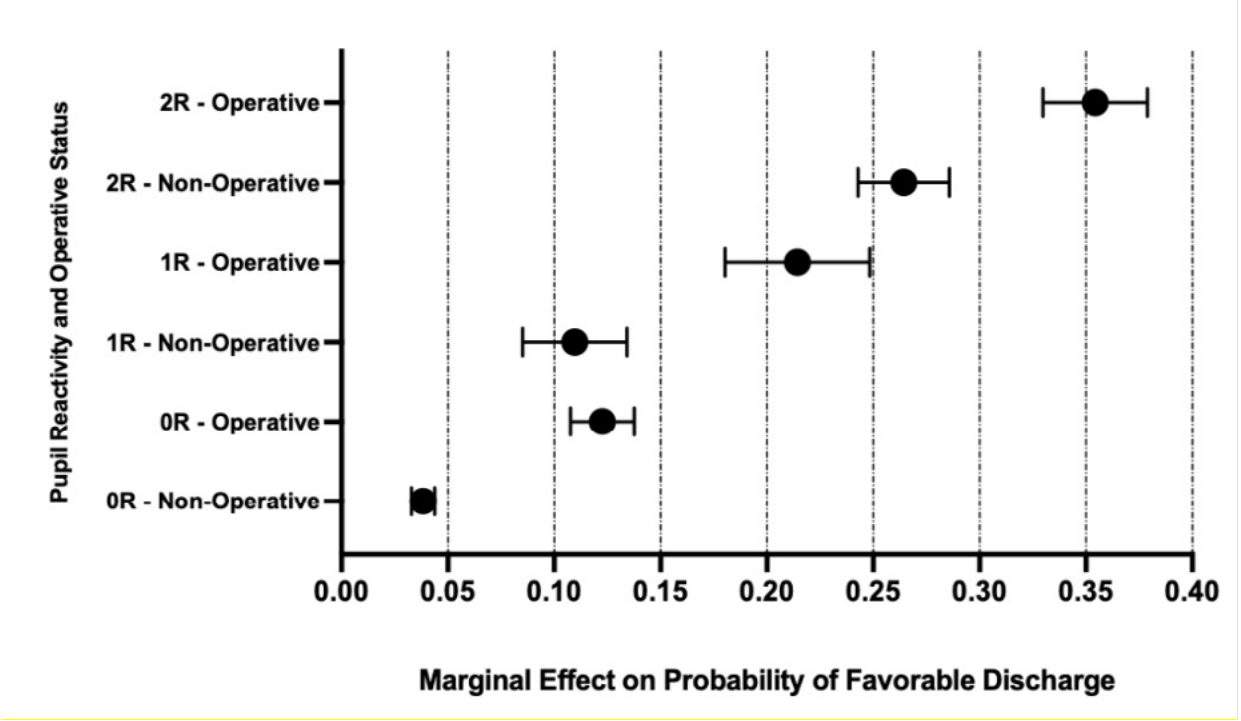


Figure 1. Probability of favorable discharge among all patients with severe TBI and midline shift due to SDH. Probabilities are stratified by operative vs. non-operative neurosurgical management. Error bars represent 95%CIs.

## *Region 4 – Basic Science*

# Post-Injury Pneumonia Induces a Unique Blood Microbiome Signature

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Background:
Previous preclinical studies have demonstrated an altered gut microbiome after traumatic injury; however, the impact of post-injury sepsis on gut epithelial permeability and particularly the consequent blood microbiome remains unknown. We hypothesized that a preclinical model of polytrauma with post-injury pneumonia would result in impaired gut permeability leading to specific blood microbiome arrays that may differ between sexes.

Study Design:
Male and proestrus female Sprague-Dawley rats (n=16/group) aged 9-11 weeks were subjected to either polytrauma (PT+PNA) (lung contusion, hemorrhagic shock, cecectomy, bifemoral pseudofractures) or PT plus 2-hours daily chronic restraint stress (PT/CS+PNA) with postinjury day 1 inoculation with *pseudomonas* pneumonia or naive controls. Infected cohorts were treated with twice daily imipenem. Whole blood microbiome was measured on day 2 using high-throughput 16S rRNA sequencing and QIIME2 bioinformatics analyses. Microbial alpha-diversity was assessed using Chao1 (number of different unique species) and Shannon (species richness and evenness) indices. Beta-diversity was assessed using principle coordinate analysis. Intestinal permeability was evaluated by plasma occludin and lipopolysaccharide-binding protein (LBP) assays. Pairwise comparisons were performed in 'R' or GraphPad, with significance defined as $p<0.05$ between males versus females.

Results:
PT+PNA and PT/CS+PNA had increased intestinal permeability with significantly elevated LBP and occludin in plasma compared to naïve ($p<0.03$). Accordingly, bacteremia was not detected in naïve controls but both PT+PNA and PT/CS+PNA had bacteremia on day 2. The PT/CS+PNA blood biome showed dominance of *Streptococcus* compared to PT+PNA ($p<0.01$). Females PT/CS+PNA had a significant abundance of *Staphylococcus* in the blood biome compared to male counterparts ($p<0.01$) (**Figure 1**).

Conclusion:
Multicompartmental trauma with post-injury pneumonia results in increased intestinal permeability and bacteremia with a unique blood biome. In particular, sexual dimorphisms are evident in the blood biome after severe injury with unique bacterial species in males and females. These findings suggest that post-injury sepsis has clinical significance and could influence outcomes after severe trauma and critical illness.

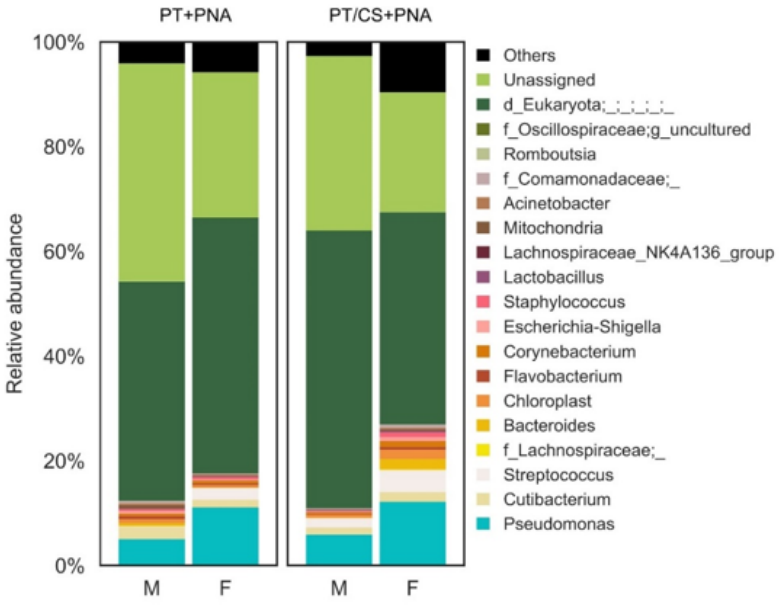



**Figure 1.** Blood microbiome composition in male (M) and female (F) rats after PT+PNA or PT/CS+PNA at day 2.

## *Region 12 – Clinical Research*

# Influence of Health Insurance Status on Timing of Mortality After a Withdrawal of Life Sustaining Treatment Decision for Adults with Isolated Severe Traumatic Brain Injury

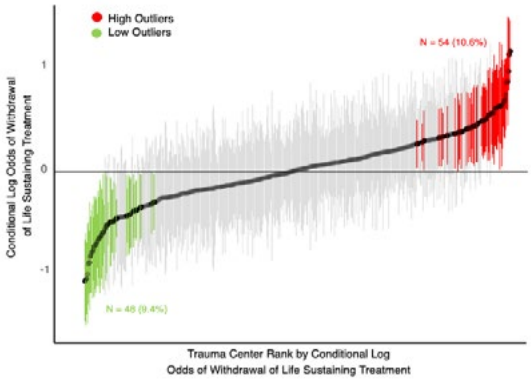
Armaan K. Malhotra, MD

Background:
Withdrawal of life sustaining treatment (WLST) in severe traumatic brain injury (TBI) is complex with a paucity of standardized guidelines to inform practice patterns. We hypothesized that there exists a presence of variability in WLST decision-making across centers, which could have important implications for equitable trauma and intensive care provision. We therefore aimed to evaluate the presence of between-center variability in WLST practice patterns across North American trauma centers.

Methods:
This retrospective study utilized data collected from trauma centers through the American College of Surgeons Trauma Quality Improvement Program between 2017-2020. We included adult patients (≥16 years) with severe TBI and a documented decision for WLST. Data analysis was conducted in 2023. We constructed a series of hierarchical logistic regression models to adjust for patient, injury and hospital attributes influencing WLST; residual between-center variability was characterized using the median odds ratio (MOR). The impact of disparate WLST practices was further assessed by ranking centers by their conditional random intercept and assessing mortality, length of stay (LOS) and WLST between quartiles.

Results:
A total of 85511 subjects with severe TBI were treated across 510 trauma centers, of which 20,300 (24%) had WLST. Patient-level factors associated with increased likelihood of WLST were advanced age, white race, self-pay, or Medicare insurance status (compared to private insurance). Black race was associated with reduced tendency for WLST. Higher severity intracranial and extracranial injuries also increased likelihood for WLST as well as treatment in non-profit trauma centers. After adjustment for patient and hospital attributes, the MOR was 1.44 (1.40-1.48 95% CI), suggesting residual variation in WLST between centers (Figure 1). When centers were grouped into quartiles by their propensity for WLST, there was increased adjusted mortality (OR 1.37, 95% CI 1.30-1.42) and shorter LOS ((-2.42 days) in fourth compared to first quartile centers. In absolute terms, for 1,000 patients presenting to first compared to fourth quartile centers, there would be 135 more patients receiving WLST and 52 more deaths.

Conclusion:
We have demonstrated significant inter-facility differences in end-of-life practices for severe TBI patients treated in North American trauma hospitals. These disparate practices were associated with meaningful differences in mortality and LOS across centers, suggesting that disparate WLST practices may play a causal role in mortality differences across centers. Recognition and exploration of the observed between-hospital WLST practice heterogeneity is necessary to ensure health system equity for patients with severe TBI.



# Comparing Risk-Adjusted Trauma Mortality Between Systems with Different Resource Availability: MGAP Is a More Appropriate Adjustment Score

Stas Amato, MD

Background:
Our previous study comparing risk-adjusted trauma mortality in India, a low/middle income country (LMIC) and USA, a high-income country (HIC), demonstrated that adjusted mortality (adjusted for age, injury burden, measured by injury severity score [ISS], and presenting physiology) difference was much higher than the crude mortality difference. However, ISS is dependent upon advanced imaging, often lacking in LMIC, to catalogue all injuries. The current study addresses this limitation by utilizing an alternative, validated trauma score (MGAP – Mechanism, Glasgow coma score, age, and systolic blood Pressure) that is not dependent upon imaging intensity. We hypothesize that the adjusted mortality in India is still higher when adjusted solely by MGAP, but the degree of difference is less than when adjusted with ISS based models.

Methodology:
A retrospective cohort study of two trauma databases: one from USA, a HIC (National Trauma Databank [NTDB]) and the other from India, a LMIC ([Towards Improving Trauma Care Outcomes [TITCO]). Risk adjusted analysis was performed solely based on MGAP. Overall mortality was compared before adjustment (crude) and after adjustment (adjusted). The MGAP adjusted mortality was compared to the historical analysis of adjusted mortality using ISS based models. Additional subgroup analyses were performed for patients presenting with or without physiologic compromise: 1) shock (SBP <90mmHg); 2) respiratory distress (rate >29 or <10); and 3) neurologic derangement (GCS <14).

Results:
687,407 adult patients (NTDB: 675,611; TITCO: 11,796) were included. Crude mortally was 8-fold higher in India (23.15% vs 2.79% – p<0.001). MGAP based mortality was 11-fold higher (OR 11.44, 95% CI 10.84-12.07 – p<0.001). While the MGAP adjusted mortality was significantly higher in India, the difference was less than our previous adjusted analysis with ISS based models where the mortality was 15-times higher (OR 15.61, 95% CI 12.83-19.99 – p<0.001). Subgroup analysis based on patients with or without physiologic compromise demonstrated that with MGAP based adjustment, odds of increased mortality in India were higher for those without physiologic compromise when comparted to those with compromise: Shock (Present OR 10.44 [95% CI 9.84-11.08] vs Absent OR 14.01 [95% CI 11.86-16.62]); Respiratory distress (Present OR 7.87 [95% CI 7.23-8.60] vs Absent OR 10.50 [95% CI 9.87-11.23]) and neurologic derangement (Present OR 9.14 [95% CI 8.56-9.75] vs Absent OR 12.98 [95% CI 11.65-14.47]).

Conclusion:
Results of the current study comparing risk adjusted mortality after injury, utilizing MGAP, a trauma score not dependent upon imaging intensity, have multiple important implications: 1) it validates the findings of our previous study – risk adjusted mortality is much higher in LMIC compared to HIC than what is suggested by looking only at crude mortality – while addressing the limitation of the previous analysis; 2) it suggests that studies comparing mortality across systems with different levels of resources should use scoring systems not dependent upon availability of advanced imaging for risk adjustment; and 3) the increased odds of mortality in LMIC being higher for the non-physiologically compromised patients, underscores that relatively simple, low-cost interventions focused on timely utilization of standardized treatment pathways/protocols have the potential of significantly improving mortality after injury.

## *Region 9 – Clinical Research*

# It's All in Your Head: Safety of Weight-Based, Targeted Enoxaparin Prophylaxis in TBI Patients

Lisa Kurth, MD

Background:
Standard enoxaparin (LVX) dosing is inferior to weight-based, anti-Xa targeted dosing regimens for venous thromboembolism (VTE) prophylaxis in trauma patients. Despite this, many trauma guidelines support empiric low-dose LVX (30mg BID) in patients with traumatic brain injury (TBI) for fear of expansion of intracranial hemorrhage (ICH) and adverse neurological outcomes. We hypothesized that weight-based, anti-Xa targeted dosing is safe and effective in trauma patients with TBI.

Study Design:
We retrospectively reviewed TBI patients admitted to a Level I trauma center from 2015-2022. LVX was cleared to start 48 hours after a stable CT head. TBI patients who received weight-based LVX dosing (50-59kg, 30mg BID; 60-99kg, 40mg BID; ≥100kg, 50mg BID) and had a peak anti-Xa level assessed (goal 0.2-0.4 IU/mL) were included. Charts were reviewed to assess for ICH expansion after initiation of LVX.

Results:
Of the 516 TBI patients included, there were eight instances (1.5%) of ICH expansion. One patient (1.7%) in the 30mg cohort developed ICH expansion and had a supra-prophylactic anti-Xa level at the time of diagnosis. Seven patients (1.7%) in the 40mg cohort developed expansion; none of these patients were supra-prophylactic based on anti-Xa levels. No patients in the 50mg cohort developed ICH expansion after LVX initiation.

| | | Lovenox Dosing (mg BID) | | | |
|---|---|---|---|---|---|
| | 30 | 40 | 50 | Total | p-value |
| Number of Patients | 60 | 404 | 52 | 516 | |
| Mean Age (Years) | 63 | 54 | 48 | | <0.001 |
| Mean Weight (kg) | 57.3 | 78.16 | 113.44 | | <0.001 |
| Increase ICH | 1 | 7 | 0 | 8 | 0.634 |

Conclusion:
In this single center pilot study, weight-based LVX dosing did not result in significant ICH expansion, directly challenging current VTE prophylaxis guidelines for patients with TBI. These results should serve as a platform for multi-center prospective data collection to ultimately determine the safety and efficacy of weight-based LVX prophylaxis regimens in TBI patients.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