

ANNANAPOLIS EXPERIENCE
Tour the Chesapeake Bay with your personal tour guides, Dr. Feliciano \& Dr. Rozycki! Enjoy an afternoon cruise, medical excursions, and a private dinner.

SANITY MAINTENACE
Welcome to a surgeon owned and operated outdoor retreat in North Central Missouri! Rich with wildlife and peaceful outdoor surroundings.

SAILING ON THE PACIFIC OCEAN
Enjoy a two night stay in the home of Dr. \& Mrs. Sise over looking the San Diego Bay. Best of all, Dr. Sise will handle all of the cooking!

GOLF WITH THE FOUR AMIGOS
Get ready to laugh and join our funniest past-presidents for a tropical round of golf in Waikoloa, HI.

WATERSKI WEEKEND
Spend the weekend in Sacramento and learn how to ski from a 2018 world champion three event skier! Enjoy a pool, spa, and dinner overlooking the lake.

2 pieces of art by Mrs. Debbie Livingston, Leaves and Shapes \& Iris Lake

Choose from three Level 1 trauma centers
One-of-a-kind, handmade quilt by Dr. Eileen Bulger JTACS \& TSACO publication charge waivers (pssttt... two of each are available!)
Playstation 4 Pro
Lenovo Laptop Roomba i7+

Apple Watch Series 4


## Program Requirements

## 1. Continuing Medical Education Credit Information

## CONTINUING MEDICAL EDUCATION CREDIT INFORMATION

## Accreditation

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American College of Surgeons and the American Association for the Surgery of Trauma. The American College of Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

> AMA PRA Category 1 Credits ${ }^{\mathrm{TM}}$
> The American College of Surgeons designates this live activity for a maximum of 33.00 AMA PRA Category 1 Credits ${ }^{\text {TM. Physicians should claim only the credit commensurate with the extent of their }}$ participation in the activity.
> Of the AMA PRA Category 1 Credits $^{\mathrm{TM}}$ listed above, a maximum of 16.75 credits meet the requirements for Self-Assessment.
> Of the AMA PRA Category 1 Credits ${ }^{\mathrm{TM}}$ listed above, a maximum of 33.00 hours meet the requirements for Trauma.*
> Of the AMA PRA Category 1 Credits ${ }^{\mathrm{TM}}$ listed above, a maximum of 8.00 hours meet the requirements for Pediatric Trauma. *
> Of the AMA PRA Category 1 Credits ${ }^{\mathrm{TM}}$ listed above, a maximum of 6.00 hours meet the requirements for Surgical Critical Care.*
> *The content of this activity may meet certain mandates of regulatory bodies. Please note that 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.

AMERICAN COLLEGE OF SURGEONS DIVISION OF EDUCATION

## 2. PROGRAM OBJECTIVES

The entire meeting is based on scientific research conducted at individual sites and through multicenter sites. The research has been conducted within the past 12-24 months and is being presented at AAST as original work. All presentations are new research and all presentations could not have been presented prior to AAST.

## 3. DISCLOSURE INFORMATION

In compliance 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 see the insert to this program for the complete disclosure list.

For additional information, please visit the ACCME website (see below for definitions).
Commercial Interest: The ACCME defines a "commercial interest" as any entity producing, marketing, re-selling, or distributing health care goods or services used on or consumed by patients. Providers of clinical services directly to patients are NOT included in this definition.
Financial Relationships: Relationships in which the individual benefits by receiving a salary, royalty, intellectual property rights, consulting fee, honoraria, ownership interest (e.g., stocks, stock options or other ownership interest, excluding diversified mutual funds), or other financial benefit. Financial benefits are usually associated with roles such as employment, management position, independent contractor (including contracted research), consulting, speaking and teaching, membership on advisory committees or review panels, board membership, and other activities from which remuneration is received, or expected. ACCME considers relationships of the person involved in the CME activity to include financial relationships of a spouse or partner.
Conflict of Interest: Circumstances create a conflict of interest when an individual has an opportunity to affect CME content about products or services of a commercial interest with which he/she has a financial relationship.

## 4. Commercial Support Acknowledgement

The American Association for the Surgery of Trauma wishes to recognize and thank the following companies for their commercial support of this educational activity:

- SAGES
- Boston Scientific
- US Endoscopy
- ERBE
- Ovesco
- FUIJIFILM Medical Systems USA

AMERICAN COLLEGE OF SURGEONS

## DISCLOSURE INFORMATION

## $78^{\text {th }}$ Annual Meeting of AAST \& Clinical Congress of Acute Care Surgery September 18-21, 2019 Dallas, Texas

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 (planners and speakers/authors/discussants/moderators) has disclosed all financial relationships with any commercial interest (see below for definitions).

Commercial Interest: The ACCME defines a "commercial interest" as any entity producing, marketing, re-selling, or distributing health care goods or services used on or consumed by patients. Providers of clinical services directly to patients are NOT included in this definition. Financial Relationships: Relationships in which the individual benefits by receiving a salary, royalty, intellectual property rights, consulting fee, honoraria, ownership interest (e.g., stocks, stock options or other ownership interest, excluding diversified mutual funds), or other financial benefit. Financial benefits are usually associated with roles such as employment, management position, independent contractor (including contracted research), consulting, speaking and teaching, membership on advisory committees or review panels, board membership, and other activities from which remuneration is received, or expected. ACCME considers relationships of the person involved in the CME activity to include financial relationships of a spouse or partner.
Conflict of Interest: Circumstances create a conflict of interest when an individual has an opportunity to affect CME content about products or services of a commercial interest with which he/she has a financial relationship.

The ACCME also requires that ACS manage any reported conflict and eliminate the potential for bias during the educational activity. Any conflicts noted below have been managed to our satisfaction. The disclosure information is intended to identify any commercial relationships and allow learners to form their own judgments. However, if you perceive a bias during the educational activity, please report it on the evaluation.

| Speakers / Moderators / Discussants | Nothing to Disclose | DISClosure |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Company | RoLE | Received |
| Example: John Smith |  | Company X | Speaker | Honorarium |
| Aaron M. Williams | x |  |  |  |
| A. Britton Christmas |  | UpToDate, Inc | Chapter Author | Royalties |
| Aaron Strumwasser | x |  |  |  |
| Abdul Q. Alarhayem | x |  |  |  |
| Abdul Tawab Saljuqi | X |  |  |  |
| Addison May |  | Atox Bio | Consultant | Consulting Fees |
| Alan Guo | X |  |  |  |
| Alberto Federico Garcia | x |  |  |  |
| Alessandro Orlando | x |  |  |  |
| Alexander Coomey Schwed | X |  |  |  |
| Alexander R Nelson | X |  |  |  |
| Ali Salim | X |  |  |  |
| Alicia Mangram | X |  |  |  |
| Alicia Mohr | X |  |  |  |
| Allen Tanner | X |  |  |  |
| Allison E Berndtson | X |  |  |  |
| Allison Schulman |  | Apollo <br> Endosurgery, <br> Boston Scientific, <br> MicroTech | Consultant, Consultant, Consultant | Consult fees, Consult fees, Consult fees |


| Amanda Beth Sosulski | x |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Amelia C Lucisano | X |  |  |  |
| Amy J. Goldberg | X |  |  |  |
| Amy Makley | x |  |  |  |
| Amy McDonald | X |  |  |  |
| Amy N. Hildreth | x |  |  |  |
| Anaar Eastoak Siletz | x |  |  |  |
| Anamaria Joyce Robles | X |  |  |  |
| Andre Campbell | X |  |  |  |
| Andrew Bernard | X |  |  |  |
| Andrew Doben |  | Zimmer Biomet | Consultant | Royalty/Honoraria |
| Andrew J Kerwin | x |  |  |  |
| Andrew-Paul Deeb | x |  |  |  |
| Angela Ingraham | x |  |  |  |
| Angela M Crawford | X |  |  |  |
| Angela Sauaia | x |  |  |  |
| Anne Mosenthal | x |  |  |  |
| Anne Rizzo | x |  |  |  |
| Anuradha Subramanian | x |  |  |  |
| Areg Grigorian | X |  |  |  |
| Barbara Gaines | x |  |  |  |
| Bellal Joseph | x |  |  |  |
| Ben Zarzaur | X |  |  |  |
| Benjamin Lee Gough | x |  |  |  |
| Benjamin M Hall | X |  |  |  |
| Benjamin Nabil Gayed | x |  |  |  |
| Bijan S Kheirabadi | X |  |  |  |
| Bourke W Tillmann | X |  |  |  |
| Brandon Snook | X |  |  |  |
| Brent Emigh | X |  |  |  |
| Brent Matthews | X |  |  |  |
| Brian Eastridge | X |  |  |  |
| Brian Williams | x |  |  |  |
| Brian Thomas Young | x |  |  |  |
| BrookeAnne Magrum | X |  |  |  |
| Bryan A. Cotton |  | Haemonetics | Consultant | Consulting Fee |
| Bryan W Carr | x |  |  |  |
| C. Caleb Butts | X |  |  |  |
| Caitlin Cohan | x |  |  |  |
| Carlos Brown | X |  |  |  |
| Carlos Mesquita, MD | x |  |  |  |
| Caroline Park | X |  |  |  |
| Carrie Sims | X |  |  |  |
| Chad Ball | X |  |  |  |
| Chadwick Parrish Smith | x |  |  |  |
| Charles Fox |  | Prytime Medical Inc | N/A | Consultant |
| Charles Adam Mouch |  | Blue Cross Blue Shield of Michigan | Independent Contractor | Grant |
| Charles Liu | x |  |  |  |
| Chelsea Hoenes | X |  |  |  |
| Cheryl K Zogg | X |  |  |  |
| Chinmay Bhoot | X |  |  |  |


| Christian Streck | x |  |  |  |
| :--- | :---: | :--- | :--- | :--- |
| Christina Xinyue Zhang | x |  |  |  |
| Christine Gaarder | x |  |  |  |
| Christopher A. Behr | x |  |  |  |
| Christopher D Barrett | x |  | Ownership |  |
| interest |  |  |  |  |


| Eric H Bradburn | X |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Eric Ley | X |  |  |  |
| Erica L.W. Lester | x |  |  |  |
| Eric Pauli |  | CR Bard, Cook, Boston Scientific, Actuated Medical, Springer, UpToDate | Speaking/Clinical <br> Trial, Speaking, Speaking/Consulti ng/SAB, Consulting, Published works, Published works | Honorarium/resea rch support, Honorarium, Honorarium, Honorarium, Royalties, Royalties |
| Erica Ludi | X |  |  |  |
| Erin Grace Andrade | X |  |  |  |
| Erin Hall | X |  |  |  |
| Errington Thompson | X |  |  |  |
| Ethan A Ferrel | X |  |  |  |
| Fahim Habib | X |  |  |  |
| Felipe Vega | X |  |  |  |
| Fernando Kim | X |  |  |  |
| Francois Khazoom |  | Sanofi | Master Student | Medication Rasburicase given by SANOFI |
| Fred Luchette | X |  |  |  |
| Frederick B Rogers | X |  |  |  |
| Fredric M Pieracci |  | DePuy Synthes | Investigator <br> Initiated <br> Researcher | Research Grant |
| Gail Tominaga | x |  |  |  |
| Galinos Barmparas | X |  |  |  |
| Ganesh Sankaranarayanan | X |  |  |  |
| Genna Beattie | X |  |  |  |
| George Kasotakis | x |  |  |  |
| Glen Franklin | X |  |  |  |
| Glen Tinkoff | X |  |  |  |
| Grace Rozycki | x |  |  |  |
| Grant Bochicchio | X |  |  |  |
| Gregory Jurkovich | X |  |  |  |
| Greta Piper | X |  |  |  |
| Heather Dolman | X |  |  |  |
| Heena P Santry |  | Johnson \& Johnson | Consultant | Consulting Fee |
| Henry Obinna Nnajiuba | x |  |  |  |
| Hiroshi Matsuura | X |  |  |  |
| Hunter Burroughs Moore | X |  |  |  |
| Husayn A Ladhani | X |  |  |  |
| Indermeet S. Bhullar | X |  |  |  |
| J. Wayne Meredith | X |  |  |  |
| Jack P Vernamonti | x |  |  |  |
| Jacob A Quick | X |  |  |  |
| Jacob W Roden-Foreman | x |  |  |  |
| Jake Forman | X |  |  |  |
| James Haan | x |  |  |  |
| James M Prieto | X |  |  |  |
| Jamie E Anderson | X |  |  |  |
| Jamie Coleman | X |  |  |  |
| Jan Jansen | X |  |  |  |


| Jared Mark Wohlgemut | X |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Jason Paul Hecht | X |  |  |  |
| Jason Sperry | X |  |  |  |
| Jason W Smith | x |  |  |  |
| Javier Enrique Rincon | X |  |  |  |
| Jay Doucet | X |  |  |  |
| Jay Johannigman | X |  |  |  |
| Jeffrey Claridge | x |  |  |  |
| Jeffrey Marks | X |  |  |  |
| Jennifer Albrecht | X |  |  |  |
| Jennifer Gurney | X |  |  |  |
| Jennifer Hartwell | X |  |  |  |
| Jennings H Dooley | X |  |  |  |
| Jeremy Cannon |  | UpToDate | Author | Royalties |
| Jessica Kramer | X |  |  |  |
| Jessica Robin Burgess | X |  |  |  |
| Joanelle A Bailey | x |  |  |  |
| Joergen Joakim Joergensen | X |  |  |  |
| John Andrew Harvin | X |  |  |  |
| John K Bini | X |  |  |  |
| John Fildes | X |  |  |  |
| John Holcomb |  | Prytime Medical, <br> Arsenal, Cellphire, <br> Zibrio, <br> DecisionHealth | CMO (left April 2019), consultant, consultant, board member, board member | Salary, salary, salary, equity, equity |
| John P Sharpe | X |  |  |  |
| John Roland Taylor |  | Prytime Medical | Speaker/Teacher | Honoraria |
| John W Scott | X |  |  |  |
| Jon Simmons | X |  |  |  |
| Jonathan Morrison | x |  |  |  |
| Jordan Weinberg | X |  |  |  |
| Joseph DuBose |  | Velico Medical, Arsenal Medical, Haemonetics | Consultant, Consultant, Consultant | N/A, N/A, N/A |
| Joseph Ebersole | X |  |  |  |
| Joseph Fernandez-Moure | X |  |  |  |
| Joseph Galante | X |  |  |  |
| Joseph Minei | X |  |  |  |
| Joseph Rappold, MD | X |  |  |  |
| Josephine Grace Hein | X |  |  |  |
| Joshua Calem Dilday | X |  |  |  |
| Joshua D. Jaramillo | X |  |  |  |
| Joy D Hughes | X |  |  |  |
| Juan Duchesne | X |  |  |  |
| Juan Pablo Ramos | X |  |  |  |
| Julie Dunn, MD | X |  |  |  |
| JULIET ALTENBURG | X |  |  |  |
| K Hope Wilkinson | X |  |  |  |
| Kamil Hanna | X |  |  |  |
| KAORI ITO | X |  |  |  |
| Katie O'Connell | X |  |  |  |
| Karen Brasel | X |  |  |  |
| Katherine Marie Kelley | X |  |  |  |
| Katherine Reitz | X |  |  |  |


| Katherine Wright | x |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Kathryn D. Bass, MD | X |  |  |  |
| Kazuhiro Okada | X |  |  |  |
| Keith R Miller | X |  |  |  |
| Kenji Inaba | X |  |  |  |
| Kenneth Stewart | x |  |  |  |
| Kimberly A. Davis | X |  |  |  |
| Krista L Haines | X |  |  |  |
| Krista Kaups | x |  |  |  |
| Kristan Staudenmayer | X |  |  |  |
| Kristen T Carter | X |  |  |  |
| Kristin Salottolo | X |  |  |  |
| Kurun Partap Singh Oberoi | x |  |  |  |
| Kyle D Checchi | x |  |  |  |
| Kyle J Kalkwarf | x |  |  |  |
| L.D. Britt | X |  |  |  |
| L R Tres Scherer III | x |  |  |  |
| Lacey Nicole LaGrone | x |  |  |  |
| Laura Allen | x |  |  |  |
| Laura N Godat | X |  |  |  |
| Laura Moore | x |  |  |  |
| Lauren Michele Sinik | X |  |  |  |
| Lawrence N. Diebel | x |  |  |  |
| Lena Napolitano | X |  |  |  |
| Li Hsee | X |  |  |  |
| Lillian Kao | x |  |  |  |
| Linda A Dultz | X |  |  |  |
| Linda Maerz | X |  |  |  |
| Linda Marie Schutzman | X |  |  |  |
| Lisa M Knowlton | X |  |  |  |
| Louis J Magnotti | x |  |  |  |
| Lucy Zumwinkle Kornblith | X |  |  |  |
| M Margaret Knudson | x |  |  |  |
| Mackenzie Charles Morris | x |  |  |  |
| Manuel Castillo-Angeles | X |  |  |  |
| Marc deMoya | x |  |  |  |
| Marie Crandall | X |  |  |  |
| Marissa Ashleigh Boeck | x |  |  |  |
| Mark Bowyer | X |  |  |  |
| Mark Gestring | x |  |  |  |
| Mark Seamon | X |  |  |  |
| Marta McCrum | x |  |  |  |
| Martin A. Schreiber | x |  |  |  |
| Martin Zielinski |  | Allergan Inc | Consultant | Consulting Fee |
| Mary Margaret Knudson | x |  |  |  |
| Masayuki Yagi | x |  |  |  |
| Matthew B Bloom | X |  |  |  |
| Matthew J Forestiere | X |  |  |  |
| Matthew J. Bradley | X |  |  |  |
| Matthew Lissauer |  | La Jolla Pharmceutical | Speakrs' bureau | Honoraria |
| Matthew Martin | X |  |  |  |
| Matthew P Guttman | x |  |  |  |
| Matthew Tadlock | X |  |  |  |


| Mayur Patel | x |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Megan Brenner |  | Prytime Medical, Inc | Consultant | Ownership Interest |
| Mehreen Kisat | x |  |  |  |
| Melissa Sorensen | x |  |  |  |
| Michael C Cox | x |  |  |  |
| Michael D Jones | x |  |  |  |
| Michael Ditillo | x |  |  |  |
| Michael Nance | X |  |  |  |
| Michael Ordonez | x |  |  |  |
| Michael Sise | x |  |  |  |
| Michael Steven Farrell | x |  |  |  |
| Michael T Meschino | x |  |  |  |
| Michael Ujiki | x |  |  |  |
| Michaela West | x |  |  |  |
| Michel Aboutanos | x |  |  |  |
| Michelle K McNutt | x |  |  |  |
| Mira H Ghneim | x |  |  |  |
| Mitchell Cohen | x |  |  |  |
| Mitsuaki Kojima | x |  |  |  |
| Morgan E Sindall | x |  |  |  |
| Morgan McMonagle | x |  |  |  |
| Murray Cohen | X |  |  |  |
| Nancy Parks | x |  |  |  |
| Nathan Mowery | x |  |  |  |
| Nicholas Namias | x |  |  |  |
| Nicholas Paul Rottler | X |  |  |  |
| Nicole Stassen | x |  |  |  |
| Nina Elizabeth Glass | X |  |  |  |
| Nobuyuki Saito | x |  |  |  |
| Oliver Gunter | x |  |  |  |
| Onaona Gurney | x |  |  |  |
| Orlando Kirton | x |  |  |  |
| Oscar Guillamondegui | x |  |  |  |
| Panna Codner | X |  |  |  |
| Parker Hu | x |  |  |  |
| Patricia Ayoung-Chee | X |  |  |  |
| Patrick B Murphy | x |  |  |  |
| Patrick Berg | x |  |  |  |
| Patrick Kim | x |  |  |  |
| Pauline K. Park |  | NHLBI, Department of Defense | Member of advisory/review committee | Grant Support/Honorari a |
| Peter Fischer | x |  |  |  |
| Peter Fuming Hu | x |  |  |  |
| Peter Jenkins | x |  |  |  |
| Peter M. Hammer | X |  |  |  |
| Peter Rhee | x |  |  |  |
| Priti P Parikh | X |  |  |  |
| R. Stephen Smith | x |  |  |  |
| Rachael A Callcut |  | General Electric Healthcare | Researcher | Grant Support |
| Raminder Nirula | x |  |  |  |
| Ramiro Manzano Nunez | x |  |  |  |


| Rebecca Vogel | x |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Richard Harlow Lewis, Jr | X |  |  |  |
| Richard Miller | X |  |  |  |
| Rick Meinig | X |  |  |  |
| Rindi Uhlich | X |  |  |  |
| Robert David Becher | X |  |  |  |
| Robert Lim |  | UpToDate, Inc | Consultant | Honorarium |
| Robert Winchell | x |  |  |  |
| Robert Winfield |  | Elsevier | Associate Social Media Editor, Surgery | Honorarium |
| Ronald I. Gross | X |  |  |  |
| Ronald Simon | x |  |  |  |
| Ronald Stewart | X |  |  |  |
| Rondi Gelbard | X |  |  |  |
| Rosemary Kozar | X |  |  |  |
| Ross Euen Anderson | x |  |  |  |
| Roxie M. Albrecht | X |  |  |  |
| Roy Spijkerman | X |  |  |  |
| Ruben Peralta | X |  |  |  |
| Ryan Phillips | X |  |  |  |
| RYO YAMAMOTO | x |  |  |  |
| Sabino Tamez Lara | X |  |  |  |
| Sahaja Atluri | X |  |  |  |
| Saman Arbabi | x |  |  |  |
| Samuel Hawkins | X |  |  |  |
| Samuel P Carmichael | X |  |  |  |
| Samuel Tisherman | X |  |  |  |
| Samuel Wade Ross | X |  |  |  |
| Sandro Rizoli | X |  |  |  |
| Sara Hennessy | X |  |  |  |
| Sarah Beth Dinwiddie | x |  |  |  |
| Sascha Halvachizadeh | X |  |  |  |
| Saskya Byerly | X |  |  |  |
| Shahid Shafi | X |  |  |  |
| Shahin Mohseni | X |  |  |  |
| Shannon Marie Foster | X |  |  |  |
| Sharon Henry | X |  |  |  |
| Sharven Taghavi | X |  |  |  |
| SHEKHAR GOGNA | X |  |  |  |
| Shokei Matsumoto | X |  |  |  |
| Simone Frassini | X |  |  |  |
| Sorena Keihani | X |  |  |  |
| Spogmai Komak | X |  |  |  |
| Stacy Shackleford | x |  |  |  |
| Stan Rogers | x |  |  |  |
| Stephanie A. Savage | X |  |  |  |
| Stephanie Bonne | X |  |  |  |
| Stephen Ellery Ranney | X |  |  |  |
| Stephen M Cohn | X |  |  |  |
| Steven Shackford | X |  |  |  |
| SUBODH KUMAR | x |  |  |  |
| Susan Evans | X |  |  |  |


| Susan Rowell | x |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Susannah Elizabeth Nicholson | X |  |  |  |
| Suzan Dijkink | x |  |  |  |
| Tanya Anand | x |  |  |  |
| Tanya Zakrison | X |  |  |  |
| Taylor Renee Kai | x |  |  |  |
| Terence O'Keeffe | x |  |  |  |
| Thomas Esposito | X |  |  |  |
| Timothy Fabian | X |  |  |  |
| Timothy William Wolff | X |  |  |  |
| Todd Rasmussen | X |  |  |  |
| Todd W Costantini | X |  |  |  |
| Tracey Dechert | x |  |  |  |
| Tyler John Loftus | X |  |  |  |
| Vanessa Buie | X |  |  |  |
| Vanessa P. Ho |  | Atricure, Medtronic | Spouse Consultant, Spouse Consultant | Consulting Fee, Consulting Fee |
| Victor Roger Vakayil | x |  |  |  |
| Vincent Anto | X |  |  |  |
| Vinciya Pandian |  | HJF | Researcher | Research Grant |
| Walter L Biffl | X |  |  |  |
| Wenjun Z Martini | x |  |  |  |
| William Cioffi | X |  |  |  |
| William Weber | X |  |  |  |
| Yasuhiro Otomo | X |  |  |  |
| Zaid Haddadin | X |  |  |  |
| Zara Cooper | X |  |  |  |
|  |  |  |  |  |
|  | Nothing to |  | DISCLOSURE |  |
| Planning Committee | Disclose | Company | ROLE | Received |
| Karen Brasel | X |  |  |  |
| Eileen Bulger | X |  |  |  |
| Clay Burlew | X |  |  |  |
| Martin Croce | X |  |  |  |
| Timothy Fabian | X |  |  |  |
| Rosemary Kozar | X |  |  |  |
| Louis Magnotti | X |  |  |  |
| Ernest Moore |  | Haemonetics; Instrumentation Laboratory; Stago; Thrombo Therapeutics | PI; PI; PI; Co- <br> Founder | Research Support; Research Support; Research Support; Stock |
| Lena Napolitano | x |  |  |  |
| Patrick Reilly | X |  |  |  |
| Jason Smith | X |  |  |  |
| David Spain | X |  |  |  |
| Robert Winchell | X |  |  |  |

## SCHEDULE



## General \& Scientific Program Schedule

*Meeting room locations are subject to change. Please check the Annual Meeting App for the most up to date room assignments.

Monday, September 16, 2019

7:30 AM-4:00 PM
Tuesday, September 17, 2019
7:30 AM-4:00 PM

7:30 AM-4:30 PM

2:00 PM-6:30 PM
Emergency General Surgery Course (additional fee) Location: State Room 1

AAST Boad of Managers Meeting Location: Houston Ballroom A

Registration
Location: Skybridge Registration

Wednesday, September 18, 2019

7:00 AM-11:30 AM

7:00 AM-11:45 AM

7:00 AM-11:30 AM Presession: Sponsored by the Acute Care Surgery Committee/SAGES "Endoscopic Management of GI Bleeding for the Acute Care Surgeon" Location: Houston Room A Location: Houston Room B

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11:00 AM-12:00 PM
    Disaster Committee Meeting
    Patient Assessment Committee Meeting
    Journals Oversight Committee Meeting
    Research and Education Fund Committee Meeting
    Geriatric/ACS Trauma Committee Meeting
    Health Care Economics Committee Meeting
    Multi-Institutional Trails Committee Meeting
    Communications Committee Meeting
    Pediatric Trauma Surgery Committee Meeting
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Committee Meetings - Session I
Location: San Antonio Room A
Location: San Antonio Room B
Location: Houston Room C
Location: State Room 1
Location: State Room 2
Location: State Room 3
Location: State Room 4
Location: Trinity Room 2
Location: Trinity Room 4
12:30 PM-1:00 PM

Welcome：
Location：Lone Star Ballroom A／B

Session I：Plenary Papers 1－8
Moderator：Martin Croce，MD Recorder：Patrick Reilly，MD Location：Lone Star Ballroom A／B

Paper 1 1：00 PM－1：20 PM
PREHOSPITAL PLASMA IN INJURED PATIENTS IS ASSOCIATED WITH SURVIVAL PRINCIPALLY IN BLUNT INJURY：RESULTS FROM TWO RANDOMIZED PREHOSPITAL PLASMA TRIALS
Presenter：Katherine Reitz，MD Discussant：Donald Jenkins，MD
Paper 2 1：20 PM－1：40 PM
SELF－EXPANDING FOAM VS．PRE－PERITONEAL PACKING FOR EXSANGUINATING PELVIC HEMORRHAGE
Presenter：David King，MD Discussant：John Harvin，MD
Paper 3 气紛
1：40 PM－2：00 PM
SURVIVAL BENEFIT FOR PELVIC TRAUMA PATIENTS UNDERGOING RESUSCITATIVE
ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA：RESULTS OF AAST，AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY（AORTA）REGISTRY
Presenter：John Bini，MD Discussant：James Haan，MD

## Paper 4 <br> 2：00 PM－2：20 PM

LONG－TERM OUTCOMES AFTER VIOLENCE－RELATED TRAUMA：A MULTI－CENTER COHORT STUDY
Presenter：Manuel Castillo－Angeles，MD，MPH Discussant：Amy Goldberg，MD
Paper 5 筑领 2：20 PM－2：40 PM
PLASMA RESUSCITATION WITH ADJUNCTIVE PERITONEAL RESUSCITATION REDUCES ISCHEMIC INTESTINAL INJURY FOLLOWING HEMORRHAGIC SHOCK
Presenter：Jason Smith，MD，PhD，MBA
Discussant：Stephen Cohn，MD
Paper $6 \quad$ 2：40 PM－3：00 PM
RADIOGRAPHIC PREDICTORS OF THERAPEUTIC OPERATIVE INTERVENTION AFTER BLUNT
ABDOMINAL TRAUMA：THE RAPTOR SCORE
Presenter：Dina Filiberto，MD Discussant：Lillian Kao，MD，MS

| Paper 7 | 3：00 PM－3：20 PM |
| :--- | ---: |
| DISPROPORTIONALLY LOW NIH FUNDING FOR TRAUMA RESEARCH：THE CALL FOR A NATIONAL |  |
| INSTITUTE OF TRAUMA |  |
| Presenter：Nina Glass，MD |  |
| Discussant William Cioffi，MD |  |

DELAYED SPLENECTOMY IN PEDIATRIC SPLENIC INJURIES: IS CONSERVATIVE MANAGEMENT OVERUSED?
Presenter: Zaid Haddadin, MD Discussant: M. Margaret Knudson, MD

| 3:40 PM-4:10 PM <br> Session II: Master Sur <br> Presen | urgeon Lecture I - "Operative Thoracic Trauma: Tips, Tricks, and Occasional Anecdote" er: J. Wayne Meredith, MD - Wake Forest Baptist Health Location: Lone Star Ballroom A/B |
| :---: | :---: |
| 4:10 PM-5:25 PM <br> Session III: Panel <br> Panel <br> Christine Gaarder, | Financing Trauma Care: International Perspectives ists: Felipe Vega-Rivera, MD; Yasuhiro Otomo, MD, PhD MD, PhD; Li Hsee, MD; Kristan Staudenmayer, MD, MSc Moderator: Kristan Staudenmayer, MD, MSc Location: Lone Star Ballroom A/B |
| 5:30 PM-7:30 PM | Exhibits Open Location: Lone Star Preconvene ABC |
| 5:30 PM-6:30 PM | Session IV: Poster Session I |
| Group I:Thoracic Trauma | Frederick Pieracci, MD, MPH \& Andrew Doben, MD Location: Lonestar Preconvene (near C4) |
| Group II: Abdominal Trauma | Patrick Kim, MD \& Susan Rowell, MD Location: Lonestar Preconvene (near C4) |
| Group III: Trauma/Education Prevention | Marc deMoya, MD \& D'Andrea Joseph, MD Location: Lonestar Preconvene (near C4) |
| Group IV: Pediatric Trauma/Neurotrauma | Kathryn Bass, MD \& Michael Nance, MD Location: Lone Star Ballroom C1 |
| Group V: Geriatric Trauma | Vanessa Ho, MD, MPH \& Orlando Kirton, MD, MBA Location: Lone Star Ballroom C2 |
| Group VI: Trauma Systems | Thomas Esposito, MD, MPH \& Julie Dunn, MD Location: Lone Star Ballroom C3 |
| Group VII: Trauma Systems II | Nicholas Namias, MD, MBA \& Louis Magnotti, MD Location: Lone Star Ballroom C4 |
| 6:30 PM-7:30 PM | Welcome Reception Location: Lone Star Preconvene ABC |
| 6:45 PM-10:00 PM | JTACS Editorial Meeting/Buffet Dinner Location: Houston Room A |


| 7:00 AM-8:30 AM | Location: Lone Star Preconvene ABC |
| :---: | :---: |
| 7:00 AM-3:00 PM | Exhibits Open |
|  | Location: Lone Star Preconvene ABC |
| 7:00 AM-4:00 PM | Registration: |
|  | Location: Skybridge Registration |
| 6:15 AM-7:30 AM | Committee Meetings - Session II |
| Prevention Committee Meeting | Location: San Antonio Room A |
| 䯳 Military Committee Meeting | Location: San Antonio Room B |
| Acute Care Surgery Committee Meeting | Location: Houston Room C |
| Reimbursement/Coding Committee Meeting | Location: State Room 2 |
| Critical Care Committee Meeting | Location: State Room 3 |
| Palliative Care Committee Meeting | Location: State Room 4 |
| Education Committee Meeting | Location: Trinity Room 2 |
| 6:15 AM-7:30 AM R | Resident, Student, and In-Training Fellow Breakfast |
|  | Presenter: David Spain, MD, President-Elect |
|  | Location: Lone Star Ballroom C3 |
| 6:15 AM-7:30 AM | International Attendee Breakfast |
|  | International Relations Committee |
|  | hage Control in Pelvic Ring Injuries" |
|  | Location: Lone Star Ballroom C4 |
| 7:30 AM-9:30 AM | Session V: Canizaro Papers 9-14 |
| Moderator: David Livingston, MD Recorder: Rachael Callcut, MD, MSP |  |
| Location: Lone Star Ballroom A/B |  |
| Paper 9 \% | 7:30 AM-7:50 AM |
| EXTRACORPOREAL SUPPORT FOR TRAUMA: A TRAUMA QUALITY IMPROVEMENT PROJECT |  |
| (TQIP) ANALYSIS IN PATIENTS WITH ARDS |  |
| Presenter: Aaron Strumwasser, MD | Discussant: David Zonies, MD, MPH |
|  | 7:50 AM-8:10 AM |
| UNDERSTANDING THE MAKEUP OF A GROWING FIELD: A COMMITTEE ON TRAUMA SURVEY OF |  |
| THE NATIONAL NETWORK OF HOSPITAL-BASED VIOLENCE INTERVENTION PROGRAMS |  |
| Presenter: Stephanie Bonne, MD | Discussant: Glen Tinkoff, MD |
| Paper 11 \% | 8:10 AM-8:30 AM |
| RANDOM FOREST MODEL PREDICTS ACUTE KIDNEY INJURY AFTER TRAUMA LAPAROTOMY |  |
| Presenter: Rondi Gelbard, MD | Discussant: Jordan Weinberg, MD |
| Paper 12 \% | 8:30 AM-8:50 AM |
| ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS) AFTER TRAUMA: STILL HIGHLY MORBID |  |
| AND MORTAL |  |
| Presenter: George Kasotakis, MD, MPH | Discussant: Pauline Park, MD |
| Paper 13 | 8:50 AM-9:10 AM |
| A GLIMPSE INTO THE STATE OF GENDER TRENDS IN THE TRAUMA COMMUNITY: CURRENT |  |
| APPRAISAL AND OPPORTUNITIES |  |
| Presenter: Shannon Foster, MD | Discussant: Roxie Albrecht, MD |

# WHO RETURNS HOME AFTER ADMISSION FOR FALL? PATIENT FACTORS RELATED TO 

 RESIDENCY ONE YEAR LATERDiscussant: Stephanie Savage, MD
9:30 AM-10:00 AM

10:00 AM-10:20 AM

10:20 AM-11:20 AM
Session VI: Scholarship Presentations
Moderator: Martin Croce, MD
Location: Lone Star Ballroom A/B
Break in the Exhibit Hall
Location: Lone Star Preconvene ABC
Session VII: Papers 15-17
Moderator: Raminder Nirula, MD, MPH Recorder: Brian Eastridge, MD Location: Lone Star Ballroom A/B

## Paper 15

10:20 AM-10:40 AM
THE IMPACT OF INTERHOSPITAL TRANSFER ON MORTALITY BENCHMARKING AT LEVEL III AND IV TRAUMA CENTERS: A STEP TOWARDS SHARED MORTALITY ATTRIBUTION IN A STATEWIDE SYSTEM
Presenter: Daniel Holena, MD Discussant: Peter Fischer, MD, MSc
Paper 16
10:40 AM-11:00 AM
IS NBATS-2 UP TO THE TASK? ACTUAL VS PREDICTED PATIENT VOLUME SHIFTS WITH THE ADDITION OF ANOTHER TRAUMA CENTER
Presenter: Jennings Dooley, BS Discussant: Robert Winchell, MD
Paper 17 気
11:00 AM-11:20 AM
OUTCOMES IN ISOLATED TBI: THERE'S MORE TO IT THAN 'RIGHT PLACE, FIRST TIME'
Presenter: Henry Nnajiuba, MD, MSc, BSc
Discussant: Deborah Stein, MD, MPH

## Lunch Session I

"The Meaning Of Rejection (and Revision): Useful Suggestions and Guidance For Reviewers and Authors"
Sponsored by The Journal of Trauma and Acute Care Surgery Location: Houston Room A

## Lunch Session II

"Structuring A Fiscally Viable ACS Service"
Sponsored by the Healthcare Economics Ad Hoc Committee Location: Lone Star Ballroom C2
Lunch Session III
"Experts on the Hot Seat:Top 10 Topics in Critical Care"
Sponsored by the Critical Care Committee
Location: Lone Star Ballroom C3
Lunch Session IV
"10 Principles of Reoperative Surgery"
Sponsored by the Acute Care Surgery Committee Location: Lone Star Ballroom C4

## Lunch Session V

"Acute Care Surgery: Ensuring the Success of the Next Generation"
Sponsored by the Acute Care Surgery Committee
Location: Houston Room B

## Lunch Session VI 嘅

"Mission Zero: How Military-Civil Partnerships Enhance Mass Trauma Responses"
Sponsored by the Disaster and Military Committees
Location: Lone Star Ballroom C1


Moderator: Daniel Marguiles, MD Recorder: Gail Tominaga, MD Location: Lone Star Ballroom B

Does Simulation Work? Monthly Trauma Simulation and Procedural Training is Associated with Decreased Time to Intervention.
Presenter: Caroline Park, MD, MPH
Discussant: Mark Bowyer, MD
Paper 29
2:40 PM-3:00 PM
USING ARTIFICIAL INTELLIGENCE TO IMPROVE RELIABILITY OF THE FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA (FAST): A PILOT STUDY OF FAST-AI.
Presenter: Rachael Callcut, MD, MSPH Discussant: Matthew Bloom, MD
Paper 30
3:00 PM-3:20 PM
TURNING VALUE INTO ACTION: THE IMPORTANCE OF PUBLIC NARRATIVE AMONG HEALTHCARE PROVIDERS USING DIVERSE MEDIA TO ENACT CHANGE
Presenter: Marissa Boeck, MD, MPH
Discussant: Nicole Stassen, MD
Paper 31
3:20 PM-3:40 PM
EXPORTED CRIME GUNS, TRAFFICKING, AND STATE ANTI-TRAFFICKING LAWS
Presenter: Erin Andrade, MD, MPH
Discussant: Deborah Kuhls, MD

## Paper 32

3:40 PM-4:00 PM
COMPARISON OF SURGICAL CRICOTHYROIDOTOMY TRAINING: A RANDOMIZED TRIAL OF A LIVE PIG MODEL VS. AN ADVANCED SIMULATION MANIKIN

Presenter: Rob Leeper, MD
Paper 33
Discussant: Kenji Inaba, MD

ELECTRIC SCOOTERS: IMPACT ON A COMMUNITY
Presenter: Matthew Bloom, MD
Paper 34
Discussant: Nancy Parks, MD

DO ADOLESCENT PATIENTS WITH PENETRATING TRAUMA HAVE BETTER OUTCOMES AT PEDIATRIC TRAUMA CENTERS VERSUS ADULT TRAUMA CENTERS?
Presenter: Frederick Rogers, MD, MS
Discussant: Kathryn Bass, MD
Paper 35
4:40 PM-5:00 PM
PEDIATRIC EXTREMITY VASCULAR TRAUMA: HOW AND WHERE IS IT TREATED?
Presenter: James Prieto, MD
Discussant: Ben Zarzaur, Jr, MD, MPH

President's Dinner Location: Invitation Only

Breakfast Session I<br>"Video Session: Emergency General Surgery Tips and Tricks"<br>Sponsored by the Acute Care Surgery Committee/SAGES<br>Location: Lone Star Ballroom C1

## Breakfast Session II

"Beyond Yoga and Mindfulness: Sustaining Surgeon Well Being for You and Your Team" Sponsored by the Communications Committee

Location: Houston Room A

## Breakfast Session III

"Do Military Innovations Work and Can They Be Studied in the Civilian World?"
Sponsored by the Military Liaison Committee Location: Lone Star Ballroom C2

## Breakfast Session IV

"Supporting Diversity and Inclusion in Academic Acute Care Surgery" Sponsored by the Patient Assessment Committee

Location: Houston Room B
Breakfast Session V
"Geriatric Trauma - Now the Good News"
Sponsored by the Geriatric Trauma, Acute Care
Surgery, and Critical Care Committees Location: Lone Star Ballroom C3

## Breakfast Session VI

"Using Evidence and New Technology to Reduce Imaging in Blunt Abdominal Trauma"
Sponsored by the Pediatric Committee Location: Lone Star Ballroom C4

7:00 AM-8:30 AM | Breakfast in Exhibit Hall |
| ---: |
| Location: Lone Star Preconvene ABC |

7:00 AM-2:00 PM

7:00 AM-3:00 PM

7:30 AM-8:00 AM

8:00 AM-11:00 AM
Session XI: Papers 36-44

Paper 36
8:00 AM-8:20 AM
BARRIERS TO IMPROVING HEALTHCARE VALUE IN EMERGENCY GENERAL SURGERY: A NATIONWIDE ANALYSIS
Presenter: Kamil Hanna, MD Discussant: Kristan Staudenmayer, MD, MSc
Paper 37
8:20 AM-8:40 AM
LONG-TERM FUNCTIONAL OUTCOMES AFTER TRAUMATIC POPLITEAL ARTERY INJURY: A 20YEAR EXPERIENCE
Presenter: Louis Magnotti, MD, MS Discussant: Michael Sise, MD
Paper 38
8:40 AM-9:00 AM
MANAGEMENT OF CHOLEDOCHOLITHIASIS IN THE ELDERLY: IS ERCP ALONE REALLY A SAFE
ALTERNATIVE?
Presenter: Allison Berndtson, MD Discussant: Oscar Guillamondegui, MD, MPH

| Paper 41 | 9:40 AM-10:00 AM |
| :---: | :---: |
| THE EFFECT OF EMS TRANSPORT TIME ON IN-TRANSIT CLINICAL DECLINE IN A RURAL STATE |  |
| Presenter: Taylor Kai, BS | Discussant: Jan Jansen, MBBS |
| Paper 42 榣 | 10:00 AM-10:20 AM |
| GOT CALCIUM? ADMISSION IONIZED-CALCIUM IN TWO CIVILIAN RANDOMIZED CLINICAL |  |
| TRIALS OF PRE-HOSPITAL PLASMA |  |
| Presenter: Hunter Moore, MD, PhD | Discussant: Jeremy Cannon, MD |
| Paper 43 | 10:20 AM-10:40 AM |
| EFFECT OF PLASMA TRANSFUSION RATIO TO RED BLOOD CELLS BETWEEN GERIATRIC AND |  |
| NON-GERIATRIC MASSIVELY TRANSFUSED TRAUMA PATIENTS: ELDERLY PATIENTS BENEFIT |  |
| LESS! |  |
| Presenter: Mitsuaki Kojima, MD, PhD | Discussant: Jason Sperry, MD, MPH |
| Paper 44 | 10:40 AM-11:00 AM |
| BENCHMARKING THE VALUE OF CAR | OSPITAL COSTS FOR COMMON |
| OPERATIONS AND ITS ASSOCIATION | VOLUME |
| Presenter: Cheryl Zogg, MSPH, MHS | Discussant: Jason Smith, MD PhD, MBA |

11:00 AM-12:00 PM Session XII: Fitts Lecture - A Seussian Tale of a Trauma Time

12:00 PM-1:00 PM
Group VIII: Shock/Transfusions

Group IX: Shock/Transfusions II

Group X: Shock/Transfusions III
( Group XI: Critical Care

Group XII: Emergency General Surgery

Group XIII: Emergency General Surgery/Outcomes Addison May, MD, MBA \& Linda Maerz, MD

Group XIV: Outcomes/Guidelines

1:00 PM-1:45 PM

Location: Lone Star Ballroom C3

## Session XIII: Poster Session II

Christine Gaarder, MD, PhD \& Joseph Rappold, MD
Location: Lonestar Preconvene (near C4)
Todd Rasmussen, MD \& William Chiu, MD
Location: Lonestar Preconvene (near C4)
Grant Bochicchio, MD, MPH \& Morgan McMonagle, MD, MB, BCh, BAO
Location: Lonestar Preconvene (near C4)
Heather Dolman, MD \& Ronald Simon, MD Location: Lone Star Ballroom C1

Martin Zielinski, MD \& Christopher Dente, MD Location: Lone Star Ballroom C2

Michel Aboutanos, MD \& Amy McDonald, MD Location: Lone Star Ballroom C4

Lunch provided with Exhibitors (AAST provides lunch) Location: Lone Star Preconvene ABC


Session XIVB: Papers 54-63
Moderator: Luke PH Leenen, MD, PhD Recorder: Sharon Henry, MD
Location: Lone Star Ballroom B
Paper 54
2:00 PM - 2:20 PM
EARLY TREATMENT WITH MESENCHYMAL STEM CELL-DERIVED EXOSOMES PROVIDES
NEUROPROTECTION AND IMPROVES BLOOD-BRAIN BARRIER INTEGRITY IN A SWINE MODEL OF TRAUMATIC BRAIN INJURY AND HEMORRHAGIC SHOCK
Presenter: Aaron Williams, MD
Discussant: Carrie Sims, MD

| Paper 55 | 2:20 PM-2:40 PM |
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| THE GUT MICROBIOME (GM) IS PREDICTIVE OF CLINICAL OUTCOMES FOLLOWING TRAUMATIC INJURY |  |
|  |  |
| Presenter: Susannah Nicholson, MD, MS | D, MSc |
| Paper 56 | 2:40 PM-3:00 PM |
| P-SELECTIN ANTIBODY TREATMENT AFTER BLUNT THORACIC TRAUMA PREVENTS PULMONARY |  |
| ARTERIAL THROMBOSIS WITHOUT SYSTEMIC COAGULATION CONSEQUENCES |  |
| Presenter: Linda Schutzman, MD | Discussant: Amy Makley, MD |
| Paper 57 | 3:00 PM-3:20 PM |
| A GENOMICS JOURNEY TO IMPROVED UNDERSTANDING OF POST-INJURY PLATELET BIOLOGY: |  |
| PLATELET RNA SIGNATURES IN TRAUMATIC BRAIN INJURY |  |
| Presenter: Lucy Kornblith, MD | Discussant: Martin Schreiber, MD |
| Paper 58 | 3:20 PM-3:40 PM |
| THE AAST PROSPECTIVE, OBSERVATIONAL, MULTICENTER STUDY INVESTIGATING THE INITIAL EXPERIENCE WITH REVERSAL OF NOVEL ORAL ANTICOAGULANTS IN TRAUMA PATIENTS |  |
|  |  |
| EXPERIENCE WITH REVERSAL OF NOVEL ORAL ANTICOAGULANTS IN TRAUMA PATIENTS Presenter: Brent Emigh, MD Discussant: Sandro Rizoli, MD |  |
| Paper 59 | 3:40 PM-4:00 PM |
| GERIATRIC TBI: WHAT WE KNOW NOW |  |
| Presenter: Mira Ghneim, MD | Discussant: Mayur Patel, MD, MPH |
| Paper 60 | 4:00 PM-4:20 PM |
| THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA (AAST) RENAL INJURY |  |
| GRADING SCALE: IMPLICATIONS OF THE 2018 REVISIONS FOR INJURY RECLASSIFICATION AND |  |
| PREDICTING BLEEDING INTERVENTIONS |  |
| Presenter: Sorena Keihani, MD | Discussant: Fernando Kim, MD |
|  |  |
| EXTRA-PERITONEAL PACKING IN UNSTABLE BLUNT PELVIC TRAUMA, A PROPENSITY SCORE ANALYSIS |  |
|  |  |
| Presenter: Simone Frassini | sant: Joergen Joakim Joergensen, MD |
| IMPLEMENTATION OF A MULTIDISCIPLINARY PERINATAL EMERGENCY RESPONSE TEAM (PERT) |  |
|  |  |
| IMPROVES TIME TO DEFINITIVE OBSTETRICAL EVALUATION AND FETAL ASSESSMENT IN |  |
| PREGNANT TRAUMA PATIENTS |  |
| Presenter: Amanda Sosulski, MD | Discussant: Tanya Zakrison, MD, MPH |
| Paper 63 | 5:00 PM-5:20 PM |
| OPIOID RISK TOOL CAN IDENTIFY PATIENTS WITH INCREASED INPATIENT OPIOID USE AFTER A |  |
| TRAUMATIC INJURY |  |
| Presenter: Husayn Ladhani, MD | Discussant: Andrew Bernard, MD |
| 5:20 PM-7:00 PM | AAST Annual Business Meeting Location: Lone Star Ballroom B |
| 7:30 PM-8:00 PM | Location: Lone Star Preconvene ABC |
| 8:00 PM-11:00 PM | Banquet |
|  | cation: Lone Star Ballroom |

## Saturday, September 21, 2019



SEVERITY OF HEMORRHAGE AND THE SURVIVAL BENEFIT ASSOCIATED WITH PLASMA: RESULTS FROM A RANDOMIZED PREHOSPITAL PLASMA TRIAL
Presenter: Vincent Anto, BS
Discussant: Jennifer Gurney, MD

## Quickshot 6 第

9:40 AM-9:46 AM
RIGHT INTO THE DANGER ZONE: COMPLICATIONS OF RESUSCITATIVE ENDOVASCULAR
BALLOON OCCLUSION OF THE AORTA (REBOA) AT ZONE 1 AND 3 FROM THE AAST AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY (AORTA) TRIAL
Presenter: Megan Brenner, MD, MS
Discussant: Marc DeMoya, MD
Quickshot 7
9:46 AM-9:52 AM
THROMBOELASTOGRAPHY (TEG) VS. CONVENTIONAL CLOTTING TEST: WHICH TEST
ACCURATELY PREDICTS INCREASED BLEEDING RISK IN A RABBIT HEMORRHAGIC SHOCK MODEL
Presenter: Bijan Kheirabadi, PhD Discussant: Mitchell Cohen, MD
Quickshot 8
9:52 AM-9:58 AM
SMALL BOWEL OBSTRUCTION MANAGED WITHOUT HOSPITAL ADMISSION: A SAFE WAY TO
REDUCE TIME IN THE HOSPITAL?
Presenter: Joy Hughes, MD Discussant: Andre Campbell, MD

## Quickshot 9 筡

9:58 AM-10:04 AM
IMPACT OF DELTA SYSTOLIC BLOOD PRESSURE AFTER REBOA PLACEMENT IN NON-
COMPRESSIBLE TORSO HEMORRHAGE PATIENTS: AN ABOTRAUMA REGISTRY AND AORTA
DATABASE ANALYSIS
Presenter: Juan Duchesne, MD Discussant:Terence O'Keeffe, MD
Quickshot 10
10:04 AM-10:10 AM
EVALUATION OF AGE-ADJUSTED SYSTOLIC BLOOD PRESSURE AND SHOCK INDEX FOR PEDIATRIC TRAUMA TEAM ACTIVATION
Presenter: Elissa Butler, MD Discussant: Barbara Gaines, MD
Quickshot 11
10:10 AM-10:16 AM
OPTIMISING PREHOSPITAL TRIAGE IN AN INCLUSIVE URBAN MAJOR TRAUMA SYSTEM
Presenter: Henry Nnajiuba, MD, MSc, BSc Discussant: Mark Seamon, MD
Quickshot 12
10:16 AM-10:22 AM
MODIFIED ABBREVIATED BURN SEVERITY INDEX AS A PREDICTOR OF IN-HOSPITAL MORTALITY
IN PATIENTS WITH INHALATION INJURY: DEVELOPMENT AND VALIDATION USING
INDEPENDENT COHORTS
Presenter: Ryo Yamamoto, MD Discussant: Glen Franklin, MD
Quickshot 13
10:22 AM-10:28 AM
MASS CASUALTY PREPARATION: INJURY PATTERNS AND RESOURCE UTILIZATION OF SURVIVORS AND DECEDENTS
Presenter: Chadwick Smith, MD
Discussant: David Shatz, MD
Break
Session XVI: Quickshot Session II - Papers 14-26
10:28 AM-10:38 AM
10:38 AM-11:56 AM
Moderator: David Shatz, MD
Location: Lone Star Ballroom B
Quickshot 14
10:38 AM-10:44 AM
EARLY HYPERMETABOLISM IS UNCOMMON IN TRAUMA ICU PATIENTS
Presenter: Saskya Byerly, MD, MS
Discussant: Panna Codner, MD

## Quickshot 16

10:50 AM-10:56 AM
OUT-OF-POCKET SPENDING BY TRAUMA PATIENTS FOLLOWING IMPLEMENTATION OF THE AFFORDABLE CARE ACT
Presenter: Charles Liu, MD
Discussant: Nathan Mowery, MD
Quickshot 17
10:56 AM-11:02 AM
SIX IS THE NEW FIVE: MINOR CHANGE IN INITIAL PEEP SETTING DECREASES RATES OF
VENTILATOR ASSOCIATED EVENTS IN MECHANICALLY VENTILATED TRAUMA PATIENTS
Presenter: Ethan Ferrel, MD Discussant: Rachael Callcut, MD,MSPH
Quickshot 18 11:02 AM-11:08 AM
IDENTIFYING OBJECTIVE MEASURES FOR TRAUMA CENTER ACCESSS ASSESSMENT USING GISBASED TECHNOGLOGY
Presenter: Suzan Dijkink, MD Discussant: Frederick Rogers, MD
Quickshot 19
11:08 AM-11:14 AM
THE ROLE OF CRYOPRECIPITATE IN MASSIVELY TRANSFUSED PATIENTS: RESULTS FROM THE TQIP DATABASE MAY CHANGE YOUR MIND
Presenter: Michael Ditillo, DO Discussant: John Holcomb, MD
Quickshot 20
11:14 AM-11:20 AM
SAFETY AND FEASIBILITY OF ERECTOR SPINAE PLANE BLOCKS IN PATIENTS WITH CHEST WALL TRAUMA ON HIGH DOSE ENOXAPARIN
Presenter: Linda Dultz, MD, MPH Discussant: Ronald Gross, MD
Quickshot 21
11:20 AM-11:26 AM
TIME TO TRACHEOSTOMY IMPACTS OVERALL OUTCOMES IN PATIENTS WITH CERVICAL SPINAL CORD INJURY (CSCI)
Presenter: Tanya Anand, MD Discussant: Murray Cohen, MD

## Quickshot 22

11:26 AM-11:32 AM
AAST GRADING SCALE FOR ACUTE MESENTERIC ISCHEMIA ACCURATELY PREDICTS MORBIDITY AND MORTALITY: A VALIDATING RETROSPECTIVE COHORT STUDY
Presenter: Jake Forman, DO
Discussant: Shahid Shafi, MD, MPH, MBA

## Quickshot 23

11:32 AM-11:38 AM
OBESITY AND IMPAIRED VASCULAR BARRIER FUNCTION AFTER SHOCK: A BIOMETIC IN VITRO MODEL USING MICROFLUIDICS
Presenter: Lawrence N. Diebel, MD Discussant: Susan Evans, MD
Quickshot 24
11:38 AM-11:44 AM
REGIONALIZATION OF EMERGENCY GENERAL SURGERY OPERATIONS: A SIMULATION STUDY
Presenter: Robert Becher, MD, MS Discussant: Nancy Parks, MD
Quickshot 25
11:44 AM-11:50 AM
COMMON SENSE CAN REDUCE AFRICAN AMERICAN HOMICIDE RATES: THE EFFECT OF UNIVERSAL BACKGROUND CHECKS
Presenter: Elinore Kaufman, MD, MS Discussant: Tracey Dechert, MD
Quickshot 26
11:50 AM-11:56 AM
COMPARISON OF A TRAUMA COMORBIDITY INDEX WITH OTHER MEASURES OF COMORBIDITIES TO PREDICT MORTALITY FOLLOWING TRAUMA
Presenter: Peter Jenkins, MD
Discussant: Alan Guo, MD, PhD

## AAST <br> INFORMATION

## HISTORICAL BACKGROUND

## AAST

The American Association for the Surgery of Trauma started with conversations at the meetings of the Western Surgical Association and Southern Surgical Association in December 1937. The 14 founders, who were present at one or both of these meetings, sub-sequently invited another 68 surgeons to a Founding Members meeting in San Francisco on June 14, 1938. The first meeting of the AAST was held in Hot Springs, Virginia, in May, 1939, and Dr. Kellogg Speed's first Presidential Address was published in The American Journal of Surgery 47:261-264, 1940. Today, the Association holds an annual scientific meeting, owns and publishes The Journal of Trauma and Acute Care Surgery, which was initiated in 1961, and has approximately 1,400 members from 30 countries.

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## FUTURE AAST MEETINGS

## 2020

79th Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery

September 9-12, 2020
Hilton Waikoloa Village
Waikoloa, HI

* Please note date change


## 2021

80th Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery

September 29-October 2, 2021
Hilton Atlanta
Atlanta, GA

## 2022

81 st Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery

September 21-24, 2022
Hyatt Regency Chicago
Chicago, IL

## 2023

82nd Annual Meeting of the American Association for the Surgery of Trauma and Clinical Congress of Acute Care Surgery

September 20-23, 2023
Hilton Anaheim
Anaheim, CA

## PAST PRESIDENTS AND MEETING SITES

2018
2017
2016
2015
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San Diego, California
Baltimore, Maryland
Waikoloa, Hawaii
Las Vegas, Nevada
Philadelphia, Pennsylvania
San Francisco, California
Kauai, Hawaii
Chicago, Illinois
Boston, Massachusetts
Pittsburgh, Pennsylvania
Maui, Hawaii
Las Vegas, Nevada
New Orleans, Louisiana
Atlanta, Georgia
Maui, Hawaii
Minneapolis, Minnesota
Orlando, Florida
No Meeting Due to 9/11
San Antonio, Texas
Boston, Massachusetts
Baltimore, Maryland
Waikoloa, Hawaii
Houston, Texas
Nova Scotia, Canada
San Diego, California
New Orleans, Louisiana
Louisville, Kentucky
Philadelphia, Pennsylvania
Tucson, Arizona
Chicago, Illinois
Orange County, California
Montreal, Canada
Honolulu, Hawaii
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New Orleans, Louisiana
Chicago, Illinois
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Phoenix, Arizona
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L.D. Britt, M.D., M.P.H.

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C. William Schwab, M.D.

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Ronald V. Maier, M.D.
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J. David Richardson, M.D.

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Kenneth L. Mattox, M.D.
Cleon W. Goodwin, M.D.
Ernest E. Moore, M.D.
C. James Carrico, M.D.

Lewis M. Flint, M.D.
F. William Blaisdell, M.D.
P. William Curreri, M.D.
H. David Root, M.D., Ph.D.

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Donald D. Trunkey, M.D.
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Detroit, Michigan
Colorado Springs, Colorado
Scottsdale, Arizona
Hot Springs, Virginia
Chicago, Illinois
San Francisco, California
New York City, New York
Chicago, Illinois
Portland, Oregon
Montreal, Canada
Chicago, Illinois
Santa Barbara, California
Philadelphia, Pennsylvania
Chicago, Illinois
San Francisco, California
Hot Springs, Virginia
Chicago, Illinois
Coronado, California
Bretton Woods, New Hampshire Chicago, Illinois Hot Springs, Virginia Santa Barbara, California Chicago, Illinois Atlantic City, New Jersey Chicago, Illinois New York City, New York Montreal, Canada Salt Lake City, Utah Atlantic City, New Jersey Chicago, Illinois Atlantic City, New Jersey San Antonio, Texas No Meeting Due to War Chicago, Illinois No Meeting Due to War Boston, Massachusetts Montreal, Canada Atlantic City, New Jersey Hot Springs, Virginia

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\begin{gathered}
\text { AAST } \\
\text { ABSTRACT OF } \\
\text { PAPERS }
\end{gathered}
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## 78th Annual Meeting of the American Association for the Surgery of Trauma and Clinical Acute Care Surgery



AMA PRA Category 1
Credits ${ }^{\text {TM }}$ will be awarded
based upon actual hours
attended. Total number of
hours will be calculated from
information individual
physicians provide in the
online CME evaluation forms.

## Welcome

Wednesday, September 18, 2019 12:30 PM - 1:00 PM
Location: Lone Star Ballroom A/B Presiding: Martin Croce, MD

Session I: Plenary Papers \#1-8
Wednesday, September 18, 2019
1:00 PM - 3:40 PM
Location: Lone Star Ballroom A/B
Moderator: Martin Croce, MD
Recorder: Patrick Reilly, MD

## PREHOSPITAL PLASMA IN INJURED PATIENTS IS ASSOCIATED WITH SURVIVAL PRINCIPALLY IN BLUNT INJURY: RESULTS FROM TWO RANDOMIZED PREHOSPITAL PLASMA TRIALS

Katherine Reitz MD, Hunter Moore MD, Frank Guyette MD,MPH, Angela Sauaia* Ph.D., Anthony Pusateri* Ph.D., Ernest Moore* MD, Michael Chapman MD, Brian Daley* MD, Richard Miller* MD, Brian Harbrecht* MD, Jeffrey Claridge* MD, Herb Phelan* MD, Joshua Brown MD, Jason Sperry* MD,MPH, University Of Pittsburgh

Invited Discussant: Donald Jenkins, MD
Introduction: Recent evidence demonstrated that prehospital plasma in patients at risk of hemorrhagic shock was safe for ground transport and resulted in a 28 -day survival benefit for air medical transport patients. Whether any beneficial effect of prehospital plasma varies across injury mechanism remains unknown. We sought to characterize prehospital plasma across blunt and penetrating injury with the hypothesis that a survival benefit would be apparent irrespective of injury mechanism.
Methods: We performed a secondary analysis using a preplanned harmonized dataset derived from two recent prehospital plasma randomized trials. Two units of prehospital plasma were provided in both trials as compared to standard care resuscitation. Identical inclusion/exclusion criteria and primary/secondary outcomes were employed for the trials. Prehospital time, arrival shock parameters and 24 -hour transfusion requirements were compared across plasma and control groups stratified by mechanism of injury.Stratified survival analysis and Cox hazard regression were performed to determine the independent survival benefits of plasma across blunt and penetrating injury.
Results: Plasma and cotrol arm comparisons for both trials demonstrated excellent randomization. Blunt patients had higher injury severity, were older and had a lower GCS. Arrival indices of shock and transfusion requirements over 24 hours across plasma and control arms for blunt and penetrating patients were similar. The percentage of patients with a prehospital time less than 20 mins was significantly higher for penetrating patients relative to blunt injured patients ( $26.7 \% \%$ vs $11.4 \%, \mathrm{p}<0.01$ ). A generalized estimating equations model accounting for intra-trial cluster effects and multiple confounders was used to test for interaction between mechanism of injury (blunt vs. penetrating) and randomization group (plasma vs control) and was highly significant (interaction $\mathrm{p}<0.01$ ). Stratified Kaplan-Meier curves (Figure) demonstrated a significant separation for blunt injured patients ( $\mathrm{n}=501, \mathrm{p}=0.01$ ) with no separation demonstrated for penetrating injured patients ( $\mathrm{n}=125, \mathrm{p}=0.62$ ) Stratified Cox hazard regression verified, after controlling for all important confounders, that prehospital plasma was associated with a $35 \%$ lower independent hazard for 28 day mortality in blunt injured patients (HR $0.65,95 \% \mathrm{CI} 0.45-0.93, \mathrm{p}=0.02$ ) with no

independent survival benefit found in penetrating patients (HR $0.96,95 \% \mathrm{CI} 0.2-3.3, \mathrm{p}=0.97$ ).
Conclusion: A survival benefit associated with prehospital plasma exists primarily in blunt injured patients with no benefit shown in penetrating trauma patients. No detrimental effects attributable to plasma are demonstrated in penetrating injury. These results have important relevance to military and civilian trauma systems. It remains unknown if prehospital plasma is beneficial in penetrating patients in different prehospital environments such as prolonged field care situations. Using data derived from two civilian randomized prehospital plasma trials, a 28-day survival benefit is principally demonstrated in blunt injured patients only.

Notes

# SELF-EXPANDING FOAM VS. PRE-PERITONEAL PACKING FOR EXSANGUINATING PELVIC HEMORRHAGE 

David R. King* MD, Ahmed E. Elsharkawy MD, Ahmed I. Eid MD, Michael J. Duggan DVM, John Beagle BS, April Mendoza MD,MPH, Noelle Saillant MD, Martin G. Rosenthal MD, Haytham M. Kaafarani* MD,MPH, Peter Fagenholz MD, John O. Hwabejire MD,MPH, Quynh P. Pham BS, PhD, Shawn Gelsinger BS, M.S., Michael Fornaciari BS, Upma Sharma BS, PhD Harvard Medical School/ Massachusetts General Hospital

## Invited Discussant: John Harvin, MD

Introduction: Mortality for pelvic fracture patients presenting with hemorrhagic shock ranges from 21-50\%. The objective of this study was to develop a reproducible, lethal, and clinically-relevant pelvic hemorrhage animal model with and without bony fracture for evaluating therapeutic interventions. ResQFoam, a novel, self-expanding foam, has previously been described in the pre-clinical literature to significantly decrease mortality in large-animal models of abdominal exsanguination. We hypothesized that percutaneously-administered ResQFoam could decrease mortality in exsanguinating pelvic hemorrhage with and without bony fracture relative to control and pre-peritoneal packing.

Methods: Two pelvic hemorrhage models were developed using non-coagulopathic Yorkshire swine. Pelvic hemorrhage model \#1: bilateral, closed-cavity, major vascular retro-peritoneal hemorrhage without bony pelvic fracture. After injury, animals received resuscitation (control, $n=9$ ), underwent pre-peritoneal pelvic packing using laparotomy pads $(\mathrm{n}=8)$, or received ResQFoam ( $\mathrm{n}=8$ ) injected into the pre-peritoneal space. The interventions were initiated post-injury when the mean arterial pressure (MAP) declined below 30 mmHg . Pelvic hemorrhage model \#2: unilateral, closed-cavity retro-peritoneal hemorrhage injury (with intra-peritoneal communication) combined with complex pelvic fracture. After injury, animals received resuscitation (control, $\mathrm{n}=12$ ), pre-peritoneal packing $(\mathrm{n}=10)$, or ResQFoam injection $(\mathrm{n}=10)$ into the pre-peritoneal space 1 min post-injury. In both models, animals were monitored for 3 hrs or until death.

Results: For model \# 1, both foam and packing showed significant survival advantage compared to controls, with foam demonstrating better outcomes than packing. Median survival times were 5,53 , and 89 minutes in control, packing, and foam groups, respectively. Survival at 1 hour was $71 \%$ for foam compared to $0 \%$ in the control and $43 \%$ in the packing group ( $\mathrm{p}=0.0001$ and 0.2178 , respectively); survival at 3 hours was $29 \%$ for foam compared to $0 \%$ in both the control and packing groups ( $\mathrm{p}=0.0001$ and 0.094 , respectively). Foam treatment facilitated hemodynamic stabilization and resulted in significantly less hemorrhage relative to control and packing groups $(20.8 \pm 5.8 \mathrm{~g} / \mathrm{kg}$ vs. $30.5 \pm 3.8 \mathrm{~g} / \mathrm{kg}$ and $31.9 \pm 6.1 \mathrm{~g} / \mathrm{kg}$, respectively, $\mathrm{p}=0.001)$. For model $\# 2$, foam and packing prolonged survival. Median survival times were 4,76 and 83 minutes in the control, foam, and packing groups, respectively. Survival at 1 hour was $70 \%$ for foam and $60 \%$ for packing, compared to only $8 \%$ in the control group ( $\mathrm{p}=0.0013$ and 0.0074 , respectively); at 3 hours, survival with foam and packing group were both $50 \%$ vs $0 \%$ in controls ( $p=0.0018$ and 0.0034 , respectively). Both interventions increased MAP compared to the controls and reduced hemorrhage from $37.5 \pm 7.2 \mathrm{~g} / \mathrm{kg}$ in controls to $29.1 \pm 9.0 \mathrm{~g} / \mathrm{kg}$ and $28.4 \pm 8.1 \mathrm{~g} / \mathrm{kg}$ in the foam and packing groups, respectively ( $\mathrm{p}=0.054$ ).


Conclusion: Two new, clinically-relevant, lethal, pelvic hemorrhage animal models were developed. Percutaneous injection of ResQFoam into the pre-peritoneal space improved survival relative to controls, and similar or better survival benefit and outcomes were achieved compared to standard pre-peritoneal pelvic packing.

Notes

# SURVIVAL BENEFIT FOR PELVIC TRAUMA PATIENTS UNDERGOING RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA: RESULTS OF AAST, AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY (AORTA) REGISTRY 

John K. Bini* MD, Claire Hardman RN, Jonny Morrison* MD,Ph.D., Thomas M.<br>Scalea* MD, Laura J. Moore* MD, Jeanette M. Podbielski RN, CCRP, Kenji Inaba* MD, Alice Piccinini* MD, David S. Kauvar* MD, Jeremy Cannon* MD, Mark Seamon*<br>MD, Chance Spalding* DO,Ph.D., Chuck Fox* MD, Ernest E. Moore* MD, Joseph J. Dubose* MD, Wright State University<br>Invited Discussant: James Haan, MD

Introduction:Aortic occlusion (AO) to facilitate the acute resuscitation of trauma and acute care surgery patients in shock remains a controversial topic. (1-6). Resuscitative Endovascular balloon occlusion of the aorta (REBOA) is an increasingly deployed method of AO. We hypothesized that in patients with non-compressible hemorrhage below the aortic bifurcation, the use of REBOA instead of open AO may portent a significant survival benefit.
Methods:The AAST, Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry prospectively identified 1494 patients requiring AO from 45 level 1 and 4 level 2 centers. Presentation, intervention and outcome variables were collected and analyzed to compare REBOA and open AO in patients with non-compressible hemorrhage below the aortic bifurcation.
Results: From December 2014 to January 2019, 217 patients with Zone 3 REBOA or Open AO who required pelvic packing, pelvic fixation or pelvic angio-embolization were identified. 109 AO patients with injuries isolated to below the aortic bifurcation were captured (REBOA, 84; open AO, 25); $68.8 \%$ were male, and $93.6 \%$ were blunt injuries. Patients with intra-abdominal or thoracic sources of bleeding, above deployment zone 3 were specifically excluded from analysis. Excluding patients who arrived with CPR in progress, presenting base deficit, lactate, and SBP were not significantly different between the REBOA group and the open AO group. Admission GCS was lower in the open AO group ( $\mathrm{p}=.003$ ). Overall mortality was lower in the REBOA group ( $35.17 \%$ vs $80.00 \%, \mathrm{p}<.001$ ). Excluding patients who arrived with CPR in progress, the REBOA group had lower mortality ( $33.33 \%$ vs. $68.75 \%, \mathrm{p}=0.008$ ). When stratified based on presenting SBP either $<60$ or $>/=60$, the patients in the REBOA group had lower mortality in both groups ( $\mathrm{SBP}<60,28.57 \%$ vs $66.67 \%, \mathrm{p}=0.500$ ); ( $\mathrm{SBP}>/=60,33.80 \%$ vs. $69.23 \%, \mathrm{p}=0.020$ ). In the REBOA group, 9 patients had complications secondary to vascular access (need for surgical closure of arteriotomy, patch angioplasty, limb ischemia, distal embolization, amputation). None of the vascular access complications resulted in limb loss or long-term disability. Of the survivors, complications including MOF, ALI, pneumonia, AKI, and need for dialysis, were not significantly different between groups. Overall hospital length of stay, ICU length of stay, and PRBC use were not significantly different between groups.
Conclusion: The AAST AORTA registry is the largest ongoing prospective attempt to capture data regarding AO. This study specifically looked at the application of REBOA for patients with exsanguinating hemorrhage below the aortic bifurcation. Our data show a clear survival advantage in patients who undergo REBOA as a means of AO compared to open AO. The survival advantage seen with REBOA was accomplished without increasing systemic complications. We conclude that REBOA should be strongly considered for patients in hemorrhagic shock secondary to pelvic trauma vice open AO.

Notes

# LONG-TERM OUTCOMES AFTER VIOLENCE-RELATED TRAUMA: A MULTI-CENTER COHORT STUDY 

Manuel Castillo-Angeles MD,MPH, Juan Herrera-Escobar MD,MPH, Alexander Toppo
BS, Sabrina Sanchez MD, Haytham M. Kaafarani MD,MPH, Ali Salim* MD, Adil Haider* MD,MPH, Deepika Nehra MD, Brigham and Womens Hospital

Invited Discussant: Amy Goldberg, MD

Introduction: Violence continues to be a significant public health burden, but little is known about the long-term outcomes of these patients. Our goal was to determine the impact of violence-related trauma on long-term functional and psychosocial outcomes. Methods: We identified trauma patients with moderate to severe injuries (ISS $\geq 9$ ) treated at one of 3 level 1 trauma centers. These patients were asked to complete a survey over the phone between 6-12 months after injury evaluating both functional and psychosocial outcomes (SF-12, T-QoL, PTSD screen, chronic pain, return to work). Patients were classified as having suffered a violent injury if the mechanism of injury was a stab, gunshot or assault. Self-inflicted wounds were excluded. Adjusted logistic regression models were built to determine the association between a violent mechanism of injury and long-term outcomes.
Results: 1,902 patients moderate-to-severely injured patients were successfully followed, of whom $162(8.5 \%)$ were victims of violence. For the victims of violence: mean age was 35 years (SD15.3), $84 \%$ were male and $55.6 \%$ were black. $33.3 \%$ reported newly needing help with at least one activity of daily living after the violence-related event. 55/109 $(50.4 \%)$ of patients who were working prior to their injury had not yet returned to work. $43.3 \%$ screened positive for PTSD and $52.5 \%$ reported chronic pain. On multivariate analysis, a violent mechanism was significantly associated with PTSD (OR 2.33, 95\% Confidence Interval 1.43-3.80, $\mathrm{p}=0.001$ ), but not associated with chronic pain, return to work or functional outcomes.

| Variable | Odds ratie (95\% Caufiolece interval) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | PTSD | Functional Limitation | Noretera to work | Caronik Pain |
| Vidence-relted trama (Ref set-viblet) | 2.33 (1.43-3.80) | 1.12 (0.84-2.10) | 0.98(0.54-1.76) | 0.99 (0.82-1.57) |


Conclusion: The physical and mental health burden after violence-related trauma is not insignificant. Further work is needed to identify intervention strategies and social support systems that may be beneficial to reduce this burden.

Notes

# PLASMA RESUSCITATION WITH ADJUNCTIVE PERITONEAL RESUSCITATION REDUCES ISCHEMIC INTESTINAL INJURY FOLLOWING HEMORRHAGIC SHOCK 

Jason W. Smith* MBA,MD,Ph.D., Jessica Schucht MD, Brian Harbrecht* MD, Logan Bond MD, Glen A. Franklin* MD, Paul J. Matheson Ph.D., University of Louisville

Invited Discussant: Stephen Cohn, MD

Introduction: Ischemia-reperfusion injury to the intestine during hemorrhagic shock (HS) and subsequent resuscitation leads to damage to the intestine, intestinal barrier breakdown and is the inciting factor for inciting for multiple organ dysfunction syndrome in a subset of trauma patients. Hemostatic resuscitation with blood product may not completely restore or protect the GI tract following. We postulated that resuscitation with DPR combined with FFP would result in improved intestinal blood flow and decreased intestinal injury compared to conventional methods of resuscitation.

Methods:Using a previously published HS protocol Sprague Dawley rats underwent HS and were assigned to one of 5 resuscitation groups ( $\mathrm{n}=7$ ): Sham; HS+ crystalloid resuscitation $\boldsymbol{C R}$ (shed blood plus 2 volumes crystalloid resuscitation); $\boldsymbol{H} \boldsymbol{S}+\boldsymbol{C R}+\boldsymbol{D P R}$ (intraperitoneal (IP) dialysis fluid); $\boldsymbol{H} \boldsymbol{S}+\boldsymbol{F F P}$ (shed blood plus 2 volumes FFP); and $\boldsymbol{H S}+\boldsymbol{D P R}+\boldsymbol{F F P}$ ( (IP) dialysis fluid, 2 volumes FFP). Laser Doppler flowmetry of the bowel, serum samples free fatty acid binding proteins (FABP), and H\&E and immunohistochemistry (IHC) staining were used to assess the intestinal injury and blood flow after HS. P-values $>0.05$ were considered significant.

Results: Following HS, the addition of DPR to either resuscitation modality led to increased intestinal blood flow. (Figure 1) At 4 hours after HS and resuscitation, FABP2 (intestine and colon) and FABP6 (ileal) were elevated in the CR group and reduced in both the FFP and the DPR groups. Intestinal cell nuclear thinning, denuded intestinal villi and disruption of the intestinal cell lamina propria was identified within 4 hours of HS-induced ischemic injury in both the FFP and the CR groups with the CR group being worst. Combination therapy with FFP and DPR demonstrated minimal to no cell injury in H\&E and IHC graded samples and a significant reduction in FABP levels following. (Figure 4)

Conclusion: HS leads to ischemic-reperfusion injury of the intestine, both FFP and DPR reduced intestinal damage, and combination therapy alleviated most signs of organ injury. Combination therapy with DPR to restore intestinal blood flow following shock could be an essential method of reducing morbidity and mortality after trauma.


Notes

# RADIOGRAPHIC PREDICTORS OF THERAPEUTIC OPERATIVE INTERVENTION AFTER BLUNT ABDOMINAL TRAUMA: THE RAPTOR SCORE 

Dina M. Filiberto MD, Muhammad O. Afzal MD, John P. Sharpe MD, Catherine Seger<br>MD, Sridhar Shankar MD, Martin A. Croce* MD, Timothy C. Fabian* MD, Louis J. Magnotti* MD, University of Tennessee Health Science Center - Memphis<br>Invited Discussant: Lillian Kao, MD, MS

Introduction: Bowel and mesenteric injuries are rare in patients following blunt abdominal trauma. These injuries represent a diagnostic challenge, often presenting in a delayed fashion. Computed tomography (CT) imaging has become a mainstay in the work-up of the stable trauma patient. Yet, the role of CT in diagnosing those injuries requiring operative intervention remains controversial. The purpose of this study was to identify radiographic predictors of therapeutic operative intervention in patients after blunt abdominal trauma.

Methods: All patients with a discharge diagnosis of a mesenteric injury after blunt trauma were identified over a 5-year period. A radiologist, blinded to the patients' management and outcome, reviewed the admission CT scan to identify potential predictors of bowel and/or mesenteric injury. Patients were then stratified by operative intervention [therapeutic laparotomy (TL) vs. non-therapeutic laparotomy (NTL)] and compared. Multivariable logistic regression (MLR) analysis was performed to determine independent predictors of TL. All potential predictors included in the initial regression model were assigned one point and a score based on the number of predictors was calculated: The Radiographic Predictors of Therapeutic Operative Intervention (RAPTOR) Score. Youden's index was used to determine the optimal RAPTOR score.

Results: 151 patients were identified. 114 (76\%) patients underwent operative intervention. Of these, 75 patients ( $66 \%$ ) underwent TL. There were no missed injuries in patients managed non-operatively. Multifocal hematoma, acute arterial extravasation, bowel wall hematoma, bowel devascularization, fecalization, free air and fat pad injury, identified as potential predictors of bowel and/or mesenteric injuries on univariable analysis, were included in the initial MLR model and comprised the RAPTOR score. The optimal RAPTOR score was identified as $\geq 3$, with a sensitivity, specificity and positive predictive value of $67 \%, 85 \%$ and $86 \%$, respectively. MLR identified acute arterial extravasation (OR 3.8; 95\%CI 1.2-4.3), bowel devascularization (OR 14.5; 95\%CI 11.8-18.4) and fat pad injury (OR $4.595 \%$ CI 1.6-6.2) as independent predictors of TL following blunt abdominal trauma (AUC 0.91 ).

Conclusion: CT imaging remains vital in assessing for potential bowel and/or mesenteric injuries following blunt abdominal trauma. The RAPTOR score provides a simplified approach for those patients that may benefit from early operative intervention. In fact, this score could potentially represent an invaluable tool in the management of blunt trauma patients without a clear indication for laparotomy but at risk for blunt bowel and/or mesenteric injuries.

Notes

Session I: Plenary Papers 1-8
Paper 7: 3:00 PM - 3:20 PM

# DISPROPORTIONALLY LOW NIH FUNDING FOR TRAUMA RESEARCH: THE CALL FOR A NATIONAL INSTITUTE OF TRAUMA 

Nina E. Glass MD, Julia Riccardi BA, Nicole I. Farber BS, Stephanie Bonne* MD, David H. Livingston* MD, Rutgers New Jersey Medical School

Invited Discussant: William Cioffi, MD
Introduction: Injury is the leading cause of death in young Americans up to age 46. Despite this chilling statistic, funding for trauma is well below that of other conditions, such as cardiovascular disease and cancer. Previous analyses demonstrating disproportionately low NIH funding for trauma were based on administrative reviews which likely overestimate the true proportion of trauma funding. Without accurate data, policy makers cannot make informed decisions and the status quo will never change. We hypothesized that NIH funding for trauma is lower than previously reported. The lack of a dedicated home for trauma research results in diffusion of grants across the NIH and hampers effective funding opportunities.
Methods: The NIH Research Portfolio Online Reporting Tools Expenditures and Results database was initially screened using a keyword search of over 20 terms including 'trauma', 'injury', 'shock', 'MVC' and excluding terms like 'cancer', 'congenital', 'autism' to capture all possible trauma-related and exclude obvious non-trauma grants. The title, abstract, and project terms of all grants which screened positive were reviewed using an inductive coding schema to positively identify trauma-related grants. An expert panel was used to adjudicate any ambiguity.
Results: 50,137 NIH grants were awarded in FY2016; 6,676 (13\%) were captured by our initial screen. Of these, only 1,888 (28\%) were found to be trauma research representing $3.7 \%$ of all NIH grants. Of the total $\$ 25$ billion NIH research budget only $\$ 720$ million ( $2.9 \%$ ) was awarded for trauma research. Trauma related grants were awarded from 24 institutes with a range of funding from $0.01 \%$ (NCI) to $11 \%$ (NINDS and NIAMS). Approximately $4 \%$ of investigator initiated (e.g. R01, R21) and $4.5 \%$ of training grants (e.g. K23, K08) were trauma related. Of note, the awards with the highest proportion containing trauma related research were large multidisciplinary longitudinal grants including $30 \%$ of P60 centers, and $15 \%$ of P01 projects and U19 agreements. <100 trauma-related grants were awarded to Departments of Surgery.
Conclusion:This review provides the most detailed analysis of NIH trauma-related funding to date. The disproportionately low percentage of funding, spread across NIH Institutes and Centers, results in a diffusion of purpose and makes advocating for trauma research nearly impossible. Compared to the burden of disease and current goal of zero preventable deaths this dearth of federal funding is shameful. These data demonstrate a need for the creation of a National Institute of Trauma at the NIH.

Notes

Session I: Plenary Papers 1-8
Paper 8: 3:20 PM - 3:40 PM

## DELAYED SPLENECTOMY IN PEDIATRIC SPLENIC INJURIES: IS CONSERVATIVE MANAGEMENT OVERUSED?

Zaid Haddadin MD, Kamil Hanna MD, Lourdes Castanon MD, Mohammad Hamidi MD, Lynn Gries MD, Narong Kulvatunyou MD, Ashley Northcutt MD, Andrew Tang MD, Bellal Joseph* MD, University of Arizona - Tucson<br>Invited Discussant: Margaret Knudson, MD

Introduction: Non-operative management (NOM) of pediatric splenic injuries has become the mainstay of treatment. The long-term failure rate of NOM is not well established. The aim of our study was to evaluate the NOM failure rate and ascertain the predictors of delayed splenectomy upon readmission in pediatric splenic injuries.

Methods: The (2011-2014) National Readmission Database was queried for all patients $<18 y$ admitted with an isolated splenic injury. Patients were stratified into 3 groups: splenectomy, angioembolization, and NOM. Outcome measures were the rates of readmission, blood-transfusion and delayed splenectomy. Multivariable logistic and Cox regression were performed to determine the predictors of delayed splenectomy upon readmission.

Results: A total of 9,506 patients with splenic injuries were identified. Mean age was $14 \pm 4 \mathrm{y}$. Most patients underwent NOM 7,318 (77\%), 1,541 (16.2\%) underwent splenectomy, and 647 (7\%) angioembolization. High-grade splenic injuries (grades 4-5) were more common among splenectomy 1,133 ( $74 \%$ ) and angioembolization 445 (69\%) patients relative to NOM patients 3,017 (48\%); (p<0.001). Overall, 589 ( $6 \%$ ) were readmitted within 6 months with a median time to readmission of 12[5-23] d. The angioembolization and NOM groups had higher readmission rates ( $12 \%$ and $8 \%$ vs. $5 \%$; $\mathrm{p}<0.001$ ), and blood-transfusion rates ( $6.8 \%$ and $6.4 \%$ vs. $2 \%$; $\mathrm{p}<0.001$ ) compared to the splenectomy group. The rate of delayed splenectomy was $15 \%$ ( $7.2 \%$ of NOM vs. $5.3 \%$ of angioembolization patients; $\mathrm{p}=0.026$ ). Predictors of delayed splenectomy were high-grade-injury (OR 3.37[2.25-4.17]; $\mathrm{p}=0.029$ ), blood-transfusion (OR 1.92 [1.17-2.40]; $\mathrm{p}=0.039$ ), and NOM (OR 5.65[3.37-6.39]; $\mathrm{p}=0.041$ ) relative to angioembolization. Median time to splenectomy was shorter in the NOM group vs. angioembolization (14d vs. 58d); (aHR 6.22[1.53-9.24]; $\mathrm{p}=0.034$ ).

Conclusion: One in seven children had failure of conservative management for splenic injuries and underwent a delayed splenectomy within 6-months after discharge. NOM and angioembolization demonstrate a temporary benefit. Better selection of candidates for conservative management must be performed.

Notes

## Session II: <br> Master Surgeon Lecture I



# "Operative Thoracic Trauma: Tips, Tricks, and Occasional Anecdote" 

Wednesday, September 18, 2019
3:40 PM - 4:10 PM
Location:
Lone Star Ballroom A/B
Presenter:
J. Wayne Meredith, MD

Professor, Trauma Surgery
Wake Forest Baptist School of Medicine

Chair of the Department of Surgery Wake Forest Baptist Health

## Session III:

Panel: Financing Trauma Care: International Perspectives

"Financing Trauma Care: International Perspectives"
Wednesday, September 18, 2019

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4: 10 \text { PM - 5:25 PM }
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Location: Lone Star Ballroom A/B
Panelists: Felipe Vega-Rivera, MD; Christine Gaarder, MD, PhD; Li Hsee, MD;
Yasuhiro Otomo, PhD, MD; Kristan Staudenmayer, MD, MSc
Moderator: Kristan Staudenmayer, MD, MSc

Group II: Abdominal Trauma

Group III: Trauma/Education Prevention

Group IV: Pediatric Trauma/Neurotrauma

Group V: Geriatric Trauma

Group VI: Trauma Systems

Group VII: Trauma Systems II

Posters \#11-20
Patrick Kim, MD \& Susan Rowell, MD Location: Lone Star Preconvene (near C4)

Posters \#21-30
Marc deMoya, MD \& D'Andrea Joseph, MD Location: Lone Star Preconvene (near C4)

Posters \#31-40
Kathryn Bass, MD \& Michael Nance, MD
Location: Lone Star Ballroom C1

Posters \#41-51
Vanessa Ho, MD, MPH \& Orlando Kirton, MD, MBA
Location: Lone Star Ballroom C2
Posters \#53-61
Thomas Esposito, MD, MPH \& Julie Dunn, MD
Location: Lone Star Ballroom C3
Posters \#62-71
Nicholas Namias, MD, MBA \& Louis Magnotti, MD
Location: Lone Star Ballroom C4


# Session V: <br> Canizaro Papers 9-14 

Thursday, September 19, 2019
7:30 AM - 9:30 AM
Location: Lone Star Ballroom A/B
Moderator: David Livingston, MD
Recorder: Rachael Callcut, MD, MSPH

# EXTRACORPOREAL SUPPORT FOR TRAUMA: A TRAUMA QUALITY IMPROVEMENT PROJECT (TQIP) ANALYSIS IN PATIENTS WITH ARDS 

Aaron Strumwasser* MD, MSc., Alice Piccinini MD, Bryan Love MD, Reynold Henry MD, Brad Allen MD, Kenji Inaba* MD, Kazuhide Matsushima* MD, Meghan Lewis MD, Peter Gruen MD, Demetrios Demetriades* MD,Ph.D., LAC+USC Medical Center

Invited Discussant: David Zonies, MD, MPH

Introduction: Extracorporeal membrane oxygenation (ECMO) for patients with severe traumatic ARDS is debated. We sought to determine whether trauma surgeons' experience with ECMO demonstrates improved outcomes in ARDS using the trauma quality improvement project (TQIP) institutional registry.
Methods: The TQIP database was queried for all patients that underwent ECMO and those patients that possessed a diagnosis of ARDS from 2013-2016. Exclusion criteria included an abbreviated injury score (AIS) score of 6 in any of the body regions, systolic blood pressure (SBP) or heart rate (HR) of 0 , history of CHF or arrest, transfers into the hospital, HLOS < 72 hours, patients leaving against medical advice, or patients with missing data. A propensity score analysis was used in non-ECMO patients to delineate patients at high risk of death from severe ARDS (1:1 performed without replacement, nearest neighbor method, caliper 0.2 , corrected for age, gender, HR, SBP, Glasgow Coma Score (GCS), injury severity score (ISS), and abbreviated injury score (AIS) in the following regions - head, face, neck, chest, abdomen, pelvis, extremity, external). Survival characteristics were compared between the ECMO population (97 patients) and the non-ECMO population ( $\mathrm{N}=1,266$ patients) using Cox Regression. Secondary outcomes such as hospitalization (HLOS), ICU length-of-stay (LOS) and ventilation days stratified for patient demographics (age, gender, ISS, body region), timing of ECMO and anticoagulation status were compared. Data is represented as median [IQR $25-75 \%$ ], mean $\pm$ SD or \%, as appropriate. Univariate comparisons were made via unpaired Student's t-test or Mann-Whitney U test for continuous variables and Chi Square analysis or Fisher Exact for categorical variables with p values less than 0.05 deemed significant.
Results: Survival characteristics are shown between the two groups (Figure 1). Compared to the nonECMO population, the ECMO population tended to be younger ( 35 [22-51] vs. 56 [36-68] years, $p<0.01$ ), had lower SBP (118 [90-137] vs. 130 [103-152] mmHg), higher HR (108 [88-129] vs. 96 [79-116] BPM, $\mathrm{p}<0.01$ ), higher median GCS scores (median 14 [3-15] vs. 9 [3-15], $\mathrm{p}=0.03$ ), with equal injury severity overall ( 27 [17-34] vs. 27 [19-38], $\mathrm{p}=0.3$ ). The ECMO population had fewer severe head injuries ( 29 vs . $63 \%, \mathrm{p}<0.001$ ) and more severe thoracic injuries ( $76 \mathrm{vs} .60 \%, \mathrm{p}=0.001$ ), with all other injured regions being the same between groups ( $p>0.1$ for all). Among ECMO survivors, patients that underwent ECMO earlier ( $<7$ days) had shorter HLOS ( $33 \pm 27$ vs. $47 \pm 23$ days, $\mathrm{p}=0.01$ ), shorter ICU LOS ( $24 \pm 17$ vs. $39 \pm 16$ days, $\mathrm{p}=0.0001$ ) and fewer ventilator days ( $21 \pm 18$ vs. $33 \pm 14$ days, $\mathrm{p}=0.003$ ). Compared to survivors that did not undergo ECMO, there was no difference in HLOS ( $29 \pm 22$ vs. $33 \pm 27$ days, $p=0.3$ ) or ventilator days ( $17 \pm 14$ vs. $21 \pm 18$ days, $p=0.1$ ), but prolonged ICU LOS was observed ( $24 \pm 17$ vs. $20 \pm 13$ days, $p=0.04$ ) in the ECMO population. There were no outcome differences with respect to anticoagulation status ( $p>0.1$ ) or type of anticoagulation used ( $p>0.1$ ) in the ECMO population.
Conclusion: ECMO may portend improved survival from severe ARDS at the expense of prolonged ICU LOS. Early ECMO in a younger population with severe thoracic injuries may be the optimal patient demographic. Prospective study is warranted.


Notes

# UNDERSTANDING THE MAKEUP OF A GROWING FIELD: A COMMITTEE ON TRAUMA SURVEY OF THE NATIONAL NETWORK OF HOSPITAL-BASED VIOLENCE INTERVENTION PROGRAMS 

Stephanie Bonne* MD, Ashley Hink MD,MPH, Lisa Allee MSW, Katie Bakes MD, Peter Burke* MD, Thomas Duncan* DO, Joel Fein MD,MPH, Tamara Kozyckyj MPH, David Shapiro* MD, Pina Violano MPH,Ph.D., Deborah Kuhls* MD, Rochelle Dicker* MD, UCLA David Geffen School Of Medicine

Invited Discussant: Glen Tinkoff, MD
Background: Hospital Based Violence Intervention programs (HVIPs) are becoming an increasingly prevalent injury prevention strategy in trauma centers nationwide. HVIPs practice and public health approach to violence intervention. Variation in services provided, practice patterns, funding sources, or populations served by these programs is not widely known. This study aims to raise awareness of the characteristics of these programs and better identify opportunities and gaps across HVIPs.
Methods: The 38 member programs of the National Network of Hospital Based Violence Intervention Programs (NNHVIP) were invited to participate in a Qualtrics-Based online survey administered by NNHVIP in coordination with the ACS Committee on Trauma. Survey questions were both discreet and quantitative in nature as well as open-ended, allowing qualitative analysis of responses. Quantitative responses were reported with simple descriptive statistics using Microsoft Excel. Qualitative analysis was performed by coding open-ended responses, identifying and describing commonly reported themes until theoretical saturation was achieved.
Results: 38 programs completed the survey (100\%). The most common demographics served are aged 18-45. Individuals older than age 45 rarely meet programs' inclusion criteria. Programs most commonly serve African-Americans. All programs respond to street violence and adolescent violence, as this is the focus of participating HVIPs. Some respond to domestic violence, sexual violence, or sex trafficking. Child abuse and elder abuse are rarely included. $85 \%$ of programs provide case management $>3$ years. Programs with higher levels of funding ( $>\$ 300,000$ per year) were more likely to be funded by government funding, while lower funded programs were by grants, foundations or direct philanthropy. The largest barrier to starting or sustaining a program was consistent funding, with lack of resources for addressing risk factors or mental health as secondary barriers. Qualitative analysis revealed themes including concern over funding, staffing, and the adequacy of support and related services. For programs that had overcome hurdles, the importance of hospital buy-in and secure funding were sited. Programs value NNHVIP for advocacy, networking, and technical support. Many mentioned the importance of demonstrating evidence-based outcomes to justify continued funding.

Conclusion: HVIPs focus on violence in communities and provide case management based on the needs of local populations. Case management provides mentorship and addresses social determinants of health. There is opportunity to expand HVIPs to include more sexual and domestic violence programming, and develop models to serve victims of child and elder abuse similarly utilizing a public health approach. Successful program development requires stable funding, adequate staffing models and buy-in from hospitals and staff. Physicians can provide oversight and guide evaluation of HVIPs. Continued education for physicians about the HVIP model, advocacy for program funding through fee for service policy initiatives, program evaluation and expansion of NNHVIP is essential to further expand these efforts into a nationwide best practice.

Notes

# RANDOM FOREST MODEL PREDICTS ACUTE KIDNEY INJURY AFTER TRAUMA LAPAROTOMY 

Rondi Gelbard* MD, Hannah Hensman BA, Seth Schobel Ph.D., Vivek Khatri Ph.D., Cameron W. Paterson MD, Christopher J. Dente* MD, Timothy G. Buchman* MD,Ph.D., Allan Kirk MD,Ph.D., Eric Elster* MD, Emory University<br>Invited Discussant: Jordan Weinberg, MD

Introduction: Despite advances in the management of critically ill patients, the incidence of acute kidney injury (AKI) remains high among trauma patients. Given the morbidity and mortality associated with AKI, we sought to examine the value of predictive modelling for identifying risk factors for the development of AKI.

Methods: Clinical and molecular biomarker data were collected from patients undergoing exploratory laparotomy for abdominal trauma at a Level 1 trauma center between 2014 and 2017. Serum samples were collected within 24 hours after injury. AKI was defined as either (1) Increase in serum creatinine level of $\geq 0.3 \mathrm{mg} / \mathrm{dL}$ or $\geq 1.5$ times baseline, (2) decrease in GFR by $50 \%$, or (3) urine output $<0.5 \mathrm{~mL} / \mathrm{kg}$ per hour for $\geq 6$ hours. Machine learning algorithms were employed to develop a model predicting AKI. Random forest (RF) was performed and features were selected using recursive variable elimination. The model was trained and tested with 145 records using leave-one-out cross validation.
Results: One hundred and forty-five patients were included (median age: 31, median ISS: 18). The incidence of AKI was $27.6 \%$ (40/145), diagnosed a median of 2 days (IQR: $0-13$ days) post-injury. Overall mortality was $2 \%$ ( 1 AKI vs 2 non-AKI, $p=1.0$ ). Infectious complications were more common among AKI patients ( $10 / 40,25 \%$, versus $10 / 105,9.5 \% ; p=0.03)$. A total of $17 / 40(42.5 \%)$ AKI patients progressed to Stage 3 and $3 / 40(7.5 \%)$ required renal replacement therapy. The final RF model resulted in three features (Sequential Organ Failure Assessment (SOFA) Score, Serum Monocyte Chemoattractant Protein-1 (MCP1), and serum Vascular endothelial growth factor (VEGF)) that predicted AKI with an area under the curve (AUC) of 0.739 , a sensitivity of 0.817 , and a specificity of 0.607 . A logistic regression model with the RF final features predicted with an AUC of 0.722 , a sensitivity of 0.769 , and a specificity of 0.642 .
Conclusion: Biomarkers may have diagnostic utility in the early identification of patients at risk of post-traumatic AKI. Future iterations of modeling will require accounting for the different etiologies of AKI, as well as breaking down the SOFA score to remove the creatinine component and assess overall contribution of the score components to our predictive accuracy. Further refinement and validation of the model could lend to the development of clinical decision support tools to guide resuscitation strategies and care bundles aimed at preventing AKI.


Figure 1. Receiving operator characteristic curve for the random forest AKI model.

Notes

# ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS) AFTER TRAUMA: STILL HIGHLY MORBID AND MORTAL 

George Kasotakis* MD,MPH, Krista Haines DO, Cory Vatsaas MD, Amy Alger* MD, Steven Vaslef* MD,Ph.D., Kelli Brooks* MD, Sean Montgomery* MD, Suresh Agarwal* MD, Duke University

Invited Discussant: Pauline Park, MD

Introduction: ARDS is an infrequent, yet morbid complication in injury victims. With the current project we sought to estimate trends in its incidence, determine clinically relevant outcomes, and identify risk factors for ARDS and related mortality.
Methods: The national TQIP dataset (2010-2014) was queried, after exclusion of patients who expired/had a length of stay (LOS) <48 hours. Demographics, injury characteristics and outcomes were compared between patients who developed ARDS and those who did not. Logistic regression models were fitted for the development of ARDS and mortality respectively, adjusting for age, gender, race, severity of neurologic injury, overall injury severity, presenting hypotension, mechanism of injury, blood products transfused and pre-existing comorbidities.
Results: Out of the 808,195 TQIP patients, 165,244 were excluded. Incidence of ARDS decreased over the study years ( $3 \%$ to $1.1 \%, \mathrm{p}<0.001$ ), but related mortality increased ( $18.9 \%$ to $21 \%, \mathrm{p}=0.001$ ). ARDS patients spent on average an additional 14.710 .3 days in the hospital, 9.77 .9 in the ICU, and 6.69 .4 on mechanical ventilation (all $\mathrm{p}<0.001$ ). Older age, male gender, African American race, and interestingly pre-injury steroids increased risk for ARDS, while blood product transfusions did not (table). Only age, male gender, lower GCS and higher ISS predicted mortality among ARDS patients.
Conclusion: Although the incidence of ARDS after trauma appears to be improving slightly, mortality has increased. As risk factors for ARDS or mortality are not easily modifiable, the need to develop treatments for the syndrome cannot be overemphasized.

| ARDS | Odds Ratio | P-value |
| :--- | :--- | :--- |
| Age (decade) | $1.03(1.00-1.04)$ | 0.002 |
| Male gender | $1.32(1.22-1.43)$ | $<0.001$ |
| Afr. Am. | $1.16(1.04-1.29)$ | 0.008 |
| EMS GCS | $0.89(0.88-0.90)$ | $<0.001$ |
| Steroids | $1.92(1.40-2.64)$ | $<0.001$ |
| Blunt mechanism | $0.97(0.85-1.12)$ | 0.723 |
| ISS | $1.05(1.05-1.05)$ | $<0.001$ |
| PRBC Units $(24 \mathrm{~h})$ | $1.00(1.00-1.01)$ | 0.870 |
| FFP Units (24h) | $1.00(1.00-1.01)$ | 0.665 |
| PLT Units (24h) | $1.00(1.00-1.01)$ | 0.051 |
| Cryo Units (24h) | $1.00(1.00-1.01)$ | 0.890 |

Notes

# A GLIMPSE INTO THE STATE OF GENDER TRENDS IN THE TRAUMA COMMUNITY: CURRENT APPRAISAL AND OPPORTUNITIES 

Shannon M. Foster* MD, Jennifer K. Davis* MD, Catherine G. Velopulos MD, Stephanie Bonne* MD, D'Andrea Joseph* MD, Heena Santry* MD, Jamie J. Coleman* MD, Rachael Callcut* MD, Reading hospital

Invited Discussant: Roxie Albrecht, MD

Introduction: Although women have traditionally been underrepresented in the surgical disciplines, there has been no in-depth contemporary analysis of the current state of women in the Trauma field. We aimed to understand the gender distribution of membership, leadership opportunities, and scientific contributions to annual meetings within professional organizations.
Methods: Retrospective collection of membership, leadership, presentation and publication from 2016-18 was completed for the American Association for the Surgery of Trauma (AAST), the Eastern Association for the Surgery of Trauma (EAST), and Western Trauma Association (WTA). Gender was assigned based on self-identification in demographic information, established relationships, or public sources.
Results: Women remain underrepresented in the field of Surgical Critical Care with only $28.1 \%$ of those ascertaining American Board of Surgery certification self-identifying as female. The proportion of females holding membership in EAST was comparable (29.4\%), slightly lower for WTA (19.0\%), and lowest for AAST (13.3\%, p<0.05). In contrast, AAST had the highest proportion of women participants in in executive leadership (AAST 32.5\%, WTA 19.0\%; EAST 18.8\%) and WTA the highest for committee chairs (WTA $33.3 \%$, AAST $27.8 \%$, EAST 20.5\%). AAST had the most significant increase in executive leadership over the last 3 years (AAST $28.6 \%$ to $41.6 \%$ ). The largest gap area of academic underrepresentation was for invited lectureships/masters/panelists and senior author scientific contributions (Table).
Conclusion: Fewer women than men pursue careers in the trauma field. Continuing to provide mentorship, leadership, and scientific recognition opportunities is an important component of increasing gender diversity in our field. We must continue to promote, sponsor, recognize, invite, and elect 'her'.

|  | AAST | EAST | WTA | p-walue |
| :--- | :---: | :---: | :---: | :---: |
| Membership | $13.3 \%$ | $29.4 \%$ | $19.0 \%$ | «0.0001 |
| Erecutive leadership | $32.5 \%$ | $18.8 \%$ | $19.0 \%$ | 0.397 |
| Board of Directors | - | $16.7 \%$ | $22.2 \%$ | 0.566 |
| Committee chairs | $27.8 \%$ | $20.5 \%$ | $33.3 \%$ | 0.566 |
| Committoe membars | $23.1 \%$ | $27.5 \%$ | $28.0 \%$ | 0.050 |
| Oral prosentars | $40.2 \%$ | $36.6 \%$ | $34.4 \%$ | 0.558 |
| Senior author | $20.0 \%$ | $27.6 \%$ | $13.2 \%$ | 0.022 |
| Invited dscussants | $20.0 \%$ | $31.7 \%$ | $n / 3$ | 0.023 |
| Moderators | 31.096 | $20.6 \%$ | $22.6 \%$ | 0.479 |
| Invited Speakers/Masters/Panelists | $17.9 \%$ | $23.7 \%$ | $23.5 \%$ | 0.793 |
| Qs posters/talks | $39.0 \%$ | $30.1 \%$ | - | 0.020 |
| as discussants/moderators | $23.2 \%$ | $25.0 \%$ | - | 0.79 |

Notes

# WHO RETURNS HOME AFTER ADMISSION FOR FALL? PATIENT FACTORS RELATED TO RESIDENCY ONE YEAR LATER 

Vanessa P. Ho* MD,MPH, Amy S. Kelley MD, MSHS, David F. Warner Ph.D., Jeffrey A. Claridge* MD, MS, Siran M. Koroukian Ph.D., METROHEALTH MEDICAL CENTER

Invited Discussant: Stephanie Savage, MD

Introduction: Falls represent 78\% of blunt trauma in older patients. Long-term prognostication for fall survivors is not well-described. We hypothesize fall survivors living at home one year after admission have different baseline factors than those living in a facility or those who died.

Methods: We identified community dwelling patients admitted for fall (ICD9 E880-888) in 2011-2012 from the Medicare Current Beneficiary Survey (MCBS), a longitudinal health survey with participants interviewed serially over four years. We measured baseline disease conditions and functional status, including activities of daily living (ADLs) and instrumental ADLs (IADLs), from the survey prior to the fall. We identified residency location and dates of residency changes from subsequent interviews. We compared patients living at home one year post-admission to those living in a facility or who died. We assessed association between pre-fall factors and home status using chi-square or Kruskal-Wallis tests. We constructed a Kaplan-Meier curve to illustrate the timing of transitions to home.
Results: Of 145 patients, one year after admission for fall 93 ( $64 \%$ ) were home, 18 ( $12 \%$ ) were in a facility, and $32(22 \%)$ had died. Younger age, ability to shop, and ability to pay bills independently, were associated with increased odds of living at home (all $\mathrm{p}<0.05)$. Other characteristics were not significantly associated with residence status one year after admission. Among patients who were not living at home one year post-fall, more than half had transitioned to a facility or had died within 60 days.

Conclusion:Two-thirds of community-dwelling older adults admitted after a fall were living at home one year later. Younger age and factors suggesting ability to live independently at baseline (shopping and paying bills) were positively associated with maintaining community residence.


Notes


# Session VI: Scholarship Presentations 

Thursday, September 19, 2019
9:30 AM - 10:00 AM
Location: Lone Star Ballroom A/B
Moderator: Martin Croce, MD

10:00-10:08 AM
Vanessa Ho, MD, MPH
MetroHealth Medical Center
AAST Research and Education Fund (2018-2019)
"Worse Than Death? Prognosticating Long-Term Recovery Trajectory for Elderly Survivors of Emergency General Surgery"

10:10-10:18 AM
Marta McCrum, MD, MPH University of Utah
AAST Research and Education Fund (2018-2019)
"A Geographic Information System to Evaluate Disparities in Access to
Emergency General Surgery"
Deepika Nehra, MD
Brigham and Women's Hospital
AAST Research and Education Fund (2018-2019)
"Understanding the Psychosocial Impact of Traumatic Injury"


Thursday, September 19, 2019
10:20 AM - 11:20 AM
Location: Lone Star Ballroom A/B
Moderator: Raminder Nirula, MD, MPH
Recorder: Brian Eastridge, MD

# THE IMPACT OF INTERHOSPITAL TRANSFER ON MORTALITY BENCHMARKING AT LEVEL III AND IV TRAUMA CENTERS: A STEP TOWARDS SHARED MORTALITY ATTRIBUTION IN A STATEWIDE SYSTEM 

Daniel N. Holena* MD, MSCE, Elinore J. Kaufman MD, MSHP, Justin Hatchmonji MD, Thomas<br>Wasser Ph.D., M K. Delgado MD, MS, Douglas J. Wiebe Ph.D., Brendan G. Carr MD, MSHP, Patrick M. Reilly* MD, University of Pennsylvania<br>Invited Discussant: Peter Fischer, MD, MSc

Introduction:Many injured patients presenting to level III \& IV trauma centers will be transferred to level I \& II centers, but the way in which these interhospital transfers influence benchmarking at level III \& IV centers has not been described. We hypothesized that the apparent O:E mortality ratio at level III \& IV centers is influenced by the time at which mortality is measured in transferred patients Methods:We conducted retrospective study of all adult patients presenting to Level III \& IV trauma centers in a single-state trauma system from 2008-2017, excluding burns. We used probabilistic matching on dates and patient characteristics to generate a linked dataset for patients transferred from Level III \& IV centers to Level I \& II centers. We summed patient-level predicted mortality from ASCOT models to generate center-level expected mortality, which was then compared to observed mortality at the time of discharge from the level III \& IV center $\left(\mathrm{O}^{1}\right)$ or observed mortality at the time of discharge from the level III \& IV center for non-transferred or the time of discharge from the level I \& II center for transferred patients ( $(3)$.
Results:In total, 9,336 presented to 11 Level III \& IV trauma centers over the study period ( $92 \%$ white $49 \%$ female, $96 \%$ blunt mechanism, ISS 8 IQR (6-15). Of these, 4,118 (44\%) were transferred to Level I \& II centers. Based on ASCOT modeling, expected mortality in the overall cohort was 526 (5.6\%). A total of $355(3.8 \%)$ patients died during the study period, of which $176(49.6 \%)$ patients died at the initial level III \& IV centers ( $\mathrm{O}^{1}$ ). For all level III \& IV centers, including post-transfer mortality for transferred patients in addition to observed mortality in non-transferred patients ( $\mathrm{O}^{2}$ ) resulted in worse apparent $\mathrm{O}: \mathrm{E}$ ratios (Table) and resulted in significant differences in $\mathrm{O}: \mathrm{E}$ ratios for the overall cohort ( $\mathrm{O}^{1}: \mathrm{E} 0.33,95 \% \mathrm{CI} 0.28-0.38$ vs $\left.\mathrm{O}^{2}: \mathrm{E} 0.67,95 \% \mathrm{CI} 0.60-0.74\right)$.

| Institution | N | Observed <br> Deaths (Level III/V) (O1) | Observed <br> Deaths (Final Discharge) (O2) | Expected Deaths ( $\Sigma$ (1ASCOT) <br> (E) | O1/E | O2/E | $\triangle \mathrm{O} / \mathrm{E}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 43 | 0 | 1 | 2.27 | 0 | 0.44 | 0.44 |
| 2 | 360 | 5 | 12 | 21.18 | 0.24 | 0.57 | 0.33 |
| 3 | 723 | 9 | 21 | 38.05 | 0.24 | 0.55 | 0.31 |
| 4 | 222 | 3 | 9 | 11.82 | 0.25 | 0.76 | 0.51 |
| 5 | 413 | 5 | 13 | 18.94 | 0.26 | 0.69 | 0.43 |
| 6 | 151 | 3 | 6 | 11.31 | 0.27 | 0.53 | 0.26 |
| 7 | 976 | 18 | 36 | 65.09 | 0.28 | 0.55 | 0.27 |
| 8 | 658 | 12 | 25 | 42.55 | 0.28 | 0.59 | 0.31 |
| 9 | 5378 | 110 | 214 | 293.83 | 0.37 | 0.73 | 0.36 |
| 10 | 344 | 8 | 14 | 17.1 | 0.47 | 0.82 | 0.35 |
| 11 | 68 | 3 | 4 | 4.41 | 0.68 | 0.91 | 0.23 |
| Total | 9336 | 176 | 355 | 526.54 | 0.33 | 0.67 | 0.34 |

Conclusion: The apparent O:E mortality ratio at level III \& IV centers is influenced by the time at which mortality is measured in transferred patients. To provide fair and accurate benchmarking for both level III \& IV centers and identify opportunities across the continuum of the trauma system, a system of shared attribution for outcomes of transferred patients should be devised.

Notes

Session VII: Papers 15-17
Paper 16: 10:40 AM - 11:00 AM

# IS NBATS-2 UP TO THE TASK? ACTUAL VS PREDICTED PATIENT VOLUME SHIFTS WITH THE ADDITION OF ANOTHER TRAUMA CENTER 

Jennings H. Dooley BS, Bradley M. Dennis* MD, Louis J. Magnotti* MD, John P. Sharpe MD, Oscar D. Guillamondegui* MD, Martin A. Croce* MD, Peter E. Fischer* MD, Vanderbilt University Medical Center<br>Invited Discussant: Robert Winchell, MD

Introduction: The American College of Surgeons Committee on Trauma recently modified the Needs-Based Assessment of Trauma Systems tool in an attempt to better quantify the impact of an additional trauma center to a region (NBATS-2). While this tool has been tested theoretically, it has not yet been validated. The purpose of this study was to apply NBATS-2 to a system where an additional trauma center was added to compare predicted versus actual patient volumes.
Methods: All injured patients transported from the scene by ground from 2012-2018 were collected from the trauma registry of the initial (legacy) center. Injury location, injury rate adjusted for population growth, and demographics were analyzed by zip code. Spatial modeling was conducted using ArcGIS 10.6.1 to estimate the closest center. One level 1 trauma center existed in the PRE period (2012-2014) while in the POST period (2016-2018) an additional level 2 center was active. Notably EMS destination guidelines did not change from the PRE to POST period and favored the level 1 center for severely-injured patients (ISS $>15$ ). NBATS-2 predicted volume in the POST period was compared to the actual volume received at the level 1 center.
Results: A total of 4,068 injured patients were identified across 14 counties. In the PRE period, $72 \%$ of the population and $90 \%$ of the injuries were within a 45 -minute driving distance of the legacy trauma center (Fig.1). In the POST period 75\% of the total population and $90 \%$ of the injuries were within 45 minutes of either trauma center (Fig. 2). The POST predicted volume of severely-injured patients of the legacy level 1 center based on closest facility was 434 but the actual number was 809 . For minor injuries (ISS $\leq 15$ ) the difference was even more profound at 1,677 actual vs. 581 predicted to the
 legacy level 1 center.


Conclusion: NBATS-2 failed to predict the volume changes of the legacy trauma center after the addition of another center to the region. Without a change in EMS destination guidelines this finding was not surprising for severely-injured patients. However, the $288 \%$ increase in volume of minor injuries was unexpected. NBATS-2 must be refined for local factors including EMS relationships and educational campaigns by a legacy center to maintain volume.

Notes

Session VII: Papers 15-17
Paper 17: 11:00 AM-11:20 AM

# OUTCOMES IN ISOLATED TBI: THERE'S MORE TO IT THAN 'RIGHT PLACE, FIRST TIME' 

Henry O. Nnajiuba MD, MSc BSc, Elaine Cole Ph.D., Karim Brohi* Centre For Trauma Sciences, QMUL

Invited Discussant: Deborah Stein, MD, MPH

Introduction: Traumatic brain injury (TBI) patients benefit from rapid diagnosis, early neurosurgery and neurocritical care. Trauma systems utilise triage tools to facilitate timely access to specialist trauma care for TBI patients. Overtriage of those who could potentially be safely treated in their local hospitals is associated with reduced efficiency, higher costs and poorer patient experience. The overall objective of this study was to determine outcomes of patients with isolated TBI managed within an inclusive trauma system and to determine the independent effect of initial triage decisions on outcome.
Methods: We conducted a three-year retrospective registry study of all adults (>15 years) admitted to hospitals within the London Major Trauma System (LMTS) with an isolated moderate-severe TBI (AIS head $\geq 3$, AIS all other body regions $<3$ ) from January 1st 2014. The LMTS is an inclusive urban trauma system serving over 10 million people and comprising of four 'Level 1-equivalent' Major Trauma Centres (MTCs) and 35 'Level 2/3-equivalent' Trauma Units (TUs). Patients were divided into those who had required invasive neurocritical intervention and those who were managed conservatively. Within the neurocritical group we compared outcomes for patients directly admitted to MTCs with those transferred in from TUs (NC-DIRECT vs NC-TRANSFER). Within the conservative group we compared outcomes between MTC patients and non-transferred TU patients (CONS-MTC vs CONS-TU). Multivariable regression models analysed independent relationships between patient factors, levels of care and outcomes.
Results: A total of 6200 patients with moderate-severe isolated TBI were treated by the LMTS over the study period with $12 \%$ receiving neurocritical care. Overall unadjusted mortality rates were $16 \%$ and $10 \%(\mathrm{p}=0.02)$ for NC-DIRECT and NC-TRANSFER respectively (Fig. 1). After adjusting for injury characteristics, adult (age 16-69) neurocritical patients had equivalent mortality outcomes, whilst elderly (age 70+) NC-DIRECT patients had twice the mortality risk of elderly NC-TRANSFER (OR 2.42, $\mathrm{p}=0.04$ ) (Fig. 2). Unadjusted mortality rates for CONS-MTC exceeded CONS-TU ( $13 \%$ vs $9 \%, \mathrm{p}<0.01$ ) (Fig. 3) although regression analysis showed no significant difference in mortality risk between triage groups in either age cohort (Fig. 4).


Conclusion: This study has demonstrated that isolated TBI patients requiring secondary transfer for neurocritical care do not experience an increased mortality risk compared to patients admitted directly to MTCs. This is contingent on the ability of TUs to monitor and rapidly transfer patients requiring escalated levels of care. Patients who only require conservative treatment experience no survival benefit from being triaged to MTCs. Our data suggests that within this isolated TBI population more patients can be safely managed at their local hospitals thus balancing system patient flow and improving patient experience by keeping them closer to their social support networks.

Notes

## Session VIII: Presidential Address


"Traumacare"
Thursday, September 19, 2019
11:30 AM - 12:30 PM
Location: Lone Star Ballroom A/B
Presiding: David Spain, MD
Presenter: Martin Croce, MD
President, AAST

Senior Vice President
Chief Medical Officer
Regional One Health


# Session IXA: Papers 18-26 

Thursday, September 19, 2019 2:00 PM - 5:00 PM
Location: Lone Star Ballroom A Moderator: Rosemary Kozar, MD, PhD Recorder: Frederick Luchette, MD, MSc

# EPIDEMIOLOGICAL TRENDS OF SURGICAL CRITICAL CARE ADMISSIONS IN THE UNITED STATES 

Victor R. Vakayil MBBS, MS, Nicholas E. Ingraham MD, Alexandria Coughlan MD, Rebecca Freese MS, Elise Northrop BA, Melissa Brunsvold MD, FACS, Kathryn M. Pendleton MD, Anthony Charles* MD,MPH, FACS, Jeffrey G. Chipman MD, FACS, Christopher J. Tignanelli MD, University of Minnesota Dept of Surgery

Invited Discussant: Christopher Michetti, MD

Introduction: Epidemiologic assessment of admissions into Surgical Intensive Care Units (SICUs) provides a framework to evaluate healthcare systems efficiency and project future healthcare needs.
Methods We performed a 9-year, US population-based analysis of all adult admissions from 238 SICU's using the prospectively and manually abstracted, Cerner Apache Outcomes database. We stratified patients into 11 epidemiological cohorts and modeled temporal-trends in admission, mortality, ICU length of stay (LOS) and change in functional status (FS) using mixed-effects with hospital-level random intercepts, and quasipoisson models, to obtain risk-adjusted outcomes.
Results: We evaluated 78,054 SICU admissions and observed a significant decrease in transplant and thoracic surgery admissions, with a concomitant increase in ENT and facial reconstructive surgical admissions ( $p<0.05$, Figure-1A) . While overall riskadjusted mortality following SICU admissions remained stable over the study period (Figure-1B); orthopedic, cardiac, urologic, and neurosurgical mortality declined significantly ( $p<0.05$ ). Overall ICU-LOS decreased. Cardiac, urologic, gastrointestinal, neurosurgical, and orthopedic admissions noted significant reduction in LOS ( $\mathrm{p}<0.05$, Figure-1C). The rate of FS deterioration increased per year, suggesting ICU-related disability increased over the study period (Figure-1D).
Conclusion: Temporal analysis demonstrates a significant change among SICU admissions over the last decade, with decreasing mortality, LOS, and increasing rate of FS deterioration within certain surgical cohorts. Improvement in SICU outcomes may highlight successful quality-improvement initiatives within certain surgical cohorts, while simultaneously identifying cohorts that may benefit from future intervention. Our findings have significant implications in healthcare systems planning including resource and personnel-allocation, education, and surgical training.


Notes

# RIB FRACTURE TRIAGE PATHWAY DECREASES ICU UTILIZATION, PULMONARY COMPLICATIONS, AND HOSPITAL LENGTH OF STAY 

C. Caleb Butts MD, Preston Miller* MD, Andrew Nunn* MD, Adam Nelson MD, Meagan Rosenberg Orhan Yanmis Martin Avery* MD, Wake Forest University School of Medicine<br>Invited Discussant: Carlos Brown, MD


#### Abstract

Introduction:Rib fractures are a major cause of morbidity after blunt trauma. Many patients require ICU care and develop pulmonary complications. Prior studies have identified management strategies that are associated with improved outcome in severely injured rib fracture patients, but a validated triage decision tool to direct which patients warrant ICU admissions is not available. A rib fracture triage and management pathway (TMP) was developed at our institution to standardize care. We hypothesized that this pathway would decrease complications and shorten length of stay (LOS).


Methods:Patient age, number of rib fractures, significant cardiopulmonary co-morbidities, and incentive spirometry volumes were used to determine admission disposition. 648 patients with rib fractures from November 2015 to October 2017 were identified in the trauma registry and patients before (PRE, $\mathrm{n}=278$ ) and after (POST, $\mathrm{n}=370$ ) implementation were compared. Patients with severe TBI, that arrived intubated, or that died within 48 hours were excluded.

Results:There was no difference in age, gender, GCS, ISS, predicted incentive spirometry volume or number of rib fractures. POST patients were less frequently admitted to the ICU ( $64 \%$ vs $75 \%$, $\mathrm{p}=0.003$ ), had fewer pulmonary complications ( $5.1 \%$ vs $10.4 \%, \mathrm{p}=0.01$ ), and had a shorter hospital LOS ( 6.8 d vs $7.5, \mathrm{p}=0.001$ ) with no difference in mortality ( $1.6 \%$ vs $2.5 \%, \mathrm{p}=0.42$ ) or readmission ( $0.3 \%$ vs. $0.7 \%, \mathrm{p}=0.4$ ). POST patients were also more likely to be discharged home ( $81 \%$ vs $70 \%, \mathrm{p}=0.0009$ ) with fewer going to skilled nursing facilities ( $13 \%$ vs $21 \%, \mathrm{p}=0.01$ ).

Conclusion:A rib fracture TMP decreases ICU and hospital resource utilization and decreases pulmonary complications without increasing readmissions or mortality. Patients are also more likely to be discharged home which further decreases health care costs.

Notes

# DOES INTENSIVIST MANAGEMENT OF BRAIN DEAD ORGAN DONORS RESULT IN INCREASED ORGAN YIELD? 

Sahaja Atluri, 2021 MD Candidate; Jacob Bly, 2020 MD Candidate; Maria Iliakova, MD; Marissa Mendez, MD; Kayla Briggs, MD; Melissa Ott, ARNP; Lori Markham, RN; Harry Wilkins, MD, MHA; Dustin R. Neel, MD; Scott S. Johnson, MD; Donald G. Vasquez, DO; Steven P. Whitt, MD; Xi Wang, PhD Student; Michael Moncure, MD

Invited Discussant: Ali Salim, MD

Introduction: The demand for solid organ transplantation has continued to rise despite stable availability of donated organs. There continues to be an increased number of individuals on the waiting list for various organs. In order to meet the demands, various strategies have been employed by the medical community and organ procurement organizations such as utilizing previously marginal organs and employing critical care management strategies to nurture organs making them viable for procurement. Physicians undergoing intensivist training can offer valuable information on making an organ viable for procurement due to their expertise. The purpose of this study is to determine whether intensivist management of donors increases the number of organs available for transplantation yield from brain dead organ donors.

Methods: Institutional Review Board approval was obtained for this study. De-identified data of consecutive donors from a multi-institutional organ procurement organization (OPO) was reviewed from January 2003 - October 2018. A total of 3,750 donors were analyzed. Organs analyzed include heart, lungs, pancreas, kidneys, En-bloc kidneys, liver, split-livers, and intestine, excluding donation after cardiac death. Our organization engaged intensivist physicians from January 2006 onwards, we compared organs transplanted per donor, total number of organs transplanted, total number of donors, donor age, and transplantation of all organ types before and after intensivist involvement. ANOVA and 2 sample t-test were used for analysis with a p-value of $<0.05$ deemed statistically significant.

Results: The number of organs transplanted showed statistically significant increase after intensivist involvement for all organs except the intestine and pancreas. The number of organs transplanted increased by $38 \%$ ( p -value $=0.009$ ), while the number of donors increased by $28 \%$ (p-value $=0.026$ ) following intensivist involvement. Donor age was significantly higher post-intensivist involvement ( $35.83 \pm 18.79$ vs. $38.89 \pm 22.86$, pvalue $=0.0007$ ). The number of organs transplanted per donor increased significantly after intensivist involvement ( $2.76 \pm 1.82$ vs $2.94 \pm 1.89$, $p$-value $=0.038$ ).

Conclusion: Our data suggest an increase in organs transplanted per donor may be associated with the involvement of a critical care specialist. Our study is retrospective in nature and included several evolving management strategies incorporated as guidelines suggested by our intensivists. The significant increase in donor age following intensivist involvement may be evidence that intensivists were able to coordinate with ICU and OPO teams to salvage organs for transplantation that may have been previously discarded. A logical next step may be to perform a randomized prospective multi-institution trial comparing traditional OPO coordinator management to OPO coordinators with intensivist involvement in order to validate this concept.

Notes

# QUANTIFYING BACTERIAL DNA LEVELS IN ICU PATIENTS SUSPECTED OF BACTERIAL SEPSIS USING WHOLE GENOME SEQUENCING OF PLASMA DNA 

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Invited Discussant: Jon Simmons, MD
Introduction: Critically ill patients with systemic inflammatory response syndrome (SIRS) are often suspected of bacterial sepsis and treated empirically with broad-spectrum antibiotics. In previous work, we found plasma DNA sequencing can help identify pathogens in patients with positive blood cultures. Here, we hypothesized that quantitative analysis of bacterial DNA (bDNA) levels using whole genome sequencing (WGS) of plasma DNA can enable identification and monitoring in patients with bacterial sepsis across multiple sites of infection.
Methods: We prospectively enrolled 30 consecutive patients suspected of sepsis in the Surgical Trauma ICU. Plasma samples were collected at the time of diagnostic workup for sepsis and at 7 and 14 days during hospital stay. Active bacterial infection was defined based on review of microbiology results and clinical records. We performed WGS of plasma DNA and used bioinformatics classification to calculate the fraction of bDNA reads in each sample. After log transformation, difference in bDNA levels between infection and no infection (unpaired) and longitudinal changes in bDNA levels (paired) were evaluated using t-tests.
Results: We analyzed 72 plasma samples from 30 patients. 27 samples ( $37.5 \%$ ) were collected at the time of infection. bDNA levels were 2.0 times higher on average in these samples compared to samples with no infection (Figure 1, $\mathfrak{p = 0 . 0 0 8 ) . ~ A c r o s s ~ m u l t i p l e ~}$ sources of infection (bronchoalveolar lavage, urine, intraoperative specimens, peritoneal fluid), plasma DNA analysis identified pathogens with high confidence in samples collected at the time of microbial cultures. In 22/30 patients, serial samples were collected during treatment. 17/22 patients had active infection at enrollment and bDNA levels were higher at day 0 compared to the next sample (Figure 2, $\mathrm{p}<0.001$ ). This trend was not observed in $5 / 22$ patients with no infection at enrollment (Figure 3, $\mathrm{p}=0.444$ ).
Conclusion: Changes in bacterial DNA levels in plasma can identify and monitor bacterial sepsis across multiple sites of infection. Future work should identify relevant clinical thresholds for bacterial DNA levels in ICU patients with SIRS.


Figure 1


Figure 2


Figure 3

Notes

# LONG TERM OUTCOMES IN OLDER TRAUMA PATIENTS ADMITTED TO THE ICU: A PROSPECTIVE STUDY 

Jessica R. Burgess MD, Katherine Kelley MD, Daisy Proksch BS, Sasha Shaw RN, Jay N. Collins* MD, Eastern Virginia Medical Center

Invited Discussant: Karen Brasel, MD, MPH
Introduction: As age increases, older trauma patients are at increased risk of complications. Prior studies have shown an increase in mortality and length of stay in elderly patients despite similar Injury Severity Scores when compared to their younger cohort. The purpose of this study was to prospectively examine trauma patients over 50 years old that were admitted to the ICU and determine if there were any factors during hospitalization that predicted poor long-term outcomes.
Methods: This was an IRB approved prospective study at a level I trauma center. Trauma patients $\geq 50$ years old were recruited upon admission to the trauma intensive care unit. An initial survey regarding their current health and functional status was performed as well as a prognostic survey completed by the bedside ICU nurse, resident and attending physician. Data regarding initial labs and vitals, procedures, performed, length of stay and discharge disposition were collected during the hospital stay. Patients or their surrogates were interviewed over the phone at 3 and 6 months from discharge to determine their current state of health, functional status and recent admissions to the hospital.
Results:One hundred patients were included in the study over a 6-month time period. The average age was 70.7 years (SD 12.3) and $62 \%$ were male. $90 \%$ of patients sustained blunt trauma and average ISS was 17.55 (SD 9.2). LOS and ICU LOS were 11.3(SD 12.6) and 6.2 (SD 6.3) days, respectively. There was an $18 \%$ inpatient mortality. Of the remaining 82 patients, 39 were discharged home and 43 were discharged to a rehab or skilled nursing facility. At 3 and 6 months, the overall mortality rate was $20 \%$ and $24 \%$ respectively. At 6 months, $77.8 \%$ of surviving patients were living at home or with family members and $42.9 \%$ of patients reported requiring more assistance than they did prior to their injury. Only 5 patients remained in a skilled nursing facility at 6 months. When comparing 6 -month survivors to nonsurvivors, there was no significant difference in BMI, ICU LOS and total LOS. Nonsurvivors had a significantly higher age ( 75.4 vs $69.6, \mathrm{p}=.028$ ), higher ISS ( 20.1 vs $16.3, \mathrm{p}=.035$ ), higher vent days ( 4.2 vs 2.1 , $\mathrm{p}=.047$ ), lower admission GCS (11.3 vs 13.3, $\mathrm{p}<.01$ ) and higher admission lactate ( 4.5 vs $8.8, \mathrm{p}=.013$ ).
Conclusion:Severe trauma in patients $\geq 50$ years of age carries a significant rate of mortality with $24 \%$ of patients being deceased at 6 month followup. Nonsurvivors had a higher ISS, age, lower GCS and higher lactate on admission. BMI and length of stay were not associated with increased mortality. Fortunately, nearly half of all patients are able to return to their baseline functional status and are able to live at home either independently or with family within 6 months of discharge.

Notes

# BETA-BLOCKER THERAPY IN ISOLATED SEVERE TRAUMATIC BRAIN INJURY: A PROSPECTIVE RANDOMIZED CLINICAL TRIAL 

Shahin Mohseni MD,Ph.D., Shahram Paydar MD, Amir Niakan MD, Rebecka Ahl MD,Ph.D., Gabriel Sjolin MD, Hossein Abdolrahimzadehfard MD, Zaid Haddadin MD,<br>Bellal Joseph* MD, Hossein Khalili MD, Rajaee Trauma Center, Shiraz Univeristy Hospital

Invited Discussant: Eric Ley, MD
Introduction: Several retrospective and observational prospective studies have detected better outcomes following severe traumatic brain injury (sTBI) in patients exposed to beta-blockers (BB). Prospective randomized trials in such instances are currently lacking. The aim of our study was to evaluate the impact of BB therapy on outcomes in patients with isolated severe TBI.

Methods: We performed a prospective, non-blinded randomized clinical trial, and included all adult ( $\geq 18$ years) patients with blunt isolated sTBI admitted to our Neuro ICU. We excluded patients who were on preinjury BB therapy or were transferred from a different institution. Patients who were cardiovascularly stable at 24 h after admission were randomized to either $\mathrm{BB}(+)$ or $\mathrm{BB}(-)$. Patients in $\mathrm{BB}(+)$ received oral Propanolol 20 mg twice daily for 10 days or upto discharge. Outcome measures were in-hospital mortality, functional outcome at discharge and 6 months follow-up measured by the extended Glasgow Coma Scale (E-GOS) score. The association between BB therapy and outcomes of interest was evaluated using Poisson regression model.

Results: A total of 154 patients were included. Forty-four percent of the patients were randomized to $\mathrm{BB}(+$ ). Overall, mean age was 36 (SD 18) yrs, $86 \%$ were male and median GCS was 13 (IQR 7, 15). There was no significant difference between the cohorts regarding the patients' demographics, GCS, Head-AIS, ISS, type of intracranial injury, or requirement of neurosurgical intervention. $\mathrm{BB}(+)$ had a lower in-hospital mortality compared to those in the $\mathrm{BB}(-)$ group ( $4.4 \%$ vs. $18.6 \%, \mathrm{p}=0.012$ ). On regression analysis, $B B(+)$ was associated with better survival [Adj. RR: 3.1(1.1-8.9), $p=0.037$ ]. Further, $\mathrm{BB}(+)$ was associated with better functional outcome ( $\mathrm{E}-\mathrm{GOS} \geq 5$ ) at 6 months [Adj. RR: 1.2 (1.02-1.33), $\mathrm{p}=0.023]$. However, there was no statistical difference between the two groups regarding functional outcomes at discharge [Adj. RR: 1.1 (0.94-1.32), $\mathrm{p}=0.201$ ].

Conclusion: Patients with severe TBI whom received beta-blocker therapy had improved survival and improved long-term functional neurological outcomes. Further studies for establishing specific protocols for BB therapy in the context of sTBI may lead to better outcomes.

Notes

## DIAPHRAGM PACING IMPROVES RESPIRATORY MECHANICS IN ACUTE CERVICAL SPINAL CORD INJURY

Andrew J. Kerwin* MD, Yohan Diaz Zuniga Brian K. Yorkgitis DO, Jennifer Mull RN, Albert T. Hsu MD, Firas G. Madbak* MD, David J. Ebler* MD, David J. Skarupa* MD, Joseph Shiber MD, Marie L. Crandall* MD, University of Florida, Jacksonville

Invited Discussant: Daniel Grabo, MD
Introduction:Cervical spinal cord injury (CSCI) is devastating with ventilator associated pneumonia being a main driver of morbidity and mortality. Up to $50 \%$ of patients with CSCI require mechanical ventilation at hospital discharge. Case reports of diaphragm pacing (DPS) have suggested earlier liberation from mechanical ventilation in acute CSCI patients. We hypothesized DPS implantation would improve respiratory mechanics and facilitate liberation from ventilation.
Methods:We performed a retrospective review of acute CSCI patients managed at a single level 1 trauma center between 1/2005-5/2017. Routine demographics were collected. Patients underwent propensity matching based on age, ISS, ventilator days, hospital length of stay and need for tracheostomy. Patients with complete respiratory mechanics data were analyzed and compared. Those who did not have DPS (NO DPS) had spontaneous Vt recorded at time of ICU admission, at day 7 and day 14 and patients who had laparoscopic DPS implantation (DPS) had spontaneous Vt recorded before and after DPS implantation. Time to ventilator liberation and changes in size of spontaneous tidal volume ( Vt ) for patients while on the ventilator were analyzed. Bivariate and multivariate logistic and linear regression statistics were performed using STATA v10. Results:Between 7/2011-5/2017 all acute CSCI patients were evaluated for DPS implantation. 37 patients that had laparoscopic DPS implantation (DPS) were matched to 34 who did not (NO DPS). Following implantation of DPS there was a statistically significant increase in spontaneous Vt compared to NO DPS ( +88 mL vs. -13 mL ; $95 \% \mathrm{CI}$ $46-131$ vs. $-78-51 \mathrm{~mL}$ respectively; $\mathrm{p}=0.004$ ). Median time to liberation after DPS implantation was significantly shorter ( 10 vs. 29 days; $95 \%$ CI $6.5-13.6$ vs 23.1-35.3 days; $\mathrm{p}<0.001$ ). Liberation prior to hospital discharge was not different between the two groups. DPS placement was found to be associated with a statistically significant decrease in days to liberation and an increase in spontaneous Vt in multivariate linear regression models.
Conclusion:DPS implantation in acute CSCI patients produces significant improvements in spontaneous Vt and reduces time to liberation. Comprehensive care of acute CSCI patients should include DPS implantation. Further studies to define the benefits of DPS implantation are needed.

Notes

# MITIGATING ISCHEMIA REPERFUSION INJURY USING A NEW GENERATION PH 

Corina Necsoiu MD, Bryan S. Jordan RN, James Moon MD, Jae Choi Ph.D., Mark Espinoza BS, Andriy Batchinsky MD, Leopoldo Cancio* MD, United States Army Institute for Surgical Research

Invited Discussant: Matthew Martin, MD

Introduction: Non-compressible torso hemorrhage (NCTH) is the leading cause of death on the battlefield. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a safer alternative treatment to emergency department thoracotomy, which is invasive, with a high risk of death. REBOA, although much less invasive and potentially safer that thoracotomy, is not without risks. These risks include ischemia reperfusion injury below the balloon inflation site that can translate into irreversible damage of the end organs such as intestine or kidney. To mitigate this type of injury, we tested a new generation catheter prototype with a special design that allows partial inflation of the balloon thus permitting some of the blood to flow around the balloon into descending aorta and maintaining a relatively constant range of systolic blood pressure bellow the balloon. In this study, we compared two different systolic blood pressures below the balloon, $45 \pm 5 \mathrm{mmHg}$ and $60 \pm 5 \mathrm{mmHg}$ respectively and the consequences of this permissive hypotension REBOA (PH-REBOA) on the end organs. We hypothesized that a systolic blood pressure below the balloon of 60 mmHg will be less injurious than 45 mmHg to the end organs.
Methods: Sixteen female swine, weight $45-55 \mathrm{Kg}$, instrumented and under general anesthesia were bled $50 \%$ and then PH-REBOA catheter was placed in zone I for 120 min, followed by transfusion of the shed blood and clinical observation for 24 hours. A third group ( $\mathrm{n}=6$ ) receiving full occlusion for 120 minutes was also included, however all animals in this group died soon after REBOA was deflated.
Results: In group A (PH45) only 1 animal died at the end of transfusion. In group B (PH60) all animals survived 24 hours. Hemodynamically, there were no statistically differences between the groups. In terms of lactate, liver enzymes, cardiac troponin, or myoglobin, there were also no statistically differences at any time. All subjects had significant increase in lactate at the end of 2 hours REBOA time but lactate normalized by 6 hours post-injury. Creatinine increased significantly in group A and remained higher than in group B until the end of the study (see table, $\mathrm{p}<0.05$ )

|  | Group | BL | EH | $\begin{gathered} \text { MID } \\ \text { REPOA } \end{gathered}$ | $\begin{gathered} \text { END } \\ \text { REBOA } \end{gathered}$ | 1 HR | $\begin{aligned} & \text { END } \\ & \text { STLDY } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| HR | $A(t-5)$ | $90 \pm 9.3$ | $145=119$ | $173=121$ | $181=11.4$ | $140 \pm 8 . T$ | $102 \pm 7.1$ |
|  | B ( $\mathrm{n}-8)$ | $86 \pm 4.6$ | $166=10.8$ | $184=16.7$ | $18.4=18.4$ | $133 \pm 9$ S | $103 \pm 7.7$ |
| MAP | A | $100=4.7$ | $33=3.7$ | 92-8.8 | $04=10.2$ | $122-58$ | $36 \pm 65$ |
|  | B | 101-5.5 | $49-4.8$ | $100 \pm 8.0$ | $106+7.0$ | $117 \pm 3.6$ | 89+93 |
| Lactate | A | $1.4 \pm 03$ | $4.1=0.7$ | $9.0 \pm 1.1$ | $10.0 \pm 1.5$ | $8.5 \pm 1.8$ | $1.1 \pm 03$ |
|  | B | $1.4 \pm 0.3$ | $2.3=0.7$ | $6.5 \pm 1.2$ | $8.0=1.4$ | $6.0 \pm 1.3$ | $0.5 \pm 0.1$ |
| Creatinine | A | $1.5 \pm 0.1$ | $1.9=0.1^{*}$ | $2.3=0.1^{\text { }}$ | $2.5=0.1^{*}$ | $2.2+0.1^{*}$ | $2.1 \pm 0.3^{+}$ |
|  | B | $1.3 \pm 0.1$ | $12 \pm 0.0$ | $1.7 \pm 0.1$ | $1.8 \pm 0.1$ | $1.7 \pm 0.1$ | $1.4 \pm 0.1$ |

Conclusion: Permissive hypotension is a valuable method of extending duration of the REBOA. Although both types of permissive hypotension have similar effects on the end organ, PH45 seems to have more injurious and longer lasting effects on the kidney. More studies are needed to optimize this approach.

Notes

# Plasmin-Modified Thromboelastography Rapidly Identifies Patients at Risk of Hyperfibrinolysis, Mortality, and Need for TXA: A Diagnostic Tool to Resolve an International Debate? 

Christopher D. Barrett MD, Ernest E. Moore* MD, Hunter B. Moore MD,Ph.D., Sanjeev<br>Dhara BS, James Chandler BA, Michael P. Chapman MD, Angela Sauaia* MD,Ph.D., Michael B. Yaffe MD,Ph.D., Massachusetts Institute Of Technology

Invited Discussant: Bryan Cotton, MD
Introduction: Trauma patients with hyperfibrinolysis measured by thrombelastography (TEG) gain clot strength with TXA, but TXA may harm those without hyperfibrinolysis. TEG fibrinolysis measurements (LY30) can take an hour to obtain results, wasting precious time. Therefore, we set out to develop an assay that could identify hyperfibrinolysis expeditiously to guide TXA administration. The fibrinolytic protease plasmin causes a shortening of clotting time with minimal effects on fibrinolysis in healthy volunteers, unless plasmin inhibitors are depleted. Thus, we hypothesized that trauma patients with clotting time prolongation in the presence of exogenous plasmin (compared to native TEG) are hyperfibrinolytic, have a high rate of massive transfusion (MT) and mortality, and provides an expedited time to diagnosis of hyperfibrinolysis.
Methods: Trauma patients ( $\mathrm{n}=55$ ) at a level 1 trauma center were assessed using TEG assays without exogenous additives (rapid and native), with exogenous plasmin, or with tissue plasminogen activator (t-PA). Rapid TEG was used as the standard to stratify patients into fibrinolytic phenotypes and t-PA sensitivity based off previously published thresholds. Plasmin was used in doses that had no effect on LY30 of healthy volunteer controls but caused shortened R-time (not lengthened) relative to native TEG. In trauma patients, if plasmin TEG R-time was longer than native TEG R-time the patient was considered to have a Plasmin-Associated Increased Clotting Time (PACT). A chi square test was used to determine if PACT was associated with t-PA sensitive hyperfibrinolysis, MT, and mortality.
Results: t-PA sensitive hyperfibrinolytic patients had a median time to TEG results (LY30) of 58 minutes, represented $16 \%$ of patients, and compared to the rest of the patients had a high MT rate ( $78 \%$ vs $15 \%$, $\mathrm{p}<0.001$ ) and mortality rate ( $78 \%$ vs $15 \%, \mathrm{p}<0.001$ ). PACT was also present in $16 \%$ of patients and demonstrated virtually identical results for MT and mortality rates as TEG LY30, but had a dramatically faster median time to diagnosis of 6.7 minutes ( 8.6 x faster). PACT and TEG LY30 had diagnostic agreement $67 \%$ of the time and predicted MT in $100 \%$ of these patients (6/6).


Conclusion: PACT acts as a rapid test result that predicts a high rate of MT and mortality in trauma patients in a median time of 6.7 minutes. PACT has a high probability of identifying trauma patients who are t-PA sensitive, hyperfibrinolytic, and most likely to benefit from TXA in a clinically expeditious time frame.

Notes


## Session IXB: Papers 27-35

Thursday, September 19, 2019 2:00 PM - 5:00 PM
Location: Lone Star Ballroom B
Moderator: Daniel Margulies, MD
Recorder: Gail Tominaga, MD

# WHERE IS THE EVIDENCE? THE IMPACT OF STATE LAWS ON MOTOR VEHICLE FATALITY RATES, 1999-2015 

David M. Notrica* MD, Lois W. Sayrs Ph.D., Nidhi Krishna MSc, Dorothy H. Rowe MD, Dawn E. Jaroszewski MD, Lisa E. McMahon MD, Phoenix Childrens Hospital Invited Discussant: Heena Santry, MD
Introduction: MVC fatalities have been declining while states passed various legislation targeting driver behavior. This study assesses the impact of state laws on MVC fatality rates to determine which laws were effective.

Methods: Prospective data on MVC fatalities age $\geq 16$ from FARS, state laws, crash characteristics, and verified trauma centers for 50 US states, 1999-2015(n=850) was collected. Generalize Linear Autoregressive Modelling was used to assess the relative contribution of state laws to the crude MVC fatality rate while controlling for other factors.

Results: State laws that lowered minimum allowable blood alcohol ( $\mathrm{B}=-1.7[\mathrm{p}<0.001]$ ) were associated with steep declines in MVC death for drivers age 21-55, and effects

| Law | Age Group Cohorts $\mathrm{N}=850$ <br> Unstandardized Regression Coefficient (p-value) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 16-20 | 21-55 | 56-65 | Over 65 |
| GDL | $0.06(0.001)^{* *}$ | -0.05(0.25) | -0.03(0.75) | $-0.001(0.45)$ |
| DUI laws |  |  |  |  |
| Reduced BAC | $0.23(0.001)^{* *}$ | 1.7(0.001)** | 3.2(0.001)** | 4.1(0.001)** |
| Perse BAC | -0.04(0.64) | $-0.13(0.001)^{* *}$ | -0.11(0.34) | -0.17(0.05)* |
| Enhanced DUI Penalties | -0.02(0.52) | -0.002(0.35) | -0.001(0.98) | -0.08(0.89) |
| Automatic Revocation | -0.009(0.75) | $-0.07(0.005)^{*}$ | -0.09(0.01)* | $-0.05(0.05)^{*}$ |
| Social Host | $-0.21(0.005)^{*}$ | -0.10(0.001)** | -0.022(0.89) | -0.13(0.07) |
| Seat Belt | -0.16 (0.04)* | -0.24(0.05) ${ }^{\text {\% }}$ | $-0.11(0.001)^{* *}$ | -0.02(0.56) |
| Red Light Camera | $-0.13(0.05)^{*}$ | -0.07(0.02)* | $-0.28(0.001)^{* *}$ | -0.05(0.37) | increased with age. DUI laws enhancing penalties, making revocation automatic, or targeting social hosts had mixed effects by age; increased enforcement, mandatory education, vehicle impoundment and interlock devices had no association with declining mortality. Red light camera laws ( $\mathrm{B}=-0.28[\mathrm{p}<0.001]$ ) and seat belt laws ( $B=-0.24[p<0.05]$ ) were associated with declines in mortality, but speed camera laws had no effect. Graduated Driver License laws were associated with declines for drivers $<21$ ( $B=-0.06[p<0.001]$ ); underage alcohol laws showed no association. Laws targeting specific risks (elderly, motorcycles, marijuana) or were enacted recently (cell phones) also showed no effect on declining MVC mortality during the study period.

Conclusion: A few key laws, specifically laws lowering allowable BAC, implementing red light cameras, and mandating seatbelt use significantly reduced the MVC mortality rate from 1999-2015. Simply adding more laws or penalties may not equate directly to lives saved. Continued research on state laws will better inform policy makers to meet evolving public health needs in the management of MVC fatalities.


Notes

# Does Simulation Work? Monthly Trauma Simulation and Procedural Training is Associated with Decreased Time to Intervention. 

Caroline Park MD,MPH, Jennifer Grant MD, Ryan P. Dumas MD, Kareem Abdelfattah MD, FACS, Thomas Shoultz MD, Linda A. Dultz MD,MPH, FACS, Stephen Luk* MBA,MD, FACS, FCCP, Daniel J. Scott MD, Michael Cripps* MD, MSCS, FACS University of Texas Southwestern Medical Center at Dallas

Invited Discussant: Mark Bowyer, MD

## Introduction:

Establishing proficiency in trauma procedures during surgical residency has been limited to annual courses with little data on its effect on the delivery of healthcare and patient outcomes. There is a wide variety of training on content, complexity and frequency with recent studies looking at time to imaging or secondary survey. Given the limitations of an 80 -hour work week, patient care and educational priorities, there has been more emphasis on high-yield, reproducible and frequent training for our surgical residents. In this study, we implement monthly case-based simulation after initial training on a variety of bedside trauma procedures. The overall goal is to evaluate the effect of simulation on time to specific procedures and to definitive surgical intervention.

## Methods:

This is a prospective, observational study at a single-institution, level I trauma center with a large surgical residency program between November 2018 and February 2019. A trauma simulation program was implemented in November 2018 to train and evaluate surgical residents from PGY 1 through 5. All rotating residents participated in an initial course led by ATLS-certified instructors on basic trauma procedures such as cordis placement, endotracheal intubation, tube thoracostomy, and resuscitative thoracotomy followed by an end-of-month simulation. All level I (highest level) activations from pre-intervention starting in July 2018 through February 2019 were followed; monitored patient variables included mechanism of injury, blunt or penetrating, gender, and time to intervention in the trauma bay. Pearson's coefficient was used to measure the strength of the relationship between simulation to time to patient intervention.

## Results:

Average time to most interventions improved over time but with more consistent improvement after the implementation of formal simulation and procedural training in November 2018. This was most significant in resuscitative thoracotomy and time to CT scan (Table 1).

## Conclusion:

High-complexity, routine procedural training and trauma simulation are associated with decreased time to interventions within a short period of time. Routine implementation of a training program emphasizing efficient, effective approaches to bedside procedures is necessary to train our residents in these high-acuity, low frequency situations. Future investigations are warranted in the effect of simulation on short-term and long-term patient outcomes.

|  | Average Time to <br> Intervention (pre- <br> simulation) | Average time to <br> Intervention (post- <br> simulation) | $\mathbf{r}^{2}$ |
| :--- | :---: | :---: | :---: |
| Resuscitative Thoracotomy | 13 | 3.8 | 0.35 |
| Tube Theracestamy | 12 | 9.3 | 0.1 |
| Cordis | 13 | 13 | 0.02 |
| CT scan | 48 | 39 | 0.36 |
| OR | 23 | 46 | 0.21 |

Table 1. Average time to intervention pre and post-simulation and procedural training (in minutes).

Notes

# USING ARTIFICIAL INTELLIGENCE TO IMPROVE RELIABILITY OF THE FOCUSED ASSESSMENT WITH SONOGRAPHY FOR TRAUMA (FAST): A PILOT STUDY OF FAST-AI. 

Rachael A. Callcut* MD, MSPH, AnaMaria J. Robles MD, Aaron Kornblith MD, Lucy<br>Z. Kornblith MD, Matt O'Brien MS University of California, San Francisco<br>Invited Discussant: Matthew Bloom, MD

Introduction: Artificial Intelligence (AI) or deep learning is a powerful tool that can provide approximations of human-domain cognitive processes. The FAST can improve clinically relevant outcomes, but is dependent on the expertise of the examiner and has been limited by inter- and intra-operator variability. We hypothesized that AI could be utilized to enhance imaging recognition and reliability of point of care FAST ultrasound through four algorithmic AI methods: classification, detection, localization, and segmentation.

Methods: 249 highest level trauma activation patients with complete archived FAST video stream images were identified. Two study clinicians with FAST expertise and blinded to the clinical outcomes interpreted the archived FASTs. Views were classified as positive or negative for free fluid and pixel level annotation was also performed by the clinicians to delineate structures of interest (bladder, kidney, liver, spleen, free fluid). Data was split into $80 \%$ training and $20 \%$ testing. A Residual Neural Network (ResNet) was performed to assess Classification (binary outcome of positive or negative hemoperitoneum) and Detection (identification of specific anatomic structures). A RetinaNet was utilized to assess Location and a VNET algorithm used to assess Segmentation (pixel level identification of structures).
Results: The ResNet neural network ( $\mathrm{n}=60$ patients, 141 images) Classification results were promising with $89.2 \%$ accuracy after 125 epochs (repetitions) for determination of the presence or absence of free fluid in the abdomen. In contrast, Detection of anatomic structures using ResNet was variable in performance with the best detention of the suprapubic quadrant, but worse performance for the detection of free fluid ( $40 \%$ accuracy). Localization performed similarly. Most promisingly, Segmentation (n=249 patients, 576 images) was able to identify free fluid and anatomic structures with a DICE evaluation metric (reproducibility validation metric) of 0.98 or $98 \%$ accuracy (Figure A accuracy after 50 epochs; B - identification of structures, C- identification of free fluid).


Conclusions: In this pilot study, deep learning approaches of classification and segmentation demonstrated promise for improving the reliability of the FAST exam at the point of care. Integration into the ultrasound device could extend the utility of FAST to austere environments and for those with less experience to improve the early detection of abdominal bleeding following trauma.

Notes

# TURNING VALUE INTO ACTION: THE IMPORTANCE OF PUBLIC NARRATIVE AMONG HEALTHCARE PROVIDERS USING DIVERSE MEDIA TO ENACT CHANGE 

Marissa A. Boeck MD,MPH, Catherine J. Juillard* MD,MPH, FACS, Rochelle A. Dicker* MD, FACS, Bellal A. Joseph* MD, FACS, Joseph V. Sakran MD,MPH, MPA, FACS Johns Hopkins School of Medicine

Invited Discussant: Nicole Stassen, MD
Introduction: On November 7th, 2018 the National Rifle Association tweeted about an American College of Physicians position paper on firearm injuries and deaths, "Someone should tell self-important anti-gun doctors to stay in their lane." This tweet sparked a global response from healthcare professionals that ranged from everyday stories to graphic photos about caring for firearm-injured patients. The Twitter handle @ThisIsOurLane and hashtags \#ThisIsOurLane and \#ThisIsMyLane further unified the medical community. This study aimed to evaluate a public narrative advocacy movement though social media, scientific literature, and mass media to assess differences in message volume and time course to enact real-world change.
Methods: Sources were assessed from November 2018 to February 2019 using \#ThisIsOurLane and \#ThisIsMyLane hashtags and phrases. Social media data were analyzed via Symplur Signals. Scientific literature was reviewed using PubMed, EMBASE, Web of Science, and Google Scholar. Mass media were compiled using Access World News, Newsbank, and Google.
Results: A total of 508,959 tweets were shared using \#ThisIsOurLane, \#ThisIsMyLane, or both, with a co-occurrence frequency of $21 \%$ to $39 \%$. Most participants were from the United States ( $42-44 \%$ ) and tweeting in English (95-99\%). The most tweets were sent on November 10 ( $\mathrm{n}=34,797$ \& $\mathrm{n}=115,432$ for \#ThisIsOurLane and \#ThisIsMyLane, respectively). The Twitter handle @ThisIsOurLane was created on November 10, and rapidly grew to its
Table 1. Hashtag Statistics

| Statistic | \#ThisIsOurLane <br> $(\mathrm{N}=181,887) \mathrm{N}(\%)$ | \#ThisIsMyLane <br> $(\mathrm{N}=327,072) \mathrm{N}(\%)$ |
| :--- | :---: | :---: |
| Retweets | $166,469(91)$ | $316,950(97)$ |
| Tweets with media | $78,971(43)$ | $137,196(42)$ |
| Impressions | $577,101,699$ | $704,484,080$ |
| Users | 90,045 | 158,961 |
| Users with I tweet | $63,991(71)$ | $107,617(68)$ |
| Countries | 193 | 208 |
| U.S. states | $50+$ Washington DC |  |
| Tweet languages | 24 |  |

"Impressions: \# of tweets per participant multiplied by \# of followers current 29,017 followers. There were nine scientific articles published between December 7 and February 22. There were $n=245$ mass media publications from November 9 until February 28: a mix of articles, blogs, TV interviews, petitions, press releases, and podcasts. November $20 \mathrm{had} \mathrm{n}=23$ publications, the most in one day.
Conclusions: The rapid, widespread hashtag coverage via different media, participation by healthcare societies and injury prevention groups, and a climate conducive to change were likely important factors leading to House Bill HR8 Bipartisan Background Checks. Social media enables us to quickly move a controversial, multifaceted conversation like firearms from value to action by converting raw data into real people, transcending language and culture. Firearm-related injury and death is a complex issue that requires diverse stakeholder engagement and a multidisciplinary approach, including harnessing the public narrative to shape and deliver the message. Healthcare providers are uniquely suited to do this through sharing the hidden but vivid reality of caring for firearm-injured patients. This intensive approach to policy development and implementation is just as critical as the policy itself, in order to ensure success.

Notes

# EXPORTED CRIME GUNS, TRAFFICKING, AND STATE ANTI-TRAFFICKING LAWS 

Erin G. Andrade MD,MPH, Jennifer M. Leonard MD,Ph.D., Elinore J. Kaufman MD, MSHP, Mark Seamon* MD, Laurie J. Punch MD, Mark Hoofnagle MD,Ph.D., Washington University in St. Louis

Invited Discussant: Deborah Kuhls, MD
Introduction: In states with restrictive gun laws over half of guns used in crimes are trafficked from out of state. We sought to understand the policies, which most influence crime gun trafficking within the continental US. We hypothesized that state laws related to trafficking would significantly impact the number of crime guns traced to a state.
Methods: Gun trace data from 2014-2017 was accessed from the ATF and total crime guns exported to other states for each state were normalized to population using estimates from CDC WISQARS. Firearm laws by state from 2013-2016, 2011-2014, and 2005-2008 were abstracted from the State Firearms Laws Database. The number of anti-trafficking laws were compared to crime gun traces from out of state and normalized to the originating states population. The following law types were included in the model: dealer licensing, record keeping requirements, reporting of sales records to the state, bans on "Saturday Night Specials", higher than federal minimum age requirement, universal background check, stronger state background check regulation, waiting period for purchase, restrictions on multiple purchases, and state anti-trafficking/straw purchase laws. Linear regression of these variables and figures were plotted using Prism 8.
Results: From 2014-2017 the top five states for total gun exports were Georgia, Texas, Florida, Virginia and Arizona, but states exporting the most crime guns relative to their population were Mississippi, West Virginia, Nevada, Wyoming and South Carolina. Overall increased firearm trafficking laws correlate with decreased gun exports (slope 0.55 , R ${ }^{2} 0.47, \mathrm{p}<0.0001$ ) (2017 data-figure 1). Of the examined types of anti-trafficking laws, the following significantly decreased
 gun exports at one year: enhanced state recordkeeping requirements( $\beta=-6.902$, $\mathrm{p}=0.0096$ ), permits/de facto gun registration ( $\beta=-9.076, \mathrm{p}=0.0448$ ), higher age restriction ( $\beta=-8.533, p<0.0001$ ), waiting period for purchase ( $\beta=-9.263, p=0.0191$ ), and specific anti-trafficking laws ( $\beta=-4.727,0.0244$ ). To account for "time to crime", which averages nine years, and half of trafficked guns being traced before three years in high trafficking states, we ran the analysis with a three and nine year lag. Only higher age restriction and waiting period for purchase maintain significance throughout the one, three, and nine year models. Overall this model explained $51.88 \%, 50.85 \%, 58.03 \%$ of the variance in gun exports by state at one, three and nine years respectively.
Conclusion: Increased number of state anti-trafficking laws correlates with decreased gun exports. However, substantial variability in the model remains unexplained by legislative differences alone. Future modeling efforts will incorporate relative distance between states with and without anti-trafficking laws to determine the relationship between proximity, policy, and crime gun exports.

Notes

## Comparison of Surgical Cricothyroidotomy Training: A Randomized Trial of a Live Pig Model vs. an Advanced Simulation Manikin

Vinciya Pandian BS,MBA,Ph.D.,RN, MSN, William R. Leeper MD, Christian Jones MD, Mark Bowyer* MD, Elliott R. Haut* MD,Ph.D., Johns Hopkins School of Medicine Invited Discussant: Kenji Inaba, MD

## Comparison of Surgical Cricothyroidotomy Training: A Randomized Trial of a Live Pig Model vs. an Advanced Simulation Manikin

Introduction: Airway obstruction remains a preventable cause of death on the battlefield. Surgical cricothyroidotomy (Cric) is an essential skill for immediate airway management in trauma. Training for Cric has been undertaken using simulators, cadavers, or animal models. The ideal approach to training for this low volume, high-risk procedure is unknown. We hypothesized that current simulation technology provides an equal or better education for Cric when compared to live tissue training.
Methods: We performed a prospective randomized controlled study comparing training for Cric using hands-on training on live anesthetized pigs vs. on an advanced simulation manikin. We enrolled medical students who had never performed or had formal instruction on surgical Cric. After training, participants were randomized to testing on human cadavers or the animated version of the Operative Experience Inc. Advanced Surgical Manikin. Tests were scored using checklists modified from Objective Structured Assessment of Technical Skills (OSATS) and Tactical Combat Casualty Care (TCCC). We compared scores between groups using Wilcoxon Rank Sum tests and generalized linear models.
Results: 48 participants were enrolled. There were no significant differences in any of the outcome measures between training groups. (Table)
Conclusion: Measured performance was not different between subjects trained to perform Cric on live tissue or a high fidelity manikin. The use of an advanced simulator has the potential to replace live tissue for this procedure mitigating concerns over animal rights and inherent costs.

|  |  | Pig Trained <br> $(\mathrm{n}=24)$ | Manikin Trained <br> $(\mathrm{n}=24)$ | p- <br> value |
| :--- | :--- | :---: | :---: | :---: |
| Age* | $25.6 \pm 2.3$ | $26.7 \pm 3.5$ | 0.19 |  |
| Gender $\sim$ | Women | $11(45.8)$ | $14(58.3)$ | 0.39 |
| Anticipated <br> Specialty $\sim$ | General surgery | $7(29.2)$ | $8(33.3)$ |  |
|  | Surg specialty | $7(29.2)$ | $4(16.7)$ | 0.92 |
|  | Other | $10(41.6)$ | $12(50)$ |  |
| Pre-post training self-assessment <br> score* | $3.2 \pm 2.7$ | $2.9 \pm 2.3$ | 0.70 |  |
| OSATS score* | $6.6 \pm 1.6$ | $6.9 \pm 0.8$ | 0.74 |  |
| TCCC score* | $10.6 \pm 1.0$ | $10.9 \pm 0.6$ | 0.34 |  |
| Time to establish airway* | $156.4 \pm 89.8$ | $151.4 \pm 74.3$ | 0.84 |  |
| Successful airway $\sim$ | $13(81.2)$ | $14(100)$ | 0.23 |  |

[^0]Notes

# ELECTRIC SCOOTERS: IMPACT ON A COMMUNITY 

Matthew B. Bloom* MD, Ali Noorzad MD, Carol Lin MD, Milton Little MD, Ernest Lee BS, Sam Torbati MD, Cedars-Sinai Medical Center

## Invited Discussant: Nancy Parks, MD

Introduction: Readily accessible electric scooters have demonstrated marked growth and popularity throughout the United States and internationally. This study investigates the impact of electric scooter related injuries within a hospital network.
Methods: The Deep6 artificial intelligence cohort builder was used to retrospectively identify patients involved in electric scooter accidents presenting to an urban hospital network comprised of a Level-1 trauma center, community hospital, stand-alone orthopedic clinic, and a network of urgent care and outpatient clinics, between February 2018 and December 1, 2018. Data included demographic information, mechanism and location of injury, use of protective devices, injury patterns, treatment course, and utilization information. Google Trends data of keyword searches originating from within the local community was used as a surrogate for scooter popularity and cross-referenced against presentation trends. Cost data related to hospital encounters was analyzed.
Results: Data on 248 patients were reviewed. Mean age was 35.8 years, $15(6.0 \%)$ were under 16 years old. $109(44.0 \%)$ initially presented to the Level 1 trauma center, $76(30.6 \%)$ at the affiliated community hospital, 47(19.0\%) at the outpatient orthopedic clinic, and $17(6.9 \%)$ at urgent care. Only $15(6.0 \%)$ were trauma activations, $14(5.6 \%)$ others were trauma consults. Overall $37(14.9 \%)$ of incidents required a hospital admission, and $5(2.0 \%)$ required an ICU admission. Loss of balance was implicated in $121(49 \%)$, scooter vs auto $34(13.7 \%)$, uneven pavement $25(10 \%)$, scooter vs object $6(2.4 \%)$, equipment malfunction $7(2.8 \%)$, and pedestrian hit by scooter $3(1.2 \%)$. Scooter pollution (tripping over a scooter in the street) $14(5.6 \%$ ) affected the elderly disproportionately, median[IQR] age 67[55-83], p<0.001. Eight (3.4\%) riders were using helmets, none used wrist guards or other protective gear. 103(41.5\%) required a procedure: $33(13.3 \%)$ required an operation, $32(12.9 \%)$ required orthopedic reductions in the ED, and $40(16.1 \%)$ required ED suturing. Injuries to the head and neck were seen in $92(37.0 \%)$ patients, including TBI in $5(2 \%)$ and concussion in $19(7.7 \%)$. None of these closed head injury pts. were wearing a helmet. Upper extremity fractures 19 (7.6\%), lower extremity fractures 38 ( $15.3 \%$ ), pelvic fractures $2(0.8 \%)$, spine fractures $3(1.2 \%)$. One pt. had grade III liver injury, and another had grade III spleen with multiple left rib fractures and pneumothorax. $6(2.4 \%)$ were admitted to the ICU. Complications included 2 pts. with compartment syndromes of extremities. There were no deaths. Facilities costs were greater for patients under the influence of alcohol ( $\$ 9183$ vs $\$ 4646, p=0.047$ ) and marijuana ( $\$ 25914$ vs $\$ 4794, \mathrm{p}=0.002$ ).


Conclusion: Our study highlights a wide spectrum of electric-scooter related injuries that should be recognized not only by healthcare practitioners, but by policymakers and local government as well. Future studies, city planners, and legislators should focus on maximizing the safety of both riders and pedestrians.

Notes

# DO ADOLESCENT PATIENTS WITH PENETRATING TRAUMA HAVE BETTER OUTCOMES AT PEDIATRIC TRAUMA CENTERS VERSUS ADULT TRAUMA CENTERS？ 

Frederick B．Rogers＊MD，MS，FACS，Tawnya M．Vernon BA，Barbara A．Gaines＊MD， Scott B．Armen＊MD，Brian W．Gross BS，Eric H．Bradburn MD，Penn Medicine Lancaster General Health

Invited Discussant：Kathryn Bass，MD

Introduction：There is little debate that in their totality，pediatric trauma centers（PTC） are uniquely beneficial to the pediatric trauma patient．We sought to determine if this axiom held true，specifically in adolescent patients who were the victims of penetrating trauma．Due to the increased volume of penetrating trauma treated at adult trauma centers （ATC），we hypothesized that ATC would have improved outcome in penetrating trauma for this subset of patients．
Methods：Adolescent patients（age 15－18 years）presenting to Pennsylvania accredited trauma centers between 2003－2017 with a penetrating injury were included．Those who were transferred or dead on arrival were excluded．Patient length of stay，number complications，outcomes and surgical intervention were compared to assess differences between ATC and PTC．Multivariate logistic regression models assessed the adjusted impact of PTC compared to ATC on patient care and outcomes．
Results：A total of 2，594 patients met inclusion criteria．Patients treated at PTC comprised $15 \%$ of the study population（ $\mathrm{n}=393$ ）．Adolescent presenting with penetrating injury had decreased odds（AOR：0．538； $\mathrm{p}=0.05$ ）of surgical intervention at PTC，when compared to those treated at ATC．In adjusted analysis，treatment at a PTC resulted in decreased odds of mortality（AOR：0．48； $\mathrm{p}=0.01$ ）．Patients had slightly lower odds of complication following care at PTC（AOR：0．94； $\mathrm{p}=0.273$ ）and slightly greater odds of an increased length of stay（AOR：1．48；p＝0．538）（Table 1）．
Conclusion：Adolescent penetrating trauma patients treated at PTC have overall improved mortality compared to ATC，in conjunction with the fact that significantly more patients are treated non－operatively at PTC．PTC have historically been in the vanguard of non－operative management of solid organ injury－it now appears to be extending to the penetrating trauma domain．


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Notes

# PEDIATRIC EXTREMITY VASCULAR TRAUMA: HOW AND WHERE IS IT TREATED? 

James M. Prieto MD, Jan-Michael Van Gent DO, Richard Y. Calvo Ph.D., Michael J. Sise* MD, C. Beth Sise MSN, Vishal Bansal MD, Romeo C. Ignacio MD, Scripps Mercy Hospital Trauma Service

Invited Discussant: Ben Zarzaur, Jr, MD, MPH

Introduction Few studies have evaluated characteristics of pediatric patients with extremity vascular trauma. We investigated the epidemiology and management of extremity vascular trauma in pediatric patients and evaluated differences by trauma center status.
Methods: Using the American College of Surgeons (ACS) National Trauma Databank, we identified patients $\leq 16$ years of age with extremity vascular trauma admitted in 2016. Hospitals were categorized as ACS-verified pediatric trauma centers (level I or II),
ACS-verified adult trauma centers (level I or II), or other hospitals (all other trauma centers and non-designated hospitals). Patient data were evaluated by hospital category.
Results: Among 164,882 pediatric admissions, 702 patients were identified for the study. There were 430 ( $61.3 \%$ ) patients with lower extremity injuries, 270 ( $38.5 \%$ ) with upper extremity injuries, and $2(0.2 \%)$ had both. Mean age was 11.5 years and $51.6 \%$ were blunt injured. Overall, $40.2 \%$ were admitted to pediatric trauma centers, $28.9 \%$ to adult trauma centers, and $30.9 \%$ to other hospitals. Hospitals without ACS trauma center verification had a higher amputation rate than any ACS-verified adult or pediatric center ( $\mathrm{p}=0.013$ ). Patients at pediatric trauma centers had the highest rate of discharge home ( $\mathrm{p}<0.001$ ).
Conclusion: The incidence of pediatric extremity vascular injury is low. Centers with ACS verification have greater pediatric limb salvage rates than those without verification. Future study should seek to identify specific regional or resource-related factors attributable to this disparity.

|  | Pediatric Center |  | Adult Center |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Level I $(n-207)$ | $\begin{aligned} & \text { Level II } \\ & (\mathrm{a}=-75) \end{aligned}$ | Level I $(\mathrm{n}-114)$ | $\begin{aligned} & \text { Level II } \\ & (\mathrm{a}-89) \end{aligned}$ | $\begin{aligned} & \text { Other } \\ & (\mathrm{n}-217) \end{aligned}$ | p-value |
| Primary mochanism, \% Blunt Pesetrating Other | $\begin{gathered} 50.2 \\ 45.4 \\ 3.4 \end{gathered}$ | $\begin{gathered} 65.3 \\ 33.3 \\ 1.3 \\ \hline \end{gathered}$ | $\begin{array}{r} 43.9 \\ 53.5 \\ 2.6 \\ \hline \end{array}$ | $\begin{gathered} 60.9 \\ 37.9 \\ 1.2 \\ \hline \end{gathered}$ | $\begin{gathered} 48.4 \\ 47.9 \\ 3.7 \\ \hline \end{gathered}$ | 0.193 |
| Injury sevenity score, mean | 8.1 (6.1) | 9.3 (8.4) | 9.4 (8.0) | 8.9 (7.1) | 9.2 (8.9) | 0.727 |
| Sargical techaique, \% <br> Open <br> Endovascular Bech Neither | $\begin{gathered} 49.3 \\ 3.4 \\ 5.3 \\ 42.0 \\ \hline \end{gathered}$ | $\begin{aligned} & 50.7 \\ & 1.3 \\ & 4.0 \\ & 44.0 \\ & \hline \end{aligned}$ | $\begin{gathered} 47.4 \\ 1.8 \\ 8.8 \\ 42.1 \end{gathered}$ | $\begin{gathered} 44.9 \\ 23 \\ 5.6 \\ 47.2 \\ \hline \end{gathered}$ | $\begin{gathered} 48.8 \\ 2.8 \\ 3.2 \\ 45.2 \end{gathered}$ | 0.859 |
| Received as trimfer, \% | 54.1 | 38.7 | 42.1 | 25.8 | 32.7 | $<0.001$ |
| Amputation, \% | 29 | 0.0 | 0.9 | 0.0 | 5.5 | 0.013 |
| Mortality, \%/ | 0.0 | 0.0 | 1.8 | 23 | 0.9 | 0.234 |
| Discharce bame. \% | 84.1 | 84.0 | 80.4 | 75.9 | 70.7 | <0.601 |

Notes

## Session X: Master Surgeon Lecture II



## "Pancreatic Trauma"

Friday, September 20, 2019 7:30 AM - 8:00 AM Location: Lone Star Ballroom A/B Presenter: Gregory Jurkovich, MD Professor of Surgery
Vice-Chair for Clinical Affairs and Quality
Vice-Chair, Department of Surgery UC Davis Health


# Session XI: Papers 36-44 

Friday, September 20, 2019
8:00 AM - 11:00 AM
Location: Lonestar Ballroom A/B Moderator: Alicia Mohr, MD
Recorder: John Fildes, MD

# BARRIERS TO IMPROVING HEALTHCARE VALUE IN EMERGENCY GENERAL SURGERY: A NATIONWIDE ANALYSIS 

Kamil Hanna MD, Zaid Haddadin MD, Joseph Sakran* MD,MPH, MPA, Muhammad Zeeshan MD, Lynn Gries MD, Narong Kulvatunyou* MD, Andrew Tang MD, Ashley Northcutt MD, Bellal Joseph* MD, University of Arizona - Tucson

Invited Discussant: Kristan Staudenmayer, MD, MSc

Introduction: There is a growing need to improve the quality of care while decreasing healthcare costs in Emergency General Surgery (EGS). Healthcare value includes costs and quality and is a targeted metric by improvement programs. The aim of our study was to evaluate the trend of healthcare value in EGS over time and to identify barriers to high value surgical care.
Methods: The (2011-2014) National Readmission Database was queried for patients $\geq 18 \mathrm{y}$ who underwent an EGS procedure (according to the AAST definition). Healthcare value ( $\mathrm{V}=$ quality metrics/cost) was calculated from the rates of freedom from readmission, major complications, reoperation, and FTR indexed over health-care-costs. Outcome measures- were the trends in the quality metrics: 6-months readmission, major complications, reoperation, failure-to-rescue (FTR), healthcare costs, and healthcare value over the study period. Multivariable linear regression was performed to determine the predictors of lower healthcare value.
Results: We identified 863,350 patients who underwent EGS. Mean age was $51 \pm 20$ y and $48 \%$ were male. The rates of 6 -month readmission, major complications, reoperation, and FTR increased significantly over the study period
( $p<0.05$ ). Figure 1. The median healthcare costs/admission also increased over the study period (2011: $\$ 32,000$ to 2014: $\$ 39,000 ; \mathrm{p}<0.01$ ). However, the healthcare value has decreased over the study period (2011: 1.25, 2012: 1.02, 2013: 0.88, 2014: 0.84; $\mathrm{p}<0.01$ ). Predictors of decreased health care value in EGS are illustrated in Table 1.
Conclusion: Health care value in EGS appears to be declining over time. Some of the factors leading to decreased healthcare value in EGS are potentially modifiable. Transforming the quality of surgical care requires reducing fragmentation of care, promoting regionalization, and prioritizing value improvement.


| Table 1. Predictors associated $\pi$ ith decreased Bealth Care Valoe in EGS |  |  |  |
| :--- | :---: | :---: | :---: |
| Predictor | $\beta$ | $[9596 \mathrm{CD}]$ | P-Value |
| Age 265 | -0.005 | $[-0.02-(-0.000)]$ | $<0.01$ |
| $>3$ comartidities | -0.004 | $[-0.04-(-0.002)]$ | $<0.01$ |
| Reailmission to a different hospital | -0.007 | $[-0.006(-0.008)]$ | $<0.01$ |
| Adnission to lower volutise centers | -0.003 | $[-0.003-(-0.002)]$ | $<0.01$ |
| Adnussion on a weckend | -0.004 | $[-0.005-(-0.003)]$ | $<0.01$ |
| Lasck of rehabilitation | -0.004 | $[-0.001-(-0.008)]$ | $<0.01$ |
| Frivate insurance | -0.002 | $[-0.004-(-0.001)]$ | $<0.01$ |

Notes

## LONG-TERM FUNCTIONAL OUTCOMES AFTER TRAUMATIC POPLITEAL ARTERY INJURY: A 20-YEAR EXPERIENCE

Louis J. Magnotti* MD, MS, John P. Sharpe MD, MS, Richard H. Lewis MD, Elizabeth A. Tolley Ph.D., Fridtjof Thomas Ph.D., Dina M. Filiberto MD, Cory R. Evans MD, Leo Kokorev BS, Timothy C. Fabian* MD, Martin A. Croce* MD, University of Tennessee Health Science Center - Memphis
Invited Discussant: Michael Sise, MD
Introduction: Traumatic popliteal artery injury (TPAI) remains a significant cause of limb-loss. For these patients, prolonged ischemia and concomitant injuries contribute to both lower extremity morbidity and poor rates of limb salvage at the time of initial injury. However, little published information regarding long-term functional outcomes exists. This study evaluated the impact of TPAI on long-term functional outcomes in the largest single institutional series reported in the literature.
Methods: Patients with TPAI over 20 years were identified. To better evaluate long-term functional outcomes and limit the impact of time post-injury as a potential bias, only those patients with at least a 2-year follow-up were included. Functional outcomes were measured using the Boston University Activity Measure for Post-Acute Care (AM-PAC) to assess basic mobility (BM) and daily activity (DA). Multiple linear regression, adjusted for age, severity of injury and shock, operative complexity, associated injuries, ischemic time and length of follow-up was used to identify predictors of functional outcome after TPAI.
Results: 214 patients were identified: 123 (57\%) penetrating and 91 (43\%) blunt. Overall mortality was $1.9 \%$ (all in-hospital). Of the 210 survivors, follow-up was obtained in 145 (69\%) patients. Mean follow-up was 10.6 years (range $2.4-22$ years). Mean AM-PAC scores for BM and DA were 78 and 75 ; both signifying mild impairment (normal $>84$ ). Multiple linear regression failed to identify increasing length of follow-up as a predictor of improved functional outcomes. Only age, lower extremity fracture and ischemic time were identified as predictors of decreased BM and DA.

|  |  | All $(\mathrm{n}=145)$ |  | Penetrating $(\mathrm{n}=84)$ |  | Blunt $(\mathrm{n}=61)$ |  |
| :--- | :--- | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | BM | DA | BM | DA | BM | DA |
| Age | $\beta$ | -0.42 | -0.78 | -0.82 | -1.33 | -0.22 | -0.50 |
|  | p | $<0.0001$ | $<0.0001$ | $<0.0001$ | $<0.0001$ | 0.023 | 0.003 |
| Fracture | $\beta$ | -6.44 | -8.26 | -3.32 |  | -9.47 | -14.26 |
|  | p | 0.0002 | 0.003 | 0.063 |  | 0.002 | 0.005 |
| Ischemic | $\beta$ | -2.38 | -3.60 | -1.28 | -2.33 | -1.98 | -2.85 |
| Time | p | $<0.0001$ | $<0.0001$ | 0.048 | 0.03 | 0.002 | 0.007 |

Conclusion: Increasing age, lower extremity fracture and prolonged ischemic time worsened long-term functional outcomes. Surprisingly, prolonged follow-up ( $>2$ years) did not portend improved functional outcome suggesting that maximal recovery may be achieved within the first 2 years post-injury. Thus, early revascularization emerges as the only potentiallymodifiable risk factor for improving functional outcomes following TPAI.

Notes

# MANAGEMENT OF CHOLEDOCHOLITHIASIS IN THE ELDERLY: IS ERCP ALONE REALLY A SAFE ALTERNATIVE? 

Allison E. Berndtson MD, Sara B. Edwards MD, Alan M. Smith Ph.D., Leslie<br>Kobayashi* MD, Jay J. Doucet* MD, Todd W. Costantini* MD, Laura N. Godat* MD, University of California, San Diego<br>Invited Discussant: Oscar Guillamondegui, MD, MPH

Introduction: Current guidelines recommend that patients presenting with choledocholithiasis (CDL) should undergo cholecystectomy after clearance of the common bile duct via ERCP. Adherence with this guidelines is poor in elderly patients due to perceived risks of operative intervention. We hypothesized that elderly patients treated with ERCP alone would have higher complication and readmission rates than patients treated with cholecystectomy during the index admission.
Methods: The Nationwide Readmissions Database was queried for all patients age 65 or older with an index admission for CDL during the first six months of 2016. Patients were divided into 3 groups based on treatment received: (1) No intervention, (2) ERCP alone, or (3) Cholecystectomy. Analysis included patient demographics, Charlson comorbidity index (CCI), biliary-related readmissions, complications, and mortality. Multivariate regression analyses were performed to identify predictors of procedure done during index admission and of readmissions for patients initially admitted with CDL.
Results: 16,424 patients were admitted with CDL; 38\% underwent cholecystectomy, 37\% ERCP only and $25 \%$ had neither. Increasing age (OR 1.11 to 3.74 by 5 -year group, p $<0.05$ ) and $\mathrm{CCI} \geq 3$ (OR $1.63, \mathrm{p}<0.001$ ) were associated with non-operative (no cholecystectomy) management during the index admission. Readmission rates for biliary-related complications at 180 days (see Figure) were highest for patients with no intervention, followed by ERCP alone and cholecystectomy ( $12 \%, 9 \%$ and $2 \%$ respectively, $\mathrm{p}<0.001$ ). Post-operative 180 day readmission for any complication was $7 \%$ for patients treated with cholecystectomy. On multivariate analysis, emergent readmission at 180 days was predicted by CCI $\geq 3$ (OR 1.74, p $<0.001$ ) and need for post-acute care services (OR 1.70, p < 0.001). Patients undergoing ERCP or cholecystectomy had a decreased risk of 180-day readmission (OR 0.79, p $<0.001$ and OR $0.34, p<0.001$ respectively). For patients treated with cholecystectomy, predictors of readmission were $\mathrm{CCI} \geq 3$ ( $\mathrm{OR} 2.10, \mathrm{p}<0.001$ ) and discharge to post-acute care services (OR 2.24, all $\mathrm{p}<0.001$ ); increasing age did not predict readmission. Similarly, for those undergoing ERCP only, predictors of 180-day emergent readmission were CCI $\geq 3$ (OR 1.79 , $\mathrm{p}<0.001$ ) and discharge to post-acute care services
(OR 1.78, p < 0.001).
Conclusion: ERCP alone for CDL in elderly patients has higher biliary-related readmissions and complications than cholecystectomy. Charlson comorbidity index is the strongest predictor of emergent readmission after cholecystectomy or ERCP, while increasing age is not predictive. In patients with CDL, elderly age alone may not justify avoidance of cholecystectomy.

Time to Readmission


Notes

# ENVISIONING THE PARADIGM: THE BURDEN AND OUTCOMES OF EMERGENCY GENERAL SURGERY (EGS) IN AN INTEGRATED REGIONAL HEALTH SYSTEM 

Samuel W. Ross MD,MPH, Caroline E. Reinke MD, MSHP, Bradley W. Thomas MD, Susan L. Evans MD, A. B. Christmas* MD, Ronald F. Sing* DO, Brent D. Matthews MD, Addison K. May* MBA,MD, Carolinas Medical Center

Invited Discussant: Angela Ingraham, MD
Introduction: EGS patient outcomes have been shown to differ significantly on multiple factors including the size and resources of the institution. Our objective was to evaluate our own integrated health care system's experience with EGS. We hypothesized that patients' outcomes would be improved at the larger referral centers.
Methods: Our 2600 bed, thirteen hospital, health system's billing data was queried for AAST defined EGS ICD-9 codes from 2013-2015. Codes were grouped into diagnosis and procedure categories according to prior AAST publications. Outcomes were evaluated by Trauma Center designation as a surrogate for high resource availability and EGS expertise. 30-day mortality was the primary outcome. Standard and multivariate statistics were used to evaluate predictors of mortality.
Results:There were 60,604 non-elective EGS admissions, with 6,724 (11.1\%) requiring an operation. Mortality rates for the entire population, and by Trauma Center designation are displayed in Figure 1. Patients at non-trauma centers had fewer comorbidities and predominately had minor procedures if an operation was performed. Risk factors associated with increased 30-day mortality included increased age, hospital length of stay, Charlson Comorbidity Index (CCI), cardiothoracic, bowel obstruction, soft tissue, or resuscitation diagnosis, Level III admission, and requiring a laparotomy; all $\mathrm{p}<0.0001$. On multivariate analysis, increased age (OR 1.03, 95\%CI 1.028-1.031) and CCI (1.26, $1.24-1.27)$, decreased BMI ( $0.98,0.97-0.99$ ), soft tissue ( $1.51,1.40-1.64$ ), bowel obstruction (1.53, 1.36-1.71), and resuscitation diagnoses (9.78, 9.00-10.63), laparotomy (3.94, 2.59-6.00), and Level 3 designation (1.27, 1.16-1.40) were associated with increased independent odds of 30 -day mortality.
Conclusion: EGS has a high burden of disease, and outcomes vary widely in the system but were significantly better at the Level I center with a dedicated EGS service. Additionally, we were able to identify certain high-risk features in our population. Early identification of these patients and triage to a higher level of care, through the regionalization of EGS, could help decrease their morbidity and mortality in the future.


Notes

# ACUTE CARE SURGERY MODEL LEADS TO SHORTER LENGTH OF STAY IN MILD GALLSTONE PANCREATITIS 

Samuel P. Carmichael MD, Jonathan Krebs BS, Nathan T. Mowery* MD, Wake Forest Baptist Medical Center

Invited Discussant: Kimberly A. Davis, MD, MBA

Introduction: Cholecystectomy within 48 h of admission for mild pancreatitis (Ranson $<3)$ can be safely performed leading to decreased length of stay (LOS) and hospital cost. The Acute Care Surgery (ACS) model has been associated with more efficient surgical throughput. We hypothesized that mild pancreatitis patients could safely proceed with surgery the day of consultation without an increase in complications.
Methods: Eligible patients (Ranson <3; 2016-2018) were considered for immediate surgery with goal of cholecystectomy within 12 hours of ACS service consultation (EARLY). This decision was made independent of dietary tolerance or pancreatic enzyme concentration. Patient outcomes were compared to patients in whom cholecystectomy was performed in a more traditional approach (LATE).
Results: A total of 85 patients underwent cholecystectomy. Demographic data and comorbidities between the EARLY ( $\mathrm{n}=34$ ) patients and the LATE ( $\mathrm{n}=51$ ) were similar. Compared to the LATE group, LOS and total costs were significantly decreased in the EARLY group ( 5.32 vs. 3.65 days [ $p<0.05$ ]; $\$ 14,352$ vs. $\$ 11,144$ [ $p<0.05$ ]). Operative duration between the two groups was the same ( 168.7 vs 167.6 minutes, $p>0.05$ ). There were three conversions to open surgery and one common bile duct injury, all in the LATE group. Regression analysis controlling for age and admission lipase showed that early intervention was an independent predictor of the LOS (OR 0.037, 95\% CI .024-.050, p<.001).
Conclusion: Immediate cholecystectomy in mild pancreatitis is safe and cost effective, reducing length of stay by more than 1.5 days. Under the ACS model, patients with mild pancreatitis should be posted for operation the day of consultation rather than awaiting correction of enzymes or diet tolerance.

|  | Total (n=85) | EARLY ( $n=34$ ) | LATE $(n=51)$ |  |
| :--- | :---: | :---: | :---: | :---: |
|  | Mean (5D) | Mean (SD) | Mean (SD) | p-value |
| Age (years) | $59.6(19.3)$ | $52.3(17.5)$ | $59.7(20.0)$ | $p>0.05$ |
| \% Female | 70 | 70.6 | 69.6 | $p>0.05$ |
| Lipase (U/L) | $4163(6190)$ | $3237(3868)$ | $4726(7224)$ | $p>0.05$ |
| Length of Stay (days) | $4.69(2.5)$ | $3.65(1.9)$ | $5.32(2.7)$ | $p<0.05$ |
| Total Cost (USD) | $13,140(5893)$ | $11,144(5268)$ | $14,352(5950)$ | $p<0.05$ |
| EARLY = cperation within 12 hours of consultation. |  |  |  |  |

Notes

# THE EFFECT OF EMS TRANSPORT TIME ON IN-TRANSIT CLINICAL DECLINE IN A RURAL STATE 

Taylor R. Kai BS, Marlene J. Broady Daniel L. Davenport Ph.D., Andrew C. Bernard* MD, University of Kentucky

## Invited Discussant: Jan Jansen, MBBS

Introduction: Rural systems often have longer prehospital transport times compared to urban systems. The duration after which patients experience significant clinical decline remains undefined. Despite EMS protocols directing critically ill patients to higher-level care facilities, geography may compel EMS providers to stop at lower level ones. We aimed to determine the effect of transport time on rate of clinical decline in helicopter (HEMS) and ground (GEMS) transport, as well as the prevalence of patient transport to suboptimal facilities using the EMS Field Triage Decision Scheme (FTDS).

Methods: De-identified data from the 2017 state EMS Information System were analyzed to evaluate the effect of transport time on prehospital clinical decline. Patients were subdivided into those who met or did not meet FTDS Step 1 criteria ( $\mathrm{RR}<10$ or $>29$, SBP $<90$, or GCS $<14$ ) for transport to a Level I, II, or III trauma center; transport via HEMS or GEMS; and whether the appropriate center was reached. Clinical decline was defined in those who met Step 1 criteria as any further deterioration in vital signs from baseline, or as development of FTDS Step 1 criteria en route.

Results: Patients who met Step 1 criteria showed a linear increase in decline with increasing ground transport time ( $\mathrm{p}<0.001$ ). Helicopter flights $>15$ minutes showed a similar linear increase in decline with about half the rate as GEMS Step 1 patients ( $p=0.001$; fig.). Non-Step 1 patients declined at similar rates ( $5-7 \%$ ) regardless of transport time. Of Step 1 patients, $53.9 \%$ reached an appropriate center (level I, II, III). The most common reasons for misallocation included
 "closest facility" ( $52.1 \%$ ), followed by "patient's choice" (18.4\%).

Conclusion: The FTDS Step 1 criteria accurately predict patients at greatest risk of further clinical decline during prehospital transport, with greatest risk in ground transport compared to helicopter. Rather than decline after the "golden hour", these data suggest that for trauma patients with abnormal physiology, decline is roughly linear throughout transport.

Notes

# GOT CALCIUM? ADMISSION IONIZED-CALCIUM IN TWO CIVILIAN RANDOMIZED CLINICAL TRIALS OF PRE-HOSPITAL PLASMA 

Hunter B. Moore MD,Ph.D., Mattew T. Tessmer BS, Ernest E. Moore* MD, Jason L. Sperry* MD, Mitchell J. Cohen* MD, Michael P. Chapman MD, Anthony E. Pusateri* Ph.D., Francis X. Guyette MD, Joshua B. Brown MD, Matthew D. Neal MD, Brain S. Zuckerbraun* MD, Denver Health Medical Center

Invited Discussant: Jeremy Cannon, MD
Background: Randomized clinical trials(RCTs) support pre-hospital plasma resuscitation in traumatic hemorrhagic shock(THS). However, recent reports of military experience suggest that pre-hospital transfusions predispose patients to hypocalcemia, due to citrate chelation of endogenous calcium. We reviewed admission ionized-calcium (i-Ca) blood levels of two recent pre-hospital plasma RCTs and its impact on coagulation and postinjury survival. We hypothesized that pre-hospital plasma was associated with hypocalcemia and coagulopathy, reducing its survival benefit.
Methods: Patients in two institutions participating in pre-hospital plasma RCTs (Control=normal saline) were included if i-Ca was collected prior to calcium replacement. Adults with THS (SBP $\leq 70 \mathrm{mmHg}$ or $71-90 \mathrm{mmHg}+\mathrm{HR} \geq 108 \mathrm{bpm}$ ) were eligible. Moderate hypocalcemia was defined as i-Ca $<=0.9-1.0 \mathrm{mmol} / \mathrm{L}$, severe as $\mathrm{i}-\mathrm{Ca}<0.9 \mathrm{mmol} / \mathrm{L}$.
Results: 160 subjects were included ( $76 \%$ men, $71 \%$ blunt trauma, median age 40 yrs , median injury severity score 22), of whom $48 \%$ received pre-hospital plasma. Overall, 44\% had hypocalcemia ( $31 \%$ moderate; $13 \%$ severe). Pre-hospital plasma (vs controls) was significantly associated with i-CA $<1.0 \mathrm{mmol} / \mathrm{L}$ (OR: 2.00; 95\%CI:1.06-3.79). Severe hypocalcemia significantly
 diminished plasma survival benefit (interaction severe hypocalcemia* randomization group $p=0.03$; Figure). Hypocalcemia was significantly associated with INR, thrombelastography indicators of clot formation and strength (all $\mathrm{p}<0.05$ ).
Conclusion: Pre-hospital plasma in the treatment of civilian trauma is associated with hypocalcemia, which diminished its survival benefit. These data underscore the need for calcium replacement guidelines in postinjury resuscitation with blood products.

Notes

# EFFECT OF PLASMA TRANSFUSION RATIO TO RED BLOOD CELLS BETWEEN GERIATRIC AND NON-GERIATRIC MASSIVELY TRANSFUSED TRAUMA PATIENTS: ELDERLY PATIENTS BENEFIT LESS! 

Mitsuaki Kojima MD,Ph.D., Akira Endo MD,Ph.D., Xiaofei Zhang MD,Ph.D., Atsushi<br>Shiraishi MD,Ph.D., Megan Brenner* MD, Tomohisa Shoko MD,Ph.D., Yasuhiro<br>Otomo* MD,Ph.D., Raul Coimbra* MD,Ph.D., Tokyo Medical and Dental University

Invited Discussant: Jason Sperry, MD, MPH
Introduction: Massive transfusion protocols (MTP) with well-balanced plasma to red blood cells (RBC) ratio have shown to be associated with improved outcomes in trauma. However, these results were mainly derived from young adults such as military settings. The impact of MTP on elderly trauma patients is still unclear. The aim of the study was to investigate the impact of different plasma transfusion ratios to the outcomes in the non-geriatric and geriatric trauma population.
Methods: A retrospective observational study was performed using the Trauma Quality Improvement Program database from 2013 to 2016. Major trauma patients (Injury Severity Score $\geq 16$ ) who received massive transfusion ( $\geq 4$ units of RBC within 4 hours or $\geq 10$ units within 24 hours after hospital arrival) were analyzed. Patients were divided into non-geriatric (16-64 years old) and geriatric ( $\geq 65$ years old) groups. Associations between plasma to RBC ratio and outcomes: in-hospital mortality and incidence of adverse events, were evaluated using a non-linear logistic generalized additive model (GAM). Associations between three categories according to plasma to RBC ratios [low ( $<$ 0.5 ), medium ( $0.5-1.0$ ), and high ( $\geq 1.0$ )] were also assessed using a multivariate regression model.
Results: We identified 11,744 massively transfused trauma patients, including 9,827 ( $83.7 \%$ ) non-geriatric and 1,917 ( $16.3 \%$ ) geriatric subjects. The GAM plots of the plasma to RBC ratio for in-hospital mortality (adjusted by variables including ISS, Revised Trauma Score, injury mechanisms, injured body region and hospital type) demonstrated a downward convex unimodal curve and the nadir was observed when the ratio was 0.88 in the non-geriatric group (Fig A). The geriatric group showed monotonic increase in the risk of in-hospital mortality with no specific threshold (Fig B). In the categorized multivariate regression analysis, the medium group was significantly associated with reduced in-hospital mortality when compared to low plasma to RBC ratio group in non-geriatric subjects (Table). No association between transfusion ratio and mortality was observed in the geriatric group. An increase in plasma to RBC ratio was significantly associated with a higher incidence of adverse events in both

|  |  |  | geriatrics |  |  | criatrics |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Plasma/RBC ratio |  | AOR | 95\% Cl | $p$ value | AOR | 95\% Cl | $p$ valus |
| In-bospital mortality | Low | 1.23 " | (1.11.1.37) | 20.01 | 0.89 | (0.71-1.11) | 0.30 |
|  | Medium | 1 | [Reference] | - | 1 | [Reference) | ) |
|  | High | 1.11 | (0.92-1.32) | 0.25 | 1.09 | (10.73, 1.65) | 0.65 |
| Adverse events | Low | 0.73 - | (0)65-1.81) | 40.01 | 0.66 * | (0.52-0.82) | cosit |
|  | Medium | 1 | [Reference] | - | 1 | [Reference] | 1 . |
|  | High | 1.01 | (0.85-1.19) | 0.89 | 1.26 | (0.84, 1.89) | 0.24 |



Plasma to RBCs ratio
non-geriatric and geriatric groups (Table).
Conclusion: Massive transfusion with a plasma to RBC ratio in the range of 0.5 to 1.0 was significantly associated with a reduction of in-hospital mortality among non-geriatric injured adults, but no such association was observed in geriatric patients. Higher incidence of adverse events was observed in both geriatric and non-geriatric trauma patients who received MTP with higher transfusion ratio.

Notes

# BENCHMARKING THE VALUE OF CARE: VARIABILITY IN HOSPITAL COSTS FOR COMMON OPERATIONS AND ITS ASSOCIATION WITH PROCEDURE VOLUME 

Cheryl K. Zogg MSPH, MHS, Andrew C. Bernard* MD, Joseph P. Minei* MBA,MD, Kristan L. Staudenmayer* MD, Kimberly A. Davis* MBA,MD, Yale School of Medicine

Invited Discussant: Jason Smith, MD

Introduction: Efforts to improve the value of care, defined as changes in quality/cost, have become a priority of health policy and quality improvement initiatives in the US. While many programs, such as the Center for Medicare \& Medicaid Services' Hospital Readmissions Reduction Program and American College of Surgeons’ Trauma Quality Improvement Program, have sought to increase quality by reducing variability in adverse outcomes, considerably less is known about variability in hospital costs. In conjunction with the mission of the AAST Healthcare Economics Committee, the objective of this study was to examine the extent of variability in total index hospital costs for two common acute care surgery procedures: laparoscopic appendectomy and laparoscopic cholecystectomy. We hypothesized that significant variability in costs exists and that hospitals with higher volumes of each procedure would perform more efficiently and, thereby, at lower cost.
Methods: Nationally-weighted data for adults aged $\geq 18$ years was obtained for patients with primary procedure codes corresponding to each operation in the 2014 (last full year of ICD-9-CM codes: 47.01, 51.23) and 2016 (first full year of ICD-10-CM codes: 0DTJ4ZZ, 0FT44ZZ) National Inpatient Sample. Data from each year were aggregated separately at the hospital-level in order to attain
hospital-specific median index hospital costs in 2019 USD for each operation and corresponding annual procedure volumes. Hospitals were excluded if they performed < 20 weighted operations in order to ensure estimate stability. Variability in median hospital costs and interquartile ranges (IQR) was visualized using caterpillar plots. Differences in (risk-adjusted) median costs based on variations in procedure volume were compared using: (1) lntransformed linear regression of continuous procedure volume with robust standard errors,(2) categorized procedure volume based on quintile of annual procedures performed, and (3) quantile regression comparing differences in costs based on volume at the 50/60/70/80/90th percentile of volume.
Results: In 2014, based on ICD-9-CM codes, 1,606 hospitals representing 103,520 laparoscopic appendectomies and 2,090 hospitals representing 214,170 laparoscopic cholecystectomies met include criteria. In 2016, based on ICD-10-CM codes, the numbers were similar with 1,563 hospitals representing 86,170 laparoscopic appendectomies and 2,276 hospitals representing 230,120 laparoscopic cholecystectomies. Variability in median hospitals costs (IQR) for each operation in 2014 is presented in Fig1. Compared to a global median of $\$ 11,090$ (mean: \$14,040), median total index hospital costs for laparoscopic appendectomy ranged from \$4,530 (10th percentile) to $\$ 28,080$ ( 90 th percentile). For laparoscopic cholecystectomy, values ranged from $\$ 5,460$ to $\$ 32,570$ with an overall global median of $\$ 13,390$ (mean: $\$ 16,460$ ). Cost differences were strongly associated with differences in procedure volume. Regression results for laparoscopic cholecystectomy in 2014 and 2016 are presented in Table1. Compared to the lowest quintile of procedure volume, patients undergoing surgery at the highest volume centers had risk-adjusted median costs that were on average $\$ 6,000$ ( $95 \% \mathrm{CI}$ : $\$ 6,728$ to $\$ 5,272$, $\mathrm{p}<0.001$ ) lower. For laparoscopic appendectomy, the risk-adjusted difference was $\$ 3,307$ (95\%CI: \$3,922 to $\$ 2,591, \mathrm{p}<0.001$ ) lower - a decrease of approximately $\$ 150$ per 10 additional operations.
Conclusion: Marked variability of median hospital costs for common operations exists. Conservative ranges of the extremes measured from the 10th to 90th percentile suggest differences upwards of $\$ 23,000$ per patient. Differences remained consistent across consideration of changing coding structures and database years. They were strongly associated with variations in procedure volume, even after controlling for differences in hospital characteristics and severity of patient case-mix. Taken together, the findings suggest room for improvement and a need to address large discrepancies in an often overlooked aspect of the value of care.


Notes

# $43^{\text {RD }}$ WILLIAM T. FITTS, JR., M.D., LECTURE 



## William T. Fitts, Jr., M.D. October 6, 1915 - June 17, 1984

William T. Fitts, Jr. was born on October 6, 1915, in Jackson, Tennessee. He received his A.B. degree from Union University in Jackson in 1937 and his M.D. degree from the University of Pennsylvania in 1940. He was an intern resident, Harrison Fellow in Surgical Research, Rockefeller Foundation Fellow in Surgery and Instructor in Surgery at the University of Pennsylvania from 1940-1942 and from 1945-1947. From 1942-1945, he was a Surgical Ward Officer in the Affiliated Unit of the University of Pennsylvania, the $20^{\text {th }}$ General Hospital, in the China-Burma-India Theatre of World War II. He became an Assistant Professor of Surgery in 1949, Associate Professor of Surgery in 1952, and was John Rhea Barton Professor of Surgery and Chairman, Department of Surgery, University of Pennsylvania, from 1972-1975. He spent his entire career at the University of Pennsylvania. Because of his long service to the organization, the Fitts Lecture was established by the American Association for the Surgery of Trauma in 1974 and first presented by Curtis P. Artz, M.D. at the $35^{\text {th }}$ AAST Meeting in Scottsdale, Arizona.
***************

> American Association for the Surgery of Trauma:
> Secretary, Vice-President, President-Elect, 1957-1964

President, 1964-1965
Editor, Journal of Trauma, 1968-1974
American College of Surgeons:
Vice-Chairman, Committee on Trauma, 1965-1966
Chairman, Pennsylvania Committee on Trauma, 1955-1967
National Safety Council Surgeon's Award for Distinguished Service to Safety, 1971
American Trauma Society:
President, 1972-1973

## Session XII: Fitt's Lecture



# "A Seussian Tale of a Trauma <br> Time Traveler" 

Friday, September 20, 2019
11:00 AM - 12:00 PM Location:
Lone Star Ballroom ABC Presenter:
Timothy Fabian, MD
Editor-in-Chief, Trauma Surgery of Acute
Care Open
Professor Emeritus
Department of Surgery
University of Tennessee Health Sciences

## PREVIOUS FITTS ORATORS

| 1. | 1975 | Curtis P. Artz, M.D. Charleston, SC | 21. | 1995 | Jonathan E. Rhoads, M.D. Philadelphia, PA |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 2. | 1976 | Francis D. Moore, M.D. Boston, MA | 22. | 1996 | Susan P. Baker, M.P.H. Baltimore, MD |
| 3. | 1977 | G. Tom Shires, M.D. New York, NY | 23. | 1997 | George F. Sheldon, M.D. Chapel Hill, NC |
| 4. | 1978 | Lloyd D. MacLean, M.D. <br> Montreal, Quebec, Canada | 24. | 1998 | Leonard Evans, Ph.D. Warren, MI |
| 5. | 1979 | Mr. Peter S. London Birmingham, England | 25. | 1999 | Barbara Barlow, M.D. New York, NY |
| 6. | 1980 | Carl T. Brighton, M.D. Philadelphia, PA | 26. | 2000 | Johannes A. Sturm, M.D. Hannover, Germany |
| 7. | 1981 | John W. Kinney, M.D. New York, NY | 27. | 2001 | Janet Reno Washington, DC (Cancelled) |
| 8. | 1982 | Thomas W. Langfitt, M.D. Philadelphia, PA | 28. | 2002 | C. James Carrico, M.D. Dallas, TX |
| 9. | 1983 | Col. Robert Scott, L/RAMC London, England | 29. | 2003 | Ellen J. MacKenzie, Ph.D. Baltimore, MD |
| 10. | 1984 | F. William Blaisdell, M.D. Sacramento, CA | 30. | 2004 | Colonel John Holcomb, M.D. Ft Sam Houston, TX |
| 11. | 1985 | Donald P. Becker, M.D. <br> Los Angeles, CA | 31. | 2005 | Sylvia D. Campbell, M.D. Tampa, FL |
| 12. | 1986 | Sheng Chih-Yong, M.D. <br> Woods Hole, MA | 32. | 2006 | Sten E.V. Lennquist, M.D., Ph.D. Linkoping, Sweden |
| 13. | 1987 | Paul Dudley Hart Woods Hole, MA | 33. | 2007 | Thomas M. Scalea, M.D. Baltimore, MD |
| 14. | 1988 | Roderick A. Little, M.D. <br> Manchester, United Kingdom | 34. | 2008 | Charles E. Lucas, M.D. Detroit, MI |
| 15. | 1989 | Prof. Martin Allgower, M.D. Switzerland | 35. | 2009 | Frederick P. Rivara, M.D., M.P.H. Seattle, WA |
| 16. | 1990 | Philip R. Lee, M.D. <br> San Francisco, CA | 36. | 2010 | Charles N. Mock, M.D., Ph.D., M.P.H. |
| 17. | 1991 | Donald D. Trunkey, M.D. Portland, OR |  |  | Seattle, WA |
| 18. | 1992 | Basil A. Pruitt, Jr., M.D. <br> Fort Sam Houston, TX | 37. | 2011 | H. Leon Patcher, M.D. New York, NY |
| 19. | 1993 | John H. Davis, M.D. <br> Burlington, VT | 38. | 2012 | David B. Hoyt, M.D. Chicago, IL |
| 20. | 1994 | John R. Border, M.D. | 39. | 2013 | Frank R. Lewis, Jr., M.D. Philadelphia, PA |

40. 2014 Ronald G. Tompkins, M.D. Boston, MA
41. 2015 L.D. Britt, M.D., M.P.H. Norfolk, VA
42. 2016 M. Margaret Knudson, M.D. San Francisco, CA
43. 2017 Ronald Maier, M.D.

Seattle, WA
44. 2018 William C. Schwab, M.D.

Philadelphia, PA

| Group VIII: Shock/Transfusions | Posters \# 72-81 |
| :---: | :---: |
|  | stine Gaarder, MD, PhD \& Joseph Rappold, MD Location: Lonestar Preconvene (near C4) |
| Group IX: Shock/Transfusions II | Posters \# 82-91 |
|  | Todd Rasmussen, MD \& William Chu, MD Location: Lonestar Preconvene (near C4) |
| Group X: Shock/Transfusions III Grant Bochicren | Posters \# 92-100 |
|  | MPH \& Morgan McMonagle, MD, MB, BCh, BAO |
|  | Location: Lonestar Preconvene (near C4) |
| Group XI: Critical Care | Posters \# 101-111 |
|  | Heather Dolman, MD \& Ronald Simon, MD Location: Lone Star Ballroom |
| Group XII: Emergency General Surgery | Posters \# 112-120 |
|  | Martin Zielinski, MD \& Christopher Dente, MD |
|  | Location: Lone Star Ballroom C2 |
| Group XIII: Emergency General Surgery/Outcomes | Posters \# 121-129 |
|  | Addison May, MD, MBA \& Linda Maerz, MD |
|  | Location: Lone Star Ballroom C3 |
| Group XIV: Outcomes/Guidelines | Posters \#130-139 |
|  | Michel Aboutanos, MD \& Amy McDonald, MD |
|  | Location: Lone Star Ballroom C4 |



# Session XIVA: Papers 45-53 

Friday, September 20, 2019
2:00 PM - 5:00 PM
Location: Lone Star Ballroom A
Moderator: Eileen Bulger, MD
Recorder: Addison May MD, MBA

# NATURAL LANGUAGE PROCESSING OF PREHOSPITAL EMS TRAUMA RECORDS ALLOWS FOR AUTOMATED CHARACTERIZATION OF TREATMENT APPROPRIATENESS 

Christopher J. Tignanelli MD, Greg M. Silverman BS, Elizabeth A. Lindemann BS, Alexander L. Trembley NRP, BSM, Jon L. Gipson MD, FACS, Gregory Beilman* MD, FACS, Raymond Finzel BS, Reed McEwan MS, Benjamin C. Knoll BS, Serguei Pakhamov Ph.D., Genevieve B. Melton-Meaux MD,Ph.D., FACS University of Minnesota Dept of Surgery

Invited Discussant: Mark Gestring, MD
Introduction: Inappropriate prehospital trauma care is a significant contributor to preventable deaths. Current databases lack timelines of clinical events. Temporal associations and procedural indications are critical to characterize treatment appropriateness. Natural language processing (NLP) methods present a novel approach to bridge this gap. We developed an NLP system to automatically extract procedures and procedural indications from emergency medical services (EMS) motor vehicle crash (MVC) records.
Methods: 107 records were utilized to extract airway procedures, intraosseous/intravenous (IV) access, blood transfusion, crystalloid bolus, LUCAS chest compressions, tranexamic acid bolus, and needle decompression. Reports were processed using four clinical NLP systems and augmented via a word2phrase method with a large integrated health system data repository to identify terms semantically similar with 11 procedural indications. Airway procedure was indicated in patients that were non-responsive, had respiratory distress, or a Glasgow Coma Scale < 9 . Intravenous access should be attempted for all patients. Intraosseous access was indicated if failed IV attempt or hypotensive (systolic blood pressure $<90 \mathrm{mmHg}$ ) patients requiring rapid or multiple access. Needle decompression was indicated in hypotensive patients with absent breath sounds. Tranexamic acid was indicated in all hypotensive patients (per local protocol). Blood infusion was indicated in all hypotensive patients. Crystalloid bolus was indicated for hypotensive patients when blood is not available or for continued hypotension after EMS 2 units of packed red blood cells have been transfused. LUCAS was indicated for all patients receiving cardiopulmonary resuscitation. Extracted elements were temporally related to reconstruct timelines. Indications were matched with procedures and categorized as appropriate, missed (indicated but not performed), or non-indicated. The accuracy of automated characterizations was then evaluated via manual review of 50 notes.
Results: NLP identified 150 procedures with $100 \%$ recall and $93 \%$ precision. Automated timeline summarization was completed for all patients (figure). This facilitated automated retrospective evaluation of adherence with 8 locoregional EMS practices. For each procedure, 20-86\% of patients had documentation of procedural indications but the system did not identify an associated procedure performed. Commonly missed procedures included airway control (53.8\%) and needle decompression (85.7\%). Additional measures evaluated IV guage appropriateness, only $79 \%$ of patients received a 14-18 gauge IV. $93.3 \%$ of patients received non-indicated crystalloid boluses. Conclusion: NLP methodologies allow for extraction of procedural indication data and automated timeline summarization. Future directions should focus on optimizing and expanding NLP methods and linking NLP data with current databases to facilitate locoregional performance monitoring and improvement efforts.


Notes

# HOSPITAL RESOURCES DO NOT PREDICT ACCURACY OF SECONDARY TRAUMA TRIAGE: A POPULATION-BASED ANALYSIS 

Bourke W. Tillmann MD, Avery B. Nathens* MD,Ph.D., Matthew P. Guttman MD, Priscila Pequeno MSc, Damon C. Scales MD,Ph.D., Petros Pechlivanoglou Ph.D., Barbara Haas MD,Ph.D., Sunnybrook Health Science Centre<br>Invited Discussant: Brian Eastridge, MD

Introduction: Identifying severely injured patients who require transfer to a trauma center poses a significant challenge. The structures and processes of care at non-trauma centers (NTCs) that lead to accurate secondary triage are poorly understood. The objective of this study was to evaluate the relationship between under- and overtriage, and to identify center-level factors associated with accurate secondary trauma triage.
Methods: We performed a population-based, retrospective cohort study of all injured patients transported to a NTC in a regional trauma system between fiscal years 2009 and 2016. Patients discharged from the emergency department of a NTC were excluded. NTCs were categorized based on the availability of human resources (board-certified emergency physicians, orthopedics, general surgery) and physical resources (CT imaging, ICU). Rates of under- and overtriage were calculated for the trauma system and each NTC. NTCs were stratified into tertiles based on their undertriage rates, and overtriage rates were compared. The association between under- and overtriage rates, adjusted for NTC resources and case-mix, was modelled using negative binomial regression. We then used bivariate mixed effect models, adjusted for patient case-mix, to evaluate the relationship between NTC resource strata and the accuracy of secondary triage.
Results: Inclusion criteria identified 118,973 patients at 182 NTCs. Overall 16,481 ( $13.9 \%$ ) patients were transferred to a trauma center. Among those with severe injuries ( $\mathrm{n}=37,528$ ), $77 \%$ were never transferred (undertriaged), while among patients without severe injuries ( $\mathrm{n}=81,445$ ), $11 \%$ were transferred to a trauma center (overtriaged). After adjusting for case-mix, a lower undertriage rate was associated with an increased rate of overtriage (RR 1.92, 95\% CI $1.37-2.69$ and 3.74, 95\% CI $2.52-5.54$, for medium and low undertriage rate NTCs respectively vs high undertriage rate NTCs). However, in each undertriage tertile NTCs demonstrated a wide range of overtriage (Figure). There was no relationship between hospital resources and overtriage rates. Furthermore, the availability of hospital resources was unrelated to the overall accuracy of triage ( $\mathrm{p}=0.13$ ).


Conclusions: We observed significant variation in the rates of under- and overtriage, and the accuracy of secondary triage across NTCs. While NTCs with lower undertriage rates tended to have higher overtriage rates, we identified NTCs that had low rates of both under- and overtriage. Additionally, secondary triage accuracy was not dependent on a NTC's available resources. Our findings suggest that low rates of undertriage can be achieved while maintaing acceptable rates of overtriage, and that factors other than resource availability play a key role in triage accuracy. Evaluation of processes of care at highly accurate NTCs may lead to the creation of strategies to improve triage accuracy across the trauma system.

Notes

# THE IMPACT OF MEDICAID EXPANSION ON TRAUMA-RELATED EMERGENCY DEPARTMENT UTILIZATION: A NATIONAL EVALUATION OF POLICY IMPLICATIONS 

Lisa M. Knowlton MD,MPH, FRCSC, Melody S. Dehghan BA, Amber W. Trickey Ph.D., MS, CPH, Lakshika Tennakoon MD, MPhil, Arden M. Morris MD,MPH, FACS, David A. Spain* MD, FACS Stanford University Medical Center<br>Invited Discussant: Joseph Minei, MD, MBA

Introduction: The impact of Medicaid expansion, under the Affordable Care Act (ACA) of 2014, upon national trauma-related emergency department (ED) utilization is unknown. We aimed to assess whether the ACA was associated with changes in trauma patient ED use and payer mix. We hypothesized that post-ACA ED visits would decline and that Medicaid coverage would increase disproportionately in regions of widespread policy adoption.

Methods: We queried the National Emergency Department Sample (NEDS) for those with a primary trauma diagnosis (ICD-9CM codes), aged 18 to 64 . As most states implemented Medicaid expansion in January 2014, we compared hospitalizations pre-ACA (2012) to post-ACA (10/2014 to 09/2015 to maintain consistency with ICD-9CM codes). Primary outcomes were change in ED visits and payer status; secondary outcomes were change in costs, discharge disposition and inpatient length of stay. Univariate and multivariate analyses were performed, including difference-in-differences analyses. We compared changes in ED trauma visits by payer (Medicaid, uninsured, private) in the West ( $91 \%$ living in a Medicaid expansion state) versus the South ( $12 \%$ in a Medicaid expansion state).

Results: Among 21.2 million trauma-related ED visits analyzed, there was a $13.3 \%$ decrease in ED visits post-ACA. Overall, there was a $7.2 \%$ decrease in uninsured ED visits (pre- vs. post-ACA: $25.5 \%$ vs. $18.3 \%$, $\mathrm{p}<0.001$ ), a $6.6 \%$ increase in Medicaid coverage ( $17.6 \%$ vs. $24.2 \%, \mathrm{p}<0.001$ ) and a $1.3 \%$ increase in private payer-covered visits ( $37.6 \%$ vs. $38.9 \%$, $\mathrm{p}<0.001$ ).
 Among those admitted to hospital ( $\mathrm{n}=604,126 ; 2.9 \%$ ), mean LOS was longer (pre- vs. post-ACA: 3.8 vs. 4.1 days, $\mathrm{p}<0.001$ ) and the percent discharged to rehabilitation increased ( $15.5 \%$ vs. $19.1 \%, \mathrm{p}<0.001$ ). In difference-in-differences regional comparisons, trauma patients had $40 \%$ increased odds of having Medicaid coverage post-ACA compared to pre-ACA (aOR 1.40, $\mathrm{p}<0.001$ ). Patients in the West had $31 \%$ greater odds of having Medicaid than in the South (aOR $1.31, \mathrm{p}<0.001)$. The post-ACA increase in Medicaid coverage was significantly greater in the West than in the South (aOR 1.60, p<0.001). Post-ACA, there was a $25 \%$ increase in inpatient discharge to rehabilitation (aOR $1.24, \mathrm{p}<0.001$ ). Trauma inpatients were also more likely to have Medicaid coverage than those discharged from the ED (aOR 1.20, $\mathrm{p}<0.001$ ).

Conclusion: Medicaid expansion was associated with a significant increase in insurance coverage for trauma patients and a decrease in injury-related ED visits, which may result from access to other outpatient services. Overall, increases in inpatient Medicaid coverage improved discharge to post-acute services for trauma patients. Efforts to ensure sustainability of expanded coverage will benefit injured patients and trauma systems.

Notes

# LIFTING THE BURDEN: STATE MEDICAID EXPANSION REDUCES FINANCIAL RISK FOR THE INJURED 

John W. Scott MD,MPH, Mark G. Shrime MD,MPH,Ph.D., Barclay T. Stewart MD, MscPH, Saman Arbabi* MD,MPH, Eileen M. Bulger* MD, Joseph Cuschieri* MD, Ronald V. Maier* MD, Bryce R. Robinson* MD, MS Harborview Medical Center

Invited Discussant: Jay Doucet, MD, MSc
Introduction: Injuries disproportionately affect the poor and can be expensive to treat. Uninsured patients are at greatest risk for financial strain due to high out-of-pocket healthcare costs relative to their income. As a part of national health reform, our state expanded eligibility for Medicaid coverage in 2014, which resulted in over 600,000 non-elderly adults gaining coverage. We hypothesized that state Medicaid expansion (ME) was associated with a reduction in financial risk among injured patients.
Methods: We analyzed all patients aged 18-64 years admitted for Level 1 trauma center care in our state from 2012-2017. We defined 2012-2013 as the pre-policy period and 2014-2017 as the post-policy period. To adjust for year-to-year variation in patient demographics, injury characteristics, and facility traits, we used multivariable linear regression models to evaluate for pre-/post-policy changes in length of stay, complications, mortality, failure to rescue, and discharge disposition among the policy-eligible sample. We used state and US census data to estimate post-subsistence income and out-of-pocket expenses for admitted patients. We then applied these two estimates to determine catastrophic healthcare expenditure (CHE) risk as defined by the WHO (out-of-pocket health expenses $\geq 40 \%$ of estimated post-subsistence income).
Results: We identified 16,801 patients admitted over the 6 year study period. After ME, the Medicaid coverage rate increased from $20.4 \%$ to $41.0 \%$ and the uninsured rate decreased from $19.3 \%$ to $3.7 \%$ ( $p<0.001$ for both). There was no significant change in private insurance coverage. ME was not associated with significant changes in length of stay, complications, mortality, failure to rescue, or discharge to rehab. After ME, CHE risk for the policy-eligible sample fell from $36.3 \%$ to $17.7 \%$ ( $<0.01$ ). The annual number of uninsured patients at risk for CHE fell $80 \%$ after ME, ranging from 404-437 patients in the pre-policy period to $77-90$ patients in the post-policy period (Figure, $\mathrm{p}<0.01$ ). For privately insured patients, 298-350 were at risk for CHE annually. At the facility level, the proportion of all charges paid for by charity care fell from $12.4 \%$ to $1.5 \%$ ( $\mathrm{p}<0.01$ ).
Conclusion: State Medicaid expansion led to an $80 \%$ reduction in the uninsured rate among non-elderly adults admitted for injury. The number of uninsured patients at risk of CHE and the proportion of charges paid for by charity care fell precipitously in the post-policy period. ME appears to have shifted much of the financial risk from injured patients and hospitals to the state. However, nearly one-third of privately insured patients may be underinsured as private insurance was not fully protective from CHE.


Notes

# READMISSION AFTER NON-OPERATIVE TRAUMA: INCREASED MORTALITY AND COSTS WITH DELAYED INTERVENTION 

Marta McCrum MD,MPH, Chong Zhang MS, Angela Presson Ph.D., Raminder Nirula* MD,MPH, University of Utah<br>Invited Discussant: David Spain, MD

Introduction: Nearly half of patients hospitalized after traumatic injury are managed non-operatively. These patients may have unique health needs that contribute to readmission. We sought to examine patterns of readmission after non-operative trauma, including rates of delayed operative intervention, associated mortality and cost.
Methods: The Nationwide Readmissions Database (2013-2014) was queried for all index adult trauma admissions and 30-day non-elective re-admissions. Index admissions were classified as operative (OI) or non-operative (NOI), and readmissions examined for presence of operative intervention (OR). Outcomes of interest included mortality and cost during readmission. Multivariable cox regression identified risk factors for readmission requiring OR after NOI.

Results: Of 2,244,570 eligible admissions, there were 58,495 non-elective readmissions (2.6\%): 38,235 (65.4\%) after NOI, and 20,260 (34.6\%) after OI. Overall rate of readmission was 2 -fold higher after NOI compared to OI ( $3.6 \%$ vs $1.8 \% \mathrm{p}<0.001$ ). Readmitted NOI patients were older (median 71y vs OI 69 y ) with higher proportions of severe injury ( $\mathrm{ISS} \geq 15$ ) ( $23.4 \%$ vs $17.7 \%$ ), public insurance ( $74.4 \%$ vs $66.5 \%$ ) and initial discharge home ( $42.7 \%$ vs $28.6 \%$ ), and were readmitted earlier (NOI median 8 days vs OI 9 days) ( $\mathrm{p}<0.001$ for all). Operative intervention during NOI readmission was common: $31.2 \%$ overall and $36.5 \%$ of severe injury. Among severely injured NOI patients requiring OR, $62 \%$ carried a primary diagnosis of intracranial injury, and $55.1 \%$ required non-spine neurological procedures. Mortality was higher for redamitted NOI patients requiring OR compared to OI patients ( $2.9 \%$ vs $2 \%, \mathrm{p}=0.02$ ). Operative readmission after NOI cost a median of $\$ 17,364$ [IQR $\$ 11,481, \$ 27,816]$ per admission, and carried a total annual cost of $\$ 147 \mathrm{M}$ ( $95 \%$ CI \$141M-\$154M). Intracranial hemorrhage was an independent risk factor for failed non-operative management in both the overall (HR 1.11, $95 \%$ CI 1.01-1.22) and severely injured (HR 1.46, $95 \%$ CI 1.24-1.71) populations.
Conclusions: Nearly one-third of patients readmitted after initial non-operative management of traumatic injuries require operative intervention. NOI patients requiring OR on readmission experience increased mortality and accrue nearly $\$ 150 \mathrm{M}$ in potentially preventable annual costs. Patients with head injury appear to be particularly vulnerable. Further research should focus on identifying patients and specific injury patterns at risk for failure of non-operative management prior to initial hospital discharge.


Notes

# ATTRIBUTABLE RISK OF READMISSION AFTER TRAUMA 

Erin Hall MD,MPH, Brendan Carr MD, Alexis Zebrowski MPH,Ph.D., MedStar<br>Washington Hospital Center

Invited Discussant: Saman Arbabi, MD, MPH
Introduction:Increased risk of hospital readmission after trauma is poorly characterized and difficult to benchmark because of widely varying baseline risk of hospitalization among trauma patients. Our objective was to accurately quantify the trauma attributable risk of hospital readmission and identify those populations most at risk for readmission after trauma discharge.
Methods: Patients with trauma admissions were identified in the 2013 Nationwide Readmissions Database (NRD) using ICD-9 and E-codes. Conditional Poisson regression was combined with a case-crossover design to estimate risk ratios comparing the risk of hospitalization for up to 90 days prior to the index trauma with the risk for readmission up to 90 days later. Every patient served as his or her own control allowing for an estimation of the increased risk of readmission attributable to the trauma. Results were further stratified by age, injury severity, and mechanism of injury.
Results: 811,763 trauma patients were included. Of these, the majority ( $\mathrm{n}=472,574$, $58.2 \%$ ) were minor injuries ( $\operatorname{ISS}<9$ ) and $55 \%(\mathrm{n}=379,150)$ were falls. Older age ( $\geq 60$ years old) was associated with increased risk of readmission (IRR 1.95, 95\% CI 1.94-1.97 vs. IRR $1.83,95 \%$ CI 1.81-1.86) despite more minor injuries. Injury severity resulted in a dose response effect with a $68 \%$ increased readmission risk (IRR 1.68, 95\% CI 1.66-1.69) for minor injuries, a 2.4 -fold increased risk (IRR 2.4 95\% CI 2.39-2.47) for moderate injuries, and a 3-fold increased risk (IRR 3.01, 95\% CI 2.92-3.10 for severe injuries. Attributable risk differed by mechanism with falls associated with a 2 -fold increase (IRR 2.02, 95\% CI 1.98-2.03), MVC associated with 4-fold increase (IRR 4.32 $95 \%$ CI 4.13-4.54) and GSW associated with 8-fold increased risk (IRR 8.23, $95 \%$ CI 6.94-9.76).

Conclusion: Using a novel case-crossover design, we describe significantly increased risk of subsequent hospitalization attributable to injury. This approach allows for vulnerable patients at risk for ongoing adverse health outcomes to be identified, for health systems' performance on long term outcomes to be benchmarked, and for tailored interventions to be developed and tested.

Notes

## Implementation of a Hospitalist CoManagement Program may help improve outcomes but not necessarily costs.

Patricia Ayoung-Chee MD,MPH, Erwin Wang MD, MHA, Prashant Sinha MD, Charles Okamura MD, Frank Volpicelli MD, NYU Langone Health

Invited Discussant: Zara Cooper, MD, MSc
Introduction: Comanagement is the shared responsibility, authority and accountability for patient care and outcomes. With the aging of the population, surgical patients are being admitted with more complex comorbidities, requiring highly integrated treatment strategies and coordination of care. The goal of this study was to evaluate the effectiveness of implementing a hospital comanagement program for admitted surgical patients.
Methods: This was a retrospective chart review of patients admitted to surgical services (including trauma and emergency general surgery) who met criteria for comanagement from April, 2017 to August, 2018. Patients were flagged in the electronic medical records system as having met criteria if age $<65$ years with two or more comorbidities or if age $\geq 65$ years with one comorbidity. Comorbidities included, but were not limited to coronary artery disease, diabetes, hypertension, obesity and hyperlipidemia. Outcomes such as length of stay (LOS) and mortality as well as variable direct cost (VDC) were evaluated.
Results: Over 17 months, there were 462 surgical patients included in the co-management program. The baseline population included surgical patients admitted from September, 2016 to December, 2016, prior to implementation in April, 2017. We observed a nearly $50 \%$ reduction in actual LOS and a reduction in LOS adjusted for admission comorbidities (O:E LOS). There was also a substantial reduction in observed to expected mortality ratios. Variable direct cost per case decreased by $43.3 \%$ but when adjusted for CMI, there was an

|  | Non-CoManagement Patients $(\mathrm{N}=500)$ | CoMmansement Patients $\text { ( } \mathrm{N}=462 \text { ) }$ |
| :---: | :---: | :---: |
| Actual LOS (mean) | 13.68 | 7.82 |
| Sxpected LOS (mean) - adusted for comotiditities | 10.61 | 8.15 |
| Case Mix index (CMI) | 4.97 | 2.53 |
| O:E LOS | 1.29 | 0.96 |
| O:EMortality | 1.6 | 0.52 | increase of $11.3 \%$.

Conclusion: The introduction of a hospitalist comanagement program at our hospital was beneficial with respect to length of stay and mortality, when adjusted for case mix index. There was also an associated cost benefit per patient stay. Further investigation is needed to evaluate the program's effects on additional outcomes such as complications, discharge disposition and overall transitions of care.

Notes

# MORE CALL DOES NOT MEAN MORE BURNOUT: A MULTICENTER ANALYSIS OF TRAUMA SURGEON ACTIVITY WITH FATIGUE AND BURNOUT RISK 

Timothy W. Wolff DO, Brittany L. Lisjak PA-C, Urmil B. Pandya MD, FACS, Michael Goodman* MD, Timothy Pritts* MD,Ph.D., FACS, Linda A. Dultz MD,MPH, FACS, Samir R. Pandya MD, FACS, Rajan K. Thakkar MD, Aditi M. Kapil MD, Allison E. Berndtson MD, FACS, Laura N. Godat* MD, FACS, M C. Spalding* DO,Ph.D., OhioHealth Grant Medical Center
Invited Discussant: Jamie Coleman, MD
Introduction: Long, highly stressful stretches of continuous work are thought to be significant contributing factors to the increasing rate of surgeon burnout. Modifying work hours or changing work type to improve burnout rates is a commonly assumed solution, but this remains unproven. We aimed to correlate work-related activity with measured fatigue and burnout risk among trauma and acute care surgeons. We hypothesized that fatigue levels would increase in direct response to length of call-shift, and that this would lead to higher risk of burnout.

Methods: We performed a 30 day, prospective, multicenter study involving trauma, acute care, and pediatric surgeons. Call shift schedules and duration varied among the 6 different Level I trauma centers. Fatigue was quantified for all subjects from actigraphy monitors utilizing a validated alertness model. Fatigue levels $<70$ predicts the likelihood of causing an error equivalent to a blood alcohol level of $0.08 \%$. Subjects self-reported their daily work activities as "academic" (A), "on-call" (OC), "clinical non-call" (CNC) or "not working" (NW) as well as the respective times associated with each. At the end of the trial period, each surgeon completed a Maslach Burnout Inventory (MBI) to quantify burnout risk. Fatigue levels were correlated with time of day, reported work hours, reported work type, and MBI scores. Variables were compared between call shifts scheduled for 12 and 24 hours.

Results: Mean OC fatigue levels were significantly worse among 24-hour than 12-hour call shifts ( $83.6 \mathrm{vs} .87 .3, \mathrm{p}<0.05$ ) as were minimum OC fatigue levels ( 67.0 vs . 76.2, $\mathrm{p}<0.01$ ). 24-hour call shifts were also significantly more likely to include fatigue levels $<70(61.2 \%$ vs. $28.6 \%, \mathrm{p}=0.03)$. Additionally, the proportion of total time spent with a fatigue level $<70$ while OC was higher for 24 -hour call shifts ( $10.3 \%$ vs. $5.8 \%, \mathrm{p}<0.01$ ). Mean 30-day and OC fatigue levels all correlated weakly with MBI $(R=-0.36, R=-0.19$, respectively). Total A, CNC, and NW durations, OC shifts, and OC hours also correlated weakly with MBI ( $\mathrm{R}=0.10, \mathrm{R}=0.39, \mathrm{R}=-0.32, \mathrm{R}=-0.04, \mathrm{R}<0.01$, respectively). Both mean and minimum 24-hour pre-call fatigue levels had strong correlations with OC fatigue levels ( $\mathrm{R}=0.72, \mathrm{R}=0.63$, respectively), however pre-call NW duration did not.

Conclusion: Trauma surgeon OC fatigue level is directly related to call length and correlates strongly with pre-call fatigue level. Additionally, 24-hour call shifts correlate with increased surgeon fatigue to potentially dangerous levels for longer periods. However, fatigue, call frequency, or call duration did not predict higher risk of burnout. This indicates that surgeon burnout is not a simple function of work hours or work type, and further studies should be performed to identify other modifiable factors to solve this complex problem.

Notes

# COMPARISON OF AAST GRADING SCALE TO MODIFIED HINCHEY CLASSIFICATION IN ACUTE COLONIC DIVERTICULITIS: A PILOT STUDY 

Joseph Ebersole BS, Andrew Medvecz MD, Cara Connolly MD, Katherine Sborov BS, Lauren Matevish BS, Geoffrey Wile MD, Stephen Gondek MD,MPH, Oliver Gunter* MD, Oscar Guillamondegui* MD,MPH, Brad Dennis* MD, Vanderbilt University Medical Center<br>Invited Discussant: Marie Crandall, MD, MPH

Introduction: The AAST developed an anatomic grading scale of disease severity including imaging criteria in common surgical conditions, such as diverticulitis. The Hinchey classification requires operative intervention to accurately grade and is incomplete in non-operative cases yet remains the established system for acute diverticulitis. The purpose of this pilot study is to compare the AAST grading scale for acute colonic diverticulitis to the more traditional Hinchey classification system. We hypothesize that the AAST clinical classification scale is equivalent to the Hinchey in predicting outcomes.
Methods: This is a retrospective cohort study in a large academic medical center. A consecutive sample of patients admitted from 2014-2016 with acute diverticulitis and computed tomography (CT) imaging was reviewed. Chart review identified demographic and physiologic data as well as interventional and clinical outcomes. Each patient's initial CT scan was assigned AAST and modified Hinchey classification scores by a trained radiologist. Multivariate regression and receiver-operative curve (ROC) analysis compared the scoring systems for 6 outcomes: need for procedure, complication, ICU admission, hospital length of stay, 30-day readmission and mortality.
Results: 129 patients met study criteria. $42.6 \%$ required procedural intervention, 21.7\% required ICU admission, $18.6 \%$ were readmitted, and $6.2 \%$ died. Both AAST and Hinchey classifications predicted the need for operation (AAST odds ratios (OR) 1.55, $12.7,18.09,77.24$ for stage $2-5$, respectively, relative to stage 1 ; Hinchey OR 8.85 , 11.49, 22.9 for stage $1 \mathrm{~b}-3$, respectively, relative to stage 1a, stage 4 predicted outcome perfectly). For the need for operation, the c-statistics (AUC) for the ROC analysis for AAST and Hinchey were 0.80 and 0.83 for Hinchey and AAST, respectively ( $\mathrm{p}=0.35$ ). The c-statistics curve for complication for AAST and Hinchey were 0.83 and 0.80 , respectively ( $\mathrm{p}=0.33$ ). AAST and Hinchey scores were less predictive and did not differ with respect to ICU admission, readmission, and mortality with c-statistics less than 0.80 . Conclusion: AAST grading of acute diverticulitis is equivalent to the modified Hinchey classification system in predicting the need for procedural intervention and complications in acute diverticulitis. The AAST system may be preferable to Hinchey as it can be reliably applied preoperatively and can be applied based upon imaging findings alone. Although this pilot study demonstrated that the AAST score predicts surgical need, a larger, multi-institutional study is required to establish the predictive value of the AAST score for ICU admission, readmission, hospital LOS, and mortality.

Notes


# Session XIVB: Papers 54-63 

Friday, September 20, 2019
2:00 PM - 5:20 PM
Location: Lone Star Ballroom B Moderator: Luke PH Leenen, MD, PhD
Recorder: Sharon Henry, MD

# EARLY TREATMENT WITH MESENCHYMAL STEM CELL-DERIVED EXOSOMES PROVIDES NEUROPROTECTION AND IMPROVES BLOOD-BRAIN BARRIER INTEGRITY IN A SWINE MODEL OF TRAUMATIC BRAIN INJURY AND HEMORRHAGIC SHOCK 

Aaron M. Williams* MD, Jordana F. Brown BS, Umar F. Bhatti MD, Ben E. Biesterveld<br>MD, Vahagn C. Nikolian MD, Nathan J. Graham BS, Kiril Chtraklin DVM, Ali Z.<br>Siddiqui BS, Simone E. Dekker MD,Ph.D., Yuzi Tian MD, Anuska<br>Andjelkovic-Zochowska MD,Ph.D., Ben Buller Ph.D., Hasan B. Alam* MD, University Of Michigan

Invited Discussant: Carrie Sims, MD
Objectives: Administration of human mesenchymal stem cell (MSC)-derived exosomes during the recovery period can enhance neurorestoration in models of traumatic brain injury (TBI) and hemorrhagic shock (HS). Whether early exosome treatment could attenuate the initial brain lesion remains unknown. This study was designed to investigate the impact of early exosome treatment on the severity of brain injury.
Methods: Yorkshire swine were subjected to a severe TBI (12-mm cortical impact) and HS ( $40 \%$ estimated total blood volume). One hour into shock, animals were randomized ( $\mathrm{n}=5 /$ cohort) to receive either lactated Ringer's (LR; 5 mL ) or LR + exosomes (LR+E: $1 \times 10^{12}$ exosome particles in 5 mLLR ). Animals then underwent additional shock ( 1 hr ) followed by normal saline resuscitation ( 3 x hemorrhage volume). After 6 hours of observation, brain swelling (\% increase compared to the uninjured side) and lesion size $\left(\mathrm{mm}^{3}\right)$ were assessed. Cerebral hemodynamics and circulating biomarkers of brain injury were compared. Immunofluorescence was used to assess the integrity of the peri-lesional blood-brain barrier (albumin extravasation, tight junction preservation, and laminin expression).
Results: Exosome-treated animals had significantly less ( $\mathrm{p}<0.05$ ) brain swelling (LR: $32.3 \pm 2.9 \%$; LR+E: $17.7 \pm 4.6 \%)$ and smaller lesion size (LR: $3298 \pm 374$ mm 3; LR+E: $2225 \pm 160$ $\mathrm{mm}^{3}$ ) (Figure). They also had
 significantly $(\mathrm{p}<0.05)$ decreased intracranial pressures and increased cerebral perfusion pressures. In addition, they displayed significantly decreased ( $\mathrm{p}<0.05$ ) albumin extravasation (LR: $45.2 \pm 13.8$ AUI; LR+E: $17.8 \pm 11$ AUI) and significantly higher ( $\mathrm{p}<0.05$ ) zona occludens-1 (LR: $19.5 \pm 8.4$ AUI; LR+E: $28.5 \pm 8.5$ AUI) and laminin (LR: $21.8 \pm 5.3$ AUI; LR+E: $28.8 \pm$ 3.1 AUI) expression. Serum glial fibrillary acidic protein levels were also significantly ( $\mathrm{p}<0.05$ ) lower in the $\mathrm{LR}+\mathrm{E}$ group at the end of the experiment.
Conclusions: In a large animal model of TBI and HS, early treatment with MSC-derived exosomes significantly attenuates brain swelling and lesion size, decreases biomarkers of brain injury, and improves blood-brain barrier integrity.

Notes

# THE GUT MICROBIOME (GM) IS PREDICTIVE OF CLINICAL OUTCOMES FOLLOWING TRAUMATIC INJURY 

Susannah E. Nicholson MD, MS, David M. Burmeister Ph.D., Taylor R. Johnson BS, Zhao Lai Ph.D., Shannon Scroggins MS, Mark DeRosa CRT, Rachelle B. Jonas RN, Ronald M. Stewart* MD, Martin G. Schwacha Ph.D., Donald H. Jenkins* MD, Brian J.<br>Eastridge* MD, University of Texas Health Science Center at San Antonio

## Invited Discussant: Jeffrey Claridge, MD, MSc

Introduction: Traumatic injury can lead to a compromised intestinal epithelial barrier, decreased gut perfusion, inflammation and immune derangements. While recent studies indicate that the GM is altered early following traumatic injury, the impact of GM changes on clinical outcomes remains unknown. Our objective of this follow-up study was to determine if the GM is predictive of clinical outcomes in critically injured patients.
Methods: We conducted a prospective, observational study in adult patients ( $\mathrm{n}=67$ ) sustaining severe injury admitted to a Level I Trauma Center. Fecal specimens were collected on admission to the Emergency Department (ED). Microbial DNA was isolated from all fecal samples for 16s rRNA sequencing. GM analysis and taxonomic classification were performed using the QIIME Greengenes 16 S rRNA gene database (OTUs; $97 \%$ similarity). Alpha and $\beta$-diversity were estimated using the observed species metrics. The following clinical outcomes were recorded: mortality, hospital length of stay (LOS), intensive care unit (ICU) LOS, number of days on mechanical ventilation, presence of documented infection (pneumonia, urinary tract infection, bacteremia, wound infection, etc. as documented by positive cultures), and acute respiratory distress syndrome (ARDS; as documented and confirmed by P:F ratio $\leq 300$ ). Statistical analysis of these measures were performed with a permutational analysis of variance (PERMANOVA) for overall significance, with post-hoc pairwise PERMANOVAs to assess differences across groups.
Results: Characteristics of our study population are shown in Table 1. Sex, body mass index (BMI), and injury severity score (ISS) all influence the $\beta$-diversity, whereas blunt vs. penetrating trauma does not (Table 2). Beta-diversity on admission differs in patients that died compared to patients that lived regardless of time of death (Table 2; Fig 1; mean time to death $=7.6$ days). Significant differences in admission $\beta$-diversity were also noted by hospital LOS, ICU LOS and number of days on the ventilator (Table 2). Additionally, differences in admission $\beta$-diversity were associated with presence of infection and ARDS during the hospitalization (Table 2). A number of species were enriched in the GM of injured patients that died, which surprisingly included some traditionally probiotic species (Akkermansia muciniphilia, Oxalobacter formigenes, and eubacterium biforme; $\mathrm{p}<0.05$ ).
Conclusion: GM diversity on admission in severely injured patients is predictive of mortality, hospital and ICU LOS, days on mechanical ventilation, and presence of infection and ARDS during the hospitalization. While our study does not address causality, the GM of trauma patients may provide valuable diagnostic and therapeutic targets for the care of injured patients.

|  | Control | Total |
| :--- | :--- | :--- |
| \# of subjects | 13 | 72 |
| Age | 43 | 44 |
| \# of Females | $6(46 \%)$ | $23(31.9 \%)$ |
| W of Blunt |  | $57(79 \%)$ |
| \# of Penetrating |  | $15(21 \%)$ |
| Mean ISS |  | 21 |
| Mean Shock Index <br> (HR/SBP) |  | 0.96 |






Notes

# P-SELECTIN ANTIBODY TREATMENT AFTER BLUNT THORACIC TRAUMA PREVENTS PULMONARY ARTERIAL THROMBOSIS WITHOUT SYSTEMIC COAGULATION CONSEQUENCES 

Linda M. Schutzman MD, Robert R. Rigor Ph.D., Joseph M. Galante* MD, Ian E. Brown MD,Ph.D., University of California, Davis<br>Invited Discussant: Amy Makley, MD

Introduction: Thromboembolic events within the pulmonary vasculature remain a major cause of potentially preventable morbidity and mortality after traumatic injury. Currently, the management of this complication is suboptimal as both its prevention and treatment require pharmacologic anticoagulation. Assessment of the risks and benefits of systemic anticoagulation in trauma patients is frequently complicated by the risk of recurrent bleeding from coexisting injuries such as solid organ lacerations or traumatic brain injuries. Previously, in a murine model of blunt thoracic trauma we provided evidence of de novo pulmonary thrombosis associated with an increase in the expression of the cell adhesion molecule, Pselectin. Additionally, we exhibited that systemic administration of a P-Selectin blocking antibody prevented early pulmonary thrombus formation. In this study we perform viscoelastic testing to investigate if P -selectin inhibition has a detrimental impact on normal hemostasis. We hypothesize that P-Selectin blocking antibody will not adversely affect systemic anticoagulation.
Methods: A murine model of medium velocity lateral thoracic trauma was used. Wild type mice were divided into sham control and experimental injury groups. Thirty minutes after trauma, mice were treated with one of the following: P-Selectin blocking antibody, isotype control antibody, low dose heparin, high dose heparin or normal saline. At 90 minutes, whole blood was collected via the inferior vena cava for characterization of coagulation by Viscoelastic Coagulation Monitor (VCM VetTM; Entegrion, Durham, NC), a variation of standard thromboelastography. Mean clotting time, clot formation time, clot kinetics (alphaangle) and maximum clot firmness were compared between each treatment group.
Results: In both sham and trauma groups, compared to vehicle (normal saline) alone, no statistical difference was noted in any coagulation parameters after injection with P-selectin antibody, isotype control, or low dose heparin. In contrast, mice that received high dose heparin had significantly longer clotting times ( $\mathrm{p}<0.001$ ), clot formation times ( $\mathrm{p}<0.001$ ), lower alpha angles ( $\mathrm{P}<0.001$ ) and lower clot firmness ( $\mathrm{P}<0.001$ ). Notably, in mice subject to trauma we found that P -selectin antibody treated group had a significantly higher alpha-angle ( $\mathrm{P}<0.05$ ) compared to either the low dose or high dose heparin treatment groups ( $\mathrm{p}<0.05$; T test).


Figure 1 : Viscoelastic testing results 90 minutes after trauma ( $\mathrm{n}=7-8$ in each group).
Conclusion: Administration of P-Selectin blocking antibody did not adversely affect systemic anticoagulation as measured by viscoelastic testing. Additionally, when compared to both prophylactic and treatment doses of heparin, P-selectin inhibition had less anticoagulant effect on clotting kinetics as demonstrated by a higher alpha-angle. This data further endorses Pselectin inhibition as a potentially effective and targeted therapy that may circumvent the complications associated with pharmacologic anticoagulation.

Notes

# A GENOMICS JOURNEY TO IMPROVED UNDERSTANDING OF POST-INJURY PLATELET BIOLOGY: PLATELET RNA SIGNATURES IN TRAUMATIC BRAIN INJURY 

Lucy Z. Kornblith MD, Alexander T. Fields Ph.D., Rachael A. Callcut* MD, Mitchell J. Cohen* MD, Cedric M. Bainton Roland J. Bainton MD,Ph.D., University of California, San Francisco

Invited Discussant: Martin Schreiber, MD
Introduction: Nearly half of injured patients show evidence of impaired platelet aggregation in vitro, most common in those who have severe injury, brain injury, and in those who do not survive. The underlying mechanism of this impairment is not well understood, and is not explained simply by loss of circulating platelets. Platelets are endowed by their megakaryocyte mothers with immature messenger RNAs (mRNAs) as well as RNA editing and protein synthesis machinery, allowing platelets to alter their functions based on physiologic signals. Thus, platelet genomics may provide an upstream understanding of the pathways involved in downstream impairments in platelet function brought about by the physiologic insult of trauma. As proof of concept, we sought to investigate platelet RNA signature discoverability in cell free plasma (CFP). We hypothesized that there are alterations in platelet specific RNA signatures in patients with severe isolated traumatic brain injury (TBI) vs. healthy controls. Methods: High throughput RNA sequencing with unsupervised clustering and high read depth ( $\sim 20$ million reads per sample) were applied to CFP samples that were prospectively collected from 10 patients with isolated severe TBI (AIS head score $\geq 3$, AIS all other categories $<3)$ at a single Level 1 Trauma Center from 2005-2011. Publicly available data from the CFP of 23 healthy control patients was used to statistically center and filter the trauma patient data. Classification and organospecific transcriptome enrichment comparisons were used to provide statistical power for identifying platelet specific RNA signatures in TBI vs. healthy controls. Results: A total of 40 differential platelet RNA signatures were discovered in patients with isolated severe TBI vs. healthy controls. The top ten upregulated and downregulated candidate platelet gene signatures discovered in TBI patients vs. healthy controls are listed in the Table. TBI patients had both upregulated and downregulated platelet specific gene products with up to a 36-fold increase and a 296 -fold decrease in frequency per thousand mapped reads in the top candidate platelet specific genes (Table). Conclusion: Using high throughput RNA sequencing, we have discovered a list of 40 candidate platelet RNA signatures in cell free plasma from TBI patients that are upregulated or downregulated compared to healthy controls.This proof-of-concept novel finding may indicate that during injury-stimulated platelet activation, a pool of resident pre-mRNAs may undergo modifications including splicing events for modulation of protein expression involved in platelet function. This supports our future focus on injury induced modulated platelet transcripts in both cell free plasma and isolated platelets to identify candidate genes that map to alterations in post-injury platelet function and may be used as a 'liquid biopsy' for refining targeted treatments in post-injury hemorrhage.

| Gerseicd | Gene Product | Function | CFP Rasik | Pit Ramak | FC ve Controf |
| :---: | :---: | :---: | :---: | :---: | :---: |
| HIST7H2AS | Histone H2a type 1 | Chromatin arganization | 8488 | 1129 | 35.888 |
| RPS 16 | Pribosomal Protein S16 | Translation | 259 | 3207 | 0.140 |
| PFA | Platolet Factor 4 | Chernokino | 2004 | 13 | 8.840 |
| PPBP | Platalet Basic Protein | Chemotione | 139 | 1 | S.746 |
| RPESE | 408 Ribosomal Protein 325 | Translation | 91 | 3390 | 3.288 |
| SKCA2 | Spincle and Kinetochore Associasted | Microtubule binding. rritosis: | 1134 | 11179 | -31.184 |
| SRSFS | Sor/Arg-rich Splloing Factor 6 | Aternative appoing | 1080 | $1107$ | $-31.690$ |
| GPCPD 1 | Glyceropphosuphocholine phosphochiantar wase | Mestabsoliarn, musicies chavelopment | 3673 | 4802 | $-40.018$ |
| $\begin{aligned} & \text { BAGG } \\ & \text { BLAMF? } \end{aligned}$ | Large Proline Pich Protein BLAM Family Marmber 7 | Apoptoesis, NKK cell activation tmmunity | $\begin{aligned} & 2447 \\ & 1995 \end{aligned}$ | $\begin{aligned} & 4500 \\ & 4471 \end{aligned}$ | $\begin{aligned} & -238.687 \\ & -298.421 \end{aligned}$ |
| CFP rank wes was determined ration of a gene | ermined by comparing thequenoy per thous颠 bigher thun TB1) was use | and mepped reeds (FPKKM) in CF at found in brain tissue. Fold chan CIP. The negative reciprocent of to coavert those values to fold | Pto that found ge (F2) vsca hatige hasige. | in broin votrol was cones Cliasio | latelec (PIt) rank Thermined by the PKM in control |

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# THE AAST PROSPECTIVE, OBSERVATIONAL, MULTICENTER STUDY INVESTIGATING THE INITIAL EXPERIENCE WITH REVERSAL OF NOVEL ORAL ANTICOAGULANTS IN TRAUMA PATIENTS 

Brent Emigh MD, Leslie Kobayashi* MD, Miroslav Kopp MD, Mitch Daley PharmD, James Haan* MD, Clay Cothren Burlew* MD, Raminder Nirula* MD, Forrest Moore* MD, Sigrid Burruss MD, Stephen Kaminski* MD, Julie Dunn* MD, Matthew Carrick* MD, Thomas Schroeppel* MD, Carlos V. Brown* MD, AAST Multicenter Novel Oral<br>Anticoagulants Group Dell Medical School, The University Of Texas At Austin

Invited Discussant: Sandro Rizoli, MD
Introduction: Novel oral anticoagulants (NOACs) such as direct thrombin inhibitors (Dabigatran) and Factor Xa inhibitors (Apixaban, Rivaroxaban, Edoxaban) have essentially replaced warfarin as the drug of choice in patients requiring anticoagulation. This has led to an explosion of injured patients presenting to trauma centers while taking NOACs. In 2013, 4-factor concentrates were approved for NOAC reversal, in 2015 Idarucizumab was approved for Dabigatran reversal, and in 2018 Andexanet Alfa was approved for Factor Xa inhibitor reversal. We hypothesized that recent approval of these reversal agents would lead to increased utilization as well as improved outcomes for trauma patients taking NOACs.

Methods: This was a multicenter, prospective (2015-2018), observational study of all adult trauma patients taking NOACs who were admitted to one of fifteen participating Level 1 trauma centers. Variables included demographics, admission physiology, injury pattern (AIS) and severity (ISS), type of NOAC, and treatment with reversal agent. The primary outcome was mortality.

Results: 606 patients taking NOACs were included, with an average age of 75 years old. The most injured body regions were the head (AIS $=1.5$ ), extremities (AIS $=1.2$ ), and chest (AIS $=0.66$ ). Distribution of NOACs were Apixaban (47\%), Rivaroxaban (45\%), Dabigatran (8\%), and Edoxaban ( $0.3 \%$ ). Only $13 \%$ of patients taking NOACs received a reversal agent. The most common reversal agents were factor concentrates ( $87 \%$ ), Idarucizumab (12\%), and Andexanet Alpha (1\%). Those who received a reversal agent were older ( 78 vs. $74, \mathrm{p}=0.007$ ), more severely injured (ISS: 16 vs. $7, \mathrm{p}<0.0001$ ), and had more severe head injuries (Head AIS: 2.9 vs. 1.3, $\mathrm{p}<0.0001$ ). Patients who were reversed had a higher mortality ( $12 \%$ vs. $3 \%, \mathrm{p}=0.0009$ ) but after logistic regression reversal was not independently associated with mortality ( $\mathrm{p}=0.42$ ). When comparing patients who received factor concentrates to those who received drug-specific reversal agents, there was no difference in demographics, admission physiology, injury pattern or severity, but those who received drug-specific agents had a higher mortality ( $30 \%$ vs. $8 \%, \mathrm{p}=0.04$ ). After logistic regression, receiving a drug-specific reversal agent was independently associated with mortality (OR $14.8,95 \% \mathrm{CI} 1.4-155.6, \mathrm{p}=0.02$ ).

Conclusion: The vast majority of trauma patients taking NOACs do not receive a reversal agent. Those who do have their NOAC reversed usually receive a factor concentrate and only $13 \%$ receive one of the currently available drug-specific reversal medications. Patients who received reversal were more severely injured, sustained more severe head injuries, and had a four-fold higher mortality. The subgroup of patients who received a drug-specific reversal agent had a higher mortality and receiving a drug-specific reversal agent was independently associated with mortality.

Notes

# GERIATRIC TBI: WHAT WE KNOW NOW 

Mira H. Ghneim MD, Deborah M. Stein* MD,MPH, Jennifer Albrecht Ph.D., Desmond Khor MD, Jill B. Watras* MD, James M. Haan* MD, Robert D. Winfield* MD, Sasha D. Adams* MD, Scott B. Armen* MD, Fady S. Nasrallah* MD, Julie Dunn* MD, MS, Thomas J. Schroeppel* MD, MS, Zara Cooper* MD, MSc, Karen Brasel* MD, AAST MITC Geri-TBI Study Group* R Adams Cowley Shock Trauma Center

Invited Discussant: Mayur Patel, MD, MPH
Introduction: Traumatic brain injury (TBI)-related hospitalizations and fatalities in elderly patients will continue to increase as the world's population ages. Although guidelines for the treatment of TBI have been established, they do not address the special challenges of managing TBI in older patients. The aim of the study was to describe the epidemiology and current management of a large population of geriatric patients with isolated TBI treated in trauma centers and make comparisons across age groups.
Methods: This is a prospective multi-center observational study of patients across 43 trauma centers. Inclusion criteria were age $\geq 40$ years, and computed tomography (CT)-verified TBI. Patients with any other body region injury abbreviated injury scale score (AIS) $>2$ and presentation at enrolling center $>24$ hours after injury were excluded. Demographic, clinical, injury, and outcome information was collected. Age was categorized by distribution into three categories representing the bottom quartile (group $1,40-59$ years, $\mathrm{n}=776$ ), the middle two quartiles (group 2, 60-81 years, $\mathrm{n}=1,454$ ) and the top quartile (group $3,>81$ years, $n=849$ ). Differences in distributions of variables between age categories were tested using Chi-square Goodness of Fit, and Anova or the Kruskal-Wallis test for continuous variables. We conducted additional similar analyses, restricting to patients with moderate and severe TBI, defined as Glasgow Coma Scale Score (GCS) $<13$.
Results: A total of 3,081 patients were enrolled over a 14-month period. Mean age was $70( \pm 14.1)$ years, $55 \%$ were males, $73 \%$ white non-Hispanic, and $79 \%$ of the patients presented with an AIS-head score of $\geq 3$. (Table 1) Upon stratification into age groups, the 3 groups were similar with respect to head AIS, but the older age groups had a shorter ICU length of stay (LOS), fewer days of mechanical ventilation and more palliative care interventions. Older patients were less likely to undergo intracranial pressure monitoring and neurosurgical interventions. There was a trend toward increased in-hospital mortality and older patients were less likely to be discharged home or return to preinjury level with limited restrictions on outpatient follow-up. (Table 2) When the analysis was restricted to the subgroup with moderate to severe injury ( $\mathrm{n}=711$ ), the same results were found. Mortality rates increased by age cohort and older patients were less likely to be discharged home. (Table 3)


Conclusion: Despite the public health burden, studies of elderly patients with TBI are uncommon. This large observational study is the first to describe a modern population of older patients with isolated TBI and their management. Comparisons by age reveal expected findings of overall worse outcomes in older patients. The differences observed by age provide the basis and background needed to design management strategies and interventions that can be targeted to older patients with TBI.

Notes

# THE AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA (AAST) RENAL INJURY GRADING SCALE: IMPLICATIONS OF THE 2018 REVISIONS FOR INJURY RECLASSIFICATION AND PREDICTING BLEEDING INTERVENTIONS 

Sorena Keihani MD, Bryn E. Putbrese MD, Douglas M. Rogers MD, Kaushik Mukherjee* MD, Sarah Majercik MD, Christopher M. Dodgion* MD, Scott A. Zakaluzny* MD, Brian P. Smith* MD, Jurek F. Kocik* MD, Matthew M. Carrick* MD, Reza Askari* MD, Raminder Nirula* MD, Jeremy B. Myers MD, AAST MultiInstitutional Trials Committee<br>Invited Discussant: Fernando Kim, MD

Introduction: In 2018, the original 1989 AAST Renal Injury Scaling was revised to better characterize high-grade renal trauma (HGRT) and reflect the increased reliance on CT scans and non-operative management of renal injuries. However, it is unknown how the 2018 revisions (2018-AAST) will change the grading of HGRT and if this revised grading outperforms the original 1989 grading (1989-AAST) in predicting the bleeding interventions. We aimed to contrast injury grades between the two grading systems and to compare each scale's ability to predict the need for bleeding interventions.
Methods: Data on high-grade renal trauma (AAST grades III-V) were collected from 14 Level-1 trauma centers from 2014-2017. Patients with initial CT scans were included. Two radiologists, blinded to the grades submitted by each center and outcomes, reviewed the scans to re-grade the injuries according to the 1989 and 2018 AAST grading. Descriptive statistics were used to assess the reclassifications. Mixed-effect logistic regression with clustering by facility was used to measure the predictive power of each classification in a multivariable model adjusted for age, sex, and injury severity score. The areas under the curves (AUCs) were compared.
Results: 322 patients were included. Overall, 46 patients underwent bleeding interventions including 19 renal angioembolization, 15 nephrectomies, and 12 other open procedures. Using the 2018-AAST, 87 (27.0\%) of injuries were upgraded, 11 ( $3.4 \%$ ) were downgraded, and 224 ( $69.5 \%$ ) were unchanged. Of the injuries graded as III using the 1989-AAST, $33.5 \%$ were upgraded to grade IV using the 2018-AAST grading, mostly because of segmental renal artery or vein injury. Of the injuries graded as IV using the 1989-AAST the majority ( $96.3 \%$ ) remained the same. Of grade V injuries, $58.8 \%$ were downgraded using the 2018-AAST due to changes in the definition of shattered kidney and also the requirement for active bleeding in a devascularized kidney to be considered grade V . When compared to grade III, both grade IV and V injuries had higher odds of undergoing intervention in the 2018-AAST grading. For the 1989-AAST grading, only grade V had significantly higher odds for intervention. The odds ratios from multivariable models are presented in Table-1. There was no difference in the AUC between the 2018-AAST and 1989-AAST grading ( $0.72,95 \%$ CI: $0.64-0.79$ vs. $0.68,95 \%$ CI: $0.59-0.76$ ) [Figure-1].
Conclusion: The 2018-AAST grading provides more precise definitions for HGRT and also includes radiographic findings such as active bleeding. These changes result in a better classification of grade IV and V injuries by focusing on bleeding risk. However, these revisions increase the heterogeneity for grade IV injuries mostly by including segmental vascular injuries without active bleeding. Compared to the 1989-AAST grading, the 2018AAST did not significantly improve the overall prediction for bleeding interventions. The 2018-AAST grading eliminates ambiguity in many cases of renal trauma and should serve as an anatomic description rather than a prognostic tool.


Table-1: Multivariable models comparing the 1989 and 2018 AAST renal injury grading for prediction of bleeding interventions atter HGRT.

|  | Original AAST (1989) |  | Revised AAST (2018) |  |
| :--- | :--- | :--- | :--- | :--- |
| Predictors | OR (95\% CI) | P-value | OR (95\% CI) | P-value |
| Renal injury grade |  |  |  |  |
| $\quad$ Grade III | 1.00 (Reference) | - | 1.00 (Reference) | - |
| $\quad$ Grade IV | $1.81(0.78-4.22)$ | 0.17 | $3.04(1.43-6.45)$ | 0.004 |
| $\quad$ Grade V | $9.00(2.78-29.20)$ | 0.001 | $12.03(2.52-57.53)$ | 0.002 |
| Age | $1.01(0.99-1.03)$ | 0.40 | $1.01(0.98-1.02)$ | 0.78 |
| Male Sex | $3.76(1.30-10.88)$ | 0.01 | $3.21(1.14-9.06)$ | 0.03 |
| Injury Severity Index | $1.02(0.99-1.05)$ | 0.09 | $1.03(1.00-1.06)$ | 0.03 |

Notes

# EXTRA-PERITONEAL PACKING IN UNSTABLE BLUNT PELVIC TRAUMA, A PROPENSITY SCORE ANALYSIS 

Simone Frassini Shailvi Gupta MD,MPH, Stefania Cimbanassi MD, Stefano Granieri

Fabrizio Sammartano MD, Thomas M. Scalea* MD, Osvaldo Chiara MD, Universita' Degli Studi Di Milano - ASST Niguarda Hospital
Invited Discussant: Joergen Joakim Joergensen, MD

## Introduction:

Hemodynamically unstable pelvic fractures often require a multi-modal approach including both operative and endovascular management. While an important adjunct in hemorrhage control, time to angioembolization (AE) even at the most advanced trauma centers may take hours. Extra-peritoneal packing (EPP) is a fast and effective procedure that can immediately address pelvic hemorrhage from the retroperitoneal space in severe pelvic injuries. The aim of this study is to evaluate the efficacy of early EPP in mortality and hemodynamic stability in unstable blunt pelvic trauma.

## Methods:

All trauma patients admitted to an urban Level I trauma center were evaluated from 2002 - 2018. Inclusion criteria were patients $>=14$ years old who sustained blunt trauma with pelvic fractures and hemodynamic instability (systolic blood pressure $<90 \mathrm{mmHg}$ ). Exclusion criteria were a concomitant head injury (AIS $>3$ ) and patients with extra-pelvic injury who underwent resuscitative thoracotomy. The patient population was divided into two groups: an EPP group and a no-EPP group. Our institution's practice it to perform extra-peritoneal packing in the trauma bay if necessary. Propensity score analysis (PSA) using quasi-randomization was used to adjust for differences in baseline characteristics in the two groups. A one-to-one matched analysis using nearest-neighbor matching was performed based on the estimated propensity score of each patient. A match occurred when one patient in the EPP group had an estimated score within 0.1 standard deviation (SD) of another in the no-EPP group.

## Results:

Eight hundred and sixty-six of 8374 major trauma patients presented with a pelvic fracture ( $10.3 \%$ ). Two-hundred forty four patients presented with a hemodynamically unstable pelvic fracture ( 180 no EPP, 64 EPP). With propensity score matching, thirty-seven patients in each group were analyzed. Survival within the first 24 hours was significantly improved in the EPP group ( $81.1 \%$ vs. $59.5 \%, \mathrm{p}=0.046$ ). Overall survival was significantly improved in the EPP group ( $78.4 \%$ vs. $56.8 \%$, $\mathrm{p}=0.05$ ). Those patients who underwent early EPP ( $n=64$ ) had a significant improvement in hemodynamic stability, with a pre-EPP mean arterial pressure (MAP) of 49.1 mmHg and post-EPP MAP of $68.8 \mathrm{mmHg}(\mathrm{p}<0.01)$.

## Conclusion:

EPP is an effective procedure that can be performed immediately to improve hemodynamic stability and overall survival in patients who sustain severe blunt pelvic trauma. The early use of EPP can be life saving in those facilities without immediate access to endovascular options.

Notes

# IMPLEMENTATION OF A MULTIDISCIPLINARY PERINATAL EMERGENCY RESPONSE TEAM (PERT) IMPROVES TIME TO DEFINITIVE OBSTETRICAL EVALUATION AND FETAL ASSESSMENT IN PREGNANT TRAUMA PATIENTS 

Amanda B. Sosulski MD, Jennifer Smith MD, Ramy Eskander MD, Ashkan Moazzez MD,MPH, Neil Patel MD, Brant A. Putnam* MD, Dennis Y. Kim* MD, Harbor-UCLA Medical Center<br>Invited Discussant: Tanya Zakrison, MD, MPH

Introduction: Trauma is the leading cause of non-obstetric death during pregnancy and is associated with an increased risk of maternal mortality. Fetal demise may be as high as $60 \%$ following major trauma and $80 \%$ in the presence of maternal shock. In an effort to improve the coordination and delivery of timely, efficient, and organized care for pregnant trauma patients, we developed an institutional multidisciplinary quality initiative designed to improve response times of non-trauma specialists and ensure immediate availability of resources. We hypothesized that implementation of PERT would improve time to patient evaluation by the obstetrics (OB) team and maternal/fetal outcomes.
Methods: We performed a 6-year (2012-2018) retrospective cohort analysis of consecutive pregnant trauma patients presenting to our university-affiliated, county Level 1 trauma center. Patients in the pre-PERT cohort (prior to April 2015) were compared to a post-PERT cohort. Variables analyzed included patient demographics, mechanism of injury, injury severity score (ISS), trimester of pregnancy, and level of trauma activation. The main outcome measure was time to OB evaluation. Secondary outcomes included time to fetal heart rate (FHR) monitoring, time to admission, length of stay (LOS), complications, and mortality.
Results: Of 92 pregnant trauma patients, there were 50 patients (54.3\%) in the pre-PERT cohort and $42(45.7 \%)$ in the post-PERT group. There were no significant differences between groups regarding demographics including, age, race, ISS, and mechanism of injury. Blunt injuries predominated ( $98.9 \%$ ), with the most common mechanism being motor vehicle collisions (76.1\%), followed by assaults (13\%), and falls (6.5\%). There was a significant decrease in Level 1 (highest tier) activations pre- and post-PERT ( $46 \%$ vs. $21 \%, \mathrm{p}=0.01$ ), which was accompanied by a concomitant increase in the use of lower tier trauma consultation criteria to activate the trauma team ( $38 \%$ vs. $69 \%, p=0.002$ ).The mean time to OB evaluation was 44 minutes in the pre-PERT cohort compared to 14 minutes in the post-PERT cohort $(\mathrm{p}=0.001)$ Time to FHR monitoring was also significantly decreased post-PERT implementation ( 72 vs. 37 minutes, $\mathrm{p}=0.002$ ) There were no significant differences between groups regarding time to admission ( 135 vs. 170 minutes, $\mathrm{p}=0.15$ ), complications, or LOS. There were no reported mortalities.
Conclusion: Implementation of a multidisciplinary perinatal early response team improves time to evaluation by the obstetrics team and time to fetal heart monitoring which has the potential to translate into improved care for both mother and fetus post-injury. Further research is required to determine if the costs and resources associated with PERT activation are offset by a decrease in overtriage rates and higher-tier trauma activations.

Notes

# OPIOID RISK TOOL CAN IDENTIFY PATIENTS WITH INCREASED INPATIENT OPIOID USE AFTER A TRAUMATIC INJURY 

Husayn A. Ladhani MD, Kristen J. Conrad-Schnetz DO, Brian T. Young MD, Sarah E. Posillico MD, Esther S. Tseng MD, Vanessa P. Ho MD,MPH, Jeffrey A. Claridge* MD, MS MetroHealth Medical Center<br>Invited Discussant: Andrew Bernard, MD

Introduction: The Opioid Risk Tool (ORT) is a screening test used for identifying patients with chronic pain at risk for opioid abuse. Its utility in predicting inpatient opioid use for acute pain is unknown. We hypothesized trauma patients deemed high risk by the ORT would require more inpatient opioid pain medication (OPM).
Methods: Trauma floor patients were prospectively evaluated from 11/2017 to 2/2018. Patient and injury characteristics, injury severity score (ISS), length of stay (LOS), and discharge data were obtained. ORT was completed within 24 hrs of floor admission, which classified patients into low, moderate, or high risk groups. Daily OPMs in morphine equivalent doses (MEDs) and non-opioid pain medications (NOPM) were recorded for floor days 1 to 5 , and day of discharge. Groups were compared to identify differences in injury characteristics, OPM and NOPM use as inpatient and prescribed at discharge. Kruskal-Wallis and Chi-square tests were used.
Results: 350 consecutive patients were included: median age 59 yrs (IQR 33-76), male $62 \%$, and median ISS 12 (IQR 9-17); $85 \%$ had a blunt mechanism. ORT was completed for 262 ( $75 \%$ ) patients; 139 low, 73 moderate, and 50 high-risk. The three groups significantly differed in age, gender, and mechanism of injury (all $p<0.001$ ), without a difference in ISS, LOS, or discharge disposition. Median MED ranged between 11-59mg and differed significantly between the three groups for all inpatient days (see Figure). Groups had similar inpatient NOPM use ( $94 \%$ vs. $93 \%$ vs. $92 \%, p=0.935$ ), discharge MEDs ( 113 mg vs. 180 mg vs. $210 \mathrm{mg}, p=0.174$ ), and discharge NOPMs ( $70 \% \mathrm{vs} .74 \%$ vs. $76 \%, p=0.733$ ).

Conclusion: The ORT is associated with increased inpatient OPM use after a traumatic injury. Efforts targeted towards early identification and interventions for patients at risk may help prevent future opioid abuse.


Notes


## AAST Annual Business Meeting

Friday, September 20, 2019
5:00 PM - 7:00 PM
Location: Lone Star Ballroom B

# AAST Reception and Banquet 

Friday, September 20, 2019
7:30 PM - 11:00 PM
Location: Lone Star Ballroom A

## PETER C. CANIZARO, M.D.

 June 30, 1935 - September 3, 1990

Peter C. Canizaro was born on June 20, 1935, in Vicksburg, Mississippi. He received his B.A. degree from the University of Texas, Austin, in 1956 and his M.D. degree from the University of Texas Southwestern Medical School, Dallas, in 1960. Following an internship at Parkland Memorial Hospital/UTSMS, he spent two years as a Captain in the Surgical Research Unit, Brooke Army Hospital, Fort Sam Houston. Following another year as a NIH Research Fellow, he completed his surgical residency at Parkland/UTSMS from 1964-1968. He remained on staff at Parkland/UTSMS from 1968-1974, and then subsequently served on the faculty at the University of Washington (19741976) and Cornell University Medical Center (1976-1981) where he became Professor of Surgery. Dr. Canizaro became Professor and Chairman of the Department of Surgery at the Texas Tech University Health Sciences Center in 1982 and remained there until his untimely death in 1990. Dr. Canizaro was an innovative surgical scientist who made multiple contributions to the field of trauma and resuscitation. Examples of topics covered in his published manuscripts include the following:

| 1960 | Distribution changes in extraceullular fluid during <br> acute hemorrhage (with G. Tom Shires, M.D.) |
| :--- | :--- |
| 1963 | Use of dextran |
| 1963 | Use of hypertonic glucose |
| 1969 | Diagnostic abdominal paracentesis in trauma |
| 1970 | Fluid resuscitation of hemorrhagic shock |
| 1971 | Use of Ringer's lactate during shock |
| 1974 | Oxygen-hemoglobin dissociation curve |
| 1975 | Stroma-free hemoglobin |
| 1985 | Ultrasound detection of fluid collection |
| 1986 | Endopeptidase in human lung |

In recognition of Dr. Peter Canizaro's outstanding contributions to the science of trauma, the AAST has presented the Canizaro Award since 1993 to the best paper by a new member in their first two years of membership.

## PETER C. CANIZARO AWARD

| 1993 | Philip S. Barie, M.D., M.B.A. |
| :--- | :--- |
| 1994 | Frederick A. Luchette, M.D. |
| 1995 | Patrick J. Offner, M.D. |
| 1996 | Rodney M. Durham, M.D. |
| 1997 | Ronald J. Simon, M.D. |
| 1998 | Charles N. Mock, M.D., M.P.H., Ph.D. |
| 1999 | David A. Spain, M.D. |
| 2000 | John T. Owings, M.D. |
| 2001 | Hans-Christoph Pape, M.D. |
| 2002 | Karen J. Brasel, M.D., M.P.H. |
| 2003 | James Jeng, M.D. |
| 2004 | Eileen M. Bulger, M.D |
| 2005 | Carnell Cooper, M.D. |
| 2006 | Saman Arbabi, M.D. |
| 2007 | Kari Hansen, M.D. |
| 2008 | Randall S. Friese, M.D. |
| 2009 | Andrew C. Bernard, M.D. |
| 2010 | Oscar D. Guillamondegui, M.D. |
| 2011 | Jay Manaker, M.D., FACEP |
| 2012 | Stephanie Savage, M.D. |
| 2013 | Jason Smith, M.D. |
| 2014 | Sarah Majercik, M.D. |
| 2015 | Matthew B. Bloom, M.D. |
| 2016 | Jon Simmons, M.D. |
| 2017 | Scott Brakenridge, M.D. |
| 2018 | Grace E. Martin, M.D. |



# Session XV: Sunrise Session Papers 64-66 

Saturday, September 21, 2019
8:00 AM - 9:00 AM
Location: Lone Star Ballroom B
Moderator: Ronald Stewart, MD
Recorder: Krista Kaups, MD, MSc, MS

# EFFECT OF ORAL ANTICOAGULANTS ON OUTCOMES FOLLOWING SEVERE TRAUMATIC BRAIN INJURY IN THE ELDERLY 

Jason P. Hecht PharmD, Zachary LaDuke PharmD, Anne H. Cain-Nielsen MS, Mark R. Hemmila* MD, Wendy L. Wahl* MD, St. Joseph Mercy Hospital, Ann Arbor

Invited Discussant: Rosemary Kozar, MD, PhD
Introduction: Anticoagulant agents are prescribed for atrial fibrillation and venous thromboembolism with increasing use in the elderly population. Vitamin K antagonists like warfarin have been the historical oral anticoagulants of choice, however, upwards of $50 \%$ of all new oral anticoagulant prescriptions are for direct oral anticoagulants (DOAC). Despite this change in prescribing practices, outcome data remains scarce following a severe traumatic brain injury (TBI) on these new agents. This study sought to evaluate in-hospital outcomes of elderly patients with severe traumatic brain injuries and the effect of pre-injury anticoagulants.
Methods: Patient records were obtained from 29 level 1 and 2 trauma centers in the Michigan Trauma Quality Improvement Program (MTQIP) from 2012 to 2018. Overall, 8312 patients were included who were $\geq 65$ years old, suffered a fall, and had an abbreviated injury score - head (AIS-head) of $\geq 3$. Pre-injury anticoagulant and antiplatelet agents were identified. Outcomes included hospital mortality or hospice, length of stay (LOS) and serious in-hospital complications.
Results: Of the 8312 patients 3293 were on antiplatelet agents (AP), 1083 on warfarin (VKA), 304 on DOAC, and 3632 on no agents (none). The mean AIS-head of all patients was 3.78. There were 298 (27.5\%) patients in the VKA group who died or were hospice as compared to 65 (21.4\%) in the DOAC group ( $\mathrm{p}=0.03$ ).
Mortality was then stratified by pre-injury agent and AIS-head score (Figure 1). After adjusting for patient factors there was an increased risk of mortality or hospice in the VKA group as compared to the none group (OR 1.61; 95\%
 CI 1.29 - 2.00) that was not seen in the AP (OR 1.13; 95\% CI 0.94 - 1.36) or DOAC group (OR 1.35; 95\% CI 0.92 - 1.97). The risk of serious complications was increased for the VKA (OR 1.39; $95 \%$ CI $1.08-1.79$ ) and AP groups (OR 1.30; 95\% CI 1.06-1.58) but not observed in the DOAC group (OR $1.41 ; 95 \%$ CI $0.89-2.22$ ). Hospital LOS was a mean of 6.7 days in the warfarin group, 5.7 days for DOAC, and 5.6 days for both the AP and none groups ( $p<0.001$ ).
Conclusion: In elderly severe TBI patients pre-injury DOAC patients had statistically lower mortality or hospice and hospital LOS than warfarin despite the lack of a dedicated reversal agent. After adjusting for patient factors both agents had similar increases in mortality and serious complications. Results of this study should help alleviate concerns amongst providers when prescribing DOAC agents to elderly patients.

Notes

# TIMING AND TYPE OF VTE CHEMOPROPHYLAXIS IS ASSOCIATED WITH ACUTE TRAUMATIC BRAIN INJURY OUTCOMES 

Darwin Ang* MD,MPH,Ph.D., Mark McKenney* MD, Matthew Carrick* MD, Stephen<br>Flaherty* MD, Patrick Offner* MD, Ernest Gonzalez* MD, Roger Nagy* MD, John Armstrong* MD, David Plurad* MD, David Acuna* MD, Mathis Adams MD, Nicole Tapia MD, Ocala Regional Medical Center<br>Invited Discussant: Elliott Haut, MD, PhD

Introduction:Patients with traumatic brain injury (TBI) pose a unique challenge as it is unclear when the optimal timing is to start chemoprophylaxis for venous-thromboembolic events (VTE). The purpose of this study was to determine the optimal timing and type of chemoprophylaxis for TBI patients.

Methods:This is a retrospective cohort study (2013-2018) from 87 trauma centers across the United States. The patient population consisted of those with TBIs. Patients were excluded if they were on outpatient anticoagulation. The primary outcomes were in-hospital mortality and VTE events. The exposure groups were low molecular weight heparin (LMWH) and unfractionated heparin (UFH). Data was then further stratified by timing of initiation of the VTE prophylaxis. The outcomes were risk adjusted using multivariable regression for age, gender, injury status (penetrating vs. blunt), injury severity, and patient comorbidities.

Results:A total of 61,783 patients with TBI were included in the study. The majority of patients did not receive chemoprophylaxis 52,751 ( $85.4 \%$ ), while 7,116 (11.5\%) were treated with UFH, and $1,711(2.8 \%)$ were treated with LMWH. Compared to TBI patients without VTE prophylaxis, patients on LMWH had lower mortality, aOR 0.23 ( $95 \%$ CI $0.15,0.35$ ) and had higher VTE, aOR 2.01 ( $95 \%$ CI 1.31, 3.08). Patients on UFH did not have significant decrease in mortality aOR 0.96 ( $95 \%$ CI $0.87,1.07$ ) and had higher VTE aOR 13.58 ( $95 \%$ CI $8.56,21.56$ ). When stratified by timing of administration, mortality benefit was seen if LMWH was given within 6 hours of admission, aOR $0.25(95 \%$ CI $0.09,0.66)$. This benefit persisted past 6 hours and continued past 72 hours. VTE was also lower if LMWH was given within 24-48 hours ( $0 \%$ VTE, $\mathrm{n}=266$ patients). VTE remained significantly higher in the UFH cohort regardless of timing of administration.

Conclusion:Mortality and VTE events among TBI patients may be associated with both type and timing of VTE prophylaxis. The use of LMWH has a beneficial association with both outcomes. Optimal timing of administration appears to be between 24 and 48 hours of hospital admission.

Notes

# REPEAT CT HEAD SCAN IS NOT INDICATED IN TRAUMA PATIENTS TAKING NOVEL ANTICOAGULATION: A MULTI-INSTITUTIONAL STUDY 

Caitlin Cohan MD, Genna Beattie MD, Jessica Cox MD, Joseph Galante MD, Amy M. Kwok MD,MPH, Rachel C. Dirks Ph.D., Gregory Victorino* MD, University of California San Francisco - East Bay

Invited Discussant: Bellal Joseph, MD

Introduction: Guidelines for imaging anticoagulated patients following traumatic injury are unclear. An interval CT head (CTH) is commonly performed after an initial negative CTH to assess for delayed intracranial hemorrhage (ICH-d). The rate of ICH-d is low in those taking warfarin and largely unknown in those taking novel anticoagulants (NOACs). Specifically, the clinical outcomes for patients taking NOACs who develop ICH-d remain unknown. NOACs have less interactions with other medications and in the non-traumatic setting, appear to have a better safety profile than warfarin. We hypothesized that patients taking NOACs would have a lower rate of ICH-d than those on warfarin and more favorable clinical outcomes when ICH-d occurred.
Methods: Anticoagulated patients presenting with blunt trauma to multiple level I trauma centers between 2016 and 2018 were evaluated. Patients with intracranial hemorrhage on initial CTH and those taking non-oral anticoagulation or antiplatelet agents alone (without warfarin or NOAC) were excluded. Outcomes included: ICH-d, administration of reversal agents, neurosurgical intervention, readmission, and death. Multivariable regression was performed to evaluate for patient factors associated with development of ICH-d.
Results: A total of 739 patients met inclusion criteria. Patients were divided into a warfarin only group ( $\mathrm{n}=409$ ) and NOAC only group ( $\mathrm{n}=330$ ). The average age was 76 years old with $49 \%$ males. Repeat CTH was performed in $52 \%$ of cases. The incidence of ICH-d identified by repeat CTH in the NOAC group was $2.5 \%(4 / 159)$ vs. $4 \%(9 / 224)$ in the warfarin group, $\mathrm{p}=0.42$. ICH-d did not result in neurosurgical intervention or death for those taking NOACs. When evaluating the entire NOAC group, including those without a repeat CTH, there were no neurosurgical interventions or deaths related to head injury. In the entire warfarin group, there was one neurosurgical intervention and 2 deaths due to head injury. Reversal agents were administered in $1.8 \%(6 / 330)$ of patients in the NOAC group versus $13.7 \%(56 / 409)$ in the warfarin group, $\mathrm{p}<0.01$. On multivariate regression analysis of both groups, male sex (OR 18.6, $\mathrm{p}=0.03$ ) and AIS head $\geq 2$ (OR $25.4, \mathrm{p}=0.04$ ) were strongly associated with development of ICH-d.

|  |  | NOAC | Warfarin | p |
| :--- | :--- | :--- | :--- | :--- |
| Repeat CTH (\%) | 48 | 55 | 0.07 |  |
| ICH-d (\%) | 2.5 | 4 | 0.42 |  |
| Reversal Agent Administered (\%) | 1.8 | 13.7 | $<0.01$ |  |
| Neurosurgical Intervention (n) | 0 | 1 | N/A |  |
| Readmission (\%) | 4.2 | 1 | 0.06 |  |
| Deaths from Head Injury (n) | 0 | 2 | N/A |  |

Conclusion: To our knowledge, this is the largest study of patients on NOACs assessing clinical outcomes following ICH-d. In the NOAC group, ICH-d occurred only $2.5 \%$ of the time when CTH was routinely repeated. Regardless of routine repeat CTH, none of the patients taking NOACs required neuro-intervention or died as a result of their head injury. Our findings suggest NOACs may have a better safety profile following trauma compared to warfarin and repeat CTH is not indicated for those on NOACs.

Notes


Session XVI:
Quickshots Session I: Papers 1-13
Saturday, September 21, 2019
9:10 AM - 10:28 AM
Location: Lone Star Ballroom B
Moderator: A. Britton Christmas, MD

# MODIFIED ABBREVIATED BURN SEVERITY INDEX AS A PREDICTOR OF IN-HOSPITAL MORTALITY IN PATIENTS WITH INHALATION INJURY: DEVELOPMENT AND VALIDATION USING INDEPENDENT COHORTS 

RYO YAMAMOTO MD, TAKAYUKI SHIBUSAWA MD, TOMOHIRO KURIHARA MD,Ph.D., NAOKI AIKAWA* MD,Ph.D., JUNICHI SASAKI MD,Ph.D., Keio University

Invited Discussant: Glen Franklin, MD

Introduction: The ability to accurately evaluate the severity of inhalation injury can help optimize patient care and facilitate research on novel treatments. Currently, as there is no accepted severity grading system for inhalation injury, we have developed and validated a new scale, the modified Abbreviated Burn Severity Index (mABSI), using independent cohort data.

Methods: We screened a large database from a multicenter observational registry and identified patients with inhalation injury. The inclusion criteria were age $\geq 15$ years, presentation with palpable pulse, and supplemental oxygen or mechanical ventilation requirement. Patients with missing survival data were excluded. After patient data were divided into development and validation cohorts, missing values were replaced with multiple imputation. In the development cohort, 12 potential predictors were analyzed using multivariate logistic regression to identify prognostic variables for in-hospital mortality and scores were assigned to each predictor based on odds ratios. In the validation cohort, the mABSI was analyzed using receiver operating characteristic (ROC) curve and mABSI-derived probability of in-hospital mortality was compared with observed mortality rate.

Results: We randomly assigned 1,377 and 919 patients to the development and validation cohorts, respectively. Age, self-inflicted injury, cutaneous burn area, and mechanical ventilation requirement were identified as independent predictors, and mABSI was developed with a possible score range of $1-17$. The scale has a high discriminatory power based on area under the ROC curve ( $0.94 ; 95 \%$ confidence interval $=0.92-0.97 ; p<$ 0.01 ), which is higher than other scaling systems, such as prognostic burn index and ABSI. Both estimated and observed probability of in-hospital mortality gradually increased stepwise from $1 \%$ at score $\leq 5$ to almost $100 \%$ at score $\geq 14$ with linear calibration plots (Figure).


Conclusion: We have developed and validated mABSI, a novel index that accurately estimates the severity of and predicts in-hospital mortality.

Notes

# A THREE-YEAR RETROSPECTIVE MULTI-CENTER STUDY ON TIME TO SURGERY AND MORTALITY FOR ISOLATED GERIATRIC HIP FRACTURES 

Allen Tanner MD, Stephanie Jarvis MPH, Alessandro Orlando MPH, Nnamdi Nwafo MD, Robert Madayag MD, Benoit Blondeau MD, Chad Corrigan MD, Matthew Carrick* MD, Pamela Bourg Ph.D.,RN, David Bar-Or MD, Penrose Hospital<br>Invited Discussant: Vanessa Ho, MD, MPH

Background A body of literature has reported on the effect of time to surgery on mortality and morbidity of geriatric hip fracture patients; it remains unclear if earlier surgery is associated with improved mortality. Previous studies have found that hip fracture surgery $\leq 24$ hours of admission decreases hospital length of stay (HLOS), which often equates to greater financial burden. The purpose of this study was to determine if early surgery ( $\leq 24 \mathrm{hrs}$.) is associated with mortality rates and total hospital costs in geriatric patients with isolated hip fractures admitted to four level 1 trauma centers.
Methods This was a multicenter retrospective observational study. Patients, aged $\geq 65$ years, admitted at 4 level 1 trauma centers (January 2014-December 2016) for isolated hip fractures were included. Patients were dichotomized into two groups, early surgery (defined as surgery $\leq 24$ hours from admission) or delayed surgery (> 24 hours from admission). The primary outcome was mortality, assessed in-hospital, at three-months, six-months, and one-year using the Centers for Disease Control and Prevention (CDC) National Death Index (NDI) data; only exact mortality matches were included. Secondary outcomes included HLOS (days), in-hospital complications, and total hospital cost (indirect and direct costs). Total hospital cost did not include professional provider billing to the patient. Statistical analyses included chi-squared, Fishers exact test, Kruskal-Wallis, Student's t-tests, linear mixed-effects regression (by facility), and step-wise logistic regression; an alpha of 0.05 was used.
Results There were 968 patients included, 669 (69\%) in the early group and 299 (31\%) in the delayed group. The early group had more females ( $70 \%$ vs. $58 \%$, $\mathrm{p}<0.001$ ) than the delayed group. Comorbidities were comparable across study arms. There were a higher proportion of patients in the early group (19\%) with an American Society of Anesthesiologists (ASA) score of two than in the delayed group (12\%), $\mathrm{p}=0.03$; other ASA scores were similar. The median (IQR) time to surgery was 13.5 hours (6.8-18.5) for the early group and 34.4 hours (27.3-45.1) for the delayed group. After adjustment for sex, the delayed group were 1.4 times $(0.7,3.0)$ as likely as the early group to have died at one year; however, this was not significant, $\mathrm{p}=0.31$. Mortality rates were not significantly different across study arms at any point. In-hospital complication rates were comparable between groups. The LS mean difference $(95 \%$ CI) for HLOS was 1.0 day $(0.6,1.3)$ longer for the delayed group, when compared to the early group, $\mathrm{p}<0.001$, after adjustment for ASA score. In a subset analysis of total hospital cost at 3 level 1 trauma centers ( 725 patients; 196 delayed and 529 early), the delayed group was on average ( $95 \%$ CI) $\$ 2,550(\$ 1,400, \$ 3,750$ ) more expensive than the early group (p<0.001), after adjustment for ASA score.
Conclusions The results of this study provide further evidence that surgery within 24 hours of admission is not associated with lower odds of death when compared to surgery after 24 hours of admission, even after adjustment. Other than increasing HLOS and total hospital cost, delayed surgery did not appear to adversely affect in-hospital complication rates or mortality. If causally linked, our data are $95 \%$ confident that earlier treatment for the 196 patients who received delayed surgery could have saved a maximum of $\$ 735,000$.

| Mortality \% (n) | Early <br> $\mathbf{n}=669$ | Delayed <br> $\mathbf{n}=\mathbf{2 9 9}$ | OR(CI) | P | Adjusted OR(CI) | P |
| :--- | :--- | :--- | :---: | :---: | :---: | :---: |
| In hospital | $1 \%(8)$ | $2 \%(6)$ | $1.7(0.6,5.0)$ | 0.33 | N/A | N/A |
| Three month $^{1}$ | $9 \%(60)$ | $10 \%(31)$ | $1.2(0.7,1.9)$ | 0.49 | $1.3(0.5,3.1)$ | 0.62 |
| Six month $^{1}$ | $11 \%(72)$ | $13 \%(39)$ | $1.2(0.8,1.9)$ | 0.30 | $1.4(0.6,3.3)$ | 0.39 |
| One year $^{2}$ | $15 \%(100)$ | $18.4 \%(55)$ | $1.3(0.9,1.8)$ | 0.18 | $1.4(0.7,3.0)$ | 0.31 |

OR: Odds ratio, CI: confidence interval, p : p -value, 1: adjusted for American Society of Anesthesiologists (ASA) Score, 2: Adjusted for sex and congestive heart failure (CHF). Variables available for the model: admit service, sex, pre-injury anticoagulants, admitting facility, ASA score, hip consult, and the comorbidity CHF.

Notes

# Opioid Prescribing in United States Trauma Centers: a Multi-Center, Prospective, Observational Study 

John A. Harvin* MD, MS, Charles E. Green Ph.D., LaDonna Allen RN, Jason Murry MD, John J. Radosevich PharmD, James N. Bogert* MD, Patrick B. Murphy MD,MPH, MSc, Brandy B. Padilla-Jones MD, Ben L. Zarzaur* MD,MPH, John R. Taylor MD, Kevin W. Sexton MD, Cassandra Decker BA, Thomas J. Schroeppel* MD, MS, Charles E. Wade* Ph.D., Lillian S. Kao* MD, MS McGovern Medical School At UT Health

## Invited Discussant: Greta Piper, MD

Introduction: Strategies to address the opioid epidemic have primarily focused on prescribing practices in elective surgery. Little is known about prescribing practices in trauma centers. To design effective interventions in trauma centers, the source and magnitude of prescribing variability must be better understood. The purpose of this project was to quantify variability of opioid use between and within trauma centers. Methods: Consecutive patients admitted to adult trauma services after injury at 7 U.S. centers (5 Level 1, 2 Level 2) during a 2 month period were enrolled. The primary outcome was average morphine milligram equivalents per day (MME/day). To quantify MME/day variation, a multilevel generalized linear model was created adjusting for the $a$ priori selected variables Injury Severity Score (ISS) and prior opioid use. To determine the source of variation, an intracluster correlation coefficient (ICC) was calculated.
Results: During the study period, the centers enrolled 1,731 patients. Significant differences between centers were observed in age, sex, race/ethnicity, history of prior opioid use, mechanism of injury, and ISS. Center adjusted mean MME/day ranged from 25 ( $95 \%$ CI 13-36) to 104 ( $95 \%$ CI 92-115) (p<0.001, Figure 1). The ICC was $7.0 \%$ ( $95 \%$ CI $2.4 \%-18.8 \%$ ) suggesting that only $7 \%$ of the variation in the model was due to between center differences and the majority of variation in the model (93\%) was due to within center differences. Figure 2 is a boxplot of the unadjusted MME/day by Site, graphically depicting the within-center variation ( $\mathrm{p}<0.001$ ).


Conclusion: While variation existed between trauma centers, with the greatest difference being 79 MME /day (equivalent to roughly 10, 5mg oxycodone pills/day), the majority of the overall variation was actually within each center. Therefore, global interventions to reduce opioid prescribing across trauma centers are less likely to be effective. Rather, interventions should be tailored at each trauma center to minimize surgeon-level variation and to address patient-specific characteristics.

Notes

## HOW SOON IS TOO SOON: OPTIMAL TIMING OF SPLIT-THICKNESS SKIN GRAFT FOLLOWING POLYGLACTIN 910 MESH CLOSURE OF THE OPEN ABDOMEN

Richard H. Lewis, Jr MD, John P. Sharpe MD, Martin A. Croce* MD, Timothy C.
Fabian* MD, Louis J. Magnotti* MD, University of Tennessee Health Science Center Memphis
Invited Discussant: Richard Miller, MD
Introduction: Various management strategies exist for the abdomen that will not close. At our institution, these patients are managed with polyglactin 910 mesh followed 14 days later (LATE) by split-thickness skin graft (STSG) or, in some cases, earlier (EARLY: <14 days), if the wound is judged to be adequately granulated. The purpose of this study was to evaluate the impact of STSG timing for wounds felt ready for grafting on STSG failure.

Methods: Consecutive patients over a 3-year period managed with polyglactin 910 mesh followed by STSG were identified. Patient characteristics, severity of injury and shock, time to STSG, and outcomes, including STSG failure, were recorded and compared. Multivariable logistic regression analysis was performed to identify predictors of graft failure.

Results: 61 patients were identified: 31 EARLY and 30 LATE. There was no difference in severity of injury or shock between the groups. STSG failure occurred in 11 patients ( 9 EARLY vs 2 LATE, $p<0.0001$ ). Time to STSG was significantly less in patients with graft failure ( 11 vs 15 days, $p=0.012$ ). In fact, after adjusting for age, injury severity, severity of shock and time to STSG, multivariable logistic regression identified EARLY STSG (OR 1.4; 95\%CI 1.1-1.8, $p=0.020$ ) as the only independent predictor of graft failure.

Conclusion: Appearance of the open abdomen can be misleading during the first 2 weeks following polyglactin 910 mesh placement. EARLY STSG was the only modifiable risk factor associated with graft failure. Thus, for optimal results, STSG should be delayed at least 14 days after polyglactin 910 mesh placement.

Notes

# SEVERITY OF HEMORRHAGE AND THE SURVIVAL BENEFIT ASSOCIATED WITH PLASMA: RESULTS FROM A RANDOMIZED PREHOSPITAL PLASMA TRIAL 

Vincent Anto BS, Frank Guyette MD,MPH, Joshua Brown* MD, MCS, Brian Daley* MD, Richard Miller* MD, Brian Harbrecht* MD, Jeffrey Claridge* MD, Herb Phelan* MD, A. Tyler Putnam* MD, William Witham* MD, Matthew Neal* MD, Raquel Forsythe* MD, Brian Zuckerbraun* MD, Jason Sperry* MD,MPH, University of Pittsburgh
Invited Discussant: Jennifer Gurney, MD
Introduction: Recent randomized clinical trial evidence demonstrated a survival benefit with the use of prehospital plasma in patients at risk of hemorrhagic shock. It remains unknown whether this survival benefit exists in patients who require massive transfusion and whether the benefit varies with the severity of hemorrhagic shock. We sought to characterize the survival benefit associated with prehospital plasma relative to the blood transfusion requirement over the initial 24 hours. We hypothesized that the beneficial effects of prehospital plasma would be most robust in those with higher severity of hemorrhage.
Methods: We performed a prespecified secondary analysis using data derived from a prospective randomized prehospital plasma trial. Subjects of this trial included patients with hypotension ( $\mathrm{SBP}<90 \mathrm{mmHg}$ ) and tachycardia ( $\mathrm{HR}>108$ ) or severe hypotension (SBP $<70 \mathrm{mmHg}$ ) in the prehospital arena. Red cell and blood component transfusion were recorded over the initial 24 hours. Massive transfusion (MT) was defined a priori as receiving $\geq 10$ units of red cells in 24 hrs . We evaluated the relationship between MT and 24 hour red cell transfusion volume with the effect of prehospital plasma on 30-day mortality utilizing Cox Hazard regression and adjusting for all important confounders including prehospital shock and injury severity.
Results: There were 501 patients included in this analysis with 230 randomized to prehospital plasma with 104 patients requiring MT.
Mortality in patients who received MT were higher compared to those that did not ( $42 \%$ vs $25 \% \mathrm{p}<.01$ ). Cox hazard regression demonstrated no
 significant 30 -day mortality
benefit of prehospital plasma for MT patients (HR 0.743, 95\% CI 0.381-1.451, p=0.384) while those who received less than MT demonstrated a mortality benefit (HR $0.55,95 \%$ CI $0.34-0.88 \mathrm{p}=0.01$ ). When 24 hr red cell transfusion was divided into quartiles, there was a significant independent association with survival in the patients who received 4-7 units (HR 0.22, 95\% CI 0.06-0.80, p=0.048, Figure). Mortality and measurements of coagulopathy significantly increased with higher red cell needs.
Conclusion: The survival benefits of prehospital plasma was only demonstrated in patients with red cell requirements below the transfusion level of MT. Patients who received 4-7 units of red cells demonstrated the most robust independent survival benefit attributable to prehospital plasma transfusion. Prehospital plasma may be most beneficial in those patients with moderate mortality and coagulopathy risk.

Notes

# RIGHT INTO THE DANGER ZONE: COMPLICATIONS OF RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA) AT ZONE 1 AND 3 FROM THE AAST AORTIC OCCLUSION FOR RESUSCITATION IN TRAUMA AND ACUTE CARE SURGERY (AORTA) TRIAL 

Megan Brenner* MD, MS, Bishoy Zakhary MPH, Raul Coimbra* MD,Ph.D., Jonathan
Morrison MD, Thomas Scalea* MD, Laura Moore* MD, Jeanette Podbielski John
Holcomb* MD, Kenji Inaba* MD, Jeremy Cannon* MD, Mark Seamon* MD, Chance
Spalding* MD, Charles Fox* MD, Ernest Moore* MD, Joseph Ibrahim MD, AAST
Multi-Institutional Trials Committee
Invited Discussant: Marc DeMoya, MD
Introduction: REBOA adoption and implementation is increasing exponentially, and little is known regarding complications of this new procedure in trauma.
Methods: De-identified data of patients who received REBOA Zone 1 (distal thoracic aorta) and 3 (distal abdominal aorta) was obtained from the AAST database from September 2013-December 2018. Patients were excluded if they received REBOA at Zone 2 or if successful aortic occlusion (AO) was not achieved. Primary outcomes were mortality and complications. Binomial logistic regression was performed for significant variables and validated using Hosmer \& Lemeshow test.
Results: 468 patients were identified; mean age was $43 \pm 18$ years, most patients were male (77\%), mean injury severity score (ISS) was $34 \pm 16$, and blunt mechanisms of injury (MOI) predominated (76\%). Mean systolic blood pressure (SBP) at the time of REBOA was $77 \pm 28 \mathrm{mmHg}$ which increased by a mean of $41 \pm 32 \mathrm{mmHg}$ after AO. Mean time from admission to AO was $51 \pm 63$ mins, and mean duration of AO was $50 \pm 53 \mathrm{mins}$. Overall in-hospital mortality was $57 \%$; $91 \%$ for those with ongoing cardiopulmonary resuscitation (CPR) at time of aortic occlusion (AO), and $46 \%$ for those without. Acute kidney injury (AKI) was the most common complication overall (19\%), followed by pneumonia (11\%) and acute respiratory distress syndrome or acute lung injury (ARDS/ALI). 314 patients received REBOA at Zone 1, and 154 at Zone 3. Admission SBP, ISS, SBP at time of AO and after AO, admission lactate and hemoglobin, volume of blood products transfused, and tranexamic acid (TXA) use was similar between Zone 1 and 3 patients. Access complications were also similar between groups, and distal embolism and extremity ischemia were the most common at rates of 4.5 and $4.1 \%$, respectively. Zone 3 patients had higher in-hospital survival ( $34 \%$ vs Zone $162 \%$, $\mathrm{p}<0.001$ ) despite longer durations of AO ( $59 \pm 64 \mathrm{mins}$ vs Zone $146 \pm 47 \mathrm{mins}, \mathrm{p}=0.02$ ) and a higher incidence of ARDS/ALI ( $14 \%$ vs Zone $18 \%$, $\mathrm{p}=0.032$ ). Regression analysis demonstrated Zone 1 patients are 3 times more likely to die when controlling for age, gender, SBP at the time of AO, MOI, volume of transfusions, and duration of AO than Zone 3 patients ( $\mathrm{p}=0.008$ ).
Conclusion: REBOA at Zone 1 and 3 results in similar rates of access complications. Despite similar physiology at the time of AO and a shorter duration of AO, Zone 1 patients have a higher in-hospital mortality rate than Zone 3 patients. Regardless of supra- or infra-renal occlusion and duration of AO, mitigating ischemia and/or reperfusion insults to the kidneys and lungs should be a priority to help improve outcomes in this population of severely injured patients.

Notes

# THROMBOELASTOGRAPHY (TEG) VS. CONVENTIONAL CLOTTING TEST: WHICH TEST ACCURATELY PREDICTS INCREASED BLEEDING RISK IN A RABBIT HEMORRHAGIC SHOCK MODEL 

Bijan S. Kheirabadi Ph.D., Rodolfo J. Deguzman Jr., MBA, Nahir Miranda MS, Irasema<br>B. Terrazas MS, Amber N. Voelker MS, Michael A. Dubick* Ph.D., US Army Institute Of Surgical Research

Invited Discussant: Mitchell Cohen, MD

Introduction:TEG provides a complete measure of the whole blood clotting process and currently is used to guide transfusion strategy for patients with traumatic bleeding and those undergoing procedures with high risk of bleeding. Conventional clotting tests are standard measures of the integrity of the extrinsic and intrinsic clotting pathways performed on platelet-poor plasma. We measured coagulation changes by these in vitro methods and in vivo bleeding times in the rabbits subjected to tissue trauma, hemorrhagic shock (HS) and resuscitated with blood or plasma components.

Methods:Midline laparotomy (soft tissue trauma) to expose liver lobes was performed on IV anesthetized spontaneously breathing NZW rabbits ( $3.2 \pm 0.3 \mathrm{~kg}$ ). $\sim 40 \%$ of rabbits' blood volume was then removed from their jugular veins inducing severe HS ( $\mathrm{MAP}=20-25 \mathrm{mmHg}$ ). 15 min after shock, rabbits were randomly resuscitated with a small volume ( $12.5 \mathrm{~mL} / \mathrm{kg}$ ) of rabbit fresh whole blood (FWB), rabbit thawed plasma (FFP), or $5 \%$ human albumin solution (ALB) to a hypotensive target MAP of 60 mmHg ( $\mathrm{n}=8 / \mathrm{grp}$ ) and monitored for 2 hr . Bleeding times (from liver punctures) were measured before hemorrhage and 10 min after resuscitation. Subsequently, rabbits were fully resuscitated, receiving autologous blood (Hct $\geq 34 \%$ ) and LRS, surgically repaired and recovered overnight. Blood samples were obtained at baseline, 10 -min after limited resuscitation and after operation and analyzed for ABG, CBC and coagulation values using conventional and TEG methods. TEG analysis was done by adding recombinant tissue factor (Innovin) to freshly collected blood samples (no anticoagulant) in triplicate.

Results:Following tissue trauma and hemorrhage, rabbits' lactate and base deficit levels were increased to $8.4 \pm 2.3$ and $12.4 \pm 2.5 \mathrm{mM}$, respectively, with no difference among groups. Small volume resuscitation raised the MAP and stabilized the rabbits for 2 hrs. Bleeding times increased (38\%) after resuscitation with ALB and FFP but did not change with FWB. Significant increases were measured in PT (4-8\%) and aPTT (10-32\%) in blood samples of all rabbits after surgery ( $\mathrm{p}<0.05 \mathrm{vs}$. baseline). Fibrinogen concentration however was reduced only in ALB group. Platelet count decreased ~30\% in all three groups ( $\mathrm{p}<0.05$ vs. baseline). TEG analysis of post-resus and post-op blood samples showed shorter R-times (21\%) and K-times (46\%) and larger $\alpha$ angles (19\%) and no change in MA in all groups.

Conclusion:Conventional clotting tests and in vivo bleeding time results collectively indicated development of a hypocoagulable state following hemorrhage and resuscitation in all rabbits consistent with refractory bleeding seen during suturing of the abdominal wall. In contrast, TEG data consistently showed faster clotting processes (i.e., hypercoagulable state) of all blood samples irrespective of resuscitative fluids. This discrepancy between conventional tests and TEG has also been reported in some clinical studies. In this animal model with $100 \%$ overnight recovery, conventional coagulation tests better reflected increased bleeding risks than TEG.

Notes

# SMALL BOWEL OBSTRUCTION MANAGED WITHOUT HOSPITAL ADMISSION: A SAFE WAY TO REDUCE TIME IN THE HOSPITAL? 

Joy D. Hughes MD, MICHELLE J. BERNING BS, Alexander W. Hunt BS, Eric J. Finnesgard BS, Donald H. Jenkins* MD, MARTIN D. ZIELINSKI* MD, Mayo Clinic Rochester<br>Invited Discussant: Andre Campbell, MD

## Introduction:

The management of small bowel obstruction (SBO) has evolved to include the gastrografin challenge (GGC). Additionally, the development of an Emergency Department Observation Unit (EDOU) at our institution in November of 2016 presented an opportunity to avoid hospital admission for select SBO patients who did not meet criteria for immediate operative exploration. We hypothesized that utilization of the GGC protocol in the EDOU in SBO patients would reduce cost and the total time spent in the hospital (including ED) without compromising outcomes.

## Methods:

IRB approval was obtained to review patients evaluated with a diagnosis of SBO from January 2014 to December 2018. Patients meeting criteria for immediate exploration were excluded, as well as those who did not receive GGC. Decision for patient inclusion in EDOU protocol was at the attending surgeon's discretion. Readmission was defined as 30 days from evaluation; EDOU SBO recurrences within 30 days were automatically admitted. Time-stamps from ED intake to dismissal (from ED or hospital) and time to operation were extracted. Hospital duration was calculated in hours. Cost data was extracted in dollars and savings reported as percentage in order to protect proprietary cost information. Patients treated in the EDOU were compared to those admitted to the hospital.

## Results:

Overall, 125 patients were included ( 69 +/- 14.3 years; 51\% female). There were 46 patients (37\%) in the EDOU group and 79 (63\%) in the admission group. Hospital duration was reduced among EDOU patients by a median of 58.7 hours (EDOU median 23.6 hours with IQR 17.7-159.4, with admission patients' median 82.2 hours with IQR 59.92-162.7, $\mathrm{p}<0.01$ ). Median time from ED intake to OR was statistically similar for EDOU vs. admission patients ((23.5 hours, IQR 10.8-24.5 hours vs 61.8 hours, IQR 33-118 hours, $\mathrm{p}=0.06$ ). Readmission rates were similar for EDOU and admission (6.5\%) vs $18.4 \%$, $\mathrm{p}=0.054$ ). EDOU patients had $63 \%$ (IQR 45\%-65\%, p=0.02) lower cost of care. A similar percentage of patients underwent exploration; ( $13 \%$ vs $25 \%$, $p=0.09$ ) . There were no strangulations in either group.

## Conclusion:

Management of highly selected SBO patients without criteria for immediate operative exploration using the EDOU GGC protocol was associated with decreased total cost. Additionally, duration of hospitalization was lower in EDOU GGC patients compared to universal hospital admission for the GGC. EDOU utilization did not appear to affect complications, need for surgical intervention or readmissions allowing for expansion of this practice.

Notes

# IMPACT OF DELTA SYSTOLIC BLOOD PRESSURE AFTER REBOA PLACEMENT IN NON-COMPRESSIBLE TORSO HEMORRHAGE PATIENTS: AN ABOTRAUMA REGISTRY AND AORTA DATABASE ANALYSIS 

Juan Duchesne* MD, Tal Horer MD, Megan Brenner* MD, Kristofer Nilsson MD, David McGreevy MD, Tomas Jacome* MD, Todd Rasmussen* MD, Joseph DuBose* MD, Juan Duchesne* MD, Tulane School of Medicine<br>Invited Discussant: Terence O'Keeffe, MD

Introduction:Resuscitative endovascular balloon occlusion of the aorta (REBOA) is becoming a standardized adjunct in management of Non-compressible Torso Hemorrhage (NCTH). Guidelines have been developed to help guide the best location and indications for REBOA utilization. No studies have addressed the significance of change in systolic blood pressure ( $\Delta \mathrm{SBP}$ ) after REBOA insufflation. We hypothesized a direct correlation between $\triangle \mathrm{SBP}$ and mortality.
Methods:This was an international, multicenter retrospective review of all patients managed with REBOA from the ABOTrauma Registry and the AORTA database. A non-responder was defined as a hypotensive patient with systolic blood pressure (SBP) $<90 \mathrm{mmHg}$ after REBOA placement with full aortic occlusion. $\triangle$ SBP was defined as the difference between pre- and post-REBOA insertion SBP. Significance was set at $\mathrm{P}<0.05$.
Results:The cohort included 542 patients, primarily male (74\%), blunt injured (77\%) with median age $40(27-58)$ and ISS $34(25-45) .20 \%(n=107)$ were nonresponders. Demographic and injury descriptors did not differ between groups. Overall mortality was $47 \%$ and was significantly higher in non-responders vs responders ( $64 \%$ vs $46 \%$, respectively; $\mathrm{P}=0.001$ ). Non-responders had lower median pre-insertion SBP ( 50 mmHg vs $67 \mathrm{mmHg} ; \mathrm{P}<0.001$ ) and lower $\Delta \mathrm{SBP}(20 \mathrm{mmHg}$ vs $48 \mathrm{mmHg} ; \mathrm{P}<0.001$ ).
Conclusion:REBOA non-responders present and remain persistently hypotensive and are more likely to die than responders, indicating a direct correlation between $\triangle \mathrm{SBP}$ and mortality. Future studies are needed to further elucidate the significance of $\triangle \mathrm{SBP}$ on mortality and its impacts on damage control resuscitation efforts.

Table. Multivariable logistic regression of association between injury characteristics and risk of becoming a non-responder

| Descriptor | OR | 95\% CI | P |
| :--- | :---: | :---: | :---: |
| Age | 0.993 | $0.975-1.012$ | 0.484 |
| Injury Severity Score | 1.024 | $1.000-1.049$ | 0.053 |
| Abdominal injury | 0.451 | $0.214-0.951$ | 0.036 |
| Theracic injury | 0.635 | $0.298-1.354$ | 0.240 |
| Head injury | 1.206 | $0.575-2.530$ | 0.621 |
| Penetrating injury | 1.426 | $0.509-3.998$ | 0.500 |
| Pre-hospital CPR | 0.836 | $0.346-2.020$ | 0.691 |
| SBP pre-insertion | 0.982 | $0.972-0.992$ | 0.001 |
| Inflation time (minutes) | 0.988 | $0.977-1.000$ | 0.042 |

Notes

# EVALUATION OF AGE-ADJUSTED SYSTOLIC BLOOD PRESSURE AND SHOCK INDEX FOR PEDIATRIC TRAUMA TEAM ACTIVATION 

Elissa K. Butler MD, Jonathan I. Groner* MD, Monica S. Vavilala MD, Saman Arbabi* MD,MPH, Frederick P. Rivara MD,MPH, Harborview Injury Prevention And Research Center, University Of Washington

## Invited Discussant: Barbara Gaines, MD

Introduction: Age-adjusted hypotension (SBP-AA) is one of six minimum criteria recommended by the ACS Committee on Trauma for pediatric trauma team activation. However, there is growing evidence that age-adjusted shock index (SIPA, heart rate/SBP) is more accurate than SBP-AA in triaging injured children. Cutoffs for SBP-AA and SIPA are based on published normal vital signs and may not minimize undertriage or overtriage. The objective of this study was to determine the optimal SBP and SIPA cutoffs using receiver operator curves (ROC) for early critical resource use.
Methods: Using the TQIP dataset, children 1-15 years were randomly split into two groups. The independent variables were lowest SBP and highest HR in the field or emergency department. ROC analysis was performed on the first sample to determine the maximum area under the curve (AUC) cut point for SBP-AA and SIPA to predict early critical resource use defined as: transfusion within 4h, advanced airway management within 4 h , angiography within 4 h , pericardiocentesis within 24 h , intracranial pressure monitoring within 24 h , major operation within 24 h , and/or death within 24 h . Using the second sample, undertriage and overtriage rates of SBP-AA and SIPA were determined and compared to standard SBP-AA ( $<70+2 *$ age for age $<10,<90$ for age 10-15) and SIPA cutoffs ( $>1.2$ for age 1-6, $>1$ for age $7-12$, and $>0.9$ for age 13-15).
Results: A total of 87,810 children with median age 8 (IQR: 5-12) years and median injury severity score 5 (IQR: 4-9) were included. The optimal cut point for SBP-AA was 109, 112, 114, and 119 mm Hg for ages 1-4, 5-8, 9-11, and 12-15 years, respectively (AUC
$0.544-0.587$ ). The optimal cut point for SIPA was $1.23,1.02,0.90$, and 0.78 for ages $1-3,4-6,7-12$, and $13-15$ years, respectively (AUC 0.554-0.626; see figure). SIPA had slightly lower undertriage ( $47.5 \%$ vs. $50.9 \%$ ) and overtriage ( $34.9 \%$ vs. $39.5 \%$ ) rates than SBP-AA. The ROC-determined SBPAA had lower undertriage ( $50.9 \%$ vs. $92.7 \%$ ), but higher overtriage ( $39.5 \%$ vs. $0.7 \%$ ) rates than the standard SBP-AA. The ROC-determined SIPA had lower undertriage ( $47.9 \%$ vs. $62.7 \%$ ), but higher overtriage ( $38.2 \%$ vs. $18.7 \%$ ) rates than the standard SIPA.
Conclusion: In maximizing AUC, the ROC-determined cut points for SBP-AA and SIPA were higher than the standard cut points, resulting in reduced undertriage at the cost of increased overtriage. Both SBP-AA and SIPA performed poorly in determining early critical resource need. Appropriate triage of the pediatric trauma patient must rely on other criteria in addition to vital sign criteria.
Conclusion: In maximizing AUC, the ROC-determined cut points for SBP-AA and SIPA were higher than the standard cut points,resulting in reduced undertriage at the cost of increased overtriage. Both SBP-AA and SIPA performed poorly in determining early critical resource need. Appropriate triage of the pediatric trauma patient must rely on other criteria in addition to vital sign criteria.


Notes

## OPTIMISING PREHOSPITAL TRIAGE IN AN INCLUSIVE URBAN MAJOR TRAUMA SYSTEM

Henry O. Nnajiuba MD, MSc BSc, Elaine Cole Ph.D., Rachael Fothergill Ph.D., Mark Faulkner Gurkamal Francis Imogen Gunson Fenella Wrigley MD, Karim Brohi* MD, Centre For Trauma Sciences, QMUL

Invited Discussant: Mark Seamon, MD

Introduction: Prehospital triage remains a crucial yet challenging component of trauma systems. The London Ambulance Service (LAS) triage tool identifies patients requiring admission to 'Level-1 equivalent' Major Trauma Centres (MTCs) or 'Level-2/3 equivalent' Trauma Units (TUs). Existing tools lack the sensitivity and specificity to consistently identify patients in need of MTC-level care. The overall objective of this study was to evaluate the relationship between individual steps on the triage tool and clinical outcomes to optimise patient flow in the system.
Methods: This was a one-year retrospective analysis of de-identified data matched between two trauma registries. Prehospital data including triage step activation was obtained from the LAS prehospital trauma registry for all triage-positive patients (>15 years) conveyed to an MTC within the London Major Trauma System (LMTS) in 2016. The LMTS is an inclusive regional trauma system serving over 10 million people and consists of four MTCs and 35 TUs. The LAS tool consists of Step 1 (physiology), Step 2 (anatomy), Step 3 (mechanism), Step 4 (special considerations e.g. age $>55$ ) and Step 5 (crew concern). Prehospital data was matched to corresponding demographic and outcome data obtained from the UK national trauma registry. Deterministic linkage was performed using Computer-Aided Dispatch number (CAD) as a unique identifier.
Results: From 1739 eligible triage-positive patients, 1217 (70\%) were successfully matched to their corresponding prehospital registry entries. The single largest triage group was Step 2 ( $\mathrm{n}=539$ ). Step $1(\mathrm{n}=408$ ) had the highest 30 -day mortality (18\%) (Fig. 1) and ISS scores (median 26, IQR 16-34) (Fig. 2). Early surgery ( $<24 \mathrm{hrs}$ post admission) most frequently occurred in Step 2 ( $\mathrm{n}=133$ )(Fig. 3). Only 12 patients triggering MTC admission on Steps 3, 4 or $5(\mathrm{n}=223)$ underwent an urgent surgical intervention and no mortalities were recorded among Step 3 and Step 5 patients. With Step 2 being the largest group and encompassing a wide degree of anatomical injury patterns, a sub-analysis was performed. Step 2F (spinal trauma) had the highest mortality rate (8\%) whilst 2A (chest injury) and 2D (open/depressed skull fracture) were the only two groups with median ISS scores $>15$. No 2D patients required early neurosurgery despite the suggestive injury anatomy (Fig. 4).


Conclusion: This study has demonstrated that physiological triage identifies the most severely injured patients. Anatomical triage shows differing performance between the numerous injury patterns. Triage via mechanism, patient age or EMS crew concern does not consistently identify patients warranting MTC admission. This is the first UK study to successfully link prehospital and inpatient trauma registries to analyse the impact of initial triage on the continuum of care. Work is ongoing to analyse the performance of individual anatomical triggers and to determine the optimum age cut-off for MTC triage.

Notes

# PERFORMANCE-BASED ASSESSMENT OF TRAUMA SYSTEMS: ESTIMATES FOR THE STATE OF OHIO 

Priti P. Parikh Ph.D., Pratik Parikh Ph.D., Monit Vaishnav BS, Susan Sebastian Mary C. McCarthy* MD, Robert J. Winchell* MD, Wright State University Invited Discussant: David Ciesla, MD

Introduction: The American College of Surgeons (ACS) has developed a Need-Based Assessment of Trauma Systems (NBATS) tool to estimate the optimal number of trauma centers (TCs) in a region, based on the population needs. While this initial version provides a foundation for quantitative evaluation of this need, it does not address TC location or corresponding system performance. In this study, we propose a performance-based assessment model to optimize the number and distribution of trauma centers in a region using undertriage (UT) and overtriage (OT) as the key metrics.
Methods: We obtained deidentified data for 2012 from the state of Ohio trauma and EMS registries that were probabilistically linked. There were 6242 complete matched records, and a network of 161 total hospitals ( 21 of which were LI/II TCs). We used the NBATS scoring system to evaluate the number of TCs needed in each of the 8 homeland security regions in the state (each serving as the Trauma Service Area, TSA). For the performance-based model, we used an optimization model that minimizes the number of LI/II TCs required in a given TSA for prespecified UT and/or OT. For a given trauma network, we used a notional field triage protocol to determine the destination hospital based on the injury severity and times to the nearest TC.
Results: The NBATS tool suggested fewer LI/II TCs in urban and suburban areas than existed in 2012 (12 vs. 21), while allocating at least 2 TCs to rural regions in the state that do not have a TC and are unlikely to have the resources and patient volume to support one. Both these outcomes confirm previous findings regarding the NBATS tool. As shown in Table 1, using the notional triage algorithm, the $21 \mathrm{LI} / \mathrm{II}$ centers resulted in $\mathrm{UT}=0.2$ and $\mathrm{OT}=0.5$. The performance-based model suggested that $10 \mathrm{LI} / \mathrm{II} \mathrm{TCs}$, with a slightly different geographic distribution, could emulate the same level of UT and OT. To achieve UT $\leq 0.05$ as recommended by the ACS, our model suggested a total of $21 \mathrm{LI} / \mathrm{II}$ TCs, but with significantly different geographic distribution (Figure 1). In both cases, the model suggested a less-clustered urban area and a more dispersed distribution in sub-urban and rural areas.
Conclusion: This study demonstrates an objective assessment of trauma system performance based on the threshold levels for mistriages. The model expands upon the NBATS approach, considering both TC volumes and access. Further, the geographically optimized solution may provide a useful benchmark against which to judge incremental system development or proposed changes in system structure. This type of objective data

(a)

(b) are essential to guide policy decisions.

| Approach | Constraints |  | $\begin{aligned} & { }^{H} \text { of } \\ & \text { TCs } \end{aligned}$ | $\begin{aligned} & \text { UT } \\ & \text { rate } \end{aligned}$ | $\begin{aligned} & \mathrm{OT} \\ & \text { rate } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | UT | OT |  |  |  |
| 2012 Ohio System <br> (Fig. 1a) | - | - | 21 | 0.2 | 0.5 |
| NBATS | - | - | 12 | N/A | N/A |
| Performance-Based (per curcent) | $\leq 0.2$ | S0.5 | 10 | 0.18 | 0.40 |
| Performance-Based (per ACS; Fig. 1b) | 50.05 | \$0.6 | 21 | 0.047 | 0.52 |

Notes

# Mass Casualty Preparation: Injury Patterns And Resource Utilization Of Survivors And Decedents 

Chadwick P. Smith MD, Karen Safcsak RN, Heidi Emrani MD, Joseph Ibrahim MD, Michael L. Cheatham* MD, Orlando Health<br>Invited Discussant: David Shatz, MD

Introduction: Active shooter mass casualty events are increasing in frequency. Effective trauma center response requires advance preparation. A detailed examination of mass casualty injury patterns in both survivors and decedents will improve trauma system preparation for future events.

Methods: All patients admitted to a Level 1 trauma center following an active shooter mass casualty event were analyzed. Autopsy reports of decedents were also reviewed. Patients with minor injuries treated and discharged from the emergency department and those treated at other hospitals were excluded. Survivors were compared to decedents with respect to demographic information, bullet penetration by body region, 2015 Injury Severity Score (ISS), and AAST organ injury scales (calculated by three acute care surgeons). Data are presented as mean $\pm$ standard deviation (range). Statistical significance was determined using Mann-Whitney U and Fisher's Exact tests.

Results: There were 102 known victims of the event. 49 patients were brought to the trauma center; 5 patients were pronounced dead on arrival and 4 patients arrived in extremis and died within minutes. 29 patients were admitted. 11 patients had minor injuries and were discharged. 13 victims were taken to other hospitals. 40 victims died at the scene. There were no demographic differences between survivors ( $\mathrm{n}=29$ ) and decedents ( $\mathrm{n}=49$ ). Decedents had more bullet entry wounds [4 $\pm 3$ (1-13) vs. $2 \pm 1$ (1-5), $\mathrm{p}=0.008]$. Bullet wounds to the head were more common among the deceased [ $11 \%$ vs. $3 \% \mathrm{p}=0.032$ ] while bullet wounds to the abdomen were more common in survivors [ $25 \%$ vs. $14 \%, p=0.027]$. ISS was significantly higher among the deceased [ $40 \pm 10$ (9-75) vs. $16 \pm 20$ (1-41), $\mathrm{p}<0.0001]$. Decedents were more likely to have heart, thoracic vascular, diaphragm, liver, kidney, and stomach AAST scores while survivors were more likely to have small bowel, colon, and abdominal vascular scores. Operative procedures were divided into two phases: initial 24 hours and total hospitalization. 34 cases were performed in the first 24 hours ( 20 acute care surgery, 9 orthopedic surgery, 4 hand surgery, 1 vascular surgery) with a total of 87 cases during the index hospitalization (46 acute care surgery, 15 orthopedic surgery, 12 hand surgery, 10 plastic surgery, 3 vascular surgery, 1 urology).

Conclusion: Analysis of this mass casualty event demonstrates significant differences in injury patterns between survivors and decedents. Need for specialty surgeons varied according to the phase of response. Knowledge of these patterns may enable trauma centers to better prepare for active shooter events.

Notes


Session XVII:
Quickshots Session II: Papers14-26
Saturday, September 21, 2019
10:28 AM - 11:56 PM
Location: Lone Star Ballroom B Moderator: David Shatz, MD

# EARLY HYPERMETABOLISM IS UNCOMMON IN TRAUMA ICU PATIENTS 

Saskya Byerly MD, MS, Georgia Vasileiou MD, Sinong Qian MD, Eugenia Lee MD,MPH, Jonathon Parks MD, Michelle Mulder MD, Daniel G. Pust MD, Rishi Rattan* MD, Edward Lineen MD, Patricia Byers* MD, Nicholas Namias* MD, D. Dante Yeh* MD, University of Miami
Invited Discussant: Panna Codner, MD
Introduction:It is commonly believed that critically injured patients experience an ebb/flow metabolism shortly after insult and a "stress factor" is often applied when calculating caloric prescription. However, classic experiments demonstrating hypermetabolism after major trauma were performed decades ago in a different era of critical care. We aim to describe the post-traumatic metabolic response in trauma intensive care unit (ICU) patients in the modern era.

Methods:In this prospective, observational study from 03/18-02/19, mechanically ventilated adults (age>18 years) in the trauma ICU were included. Continuous indirect calorimetry (IC) was initiated within 48 h of ICU admission and multiple daily resting energy expenditure (REE) measurements were recorded during steady state ( $<5 \%$ coefficient of variation for $\mathrm{VO}_{2}$ and $\mathrm{VCO}_{2}$ ). Basal energy expenditure (BEE) was calculated by the Harris-Benedict equation. By convention, hypometabolism was defined as average daily $\mathrm{REE}<0.85 * \mathrm{BEE}$ and hypermetabolism defined as average daily REE $>1.15^{*}$ BEE. "Classic ebb/flow" was defined as initial hypometabolism followed by hypermetabolism during the first 7 ICU days. Data collected included demographics, injury characteristics, interventions, and clinical outcomes. Descriptive statistics and multivariable logistical regression models evaluating age, body mass index (BMI), weight, injury mechanism, heart rate, and temperature with the outcome variable of hypermetabolism for the first three days ("sustained hypermetabolism") were performed.

Results:Fifty-five patients were analyzed: median age was 38 [28-56] years, 38 (69\%) were male, BMI was 28 [26-32] kg/m 2 , and ISS was 27 [19-34] with 38 ( $71 \%$ ) blunt, 8 (15\%) penetrating, and 7 (13\%) burn injury mechanism. Overall, 19 (35\%) had hypermetabolism on day 1 ("immediate hypermetabolism"), 11 ( $21 \%$ ) had sustained hypermetabolism for the first 3 days, and 4 of 32 (13\%) subjects with 7 days of REE data exhibited hypermetabolism for all 7 days. Classic ebb/flow metabolism was exhibited in only 1 (3\%) patient. Immediate hypermetabolism patients were more likely to have a hemorrhagic complication ( $21 \%$ vs $3 \%, \mathrm{p}=0.044$ ), and had longer hospital ( 50 [29-68] vs 23 [15-53] days, $\mathrm{p}=0.031$ ) and ICU stays ( 36 [22-59] vs 15 [10-36] days, $\mathrm{p}=0.019$ ). Logistic regression analysis identified only penetrating or burn mechanism as independent predictors of sustained hypermetabolism (AOR: 2.4, 95\%CI: 1.5-149.2, $\mathrm{p}=0.031$ ).

Conclusion:In the modern era, the classic ebb/flow metabolic pattern is rare after major trauma. Only a minority of injured patients are sustained hypermetabolic in the first week after injury. Indirect calorimetry is recommended to avoid systematic overfeeding of critically ill trauma patients. Immediate hypermetabolism is associated with worse clinical outcomes.

Notes

# THE "DEATH DIAMOND" - A BLACK HOLE FOR RESUSCITATION 

Michael S. Farrell BS,MD, MS, Julia Coleman MD, Mark Walsh MD, Scott Thomas*
MD, Stefani Vandelunde MD, JD,, Thomas Marconi BS, Michael Chapman MD, Mitchell Cohen* MD, Hunter Moore MD,Ph.D., Earnest Moore* MD, Sherry Sixta* MD, Christianacare Health Services
Invited Discussant: Peter Hammer, MD
Introduction: Acute coagulopathy of trauma (ACOT) is a lethal unbalanced progression of fibrinolysis after a traumatic insult. In 2015, Chapman et al recognized an initial fibrinolytic rapid thromboelastography (rTEG) tracing designated the "Death Diamond" (DD) which was noted to have a $100 \%$ positive predictive value (PPV) for mortality in their small sample size ( $\mathrm{n}=14$ ). Recognizing the potential prognostic implications and the resource savings associated with validating the DD as a marker of futile care, we sought to evaluate it within a larger trauma population. We hypothesized that the DD would again demonstrate a $100 \%$ PPV for mortality.

Methods: A multi-center, retrospective review was completed at four American College of Surgeons designated Level 1 and 2 Trauma Centers. Trauma patients were identified by their DD tracing through institutional databases. A chart review was completed assessing: demographics, injury severity score (ISS), mechanism of injury, transfusion requirements, and discharge disposition. Statistical comparison was completed between survivors and non-survivors.

Results: A total of 52 patients displayed a DD with 49 (94\%) dying during their hospital stay. There was no difference in sex ( $84 \%$ vs $67 \%$ male) ( $p=0.45$ ), mechanism of injury ( $63 \%$ vs $67 \%$ blunt) ( $p=0.9$ ), or ISS ( $33 \pm 15$ vs $20 \pm 18$ ) ( $p=0.34$ ) between the non-survivor and survivor groups, respectively. The non-survivor group was significantly older than the survivor group ( $46 \pm 21$ vs $28 \pm 4$ years old) ( $p<0.001$ ). Both groups had large transfusion requirements with an overall average of $25 \pm 24$ units of blood product used per patient. There was no difference between survivors and non-survivors in product usage (Table 1). A total of 28 patients received repeat TEGs with 11 "normalizing" through a combination of surgical interventions and transfusions. Despite the TEG correction, only 2 survived. One survivor never demonstrated a "normal" TEG.

|  | Non survivors $(\mathrm{n}=49)$ | Survivors $(\mathrm{n}=3)$ | Overall $(\mathrm{n}=52)$ | P-Value |
| :---: | :---: | :---: | :---: | :---: |
| pRBC | $14 \pm 13$ | $8 \pm 5$ | $14 \pm 12$ | 0.18 |
| FFP | $8 \pm 9$ | $7 \pm 2$ | $8 \pm 9$ | 0.58 |
| Platelets | $2 \pm 3$ | $1 \pm 1$ | $2 \pm 3$ | 0.23 |

Table 1. Mean use of blood products

Conclusion: The DD is a unique rTEG tracing that is highly predictive of mortality in association with a blunt traumatic mechanism. Hemostatic correction of the DD tracing infrequently leads to a meaningful survival, especially with advancing age. This collaboration further validates the DD as a predictor of futility and presents an opportunity for preservation of blood products and resuscitative resources.

Notes

# OUT-OF-POCKET SPENDING BY TRAUMA PATIENTS FOLLOWING IMPLEMENTATION OF THE AFFORDABLE CARE ACT 

Charles Liu MD, Yusuke Tsugawa MD,MPH,Ph.D., Thomas G. Weiser* MD,MPH, David A. Spain* MD, Melinda Maggard-Gibbons MD, MSHS Stanford University Invited Discussant: Nathan Mowery, MD

Introduction: Trauma is an expensive and potentially impoverishing driver of out-of-pocket spending for families in the US. In 2014, the Affordable Care Act (ACA) led to the expansion of Medicaid in some states and established marketplaces for individuals to purchase subsidized health insurance. We evaluated the impact of the ACA on non-elderly trauma patients' out-ofpocket spending and likelihood of incurring catastrophic health expenditures (CHE).
Methods: We identified out-of-pocket expenditures by US adults age 19-64 who had an inpatient hospital stay or ED visit for trauma using the Medical Expenditure Panel Survey, 2010-2015. CHE was defined as spending exceeding $10 \%$ of family income. Three income groups were evaluated: (1) individuals eligible for the ACA Medicaid expansions (income $\leq 138 \%$ Federal Poverty Level [FPL]),
(2) individuals eligible for ACA insurance subsidies (139-400\% FPL), and (3) policy-ineligible individuals ( $>400 \%$ FPL). Changes in out-of-pocket spending were evaluated using multivariable linear regression and changes in odds of CHE using multivariable logistic regression, controlling for age, sex, race/ethnicity, marital status, country of birth, census region, employment, family income, and family size.
Results: Trauma patients eligible for the ACA Medicaid expansions ( $\leq 138 \%$ FPL) experienced a $40 \%$ decrease in out-of-pocket spending ( $95 \%$ CI: $-58 \%$ to $-15 \%$ ) and a $41 \%$ decrease in odds of CHE (odds ratio $0.59,95 \%$ CI: 0.39 to 0.91 ). Those eligible for ACA insurance subsidies ( $139-400 \%$ FPL) experienced a $25 \%$ decrease in out-of-pocket spending ( $95 \%$ CI: $-43 \%$ to $1 \%$ ) but no significant change in odds of CHE. Those in the policy-ineligible group (>400\% FPL) experienced no significant change in out-of-pocket spending or odds of CHE.
Conclusion: Following ACA implementation, trauma patients in the income range targeted by Medicaid expansion experienced significantly lower likelihood of catastrophic expenditures, while those eligible for ACA insurance subsidies saw no significant change. More than 1 in 10 trauma patients in these income groups, however, continues to experience catastrophic expenditures.

Table. Out-of-pocket expenditures and likelihood of CHE among trauma patients pre/post ACA, by income category ( $\mathrm{n}=4,928$; weighted $\mathrm{n}=48,981,329$ ) ( ${ }^{*} \mathrm{p}<0.05,{ }^{* *} \mathrm{p}<0.01$ )

| Income Category | Annual Out-of-Pocket Expenditures, PreACA (2015 dollars) | Unadjusted Pre-Post Difference | Adjusted Percent Difference $\dagger$ | $\begin{aligned} & 95 \% \text { CI } \\ & \text { (p-valuc) } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| Medicaid Expansion-Eligible $(\leq 138 \%$ FPL $)(n=1,833)$ | \$836 | -\$172 | -40\%** | $\begin{aligned} & -58 \%,-15 \% \\ & (\mathbf{p}=0.004) \end{aligned}$ |
| Marketplace Subsidy-Eligible $(139-400 \%$ FPL $)(n=2,026)$ | \$1,124 | -\$34 | $-25 \%{ }^{*}$ | $\begin{aligned} & -43 \%,-1 \% \\ & (p=0.042) \end{aligned}$ |
| Policy-Ineligible $(>400 \% \mathrm{FPL})(\mathrm{n}=1,069)$ | \$1,246 | +\$62 | +7\% | $\begin{aligned} & -17 \%,+37 \% \\ & (p=0.62) \end{aligned}$ |
| Income Category | Annual Likelihood of CHE, Pre-ACA | Unadjusted Pre-Post Difference | Adjusted <br> Odds <br> Ratio $\ddagger$ | $\begin{aligned} & 95 \% \text { CI } \\ & \text { (p-value) } \end{aligned}$ |
| Medicaid Expansion-Eligible $(\leq 138 \%$ FPL $)(n=1,833)$ | 31.2\% | -8.7\% | 0.59* | $\begin{aligned} & 0.39,0.91 \\ & (p=0.017) \end{aligned}$ |
| Marketplace Subsidy-Eligible ( $139-400 \%$ FPL) $(n=2,026)$ | 9.2\% | +0.04\% | 1.11 | $\begin{aligned} & 0.67,1.84 \\ & (p=0.69) \end{aligned}$ |
| Policy-Incligible $(>400 \% \mathrm{FPL})(\mathrm{n}=1,069)$ | 2.5\% | -1.1\% | 0.86 | $\begin{aligned} & 0.27,2.77 \\ & (\mathrm{p}=0.80) \end{aligned}$ |

+ Linear regression of $\log (x+1)$ transformed data, with survey weights
$\ddagger$ Logistic regression, with survey weights

Notes

# SIX IS THE NEW FIVE: MINOR CHANGE IN INITIAL PEEP SETTING DECREASES RATES OF VENTILATOR ASSOCIATED EVENTS IN MECHANICALLY VENTILATED TRAUMA PATIENTS 

Ethan A. Ferrel MD, Kristina M. Chapple Ph.D., Liviu G. Calugaru RRT, Jennifer E. Maxwell MSN, Jessica N. Johnson BSN, Andrew W. Mezher BS, James N. Bogert* MD, Jordan A. Weinberg* MD, CREIGHTON UNIVERSITY ARIZONA HEALTH EDUCATION ALLIANCE: ST JOSEPH'S HOSPITAL AND MEDICAL CENTER

Invited Discussant: Rachael Callcut, MD

## Introduction:

Surveillance of ventilator-associated events (VAEs) as defined by the National Healthcare Safety Network (NHSN) is performed at many U.S. trauma centers and considered a measure of healthcare quality. The surveillance algorithm relies in part on increases in positive end-expiratory pressure (PEEP) to identify VAEs. The purpose of this study was to evaluate the effect of initiating mechanically ventilated trauma patients at marginally higher PEEP on incidence of VAEs.

## Methods:

Analysis of level-1 trauma center patients mechanically ventilated 2+ days from 2017-2018 was performed after an institutional ventilation protocol increased initial PEEP setting from 5 (2017) to 6 (2018) cmH2O. Incidence of VAEs per 1000 vent days was compared between PEEP groups. Logistic regression modeling was performed to account for age, ventilator days, injury mechanism, and severity.

## Results:

519 patients met study criteria ( 274 PEEP 5 and 245 PEEP 6). Rates of VAEs were significantly reduced among patients with initial PEEP 5 vs. 6 ( 16.17 per 1000 vent days vs. 7.78 per 1000 vent days; $p=0.028$ ). Logistic regression demonstrated that initial PEEP 6 was associated with $62 \%$ reduction in VAEs (odds ratio 0.38 [ $0.17-0.84]$ - see Table).

## Conclusion:

Our data suggest that an incrementally increased baseline PEEP setting was associated with a significantly decreased incidence of VAEs in trauma patients. This minor change in practice may have a major impact on a trauma center's quality metrics.

|  | Odds Ratio | $95 \%$ CI for Odds Ratio | P-value |
| :--- | :--- | :--- | :--- |
| Age | .99 | $0.97-1.01$ | .274 |
| ISS | 1.03 | $1.00-1.06$ | .029 |
| Penetrating Injury | 1.30 | $0.46-3.67$ | .619 |
| Vented 7+ days | 97.47 | $13.08-726.65$ | $<.001$ |
| Initial PEEP 6 | $\mathbf{0 . 3 8}$ | $\mathbf{0 . 1 7 - 0 . 8 4}$ | $\mathbf{. 0 1 7}$ |

Model AUC (95\% CI) $0.85(0.79-0.90)$

Notes

# IDENTIFYING OBJECTIVE MEASURES FOR TRAUMA CENTER ACCESSS ASSESSMENT USING GIS-BASED TECHNOGLOGY 

Suzan Dijkink MD, Robert J. Winchell* MD, Pieta Krijnen Ph.D., Inger B. Schipper MD,Ph.D., Leiden University Medical Center<br>Invited Discussant: Frederick Rogers, MD

Introduction: There is no generally accepted methodology to assess trauma system performance. Our aim was to illustrate how geographic information systems (GIS) technology can be used to evaluate trauma center (TC) access.
Methods: GIS-base analysis using ArcGIS-PRO was performed to assess the influence of geographical TC distribution (1, 2 or 3TCs) and traffic flow (rush[R]and low traffic[L] hours) on the transportation time(TT) and population coverage in a densely-populated region with 3 TCs in the Netherlands ( $\approx 1.84$ million inhabitants in an area of 3.403 km 2 ) (figure 1a).
Results: In all models, $100 \%$ of the population can be transported to one of the three TC's in $<60$ minutes during both [R] and [L] (figure 1b). During [R], the average TT increases in all models (figure 1b). In model 1, the current situation, the average TT increases from 17 minutes during [L] to 22minutes during [R] (figure 1c.). This is roughly similar to the times reported in the regional trauma registry (23 and 25 minutes respectively). The population able to reach the closest TC in $<15$ and $<30$ minutes decreases in [R] in all 7 models (figure 1b). Transportation and coverage metrics of hypothetical models with two, geographically well-spread TCs (models $2 \& 3$ ) showed similar results as the current three-TC-model. One-TC-models (5-7) showed considerable increase of TTs.
Conclusion: Our GIS-based model showed good correlation with trauma registry data regarding TTs. This approach provides a way to objectively assess the accessibility of the trauma systems as well as the effect of proposed structural trauma system changes, such as TC distribution.

Figure 1a


Figure 1b \% population covered within 50 minutes of closest $T \mathbb{C}$ in rush hour $(\mathrm{R})$ and low traffic hours(t) based on Gis-analysis



Notes

# THE ROLE OF CRYOPRECIPITATE IN MASSIVELY TRANSFUSED PATIENTS: RESULTS FROM THE TQIP DATABASE MAY CHANGE YOUR MIND 

Michael Ditillo DO, Kamil Hanna MD, Lourdes Castanon MD, Muhammad Zeeshan MD, Narong Kulvatunyou MD, Andrew Tang MD, Joseph Sakran* MD,MPH, Lynn Gries MD, Bellal Joseph* MD, Allegheny General Hospital

## Invited Discussant: John Holcomb, MD

Introduction: Cryoprecipitate was developed for the treatment of inherited and acquired coagulopathies. The role of cryoprecipitate in massively transfused (MT) trauma patients is still speculative. The aim of our study was to assess the role of cryoprecipitate as an adjunct to MT in trauma patients.
Methods: We performed a 2-year (2015-2016) analysis of the ACS-TQIP dataset and included all adult trauma patients who received MT (>10pRBCs/24-hour). Patients were stratified into two groups based on receipt of cryoprecipitate within the first 24-hours (Cryoprecipitate vs. No-Cryoprecipitate). Outcome measures were blood products transfused, in-hospital complications, and mortality. Multivariate logistic and linear regression analyses were performed.
Results: We analyzed a total of 593,818 trauma patients, of which 7,556
(Cryoprecipitate: 3,468; No-Cryoprecipitate: 4,088 ) were included in our analysis. Mean age was $40 \pm 20 \mathrm{y}$, median ISS was 31[22-42], and GCS was 8 [3-15]. Overall volume of pRBCs transfused in the first 24-hours was 16[12-24] units, plasma was 11[7-17] units, and the platelet was 3 [1-4] units. The overall complication rate was $35 \%$, mortality was $37 \%$, and $25 \%$ of the patients died in the first 24 hours. Patients in the cryoprecipitate group received a lower volume of plasma ( $\mathrm{p}<0.01$ ), and pRBCs ( $\mathrm{p}<0.01$ ). Additionally, patients who received cryoprecipitate had lower rates of 24-hrs mortality ( $\mathrm{p}<0.01$ ) and in-hospital mortality ( $p<0.01$ ). However, there was no difference between the two groups regarding complications ( $p=0.28$ ), or volume of platelet transfused ( $\mathrm{p}=0.19$ ) (Table 1). On multivariate logistic regression, the use of cryoprecipitate as an adjunct to MT was associated with decreased 24-hrs mortality (OR: 0.82[0.74-0.91], $p=0.02$ ), in-hospital mortality (OR: 0.88[0.79-0.94], $p=0.03$ ), but had no association with in-hospital complications (OR: 1.22[0.94-2.04], $p=0.58$ ). On linear regression, the use of cryoprecipitate was not associated with 24-hr pRBCs ( $\beta=-0.10[-0.34$ to 0.25 ], $p=0.41$ ), $24-\mathrm{hr}$ plasma ( $\beta=-0.09[-0.28$ to 0.31 ], $p=0.36$ ), and $24-\mathrm{hr}$ platelets transfusions ( $\beta=$ $-0.14[-0.28$ to 0.16$], p=0.16$ ).
Conclusion: The use of cryoprecipitate as an adjunct to MT may reduce mortality without affecting in-hospital complications and transfusion requirements. Further studies are needed to better understand its potentially beneficial effects in massively transfused patients.

| Outcome | Cryoprecipitate <br> $(\mathbf{n}=\mathbf{3 , 4 6 8})$ | No-Cryoprecipitate <br> $(\mathbf{n}=\mathbf{4 , 0 8 8})$ | $\boldsymbol{P}$ value |
| :--- | :---: | :---: | :---: |
| 24-hrs Transfusion, units, median [IQR] |  |  |  |
| pRBCS | $14[11-19]$ | $20[14-31]$ | $<0.01$ |
| $\quad$ Plasma | $8[5-13]$ | $14[9-23]$ | $<0.01$ |
| $\quad$ Platelets | $3[1-3]$ | $3[1-4]$ | 0.19 |
| In-hospital complications, $\%$ | $36 \%$ | $35 \%$ | 0.28 |
| 24hrs mortality, $\%$ | $22.3 \%$ | $27.3 \%$ | $<0.01$ |
| In-hospital mortality, $\%$ | $32 \%$ | $41 \%$ | $<0.01$ |

pRBCS: packed red blood cells

Notes

# SAFETY AND FEASIBILITY OF ERECTOR SPINAE PLANE BLOCKS IN PATIENTS WITH CHEST WALL TRAUMA ON HIGH DOSEENOXAPARIN 

Linda A. Dultz MD,MPH, Jennifer L. Grant MD, Ryan P. Dumas MD, Thomas H.

Shoultz MD, Caroline Park MD, Stephen S. Luk* MD, John C. Alexander MD, Irina Gasanova MD, Joseph Minei* MBA,MD, Michael W. Cripps* MD, MS UTSW Parkland Hospital
Invited Discussant: Ronald Gross, MD
Introduction: Multi-modal pain regimens for complex chest wall trauma often contain diametrically opposed recommendations. Current guidelines for severe rib fractures recommend neuraxial blockade in addition to multi-modal pain therapies. While the guidelines for venous thromboembolism prevention recommend chemoprophylaxis, these medications must be held for neuraxial blockade placement. Erector spinae plane block (ESPB) is a newly described neuraxial block used primarily for thoracic pain control. It is more appealing than its traditional counterparts due to its technical ease, quick learning curve and potential for less bleeding complications. We sought to describe the use of ESPB for rib fractures in patients on a high dose enoxaparin (HDE) protocol. We hypothesize that ESPB is safe and feasible in this patient population.
Methods: Retrospective observational cohort study of a single level 1 trauma center from September 2016-December 2018. All trauma patients with rib fractures undergoing ESPB were included. Demographics, chemoprophylaxis and anticoagulation regimens, outcomes and complications were collected. Our institution's HDE trauma protocol is 40 mg twice daily.
Results: Patients undergoing ESPB tended to be severely injured males with more than 4 unilateral broken ribs (Table 1). Most patients (87\%) received chemoprophylaxis medication without missing a dose. Nineteen patients were on a HDE protocol during their admission and 3 patients were on a full dose oral anticoagulant for other reasons. For those on HDE, 16 (84\%) were able to adhere to the protocol without missing a dose while the ESPB was performed. For the three on oral anticoagulation, two were able to continue their regimen. There were zero bleeding complications from ESPB and 2 documented VTEs.

| Characteristics of Patients Undergoing ESPB | $\mathrm{n}=25$ |
| :--- | :---: |
| Male | $18(72 \%)$ |
| Age | $53[36-63]$ |
| Flail chest | $10(40 \%)$ |
| $>4$ unilateral rib fractures | $23(92 \%)$ |
| ISS | $17[13-21]$ |
| Chest AIS | $3[3-3]$ |
| LOS | $10[7-12]$ |
| Chemoprophylaxis administered | $23(87 \%)$ |
| High-dose chemoprophylaxis administered | $19(76 \%)$ |
| Venous thromboembolism | $2(8 \%)$ |
| Bleeding complications | $0(0 \%)$ |

Table 1 - Characteristics of patients undergoing ESPB. Categorical variables represented as $n \%$. Continuous variables represented as median and interquartile ranges.
Conclusion: ESPBs can be safely and effectively placed in patients on high dose enoxaparin. This block should be considered over traditional blocks in patients with blunt chest wall trauma due to its technical ease and ability to be done with HDE.

Notes

# TIME TO TRACHEOSTOMY IMPACTS OVERALL OUTCOMES IN PATIENTS WITH CERVICAL SPINAL CORD INJURY (CSCI) 

Tanya Anand MD, Kamil Hanna MD, Narong Kulvatunyou MD, Muhammad Zeeshan MD, Michael Ditillo DO, Lourdes Castanon MD, Andrew Tang MD, Ashley Northcutt MD, Bellal Joseph* MD, University of Arizona - Tucson Invited Discussant: Murray Cohen, MD

Introduction: The morbidity associated with cervical spine injury increases in the setting of concomitant cervical spinal cord injury (CSCI). A significant proportion of these patients require placement of a tracheostomy. However, it remains unclear if timing to tracheostomy following traumatic CSCI can impact outcomes. The aim of our study was to characterize outcomes associated with tracheostomy timing following traumatic CSCI.

Methods: We performed a 5-year (2010-2014) analysis of the ACS-TQIP database and included all adult (Age ${ }^{318 y}$ ) trauma patients who had traumatic CSCI and received tracheostomy. Patients were subdivided into two-groups: early-tracheostomy (ET: $\leq 4$ days from initial intubation) and late-tracheostomy (LT: >4 days). Outcome measures included respiratory complications, ventilator days, ICU and hospital length of stay, and mortality. Multivariate logistic regression analysis was performed.

Results: A total of 5,980 patients were included in the study, of which 1,010 (17\%) patients received ET while 4,970 (83\%) patients received LT. Mean age was 46-years, and $73 \%$ were males. In terms of CSCI location, $48 \%$ of the patients had high CSCI (C1-C4) while $52 \%$ had low CSCI (C5-C7). Patients in the ET group had lower rates of respiratory complications ( $27 \%$ vs $59 \%, p=0.01$ ), fewer ventilator days (11d vs 19d, $p=0.01$ ), shorter ICU (12d vs 21d, $p=0.01$ ) and hospital length of stay ( 20 d vs $28 \mathrm{~d}, p=0.01$ ) compared to those in the LT group. On regression analysis, ET was associated with lower rates of respiratory complications in patients with high CSCI (OR: 0.49[0.36-0.71]) and low CSCI (OR: 0.82[0.61-0.93]). However, no association was found between time to tracheostomy and in-hospital mortality.

Conclusion: ET regardless of CSCI level may lead to improved outcomes. Quality improvement efforts should focus on defining the optimal time to tracheostomy and considering ET as a component of SCI management bundle.


Notes

# AAST GRADING SCALE FOR ACUTE MESENTERIC ISCHEMIA ACCURATELY PREDICTS MORBIDITY AND MORTALITY: A VALIDATING RETROSPECTIVE COHORT STUDY 

Jake Forman DO, Bethany Clutts MD, James Dove BA, Marcus Fluck BS, Jeffrey Wild MD, Denise Torres MD, Kenneth Widom MD, Geisinger Health System

Invited Discussant: Shahid Shafi, MD, MPH, MBA
Introduction: Emergency general surgery (EGS) cases historically have higher morbidity and mortality compared to elective surgeries. The American Association for the Surgery of Trauma (AAST) recently developed grading systems for the most common EGS diagnoses to help delineate peri-operative risk stratification as well as morbidity and mortality based on previous literature and expert opinion. However, the grading scales have not been externally validated to determine associated outcomes. This study externally validates the AAST grading scale for acute mesenteric ischemia (AMI).

Methods: A retrospective, single institution, multi-hospital cohort study with review of electronic medical records between $1 / 1 / 2008$ and $8 / 2 / 2018$ was performed. All patients within the aforementioned time frame with AMI were stratified by grade according to the AAST grading scale using clinical, imaging, operative and pathologic criteria.

Results: A total of 378 patients were reviewed with 132 meeting inclusion criteria. Patients were placed into five categories based on AAST grade. The majority of patients fell within grade 2 ( $44 \%$; $\mathrm{N}=58$ ) followed by grade 3 ( $26 \%$; $\mathrm{N}=34$ ), grade 4 ( $22 \%$; N=29), grade $1(7 \% ; \mathrm{N}=9)$ and lastly grade $5(2 \% ; \mathrm{N}=2)$. There was a stepwise progression in 30 day and 1-year mortality based on increasing AAST grade.
Our data supports a statistically significant correlation between increasing AAST grades and 30 -day mortality ( $\mathrm{P}=0.010$ ). The calculated correlation coefficient based on a logistic regression model for 30 -day mortality is 0.65 , indicating predictability of increasing mortality with increasing grades. Predicted probability of 30-day mortality based on increasing grades were $10 \%$ for Grade 1 ( $95 \%$ CI: $4 \%-22 \%$ ), $16 \%$ for Grade 2 ( $95 \%$ CI: $10 \%-26 \%$ ), $26 \%$ for Grade 3 ( $95 \%$ CI: 18\%-34\%), 38\% for Grade 4 ( $95 \%$ CI: 25\%-53\%) and 52\% for Grade 5 ( $95 \%$ CI: 29\%-75\%).
The data also reveals significant correlation between increasing AAST grades and 1-year mortality ( $\mathrm{P}=0.018$ ). Again, using a logistic regression model for 1-year mortality, increasing AAST grades predict increasing mortality with a correlation coefficient of 0.623 . Predicted probability of 1-year mortality based on increasing grades were $18 \%$ for Grade 1 (95\% CI: 9\%-33\%), 26\% for Grade 2 ( $95 \%$ CI: 18\%-36\%), 36\% for Grade 3 ( $95 \%$ CI: 28\%-45\%), 48\% for Grade 4 ( $95 \%$ CI: $33 \%-63 \%$ ) and 60\% for Grade 5 ( $95 \%$ CI: 36\%-79\%).

Conclusion: A retrospective validation study confirms patients with higher grades on the AAST scale for AMI accurately predict higher levels of 30 day and 1-year mortality. The AAST grading scale for AMI can be used as a tool for guiding both goals of care discussions pre and post operatively as well as paint an accurate picture of short and long-term life expectancies based on clinical, imaging, operative and pathologic findings.

Notes

# OBESITY AND IMPAIRED VASCULAR BARRIER FUNCTION AFTER SHOCK: A BIOMETIC IN VITRO MODEL USING MICROFLUIDICS 

Lawrence N. Diebel* MD, David Liberati MS<br>Wayne State University<br>Invited Discussant: Susan Evans, MD

Introduction: Obesity is associated with poorer outcomes following severe trauma and include an increase incidence of acute kidney injury, respiratory failure and ARDS as well as multiple organ failure. It has been shown that the endotheliopathy of trauma is an early phenomenon and is associated with the development of these complications. Adiponectin is a adipokine important in maintaining vascular homeostasis. Its levels are decreased in obesity and associated comorbidities. We therefore hypothesized that plasma from obese vs. non-obese patients would have different effects on the glycocalyx and endothelial vascular barrier after trauma/hemorrhagic shock (T/HS). This was studied in ain vitro model.
Methods: Human umbilical vein endothelial cell (HUVEC) monolayers established in microfluidic devices were exposed to hypoxia ( $1 \% \mathrm{O} 2$ ) and epinephrine perfusion conditions ( 90 minutes) followed by the addition of $5 \%$ plasma from obese or nonobese patients. Endothelial glycocalyx (EG) integrity was indexed by thickness using fluorescent microscopy and shedding of syndecan-1 (syn-1) and hyaluronic acid (HLA) EG components. Endothelial cellular injury/activation was indexed by soluble thrombomodulin (sTM). The adipokines adiponectin and leptin were measured in the plasma samples used for the experiments.
Results: Mean $\pm$ SD ( $\mathrm{N}=8$ for each group)
Adiponectin concentrations were $45.1 \pm 4.3$ vs. $24.9 \pm 2.1$ and leptin concentrations were $19.2 \pm 2.2$ vs. $38.7 \pm 3.6$ in non-obese vs. obese individuals respectively ( $\mathrm{P}<0.05$ ).
Conclusion: There was no effect of plasma from either nonobese or obese patients on the glycocalyx or endothelium in experiments conducted under control flow conditions. However, plasma from obese patients failed to protect the glycocalyx and endothelial vascular barrier from injury after exposure to biometic conditions of T/HS. This was related to significant differences in adiponectin and leptin concentrations in obese vs. non-obese individuals and may be a potential target for therapeutic interventions.

|  | HLA $\mid \mathrm{mg} / \mathrm{ml}$ ) | Syndecan ( $\mathrm{ng} / \mathrm{ml}$ ) | HUVEC elycocalyx thickness \|Fluor intensity) | TM (pg/ml) |
| :---: | :---: | :---: | :---: | :---: |
| HUVEC control (ON flaw) | $14.8 \pm 1.5$ | $27.5 \pm 2.4$ | $265.3 \pm 19.6$ | $27.8 \pm 1.2$ |
| HUVEC + normal plasma | $16.1 \pm 1.6$ | $27.2 \pm 28$ | $266.1 \pm 18.2$ | $28.1 \pm 1.6$ |
| HUVEC + obese plasma | $20.2 \pm 2.6$ | $29.2 \pm 2.8$ | $260.5 \pm 17.9$ | $31.1 \pm 2.5$ |
| HUVEC + Hyp + Epi | $98.4 \pm 8.2^{*}$ | $100.5 \pm 10.2^{*}$ | $143.4 \pm 18.5^{*}$ | $106.5 \pm 12.3^{*}$ |
| Hypoxia + Epi + normal plasma | $18.6 \pm 2.3$ | $31.6 \pm 4.4$ | $249.8 \pm 15.9$ | $33.6 \pm 3.5$ |
| Hypoxia + Epl + obese plasma | $513 \pm 7.1 *$ | 69.2土6.3\% | $1212 \pm 176^{47}$ | $70.6 \pm 10.6 * 7$ |

* $p<0.05$ vs. HUVEC control, \#p<0.05 vs. allothergroups

Adiponectin concentrations were $45.1 \pm 4.3$ vs. $24.9 \pm 2.1$ and leptin concentrations were $19.2 \pm 2.2$ vs. $38.7 \pm$ 3.6 in non-obese vs. obese individuals respectively ( $\mathrm{P}<0.05$ ).

Notes

# REGIONALIZATION OF EMERGENCY GENERAL SURGERY OPERATIONS: A SIMULATION STUDY 

Robert D. Becher MD, MS, Nitin Sukumar MS, Michael P. DeWane MD, Thomas M. Gill MD, Adrian A. Maung* MD, Kevin M. Schuster* MD,MPH, Marilyn J. Stolar Ph.D., Kimberly A. Davis* MBA,MD, Yale School of Medicine Invited Discussant: Nancy Parks, MD

Introduction: It has been theorized that a tiered, regionalized system of care for emergency general surgery (EGS) patients - akin to regional trauma systems - would translate into significant survival benefits. Yet data to support this are lacking. The aim of this study was to determine the potential number of lives that could be saved by regionalizing EGS care to higher-volume, lower-mortality EGS institutions.

Methods: Adult patients who underwent one of ten common EGS operations were identified in the California Inpatient Database (2010-2011). An algorithm was constructed that "closed" lower-volume, higher-mortality hospitals and referred those patients to the remaining higher-volume, lower-mortality institutions ("closure" based on hospital EGS volume-threshold that optimized to $95 \%$ probability of survival, by operation). Primary outcome was the potential number of lives saved per operation, aggregated across hospitals. Regionalization-simulations were completed 5000 times for each operation employing a bootstrap resampling method to proportionally redistribute patients. Estimates of expected deaths at the higher-volume hospitals were recalculated for every bootstrapped sample.

Results: Of the 165,123 patients who underwent EGS operations over the 2 years, a total of 17,655 ( $10.7 \%$ ) were regionalized to a higher-volume hospital. On average, $25 \%$ of lower-volume hospitals were "closed," though it varied by operation (from $3.9 \%$ closures for cholecystectomy to $57.7 \%$ for repair perforated peptic ulcers). The simulations demonstrated that EGS regionalization would prevent 9.7\% (586) of total risk-adjusted EGS deaths and significantly save lives for every EGS operation (from 4.7\% of lives saved for cholecystectomy to $22.2 \%$ for umbilical hernia repair). On average, regionalization prevented 4.6 deaths per 100 EGS patient-transfers (ranging from 1.3 for appendectomy to 8.0 for umbilical hernia repair).

Conclusion: This simulation study provides important new insight into the concept of EGS regionalization, suggesting that 1 in 10 risk-adjusted deaths could be prevented by a structured system of EGS care. Future work should expand upon these findings using discrete-event simulation models to compare triage criteria, incorporate hospital resources and time to definitive care, and study the impact on access to care for resource-limited populations.

Notes

# COMMON SENSE CAN REDUCE AFRICAN AMERICAN HOMICIDE RATES: THE EFFECT OF UNIVERSAL BACKGROUND CHECKS 

Elinore J. Kaufman MD, MS, Christopher N. Morrison Ph.D., Erik Olson MD, David
Humphreys Ph.D., Douglas J. Wiebe Ph.D., Niels D. Martin* MD, Carrie A. Sims*
MD,Ph.D., Mark Hoofnagle MD,Ph.D., Charles W. Schwab* MD, Patrick Reilly* MD, Mark J. Seamon* MD, University of Pennsylvania

Invited Discussant: Tracey Dechert, MD
Introduction: In 2017, 14,542 Americans died from firearm homicide. Federal law requires background checks for firearms purchased from licensed dealers only. As of 2017, 19 states extended this requirement to gun show and private handgun sales (UBC-HG). Although firearm homicide disproportionately affects African American (AA) populations, little is known about how UBG-HG legislation impacts AAs. We hypothesized that UBC-HG would not impact AA firearm homicide rates.
Methods: We collected Centers for Disease Control firearm homicide counts for AA and white populations in the 50 states, 1999-2017. Laws were collected from the State Firearm Laws Database. The exposure of interest was UBC-HG adoption and the outcome was firearm homicide. We used Poisson regression to perform a differences-in-differences analysis. State fixed effects accounted for time-invariant state characteristics while a categorical variable for year accounted for trends over time. We also controlled for state-specific, time-variable factors: median household income, population $<25$ or $\geq 65$ years, per capita alcohol consumption, and total count of firearm laws (UBC excluded). Standard errors were clustered by state.
Results: The overall firearm homicide rate among whites was 1.6 per 100,000 (Interquartile Range [IQR] 0.9-2.6) with a low of 1.4 in 2011 and a high of 1.8 in 2016. The firearm homicide rate was 12.3 per 100,000 (IQR 7.5-18.2) among AAs, with a low of 10.6 in 2011 and a high of 15.6 in 2016. There was no significant difference in firearm homicides among whites (Incidence rate ratio [IRR] 0.93, 95\% CI 0.73, 1.18), but passage of UBC-HG was associated with an 18\% decrease in AA firearm homicides (IRR $0.82,95 \%$ CI $0.70,0.96 ; \mathrm{p}=0.012$ ). These results were consistent across gender (Table). National UBC-HG application could have saved 23,947 (95\% CI 5587, 44,306) lives during the study period.

Conclusion: Implementing UBC-HG was associated with decreased firearm homicides among AA males and females-the population most at risk. Expanding UBC-HG may be an effective approach to reducing racial disparities in American firearm homicides.

Notes

Session XVII: Quickshot Session II 13-26
Paper QS-26: 11:50 AM - 11:56 AM

# COMPARISON OF A TRAUMA COMORBIDITY INDEX WITH OTHER MEASURES OF COMORBIDITIES TO PREDICT MORTALITY FOLLOWING TRAUMA 

Peter Jenkins MD, Brian Dixon Ph.D., Stephanie Savage* MD, Aaron Carroll MD, Craig Newgard MD, Christopher Tignanelli MD, Mark Hemmila* MD, Lava Timsina Ph.D., Indiana Univesity School of Medicine

Invited Discussant: Alan Guo, MD, PhD

Background Comorbidities influence outcomes of injured patients, and that influence is likely to grow as the population ages. Yet a lack of consensus exists regarding how best to quantify comorbidities associated with risk of mortality. In this study, we develop and validate a trauma comorbidity index (TCI), a measure of mortality risk attributable to comorbidities, designed for use specifically with trauma registry data, and we compare the association of the TCI and other existing measures of comorbidities with mortality.
Methods The study used state trauma registry data (2013-2015) to train and test the TCI. The main outcome of interest was in-hospital mortality. We selected comorbidities based on a minimum threshold p-value in bivariate analysis. We then used coefficients derived from multivariable logistic regression to calculate the TCI in a "training" cohort, and we tested internal validity of the TCI with a "testing" cohort. Finally, we used adjusted models to generate areas under receiver operator characteristic curves (AUC) to compare alternative comorbidity measures, and we compared the parsimony of the models with Akaike information criterion and Bayesian information criterion.

Results Of 85,351 patients admitted to 111 hospitals, $73 \%$ had at least one comorbidity. The TCI was significantly associated with mortality, and two-fold internal cross-validation confirmed that association. All comorbidity measures increased the AUC significantly above a baseline value (0.91).

Comparison of predicted mortality by trauma, Charlson, and Elixhauser comorbidity indexes by tertile with $95 \%$ confidence intervals


CCI - Charlson comorbidity index
ECI - Elixhauser comorbidity index
TCI - Trauma comorbidity index

The TCI demonstrated a combination of the greatest AUC (0.92) and model parsimony.
Conclusion The prevalence of comorbidities was substantial, and they were significantly associated with mortality. The TCI demonstrated superior model discrimination compared with other measures of comorbidities.

Notes

## POSTERS

# COMPARISON OF 10 GAUGE VS 14 GAUGE ANGIOCATHER FOR TREATMENT OF TENSION PNEUMOTHORAX AND TENSION INDUCED PULSELESS ELECTRICAL ACTIVITY WITH CONCOMITANT HEMORRHAGIC SHOCK: BIGGER IS STILL BETTER. 

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Introduction: Little is known regarding the effect of hemorrhagic shock on the diagnosis and treatment of tension pneumothorax (tPTX). Recently, the Tactical Combat Casualty Care (TCCC) guidelines included the 10 -gauge angiocatheter ( 10 g AC ) as an acceptable alternative to the 14 -gauge angiocatheter ( 14 g AC). This study sought to compare these two devices for decompression of tPTX and rescue from tension-induced pulseless electric activity (tPEA) in the setting of a concomitant $30 \%$ estimated blood volume (EBV) hemorrhage.

Methods: Following a controlled hemorrhage, carbon dioxide was insufflated into the chest to induce either tPTX or tPEA. tPTX was defined as a reduction in cardiac output by $50 \%$, and tPEA was defined as a loss of arterial waveform with mean arterial pressure (MAP) less than 20 mmHg . The affected hemi-thorax was decompressed using a randomized 14 g AC or 10 g AC while a persistent air leak was maintained after decompression. Successful rescue from tPTX was defined as $80 \%$ recovery of baseline systolic blood pressure. Successful return of spontaneous circulation following tPEA was defined as a MAP>20mmHg. Primary outcome was success of device.

Results: Eighty tPTX and fifty tPEA events were conducted in thirty-eight adult Yorkshire swine. There were no significant differences in the baseline characteristics between animals or devices. In the tPTX model, the 10 g AC successfully rescued $90 \%$ of events while 14 g AC rescued $80 \%$ of events ( $\mathrm{p}=0.350$ ). In the PEA model, the 10 g AC rescued $87 \%$ of events while the 14 g AC rescued only $48 \%$ of events ( $p=0.006$ ).

Conclusion: The 10 g AC was vastly superior to the 14 g AC for return of spontaneous circulation following tPEA in the setting of $30 \%$ hemorrhage. These findings further support the importance of larger caliber devices that facilitate rapid recovery from tPTX, particularly in the setting of polytrauma.

## Poster \# 2

# CHARACTERIZATION AND INFLUENCE OF SCAPULA FRACTURES AMONG PATIENTS WHO UNDERGO SURGICAL STABILIZATION OF RIB FRACURES 

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Introduction: Current algorithms involving surgical stabilization of rib fractures (SSRF) do not consider specific fracture locations. The combination of displaced, sub-scapular rib fractures and a scapula fracture creates challenges for both rib exposure and fixation, which may in turn adversely affect both hardware longevity and shoulder function. We hypothesized that a scapula fracture is associated with both acute and long term morbidity among a sample of patients with sub-scapular rib fractures who underwent SSRF.

Methods: Retrospective review of prospectively-maintained SSRF databases from two high volume (at least 30 SSRF cases per year), level I trauma centers. The sample was comprised of patients with at least one bi-cortical, sub-scapular rib fracture, defined as ribs 2-7 within 2 cm of the edge of the scapula on admission CT chest. Patients were then grouped by the presence of a scapula fracture. Demographics, injury severity, scapula fracture morphology, acute outcomes, and the need for subsequent hardware removal were abstracted.

Results: 111 patients with a median of 4 (range 1-11) sub scapular fractures underwent SSRF and were analyzed. 68 (60.3\%) patients had at least one sub-scapular plate placed. 31 (27.9\%) patients had a scapula fracture; 2 were bilateral, 2 involved the glenoid (the remainder involved only the scapula body), and 1 underwent fixation ( 4 days following SSRF). There were no differences identified in patient demographics, injury severity, or rib fracture severity as a function of a scapula fracture (Table). The overall incidence of both acute re-operation ( $n=2,1.8 \%$ ) and long-term hardware removal ( $n=4,3.6 \%$ ) following SSRF was low. However, patients with a scapula fracture were significantly more likely to require hardware removal as compared to patients without a scapula fracture ( $9.7 \%$ vs. $1.3 \%$, respectively, $\mathrm{p}=0.03$ ). Furthermore, each case of hardware removal from a patient with a scapula fracture entailed removal of sub-scapular plates specifically due to a painful grinding sensation with shoulder movement. The singular case of hardware removal in a patient without a scapula fracture was due to infection of antero-lateral plates.

Conclusion:Ipsilateral scapula fractures were present in approximately one third of patients with displaced, sub-scapular rib fractures who underwent SSRF. The vast majority of scapula fractures involved the body (directly posterior to the rib fractures) and were not repaired. Patients with a scapular fracture were significantly more likely to require rib hardware removal, specifically in the sub scapular location. Alternative techniques to SSRF in this clinical scenario, including fixation to the inner rib cortex and simultaneous scapular body fracture repair, should be studied.

## Poster \# 3

# A PROSPECTIVE STUDY TO ASSESS CYTOKINES (IL-1B, IL-6, IL-8, IL-10 \& TNF-A) AND BIOMARKERS (vWF \& CC-16) IN PATIENTS WITH CHEST TRAUMA AND THEIR CORRELATION WITH THORACIC TRAUMA SEVERITY SCORE AND PATIENTS' OUTCOME 

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Introduction - Thoracic trauma causes substantial morbidity and mortality. Severity of chest injury is assessed by Thoracic Trauma Severity Score (TTSS) but its association with cytokines and biomarkers and patient prognosis is not well elucidated. The aim of the study was to assay cytokines (IL-1 $\beta$, IL-6, IL-8, IL-10\& TNF- $\alpha$ ) and biomarkers (vWF, CC16) in patients of thoracic trauma and correlate it with TTSS and patients' outcome.

Materials and Methods - The study was conducted in the Division of Trauma Surgery \& Critical Care of a level 1 Trauma Centre. In this prospective observational study, all patients of thoracic trauma who met the inclusion criteria and gave consent were included. Serum and Broncho-alveolar lavage (BAL) fluid samples from these patients were collected on four occasions. Thoracic trauma severity score was calculated in all patients. Patient outcome parameters included discharge or death, hospital stay and intensive care unit (ICU) stay. Healthy healthcare workers were selected as controls for serum samples. Patients of carcinoma esophagus with no evidence of tracheal involvement were selected has controls for BAL sample.
Results - Forty-three patients were included in the study. In trauma patients, IL-1 and IL-10 were increased both in serum and BAL fluid and IL-6 and IL-8 were increased in only BAL fluid. Clara Cell protein (CC16) was significantly reduced in BAL fluid. The mean TTSS of patients who died was significantly more than that of patients who recovered ( 7.9 days vs 6.2 days; p-0.048). Patients with a high score also had a significant prolongation of ICU stay (17 days vs 10.2 days; p-0.048). No significant difference was observed in these cytokines and biomarkers between patients who recovered and who died. However, it was seen that lower values of CC16 in BAL was associated with a prolonged hospital stay (Correlation Coefficient - 0. 45; p-0.005).
Conclusions - TTSS is an excellent modality to assess the insult incurred by a patient of chest trauma. Patients with a high TTSS (>5) have significantly prolonged ICU stay. The mortality rate increases significantly with TTSS $>7$. Protective role of CC-16 was observed in patients who recovered. Longer prospective studies are required to determine the role of cytokines and biomarkers in patients with thoracic trauma in predicting the patient's outcome.

# INTERLEUKIN-18: A ROBUST PREDICTOR OF ACUTE RESPIRATORY DISTRESS SYNDROME IN SEVERE BLUNT TRAUMA 

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Introduction: Direct pulmonary injury and innate immune response activation primes the lungs for acute respiratory distress syndrome (ARDS) in trauma. Recently identified as a key mediator in ARDS pathogenesis is the inflammasome dependent release of Interleukin-18 (IL-18). As such, we hypothesized plasma IL-18 is a diagnostic predictor of ARDS in severe blunt trauma.
Methods: Secondary analysis of the Inflammation and the Host Response to Injury database was performed on plasma cytokines collected within 12 hours of severe blunt trauma. Trauma related cytokines, including IL-18, were compared between ARDS and non-ARDS patients, and were evaluated for association to ARDS using logistic regression. Threshold cytokine concentrations predictive of ARDS were then determined using receiver-operating curve (ROC) analysis.
Results: Cytokine analysis of ARDS ( $\mathrm{n}=19$ ) compared to non-ARDS patients ( $\mathrm{n}=61$ ) demonstrated elevated plasma IL-18 in ARDS and IL-18 strongly correlated with ARDS on logistic regression after confounder adjustment ( $\mathrm{p}=0.008$ ). Additionally, ROC analysis revealed IL-18 as a strong ARDS predictor (AUC=0.83, figure 1), with a threshold IL-18 value of $170 \mathrm{pg} / \mathrm{ml}$ (Youden Index: 0.3). IL-18 remained elevated in ARDS compared to non-ARDS patients during the acute injury phase ( $\mathrm{p} \leq 0.02$ ). Other trauma related cytokines did not correlate with ARDS.

Figure 1: Initial IL-18 Level and ARDS Development


Conclusion: In severe blunt trauma, IL-18 is a robust predictor of ARDS and remains elevated throughout the acute injury phase. These data support IL-18 as a key ARDS biomarker, promoting early identification of trauma patients at greater risk of developing ARDS. Timely recognition of ARDS and implementation of advantageous supportive care practices may reduce trauma related ARDS morbidity and costs.

## Poster \# 5

## TIMING OF REPAIR OF BLUNT TRAUMATIC THORACIC AORTICINJURY: RESULTS FROM THE NATIONAL TRAUMA DATABANK

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## Introduction:

Thoracic endovascular aortic repair (TEVAR) is currently considered the preferred operative treatment for blunt traumatic thoracic aortic injuries (BTAI), and its use is typically associated with improved outcomes compared to open surgical repair and nonoperative management. However, the optimal time from injury to repair is unknown and remains a subject of debate across societal clinical practice guidelines. The purpose of this study was to evaluate national trends in the management of BTAI and the impact of timing of repair on outcomes.

## Methods:

Using the National Trauma Databank, we identified adult patients with BTAI between 2012 and 2015. Patients with prehospital/emergency department cardiac arrest or incomplete datasets were excluded from analysis. The primary outcome evaluated was in-hospital mortality, and secondary outcomes included postoperative complications and overall length of stay. Multivariable logistic regression was performed to identify independent predictors of mortality

## Results:

A total of 5,811 patients were identified with BTAI, with 1,930 (33.2\%) undergoing TEVAR, 111 (1.9\%) open repair, and 3770 (64.9\%) managed nonoperatively. In the patients undergoing TEVAR, 1,333 underwent early repair (within 24 hours of admission), 470 patients underwent delayed repair (beyond 24 hours from time of admission), and time to operative intervention was unknown in 127 patients.
In patients who underwent early TEVAR, in-hospital mortality was 3-fold greater compared to those who underwent delayed TEVAR $\{6.4 \%(84 / 1,333)$ vs. $2.1 \%$ (10/470), $\mathrm{p}<0.05\}$. The median LOS was $17.5 d a y s$ in the early repair group versus 22.0 days in the delayed group ( $\mathrm{p}<0.05$ ).
On logistic regression analysis (adjusted for ED hypotension, admission GCS $\leq 8$, ISS, and age $\geq 65$ ), patients who underwent delayed TEVAR had a significantly lower mortality compared to those who underwent early TEVAR (adjusted odds ratio: 0.30; $95 \%$ CI: [0.15-0.60]; adjusted p value <0.01).

## Conclusion:

TEVAR is the primary operative approach in patients with BTAI. In patients with BTAI who underwent TEVAR, delayed repair after 24 hours was associated witha longer length of stay but significantly decreased mortality.

# THE PROGRESSION OF LOW GRADE BLUNT AORTIC INJURIES ON CT IMAGING 

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Introduction: A high grade (grade 3, 4) blunt aortic injury (BAI) frequently requires intervention and is a major cause of mortality in trauma patients. The management of low grade BAI (grade 1, 2) is not well characterized. This study aims to review imaging strategies and injury progression in low-grade BAI.

Methods: We identified 10,178 blunt trauma patients, who underwent 7,661 chest CTs from 2013-2016. Charts for patients with any suspicion of BAI on initial CT were reviewed for demographics, initial aortic injury grade, concurrent injuries, chest abbreviated injury score (AIS), injury severity scores (ISS), initial and delayed intervention, timing of repeat imaging, ICU length of stay, and mortality. Subjects were then stratified by initial aortic injury grade. ANOVA and Chi-squared tests of significance were performed (IBM SPSS Statistics 25) to compare the above variables across initial aortic injury grade.

Results: From this cohort, 32 BAIs were identified. Patients were $79 \%$ male with a mean age of 36 (SD 16). The median ISS score was 39.5 (IQR 16.5-62.5) and chest AIS was 4 (3-5). Nine patients ( $28 \%$ ) underwent initial intervention; 3 open ( $9 \%$ ) and 6 endovascular (19\%). Eighteen patients (56\%) underwent initial non-operative intervention with repeat imaging. The median number of rescans was 1 (IQR 0-2), and the average hours passed from initial to the first repeat CT scan was 9.5 (SD 7.6). On repeating imaging, grade 1 BAI are more likely to resolve (67\%) compared to grade 2-4 ( $0 \%, \mathrm{p}=0.029$ ). Of patients who received repeat imaging, $9(50 \%)$ required delayed intervention; 2 open (11\%) and 7 endovascular (39\%). Non-operative treatment was more likely in low grade injuries (41\%) compared with high grade injuries ( $3 \%$; $p=0.003$ ). Average ICU length of stay was 6.6 days (SD 9.6). Overall all-cause mortality in patients with BAI was 6 (19\%). Overall attributable mortality was 3 (9\%). Attributable mortality for grade $1,2,3$, and 4 injuries was $0 \%, 0 \%, 0 \%$, and $27 \%$ respectively ( $\mathrm{p}=0.097$ ).

Conclusion: No injuries showed progression on follow-up imaging, while Grade 1 injuries were more likely to resolve and not require intervention. Follow-up imaging is necessary for even low-grade injuries to determine stability.

| Variable | Overall | Grade 1 | Grade 2 | Grade 3 | Grade 4 | $p$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Number of patients, n | 32 | 13 | 5 | 3 | 11 |  |
| Initial intervention. n . (\%) |  |  |  |  |  |  |
| Open | 3 (9) | 0 (0) | 0 (0) | 0 (0) | 3 (27) | 0.097 |
| Endo | 6 (19) | 1 (8) | 0 (0) | 1 (33) | 4 (36) | 0.183 |
| Repeat CT | 18 (56) | 9 (69) | 4 (80) | 2 (67) | 3 (27) | 0.115 |
| Repeat CT status, n. (\%) |  |  |  |  |  |  |
| Resolved | 6 (33) | 6 (67) | 0 (0) | 0 (0) | 0 (0) | 0.029 |
| Stable | 12 (67) | 3 (33) | 4 (100) | 2 (100) | 3 (100) |  |
| Progressed | 0 (0) | 0 (0) | 0 (0) | 0 (0) | $0(0)$ |  |
| Delayed intervention. n , (\%) |  |  |  |  |  |  |
| Open | 2 (11) | 1 (11) | 0 (0) | 1 (50) | 0 (0) | 0.208 |
| Endo | 7 (39) | 2 (22) | 1 (25) | 1 (50) | 3 (100) | 0.103 |
| Non-operative, n , (\%) | 14 (44) | 9 (69) | 4 (80) | 0 (0) | 1 (9) | 0.003 |
| All-cause mortality, n , (\%) | 6 (19) | 2 (15) | 0 (0) | 0 (0) | 4 (36) | 0.242 |
| Attributable mortahry, n , (\%) | 3 (9) | 0 (0) | 0 (0) | 0 (0) | 3 (27) | 0.097 |

## COMPARING A BLADED TROCAR DEVICE TO TRADITIONAL OPEN TUBE THORACOSTOMY FOR PNEUMOTHORAX IN A PORCINE MODEL

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Introduction: Correct and timely tube thoracostomy can be lifesaving for a battlefield pneumothorax. The ability to safely and reliably perform tube thoracostomy in the combat theatre would be of significant value. A bladed trocar system is a hand held device to facilitate proper tube placement and has been validated for relief of tension pneumothorax compared to needle decompression. We investigate whether the bladed trocar has a similar potential for treatment of simple pneumothorax compared to traditional open tube thoracostomy.

Methods: Pneumothoraces were created in 5 in vivo swine. Interventions were randomized to open thoracostomy ( $\mathrm{OT}, \mathrm{n}=25$ ) versus bladed trocar technique $(\mathrm{BT}, \mathrm{n}=25)$. Pneumothorax resolution, tube position, and incision size were evaluated by a blinded reviewer. Thoracoscopy was used to evaluate for iatrogenic injuries.

Results: Fifty chest tubes were placed with 25 in each cohort. Immediate pneumothorax resolution was seen in $>95 \%$ of cases in each cohort. Mean insertion time did not differ between OT and BT groups ( $39.2 \pm 10.4$ seconds vs. $37.7 \pm 17.1$ seconds; $p=0.9$ ), but the $B T$ required smaller incisions ( $2.7 \mathrm{~cm} v .3 .5 \mathrm{~cm}$; $\mathrm{p}<0.05$ ). Injuries between the two groups showed no significant difference ( $\mathrm{n}=2$ vs. $\mathrm{n}=7$; $\mathrm{p}=0.06$ ). The most common injury was violation of the visceral pleura ( $10 \%, \mathrm{n}=5$ for both groups).

Conclusion: The bladed trocar was equal in comparison to open thoracostomy in regards to insertion time, pneumothorax resolution, and injury rates. The bladed trocar required a smaller incision compared to open tube thoracostomy and may be a useful adjunct in simple pneumothorax management in the combat environment.

# A COMPARISON OF DRAINAGE AND PATIENT OUTCOME METRICS BETWEEN SMALL-BORE AND LARGE-BORE CHEST TUBES IN THE SETTING OF DELAYED HEMOTHORACES: A 7-YEAR, FIVE-CENTER STUDY 

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Introduction: Large bore tubes (LB, >14Fr.) are the standard treatment for emergent hemothoraces (HTXs), but treatment of delayed HTXs remains variable. It remains unclear whether small bore ( $\mathrm{SB}, \leq 14 \mathrm{Fr}$.) pigtail tubes have the same efficacy and ability to drain delayed traumatic hemothorax (HTX) as LB (>14Fr.) tubes. The goal of our study was to compare tube and patient outcomes between SB and LB analyze the drainage and patient outcomes of SB tubes in patients with delayed HTX. We hypothesized that SB tubes would be as safe and effective as LB tubes. Methods: This was a retrospective observational study across $7.5 y$ yrs at 5 Level 1 trauma centers across three US states. We included patients 1) diagnosed with a HTX, or multiple rib fractures with bloody effusion from chest tube; 2 ) with initial chest tube placed $\geq 36 \mathrm{~h}$ of arrival. We excluded tubes placed for hemopneumothoraces. SB tubes were compared to LB tubes. The three primary outcomes were tube failure (requiring an additional/replacement tube or video-assisted thoracoscopy [VATS]), mean volume of drained fluid (mL), and rate of drained fluid (volume of fluid [mL]/hours). Secondary outcomes were tube complications (tube falling out or clogging, pleural empyema, pneumonia, retained HTX), time on chest tube, and in-hospital mortality. Patients could have had more than one tube in this study and possibly had bilateral tube placement. Dependent and independent analyses were used to assess primary and secondary outcomes.
Results: There were 160 SB patients (191 tubes) and 55 LB patients (64 tubes). There were no significant differences between study groups in 13 demographic or injury characteristics. 25 patients had bilateral chest tubes. The median (IQR) tube size for each group was as follows: SB [12Fr. (12-14)] and LB [32Fr. (28-32)]. There was no significant difference in SB and LB groups in the amount of time each tube was in place ( $89 \mathrm{vs} .134 \mathrm{hrs}, \mathrm{p}=0.35$ ). The failure rate of SB tubes was significantly smaller than LB tubes ( $5 \%$ vs. $110 \%$, $\mathrm{p}<0.001$ ). Mean (SE) volume of drained fluid was not significantly different SB vs. LB (767(345) vs. 636(221) mL, p=0.71). Similarly, the median (IQR) rate of drained fluid was not significantly different between SB and LB (54 (31-210) vs 124 ( $35-392$ ) mL/hr, $\mathrm{p}=0.36$ ). SB tubes clogged or fell out significantly more often than LB tubes ( $4 \%$ vs. $0 \%, \mathrm{p}<0.001$ ); clogged SB tubes ranged from $10-14 \mathrm{Fr}$, while those that fell out ranged from 8-14Fr. There were two cases of pleural empyema, both in the SB group. There was no significant difference between SB and LB tubes in rates of retained HTX ( $8 \%$ vs. $6 \%, \mathrm{p}=0.79$ ), pneumonia ( $6 \%$ vs. $0 \%$, $\mathrm{p}=0.08$ ), or returning to prior function ( $36 \%$ vs. $44 \%, \mathrm{p}=0.31$ ). However, in-hospital mortality was significantly higher in LB vs. SB ( $8 \%$ vs. $1 \%$, $\mathrm{p}=0.02$ ). Conclusion. While there is a perceived reluctance to use a SB tube to manage delayed HTX, our data indicate they are effective in draining a delayed HTX. SB tubes had a significantly smaller failure rate, and similar ability to drain fluid compared to LB tubes. Nevertheless, SB tubes were significantly more prone to clogging and falling out. These multi-center data lend support to the use of SB tubes for the management of delayed HTXs.

# IN FOR A PENNY, IN FOR A POUND: OBESITY WEIGHS HEAVILY ON BOTH COST AND OUTCOME IN TRAUMA 

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Introduction: Obese patients are presumed to be at higher risk for complications after trauma, but the current literature offers mixed conclusions regarding the effect of increasing body mass index (BMI) on outcomes after trauma laparotomy. This study evaluated the impact of obesity on outcomes and cost in patients undergoing trauma laparotomy at a level 1 trauma center.
Methods: Data on all patients requiring trauma laparotomy from January 2016 to December 2016 were prospectively collected. Patients were stratified into non-obese (BMI < 30), obese (BMI 30-40), and morbidly obese (BMI > 40) groups. Multiple logistic regression analysis and multiple linear regression analysis were used to determine variables significantly associated with patient morbidity and length of stay.
Results: 313 patients underwent a trauma laparotomy: 225 (72\%) non-obese, 69 (22\%) obese, and 19 (6\%) morbidly obese. Complications occurred in 97 patients (31\%). There was no difference between the groups with respect to severity of injury or shock on presentation. However, obese and morbidly obese patients had longer intensive care unit (ICU) and hospital lengths of stay (LOS), more ventilator days, larger hospital cost, and a higher morbidity and mortality compared to non-obese patients (Table). Multiple logistic regression analysis and multiple linear regression analysis found increasing obesity to be an independent predictor for patient morbidity (OR 3.0, CI 1.7-5.2), ICU LOS ( $\beta=2.8$, $\mathrm{p}=0.02$ ) and hospital LOS ( $\beta=7.4, \mathrm{p}<0.001$ ).

|  | Non-obese | Obese | Morbidly Obese |
| :--- | :---: | :---: | :---: |
| Morbidity | $25 \%$ | $42 \%$ | $63 \%$ |
| Hospital LOS (days) | 13 | 21 | 30 |
| ICU LOS (days) | 4 | 10 | 12 |
| Ventilator days | 3 | 8 | 11 |
| Hospital cost | $\$ 47,498$ | $\$ 85,623$ | $\$ 118,958$ |
| Mortality | $6 \%$ | $17 \%$ | $6 \%$ |

Conclusions: Morbidity, mortality, and length of stay increased with worsening obesity after trauma laparotomy. These discrepancies contributed to rising hospital costs and added burden for the trauma center.

# NEPHRECTOMY IS INDEPENDENTLY ASSOCIATED WITH INCREASED MORTALITY AFTER RENAL TRAUMA: AN ANLAYSIS FROM THE NATIONAL TRAUMA DATA BANK 2007-2016 

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Introduction: The vast majority of high-grade renal trauma can be managed conservatively; however, nephrectomy is still common in the acute management setting. When controlling for multiple patient and injury severity measures, we sought to determine if nephrectomy was associated with increased mortality within the National Trauma Data Bank (NTDB).
Methods: We identified renal trauma patients from NTDB from 2007-2016. We excluded patients $<18$ years old, mechanisms other than blunt or penetrating trauma, missing facility codes, severe head injuries (abbreviated injury severity (AIS) score 6 or 7), and death within 4 hours of admission. We performed conditional logistic regression analysis to determine if nephrectomy was an independent predictor of mortality controlling for: age, sex, race (Caucasian/nonCaucasian), ethnicity (Hispanic /non-Hispanic), mechanism of injury (blunt /penetrating), shock (systolic BP <90 on admission), blood transfusion (yes/no), Glasgow Coma Score (GCS), Revised Trauma Score (RTS), and Injury Severity Score (ISS). We did not control for renal AIS score because of concern over inaccuracies in the NTDB.
Results: We identified 62,987 renal trauma patients that met our inclusion criteria; $75.8 \%$ were male, and $82.6 \%$ had a blunt mechanism of injury. Nephrectomy was performed in 3,348 (5.29\%). In patients undergoing nephrectomy, 569 (17\%) died vs 3,467 ( $5.81 \%$ ) in the non-nephrectomy group. On multi-variable logistic regression, nephrectomy was associated with $72 \%$ increased odds of death (OR 1.72, $95 \%$ CI 1.56-1.91). Other significant associations with death included: age, non-Caucasian race, penetrating mechanism, hypotension, blood transfusion, lower GCS, lower RTS, and higher ISS (table 1).
Conclusion: In the NTDB, nephrectomy is associated with 72\% increased risk of mortality even after adjusting for demographic, injury characteristics, and multiple measures of overall injury severity. In many circumstances, nephrectomy cannot be avoided in the management of acute trauma; however, nephrectomy may impact overall survival and is imperative to be avoided when possible.

Table 1: Logistic regression model for predicting mortality in renal trauma patients

| Variables | OR | 95\% CI Limit | P-Value |
| :--- | :--- | :--- | :--- |
| Age $^{*}$ | 1.0332 | $1.032-1.035$ | $<0.001$ |
| Sex (male) | 0.9705 | $0.902-1.045$ | 0.425 |
| Race (non-caucasian) | 1.115 | $1.031-1.206$ | 0.006 |
| Ethnicity (hispanic) | 0.970 | $0.947-1.176$ | 0.332 |
| Mechanism (penetrating) | 1.355 | $1.223-1.503$ | $<0.001$ |
| Hypotension | 1.249 | $1.133-1.376$ | $<0.001$ |
| Blood transfusion | 1.479 | $1.368-1.599$ | $<0.001$ |
| Glasgow Coma Score (GCS)* | 0.912 | $0.894-0.930$ | $<0.001$ |
| Revised Trauma Score (RTS)* | 0.836 | $0.794-0.881$ | $<0.001$ |
| Injury Severity Score (ISS)* | $\mathbf{1 . 0 4 9}$ | $1.046-1.051$ | $<0.001$ |
| Nephrectomy | 1.724 | $1.557-1.909$ | $<0.001$ |

*Each 1-point increase in GCS improved survival by $8.8 \%$ and in RTS by $16.4 \%$; each 1-point increase in ISS worsened survival by $4.9 \%$; each year increase in age worsened survival by $3.3 \%$

## TIME FOR AN UPGRADE: NEW GRADING SYSTEM FOR BLUNT SPLENIC TRAUMA INCORPORATING ANATOMIC INJURY AND CONTRAST BLUSH

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Introduction: The purpose of this study was to determine which grades (I-V) of injury have a significantly higher failure rate in the presence of contrast blush (CB). The results were then used to propose a new grading system that incorporates both anatomic injury and CB to more accurately define failures for nonoperative management (NOM).

Methods: All blunt splenic trauma (BST) patients presenting at a single institution over 11 year period were retrospectively reviewed. Demographics, grade of injury (AAST scale), number of patients that underwent NOM both with and without CB, and failures of NOM were analyzed. Patients that had operative intervention for hemodynamic instability and those that underwent NOM after angio-embolization (AE) for CB were excluded from the study. Failure rates were compared for each grade between patients with CB vs. those without. Statistical analysis was performed using Fisher's exact test.

Results: 539 hemodynamically stable patients were eligible for NOM. Of these 104 (19\%) patients were excluded for AE for CB. The remaining 435 (81\%) patients that underwent NOM were separated into two groups (NO-CB vs. CB) and failure rates were compared based on grade: (NO-CB vs. CB) I ( $1 \%$ vs. $0 \%, \mathrm{p}=1$ ), II ( $2 \%$ vs. $0 \%$, $\mathrm{p}=1$ ), III ( $3 \%$ vs. $67 \%, p=0.02$ ), IV ( $17 \%$ vs. $100 \%, p=0.16$ ), V ( $57 \%$ vs. $100 \%, p=1$ ). In the NO-CB group the failure rate for grade I-III was only $1-3 \%$ with no significant difference between the grades. However, both grade IV and V, had a significantly higher failure rates when compared to I-III for NO-CB group. Therefore, in the new grading system, for NO-CB patients, we can likely combine grades I-III but keep Grade IV and V separate. For the CB group, grades I-II rarely had CB while grades III-V had high failure rates with no significant difference between the grades (67-100\%). The lowest failure rate of $67 \%$ for grade III with CB was higher than the failure rate of $57 \%$ for grade V without CB. This supports the need to modify the current anatomy based grading system to include CB. The following new grading system is therefore proposed (Figure 1). These modifications remove the complex measurements needed with the previous grading system to differentiate between grade I-III and provide more accurate failure rates to guide management decisions based on resources at each individual institution.

Conclusion: A new grading system that incorporates both anatomic injury and CB to more accurately define failures rates of NOM is proposed.

# ZONE III REBOA PLACEMENT: ARE EXTERNAL LANDMARKS ACCURATE FOR PLACEMENT? 

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Introduction: Placement of a REBOA catheter in Zone III of the aorta for temporary control of pelvic hemorrhage in the hypotensive patient has grown in popularity. Appropriate balloon placement is traditionally confirmed with Xray or fluoroscopy, however external landmarks of the umbilicus and the xiphoid process have been used to approximate insertion distance. Although the use of external landmarks for zone I occlusion are well described, there is little data to validate the use of external landmarks for zone III occlusion and underestimation of catheter insertion distance with iliac artery inflation carries significant potential morbidity.

Methods: Using a human cadaver model, external measurements of common anatomic landmarks were made. With a start point of 2 cm distal to the midpoint of the inguinal ligament, measurements included right and left groin to umbilicus (UMB) and groin to xiphoid (XIP). Bilateral groin cutdowns were perfomed and a 7F sheath was inserted into the common femoral artery 2 cm proximal to the profunda femoral artery and an ER-REBOA© catheter inserted and inflated. A laparotomy was then performed and intravascular distance to the proximal (renal arteries) and distal-most (aortic bifurcation) aspect of Zone III recorded. Measurements were correlated to determine accuracy of external landmarks at predicting the internal landing zone.

Results: Bilateral groins of 21 cadavers were used resulting in 42 entries. The mean distance from the groin to the umbilicus ( $15.7 \pm 1.7 \mathrm{~cm}$ ) and the groin to the xiphoid ( $31.6 \pm 2.6 \mathrm{~cm}$ ) was similar on the right and left sides ( $p=0.60$ and $p=0.55$, respectively). Internally, the mean distance to the superior and inferior aspects of ZONE III were $29.3 \pm 2.5 \mathrm{~cm}$ and $23.3 \pm 2.4 \mathrm{~cm}$, respectively, with no significant difference between right and left side ( $p=0.28 ; p=0.60$ ), with an overall Zone III length of 6.0 cm [2.5-9.5cm]. Using the p-tip to umbilicus measurement, the balloon on all catheters (42/42) would be placed below zone III by a mean distance of 7.8 cm [ $3.5-13 \mathrm{~cm}$ ]. Using the p-tip to xiphoid measurement, $24 \%(10 / 42)$ of catheters would occlude at zone III, and $67 \%$ (28/42) would occlude at or distal to the aortoiliac bifurcation missing Zone III by a mean of 1.9 cm [ $0.15-5.35 \mathrm{~cm}$ ].

Conclusion: The landing zone for Zone III REBOA placement is small and the current external landmark measurement of catheter tip to xiphoid process is poor at estimating safe balloon occlusion zone and results in iliac artery placement in $2 / 3$ of patients. Using external landmarks alone for Zone III occlusion should be done with caution.

# TRUST THE FAST: CONFIRMATION THAT A POSITIVE FAST EXAM IS HIGHLY SPECIFIC IN OVER 1,000 PATIENTS WITH PELVICFRACTURES 

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Introduction: Use of the Focused Abdominal Sonography for Trauma (FAST) exam in patients with pelvic fractures has been reported as unreliable. We hypothesized that FAST is a reliable method for detecting clinically significant intra-abdominal hemorrhage in patients with pelvic fractures.

Methods: All patients with pelvic fractures over a 10-year period were reviewed at a Level I trauma center. FAST exam results were compared with computed tomographic (CT) findings and/or findings at laparotomy.The predictive ability of FAST was assessed by calculating the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the examination in this cohort. The FAST exam was considered "false negative" if findings at laparotomy indicated traumatic intra-abdominal hemorrhage. Likewise, the FAST exam was considered "false positive" if findings at laparotomy indicated no intra-abdominal hemorrhage or CT scan failed to demonstrate intra-abdominal fluid or injury. Hemodynamic Instability Scores (HIS) were calculated for all patients.

Results: 1460 patients with pelvic fractures and an initial FAST were reviewed;1192 underwent FAST and either CT or operative exploration. Mean age was $42.7 \pm 19.7$ yeafs and ISS was $17.8 \pm$ 12.0. The sensitivity and specificity for

|  | Confirmed ( + ) | Confirmed ( - ) | Total Patients |
| :--- | :---: | :---: | :---: |
| FAST $(+)$ | 76 | 18 | 94 |
| FAST $(-)$ | 46 | 1052 | 1098 | FAST in this group of patients with pelvic

fracture was $62.3 \%$ and $98.3 \%$, respectively. The PPV and NPV were $80.9 \%$ and $95.8 \%$, respectively. Of patients with a positive FAST and identified negative findings, 15 (83.3\%) were confirmed with a negative CT scan, and 3 ( $16.7 \%$ ) underwent laparotomy without findings of intra-ableminel hemorrhage. Of patients with a negative FAST exam and confirmed positive findings (46 patients, $3.5 \%$ of all FAST negative patients), all were identified at laparotomy. The specificity remained high regardless of HIS grade.

| HIS Grade 0 | 1013 | 85.0 |
| :--- | :--- | :--- |
| HIS Grade 2 | 47 | 3.9 |
| HIS Grade 3 | 48 | 4.0 |
| HIS Grade 4 | 41 | 3.4 |
| HIS Grade 5 | 24 | 2.0 |
| Data Unavailable | 19 | 1.6 |

Conclusion: A positive FAST exam in a patient with a pelvic fracture is highly specific for intra-abdominal fluid. These data suggest that a positive FAST in this clinical scenario should be considered to represent intra-abdominal fluid. This series contradicts prior reports that FAST is unreliable in patients with pelvic fracture.

Poster \# 14

# HYBRID EMERGENCY ROOM SYSTEM (HERS) IMPROVES TIMELINESS OF ANGIOEMBOLIZATION FOR PELVIC FRACTURE 

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Introduction: Timely angioembolization (AE) is well known to improve outcomes of patients with hemorrhage due to pelvic fracture. In July 2017, our institution installed a hybrid emergency room system (HERS) equipped with a computed tomography scanner, fluoroscopy, and operating room set-up. In the HERS, surgeons and interventional radiologists (IRs) can perform damage control surgery and AE simultaneously or subsequently. We hypothesized that the HERS improves the timeliness of AE for pelvic fracture.
Methods: A retrospective medical record review was performed for patients who underwent AE for pelvic fracture at our institution (4/2015-12/2018). Patients’ demographics, the location of AE, the injury severity score (ISS), the revised trauma score (RTS), the probability of survival by the trauma and injury severity score (TRISS) method, the activation of a massive transfusion protocol (MTP), the presence of surgeons and IRs upon patient arrival, the time from arrival to AE, the type of procedures, and the in-hospital mortality rate were analyzed. These data were compared between patients who underwent AE in the regular angio-suite (Non-HERS group) and in the HERS (HERS group).
Results: In total, 96 patients met the inclusion criteria. The Non-HERS group comprised 72 patients, and the HERS group comprised 24 patients. Compared with the Non-HERS group, the HERS group had a higher incidence of MTP activation, simultaneous or subsequent surgery, and performance of resuscitative endovascular balloon occlusion of the aorta. Surgeons and IRs were more frequently present upon patient arrival in the HERS than Non-HERS group. The time from arrival to AE was shorter in the HERS than NonHERS group. The time spent in the emergency room was longer in the HERS than NonHERS group. There were no differences in the rates of infectious complications or inhospital mortality between the two groups. Survivors in the HERS group had a higher ISS, RTS, and probability of survival by the TRISS method than survivors in the Non-HERS group (Table 1).
Conclusion: The HERS improved the timeliness of AE for pelvic fracture. More severely injured patients were able to survive in the HERS. Simultaneous or subsequent surgery could be performed in a timely fashion. The new team building involving the addition of IRs to the traditional trauma resuscitation team will enhance the benefit of the HERS. Further study is warranted to establish a standardized protocol for care of trauma patients in the HERS.

Table 1. Outcomes of patients who underwent angiocmbolization for petvic fracture

|  | Non-HERS group ( $\mathrm{n}=72$ ) | HERS group ( $\mathrm{n}=24$ ) | P value |
| :---: | :---: | :---: | :---: |
| ISS | $29(9-57)$ | $35(17-57)$ | 0.849 |
| ISS in survivors | 27 (9-57) | $36(17-57)$ | 0.405 |
| RTS | 7.8 (0-7.8) | 6.1 (2.6-7.8) | 0.012 |
| RTS in survivers | 7.8 (2.6-7.8) | $5.7(2.6-7.8)$ | 40.001 |
| TRISS Pr. \% | $90(1-99)$ | 60 (1-98) | 0.356 |
| TRISS Ps in survivers, \% | 93 (1-99) | 61 (1-98) | cli.001 |
| Massive transfusion protocol activation | 23 (32\%) | 17 (71\%) | 0.001 |
| Surgeons present on patient arrival | 51 (71\%) | 22 (92\%) | 0.030 |
| IRs present on patient arrival | 15 (22\%) | 19 (79\%) | <0.001 |
| Simultancous or subsequent surgery | 12 (17\%) | 13 (54\%) | 0.001 |
| Surgery first | 7 (6.4\%) | 1 (8\%) | 0.006 |
| REBOA | 8 (11\%) | 7 (29\%) | 0.042 |
| Time to AE, minutes | 103 (2-690) | 46 (5-75) | <0,001 |
| AE time, minutes | 65 (24-150) | 53 (25-149) | 0.719 |
| Time spent in the ER, minutes | 40 (17-186) | $150(30-343)$ | 40,001 |
| Infectious complications | $8(11 \%)$ | 3(13\%) | 0.553 |
| In-hospital mortality | 11 (15\%) | 3(13\%) | 0.516 |
| Data are presented as median (range) or n (\%), ISS, injury severity score; HERS, hybrid emergency room system; RTS, revised trauma score; TRISS Ps, probability of survival by trauma and injury severity score method: IRs, interventional radiologists; REBOA, resuscitative endoyascular balloon occlusion of the aoota; AE, angiocmbolization; ER, einergency room |  |  |  |

# RISK FACTORS FOR DUODENAL REPAIR LEAK AFTER TRAUMA- A PANAMERICAN MULTI-CENTRIC TRIAL 

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Introduction: Leak after repair of duodenal injury (DI) increases morbidity and mortality. We performed a secondary analysis of a retrospectively collected database conformed from 11 Panamerican Trauma Society centers to identify risk factors of leak after repair of DI.
Methods: Patients $\geq 18$ years old with repair of DI from 2006 to 2017 were included. Deaths in the first 48 hours were excluded. Demographics, mechanism, injury severity, associated injuries, transfusions and type of repair were examined as potential risk factors for leak. Multiple logistic regression (MLR) modeling was used to identify independent risk factors for leak.
Results: A total of 308 patients were included. Penetrating trauma occurred in 234, ( $76.0 \%$ ). Duodenal leak after repair developed in 52 subjects (16.9\%). Compared to those without leak, patients with leak had significantly lower SBP at admission, higher ISS, higher abdominal AIS, and a higher proportion of AAST III, IV and V DI.Complex repair was performed more frequently in patients who leaked. Pancreatic and major vascular injury did not predict leak.

Table. MLR analysis of independent risk factors of leak of duodenal repair.

| Variable | OR (95\% C.I.) | p-value |
| :--- | :---: | :---: |
| Hypotension, SBP $<90 \mathrm{~mm} \mathrm{Hg}$ | $3.108(1.434-6.737)$ | 0.004 |
| Abdominal AIS | $1.764(1.205-2.583)$ | 0.004 |
| Duodenal AAST grade $\geq 3$ | $1.434(1.011-2.034)$ | 0.043 |
| Surgical treatment |  |  |
| Primary repair, (reference) | 1 |  |
| Suture + duodenostomy | $5.678(1.957-16.473)$ | 0.001 |
| Complex repairs | $5.572(2.334-13.293)$ | $<0.001$ |
| Area under ROC curve $=0.810(0.748-0.873)$ | Goodness of fit $p=0.298$ |  |

MLR identified hypotension, abdominal AIS, duodenal AAST severity $\geq 3$ and type of repair as independent predictors (table).
Conclusion: Hypotension, severity of abdominal trauma and severity of duodenal trauma independently predicted leak. Primary repair with duodenostomy and more complex repairs were associated with significantly higher rates of leak compared to primary repair alone.

## Poster \# 16

## CONTEMPORARY USE OF RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA: ARE WE CHOOSING THE RIGHT PATIENT?

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Introduction: There have been conflicting reports on the patient outcomes by using resuscitative endovascular balloon occlusion of the aorta (REBOA) in trauma. While clinical indications for REBOA differ between institutions, it is typically indicated for non-compressible truncal hemorrhage (NCTH), and contraindicated for severe head, neck, and thoracic injuries as it can potentially increase blood loss. A large majority of earlier studies were performed at a single center and few at major Level 1 trauma centers. It remains unknown how REBOA is utilized in the United States. We hypothesized that REBOA might often be used for trauma patients for whom REBOA is not indicated.

Methods: This is a retrospective cohort study using the American College of Surgeons Trauma Quality Improvement Program (ASC-TQIP). We included patients who underwent REBOA from January to December 2016. We defined an appropriate REBOA candidate as a patient with: 1) abdominal organ injuries or pelvic fractures (AIS $\geq 3$ ), and 2) no associated severe head, neck, face, or thoracic injuries (AIS $\geq 4$ ). We compared patient demographics, injury severity and clinical outcomes between REBOA candidates and non-candidates.
Results: A total of 71 patients were included. Median age was 48 (IQR: 29-62), 73.2\% were male. A large majority of patients sustained blunt trauma ( $88.7 \%$ ) and median ISS was 29 (IQR: 21.5-40.5). A median time to REBOA use was 96 min (IQR: 39.8-261.7). Of those, 42 patients (59.2\%) met the injury criteria for the use of REBOA. On the other hand, 29 patients ( $40.8 \%$ ) were considered non-candidates. In-hospital and 24-hour mortality were significantly higher in the non-candidate group ( $62.1 \%$ vs. $31.0 \%$, $\mathrm{p}=0.019$ and $27.5 \%$ vs. $11.9 \%, \mathrm{p}=0.04$, respectively).
Conclusion: Our data suggest that REBOA was often used for patients who did not meet the injury criteria currently recommended in the guidelines. The use of REBOA in non-candidates was associated with a significantly higher mortality.

| Variables | Candidate group <br> $(\mathbf{n}=\mathbf{4 2})$ | Non-candidate group <br> $(\mathbf{n}=\mathbf{2 9})$ | $\mathbf{p}$ value |
| :--- | :---: | :---: | :---: |
| Median age (IQR) | $45(30-58)$ | $50(29-64)$ | 0.38 |
| Male sex $(\%)$ | $34(81.0)$ | $18(62.1)$ | 0.08 |
| GCS $<9(\%)$ | $10(23.8)$ | $16(55.2)$ | 0.008 |
| RR $>20(\%)$ | $8(19.0)$ | $12(41.4)$ | 0.046 |
| Median ISS (IQR) | $28(21-34)$ | $36(29-50)$ | 0.007 |
| Laparotomy (\%) | $13(31.0)$ | $10(34.5)$ | 0.96 |
| Angioembolization (\%) | $14(33.3)$ | $10(34.5)$ | 0.90 |
| Level 1 center (\%) | $27(64.3)$ | $16(55.2)$ | 0.71 |

Poster \# 17

## PROXIMAL ARTERIAL PRESSURE AND ASSOCIATED DISTAL BLOOD FLOW PATTERNS DURING RESUSCITATIVE ENDOVASCULAR BALLON OCCLUSION OF THE AORTA

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Introduction: Resuscitative endovascular balloon occlusion of the aorta (REBOA) and partial REBOA (pREBOA) are novel adjuncts for noncompressible truncal hemorrhage. To date, distal blood flow during partial occlusion is poorly characterized. This study aims to compare proximal arterial pressure to distal aortic and visceral blood flow with standard REBOA and prototype partial REBOA devices.
Methods: Twenty Yorkshire swine (35-55kg) were randomized to normal physiologic conditions with zone 1 REBOA ( $\mathrm{nSR}, \mathrm{n}=5$ ) vs pREBOA ( $\mathrm{nPR}, \mathrm{n}=5$ ) or a $20 \%$ controlled hemorrhage and iliofemoral vascular injury with zone 1 REBOA (iSR, n=5) vs pREBOA (iPR, n=5). Distal aortic and superior mesenteric artery (SMA) flow, and proximal arterial pressures were monitored. Balloon occlusion was sequentially deflated in a stepwise fashion from complete occlusion ( $0 \mathrm{~L} / \mathrm{min}$ ) to full aortic flow of $1 \mathrm{~L} / \mathrm{min}$.
Results: Two iPR animals were excluded due to early demise from non-study factors. The nSR cohort displayed distal aortic to SMA flow ratios suggestive of significantly decreased SMA perfusion compared to nPR at all aortic flow rates (all $\mathrm{p}<0.05$ )(Fig. 1). In the hemorrhage cohorts, iSR displayed proximal arterial pressure to distal aortic flow ratios suggestive of a greater reliance on proximal pressures for downstream perfusion compared to iPR at all aortic flow rates (all $\mathrm{p}<0.05$ ) (Fig. 2), with an equivalent reliance on proximal arterial pressure for visceral perfusion in both cohorts.
Conclusion: pREBOA demonstrated equivalent or superior distal blood flow profiles compared to its standard REBOA counterpart during normal and hemorrhagic shock conditions. Proximal arterial pressures may be used to predict distal aortic blood flow during resuscitation and pREBOA devices may be associated with favorable distal vascular response and fluid dynamics.


# INITIAL EXPERIENCE IN MINIMALLY INVASIVE SURGERY IN DIAGNOSIS AND TREATMENT OF PENETRATING INJURIES 

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## Introduction:

In the last decades the minimally invasive approach has become the standard of care for elective abdominal and thoracic surgeries. However in penetrating trauma its use is still controversial due to the initially increased risk of missedinjuries.

The aim of this study was to describe our initial results of a minimally invasive approach for thoracic and abdominal penetrating injuries.

## Methods:

Prospective study that included the first 50 patients operated between January 2017 and June 2018. Inclusion criteria were: penetrating abdominal or thoracic trauma, hemodynamically stable patients, trained laparoscopic surgeon available. Patients candidates to non operative care were excluded. All patients underwent preoperative CT scan. Perioperative data, surgery videos and 90 -day follow up were analyzed.

## Results:

A total of 50 patients with penetrating trauma underwent a minimally invasive procedure during the study period, $94 \%$ were male. Thirty-two patients underwent a laparoscopic approach, 18 a video-assisted thoracoscopic surgery (VATS) and one patient had a combined abdominal and thoracic approach. Stab wounds (SW) accounted for $70 \%$ of the injuries.
In the laparoscopic group, $46.8 \%$ of the patients underwent a diagnostic laparoscopy and 46.8 underwent a therapeutic laparoscopy . Conversion rate was $6.2 \%$ mainly at the beginning of the series with no differences between SW and GSW. Therapeutic laparoscopies included diaphragm suturing, liver hemostasis, small bowel and gastric suturing, small bowel resection and anastomosis, colon repair and bladder repair. Average length of stay was 3.4 days (range 1-9). Two patients had complications, one managed endovascular and one reoperation because of a pararectal abscess.
In the VATS group, all patients underwent a therapeutic procedure, and 1 patient was converted to an open approach. The most common indication was hemothorax and most patients underwent hemostasis of the thoracic wall. Average length of stay was 3.8 days (range 2-8). No missed injuries were identified in this initial experience. No complications were identified during followup.

## Conclusion:

A minimally invasive approach can be utilized for hemodynamically stable patients. The adequate selection of patients and the presence of a traine MIS surgeon is the key factor to positive results.

# ARE DECREASED RATES OF SPLENECTOMY FOR BLUNT SPLENIC INJURY JUSTIFIED? 

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Introduction: Non-operative management (NOM) of blunt splenic injury (BSI) and the use of splenic angioembolization (SAE) has increased over time. A recent National Trauma Data Base study showed splenectomy is performed in $24 \%$ of patients with high-grade BSI. Our goal is to quantify changing trends in the management of BSI at our institution. We hypothesize the rate of splenectomy for BSI continues to decrease.
Methods: We identified patients (pts) with BSI $\geq 16$ years old from 2012 to 2017 using our institutional trauma registry. After IRB approval, medical records were reviewed for demographic information, AAST splenic injury grade, volume of hemoperitoneum, presence of contrast blush, management strategy, admission systolic blood pressure (SBP $<90$ ), injury severity score (ISS) and survival. CT scans were reviewed by radiologists blinded to care to assign injury grade, hemoperitoneum volume and contrast blush. Management strategy was characterized as operative (splenectomy, splenorrhaphy or laparotomy only) versus non-operative (NOM) (with SAE considered an adjunct to NOM). Failure of NOM was defined as surgery, either splenectomy or splenorrhaphy, or death from hemorrhage after initial intention to treat non-operatively. Age > 55, AAST Injury Grade, ISS, SBP < 90, and/or presence of large hemoperitoneum on CT scan were analyzed for association with splenectomy. We utilized binary logistic regression procedures to calculate odds ratios to determine the effect on splenectomy rate.
Results: 325 pts with BSI were identified. Ages ranged from 16 to 101 (mean: 41) with $26 \%$ of pts $\geq 55$ years of age. AAST injury grades were as follows: I-87; II-104; III-65; IV-45: V-13. Eleven pts were not imaged and went directly to the OR. The ISS ranged from 4 to 75 (mean 22). 28 pts ( $8.6 \%$ ) presented with SBP $<90$ or MAP $<60$. A contrast blush was present on CT imaging in 82 ( $25 \%$ ) pts. Large volume hemoperitoneum was present in 109 (33\%) pts. Successful NOM was achieved in $89.8 \%$ of pts, with $15.8 \%$ of these pts undergoing SAE. Splenectomy was performed in $7.7 \%$ of pts with BSI; $3.4 \%$ underwent urgent splenectomy without imaging and $4.3 \%$ underwent splenectomy after CT imaging. Nine pts (3.1\%) failed NOM; seven of these pts proceeded to splenic surgery while two died (ISS 12 and 17). The overall mortality rate for all pts with BSI was $6.4 \%$. Splenectomy was most common in grade IV or V BSIs (6.7\% and 15.4\%). SAE was utilized frequently for high grade injuries (IV and V) with $46.7 \%$ of grade IV injuries and $69.2 \%$ of grade V injuries undergoing SAE. Factors significantly associated with splenectomy were AAST Injury Grade ( $\mathrm{p}=.009$ ), ISS ( $\mathrm{p}=.001$ ), and SBP $<90$ ( $\mathrm{p}=.010$ ). When controlling for all variables, however, enlarged hemoperitoneum was the only significant predictor in the full model ( $\mathrm{OR}=3.086, \mathrm{p}=.028$ ). Stepwise procedures revealed enlarged hemoperitoneum ( $\mathrm{OR}=3.745, \mathrm{p}=.005$ ) to be the main predictor of splenectomy, controlling for ISS ( $\mathrm{OR}=1.034, \mathrm{p}=.043$ ).
Conclusion: The rate of open splenectomy for BSI continues to decrease compared to historical controls. The strongest association with the need for splenectomy was large hemoperitoneum. This may indicate that large hemoperitoneum strongly influences the decision to proceed with surgery in stable BSI pts. BSI is more commonly managed with NOM and SAE at our institution even in pts with high-grade BSI. Our data suggests the trend towards increased NOM is safe and effective given the low rate of failure of NOM and mortality.

# SALT IN THE WOUND: DRIER PATIENTS, AND FASTER FASCIAL CLOSURE AFTER PENETRATING ABDOMINAL INJURY 

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Introduction: Hypertonic saline (HTS) improves primary fascial closure (PFC) rates in unselected injured patients undergoing damage control laparotomy (DCL). Previous reports have not specifically investigated those requiring DCL after penetrating abdominal trauma. Higher rates of operative management in this population make it ideal to study the effects of HTS. We hypothesized HTS infusion results in an improved PFC rate, decreased time to PFC, and reduces total crystalloid volume at the expense of sodium loading.
Methods: We retrospectively analyzed all penetrating abdominal injury patients undergoing DCL (January 2015 to December 2018). We compared patients who received $3 \%$ HTS at $30 \mathrm{ml} / \mathrm{h}$ to those only receiving isotonic fluid resuscitation while the fascia was open. Intergroup comparisons were by ANOVA and Tukey's comparison, students $t$, and Chi square tests.
Results: Fifty-five patients (pt) underwent DCL (HTS =14 pt, isotonic fluid =41 pt). Age ( 35.4 yrs v. 33.5 yrs, $p=0.6797$ ), gender ( $100 \%$ v. $97.6 \%$ male, $p=>0.999$ ), and ISS ( $32.6 \mathrm{v} .25 .25, p=0.5611$ ) were similar between groups. More HTS patients achieved PFC ( $100 \%$ v. $73.5 \%$; $p=0.021$ ) within 3 days. PFC was achieved more rapidly in HTS ( $36.49 \mathrm{hrs} v .59 .05 \mathrm{hrs} ; p=0.0127$ ) (Figure 1). Mean 24-hour fluids were significantly less in HTS (5.2L vs. 8.6L, $p=0.0129$ ), reducing total body water by 3.4 L . Peak sodium ( Na ) $\mathrm{mEq} / \mathrm{L}$ and DNa during the first 72 hours were increased in the HTS group (146 v.142, $p=0.0016,5.1 \mathrm{v} .2 .3$, $p=0.016$ ).
Conclusion: HTS significantly reduces time to PFC and total crystalloid volume over 24 hours but did so at the expense of increased 72 hours Na concentration. Reduced total body water may underpin successful PFC and is a controllable element during resuscitation and DCL management.

## Time to PFC



# Early Health and Social Outcomes are Demonstrated for Participants in Hospital Based Violence Intervention Programs 

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Introduction:
Recidivism is usually reported as the measure of success for Hospital Based Violence Intervention Programs (HVIPs). However, recent literature suggests time to re-injury to average 4 years. 30 HVIPs are exclusive sustained by funding that is renewed annually and cannot practically be expected to report a recidivism in that time. Early outcome successes are predictive to HVIP success (housing, employment, and mental health), therefore we suggest that reporting early health outcomes creates a mechanism for nascent programs to report their successes. The purpose of this study was to report the early positive outcomes of a nascent HVIP.

Methods:
The case management records of a nascent HVIP were reviewed from July 2017-December 2018. Patients demographics and reported needs at initial evaluation were evaluated. The attainment of these needs at the time of study completion is reported. Subset analysis was performed on individuals who "completed" the HVIP. Results:

120 patient records were reviewed. 11 (9\%) were lost to follow up after program consent. On intake, 24 (20\%) reported a need for further education, 64 (53\%) were in unstable housing situations, 95 (79\%) were unemployed or underemployed, 109 (91\%) were uninsured or underinsured for healthcare, 37 (31\%) required assistance with the criminal justice system and 98 (82\%) reported a need for mental health services. Alcohol abuse was identified in $1.7 \%$ of enrolled patients and illicit drug use in $24 \%$ of patients, $80 \%$ of which was isolated marijuana use. $50 \%$ of enrollees were scored as "moderate risk" or "high risk" by initial case worker assessment.
Ninety (75\%) patients received information or referral, 102 (85\%) obtained personal advocacy and 54 ( $44 \%$ ) successfully applied for Victims of Crime Compensation funds. Of the initially identified needed services, 7 (29\%) achieved education goals, 23 (35\%) obtained stable housing, 13 (14\%) became employed, 19 (17\%) obtained health insurance, 13 (35\%) obtained assistance with the criminal justice system and 65 (66\%) obtained mental health services. Seventeen (11\%) of participants completed the program when all personal goals were attained. Nine (53\%) had more than one accomplishment. The accomplishments were: gaining employment ( $n=10,59 \%$ ), finishing high school, trade school or GED ( $n=7,41 \%$ ), enrolling in mental health services ( $n=10,59 \%$ ), and obtaining health insurance ( $\mathrm{n}=4,23.5 \%$ ).
Conclusions:
HVIPs have been reported to decrease recidivism, but this metric may be imperfect as it can depend on ecological factors. Recidivism is difficult to capture both temporally and geographically, particularly for new programs. We suggest that early outcomes may be a better outcome measure for HVIPs and report such outcomes of a nascent HVIP. A longitudinal study linking early outcomes to decreased recidivism is needed, and a multicenter outcomes study is needed to provide benchmarking for program quality assessment.

POSTER \#22-WITHDRAWN

# TRAINING ON A VIRTUAL REALITY CRICOTHYROIDOTOMY SIMULATOR IMPROVES SKILLS AND TRANSFERS TO A SIMULATED REAL-WORLD PROCEDURE 

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Introduction: Cricothyroidotomy is a last resort emergency procedure for patients who cannot be intubated by conventional means and would otherwise face impending death. This procedure is done infrequently and training is needed for teaching and retention of the skill set. Currently, training is based on mannequin or animal models, which cannot simulate difficult airway situations. The Virtual Airway Skill Trainer (VAST-CCT) is a virtual reality simulator that was developed to train in the cricothyroidotomy procedure. The goal of the study is to test the effectiveness of training and transfer of skills of the VAST-CCT.
Methods: The study was a between subjects design with two groups, control and simulation. Subjects in the control condition did not receive any training on the task, while those in the simulation received training for ten sessions on the task over a period of two weeks. The subjects performed four critical steps in cricothyroidotomy on the simulator including 1) identifying landmarks, 2) making incision on the skin, 3) puncturing and dilating the cricothyroid membrane, and 4) intubation.
Proficiency based training model was used with subjects demonstrating proficiency score for at least two consecutive repetitions at each training session. Two expert trauma surgeons repeated the task on the simulator for five times to compute the proficiency benchmark. At the beginning of the study, both groups performed the task once on the simulator (pre-test) after which the simulation group commenced their training. Two weeks later, both groups performed the task once on the simulator (post-test) and twice on the TraumaMan (Simulab inc.) mannequin to demonstrate the transfer of skills. Subjects' performance was automatically recorded on the simulator, which included a performance score computed based on the accuracy of performance on the four tasks (maximum of 40) and completion time in seconds.
Subjects performance on the TraumaMan was evaluated using checklists, task completion time and intubation quality.
Results : The proficiency score based on experts ( $n=2$ ) performances was ( $34 \pm 4$ ). A total of $\mathrm{n}=7$ subjects (control $=3$, simulation $=4$ ) participated in the study. Paired samples $t$-test between pre and post-tests showed significant difference for the simulation group on both time ( $235.25 \pm 93$ vs $41.5 \pm 12.6, p=0.021$ ) and score ( $15 \pm 9.6$ vs $37 \pm 2, p=0.03$ ). No differences in performance was found for the control group for time ( $145 \pm 54.5$ vs $134.6 \pm 53.2$, $p=$ 0.115 ) and score ( $31.3 \pm 1.5$ vs $27 \pm 6.5, \mathrm{p}=0.34$ ). Between group analysis using an independent samples t-test showed significant differences at the post-test for both time (control $=134.6 \pm$
53.2 vs simulation $=41.5 \pm 12.6, \mathrm{p}=0.018$ ) and score (control $=27 \pm 6.5$ vs simulation $=37 \pm$ $2, \mathrm{p}=0.032$ ). Analysis of performance on the mannequin showed that the simulation group performed better on intubation calculated based on the endotracheal tube insertion depth than the control group (control $=1.6 \pm 2.6$ vs simulation $=8.1 \pm 3.7, p=0.003$ ).
Conclusion: The results from even a small sample size clearly shows the effectiveness of VASTCCT in training various steps of the cricothyroidotomy procedure as well the transfer of skills to real-world situation as demonstrated by performing on the TraumaMan mannequin


# THE BURDEN OF THE UNHELMETED MOTORCYCLIST ON A STATE WITHOUT A UNIVERSAL HELMET LAW: A PROPENSITY SCORE ANALYSIS 

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Introduction: Although helmets are associated with reduction in both mortality and cost of care of motorcycle collisions, many states, including Arizona, have failed to adopt universal helmet laws for motorcyclists, in part on the grounds that much of the existing research is limited by study design (eg. historical controls) and confounding variables. The goal of this study was to evaluate the statewide impact of helmet use in motorcycle collisions on hospital charges and mortality in trauma patients with propensity score analysis.

Methods:Motorcycle collision data from the Arizona State Trauma Registry from 2014-2017 were propensity score matched by regressing helmet use on patient age, gender, race, alcohol intoxication, illicit drug use, and comorbidities. Linear and logistic regression models were used to evaluate the impact of helmet use.

Results:Our cohort included 5,292 adult patients consisting of 2,646 propensity matched pairs. The cohort was $87.1 \%$ male with an average age of $42.4 \pm 15.6$ years. There were not significant between group differences for patient age ( $\mathrm{P}=0.771$ ), gender ( $\mathrm{P}=1.000$ ), race ( $\mathrm{P}=1.000$ ), alcohol intoxication ( $\mathrm{P}=1.000$ ), illicit drug use ( $\mathrm{P}=1.000$ ), the presence of one or more comorbidity ( $\mathrm{P}=0.826$ ), or injury severity score ( $\mathrm{P}=0.076$ ). Helmeted patients were less likely to be admitted to the ICU ( $20.6 \%$ vs. $24.2 \%$, OR $0.81[0.71$ 0.92 ) or be ventilated ( $7.3 \%$ vs $12.1 \%$, OR 0.57[0.47-0.69]). Propensity matched analyses demonstrated helmet use to be associated with a $10.9 \%$ decrease in hospital charges ( $B-0.12[-0.18-0.05]$ ) and a $56 \%$ decrease in mortality (OR $0.44[0.33-0.60]$ ).

Conclusion:In a state without mandated helmet use for all motorcyclists, the burden of the un-helmeted rider is significant with respect to lives lost and healthcare costs incurred. Although the helmet law debate with respect to civil liberties is complex and unsettled, it appears clear that helmet use is strongly associated with both survival and less economic encumbrance on the state.

## URBAN GUN VIOLENCE: PARTNERING WITH LAW ENFORCEMENT TO UNDERSTAND THE EPIDEMIC

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Introduction: Gun violence represents $10 \%$ of trauma admissions at our urban level 1 trauma center. Self-defense, hunting, and sport are primary reasons for gun ownership (Gallup 2013), but data on the circumstances of gunshot wounds (GSWs) is scarce. To inform fact-based conversations, we partnered with police to identify official circumstances of GSWs and health resource allocation. Criminal recidivism and factors related to suspect identification were also evaluated.

Methods:Police and court records were reviewed to identify GSWs in our city in 2015. Demographics, criminal history, and circumstances of gun use were recorded. Registry data for GSWs treated at our level 1 center was used for injury characteristics, outcomes, and hospital costs. Bivariate analysis identified victim factors associated with suspect identification.

Results:Manual review of 30,000 archived police records identified 688 GSWs. Lawful self-defense or accidents accounted for $2 \%$ with only 4 self-defense cases. Of the 423 GSWs (61\%) treated at our center, $44 \%$ were admitted and $29 \%$ required operation. Emergency room only costs averaged $\$ 12,500$ vs. $\$ 28,000$ per admission, a burden of $\$ 12$ million for the city.
Prior charges were noted in $62 \%$ of victims; $38 \%$ had future charges, and $32 \%$ had both prior and future charges. Suspects were named in only $23 \%$ of cases and only $40 \%$ of those suspects received convictions. Suspects had prior charges in 55\% of cases; 23\% had future charges and $17 \%$ had both. Victims with prior records ( $17 \%$ vs $22 \% \mathrm{p}=0.047$ ), male gender ( $18 \%$ vs $31 \% \mathrm{p}=0.006$ ), black race ( $18 \%$ vs $33 \% \mathrm{p}=0.007$ ), and injury severity score less than 15 ( $15 \%$ vs $35 \% \mathrm{p}<0.001$ ) had fewer suspects identified.

Conclusion:The circumstances of urban GSWs do not correlate with stated reasons for gun ownership. Gun violence represents a potentially preventable injury but appears resistant to current legal interventions as evidenced by low suspect identification and criminal recidivism.

# STOP THE BLEED: REPORT ON A STATE-WIDE BLEEDING CONTROL PROGRAM FOR THE PENNSYLVANIA STATE POLICE 

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Introduction: The Stop the Bleed (STB) program was initiated in 2015 as a result of the Hartford Consensus and has been promulgated nationally as a life-saving course to prevent death from hemorrhage. State Police officers are frequently immediate responders at the scene of an injury providing life-saving first aide to control hemorrhage, prior to EMS arrival. This study sought to examine the comfort level and knowledge of Pennsylvania (PA) State Police officers (PSP) in correctly instituting STB techniques as part of a standardized statewide educational initiative provided by trauma centers (TC) in PA in partnership with the leadership of the PSP and PA Trauma Systems Foundation.
Methods: Standardized STB courses were administered by 32 PA TC during an eight-month period in 2018 to all PSP officers utilizing a standardized curriculum with administration of questionnaires prior to and immediately following the training. Classroom and hands-on instruction consisted of teaching principles of hemorrhage control including direct pressure and tourniquet application. Each PSP officer received a free tourniquet as part of the training. Basic demographic information was collected on gender, age, prior tourniquet training and whether tourniquets had ever been applied. Data analysis consisted of chi-square analysis and McNemar Change tests for pre and post training results. A dependent t-test was calculated on the total score which was the sum of each of the seven training items giving a single point for each item answered correctly.
Results: 4200 State Police were educated by 32 TC. Pairs of pre and post education questionnaires were collected from 1,287 PSP officers undergoing STB education during the training period. Of this sample, $91.5 \%$ were male, and mean age was $37.1 \pm 8.37$ with a range of 22 to 62 years of age. Of the sample, $65.5 \%$ had received prior training in tourniquet use and $10.7 \%$ had used a tourniquet before this training. Statistically significant gains in education were shown pre to post education on five of seven items including: Where should a tourniquet be placed with respect to the bleeding source? ( $\mathrm{p}<0.001$ ), How much slack should be present, before tightening the windlass? $(\mathrm{p}<0.001)$, How many twists of the windlass should be used? ( $p<0.001$ ), Life threatening bleeding is described as all of the following EXCEPT ...? $(\mathrm{p}<0.001)$ and, Before offering help to an injured patient you must $\ldots$ ? ( $\mathrm{p}<0.001$ ). A trend to significance was shown for one item: Bleeding Control can be obtained by ...? $(\mathrm{p}=0.055)$. The overall gain in average number of correct responses was statistically significant ( $\mathrm{p}<0.001$ ) from pretest $(4.03 \pm 1.39)$ to posttest ( $5.63 \pm 1.03$ ). Prior to training, $58.2 \%$ of respondents felt "Extremely" or "Somewhat comfortable" applying a tourniquet and after training 99.1\% reported they would now be "Extremely" or "Somewhat comfortable" applying a tourniquet ( $\mathrm{p}<0.001$ ).
Conclusions: Stop the Bleed education conducted in a statewide program administered by TC to PSP officers increased the comfort level of officers in applying tourniquets and understanding principles of bleeding control techniques. The feasibility of providing high quality, standardized training to a large group of immediate responders across a large geographic area was demonstrated. Further research is recommended in studying long term retention of information and whether the education proved useful in controlling hemorrhage in actual bleeding patients.

# MASS CASUALTY INCIDENT (MCI) SIMULATION WITHOUT MASS EXPENDITURE: A NOVEL MCI CURRICULUM FOR TEACHING RESIDENTS CORE CONCEPTS OF DISASTER MANAGEMENT 

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Introduction: Mass casualty incidents (MCIs), both conventional and terrorist, are becoming more common in the US. During general surgery residency, there is a lack of formal training on the principles of disaster management required to effectively triage and treat patients during a MCI. We developed a 2-hour long MCI session including simulation geared towards filling the aforementioned training gap.
Methods: Our MCI session consisted of: 1) a 30 minute didactic session reviewing core disaster management principles, including triage, 2) a tabletop mass shooting simulation and 3) a debriefing. Prior to the session, participants took a pre-test assessing for prior training and experience as well as confidence with basic disaster management principles. For the simulation, surgical residents worked in groups to assess paper patients in a multi-staged triage and treatment simulation, needing to accurately triage patients using START criteria prior to advancing the patient to the next tier of care. This was followed by a post-test to assess for an increase in confidence as well as to solicit feedback on the quality of the session. Pre- and posttest scores for the self-assessment component were analyzed using a Wilcoxon signed-rank test with a p-value $<0.05$ considered significant.
Results: Thirty PGY 1 and 2 residents participated over 2 sessions. Background experiences varied: half rotated on a trauma service as students and/or as residents. Seven percent of individuals had prior EMT training, while 20\% had prior disaster management or MCI training. Seven percent had participated in patient triage during an actual MCI. During the 2 simulations, a total of 159 triage decisions were made. Of those, $84 \%$ were correct. There was a $7 \%$ under- and $9 \%$ over-triage rate. All participants showed a significant increase in confidence regarding principles of MCI management (Table). All participants scored the simulation $\geq 4$ on a 5 point Likert scale for being both valuable and engaging.
Conclusion: This tabletop MCI simulation is an effective method of teaching residents the core disaster management principles needed to effectively navigate a MCI, with triage rates comparable to published standards and an increase in confidence with these principles. Furthermore, it is inexpensive and easy to implement within any residency curriculum, affording training programs a unique tool to teach trainees critical skills for managing patients during a disaster.

|  | Median score (IQR) |  |  |
| :--- | :---: | :---: | :---: |
|  | Pre-Test | Post-Test | p-value |
| I can define or describe what a MCI is. | $4(3-4)$ | $5(5-5)$ | $<0.00001$ |
| I can describe the goals of providing adequate patient care <br> during a MCI (ex. triaging patients). | $3(2.25-4)$ | $5(4-5)$ | $<0.00001$ |
| I feel comfortable triaging patients during a MCI. | $2(2-3)$ | $4(4-4)$ | $<0.00001$ |
| I am aware of the other institutions in my community <br> that can provide patient care during a MCI. | $2(1.25-3)$ | $4(4-5)$ | $<0.00001$ |
| I am aware of how different CAPABILITIES of different <br> institutions (ex. hospitals) in a community can influence <br> triage decisions in order to provide optimal patient care. | $3(2-4)$ | $5(4-5)$ | $<0.00001$ |
| I can define and/ or describe the principal of surge <br> capacity. | $2(2-3)$ | $5(4-5)$ | $<0.00001$ |

*Strongly Disagree=1, Somewhat Disagree=2, Neutral=3, Somewhat Agree=4, Strongly Agree=5

# INCIDENTAL, BUT NOT INCONSEQUENTIAL: A METHOD TO IDENTIFY AND TREAT INCIDENTAL FINDINGS IN ACUTE CARE SURGERY 

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Introduction: Ubiquitous utilization of computed tomography in acute care surgery has led to the inevitable identification of incidental findings. Focus on immediate care needs has the propensity to allow incidental findings to be ignored, potentially resulting in lost opportunities to intervene. We aimed to develop a method to efficiently triage and address incidental findings (IFs) in acute care surgery.
Methods: Nurse clinicians tracked IFs through routine review of imaging for all patients admitted to, or seen in consultation for trauma and emergency surgery at our tertiary care facility over the course of one year. Incidental findings were identified and classified as Level 1 (inpatient management), Level 2 (outpatient follow-up), or Level 3 (no follow-up necessary). Patients were notified prior to discharge, and given recommendations for further treatment. When appropriate, follow-up appointments were launched within the system. Telephone follow-up was then completed within 3-6 months to ensure findings were addressed.
Results: 1147 patients were included. 622 incidental findings were identified in 389 (33.9\%) patients. Formal notification of IFs was completed in 370 (95.1\%) prior to discharge, and 33 ( $8.5 \%$ ) received additional notification by mail. Level 1 findings were identified in 41 (10.5\%) patients. The largest number of IFs were Level 2 (282, 72.5\%). Level 3 findings were identified in 66 (17.0\%). Degenerative bone disease (92,14.8\%), hernias ( $93,15.0 \%$ ), and solid organ cysts (12., 19.8\%) were the most commonly identified findings. 105 (16.9\%) neoplastic processes were identified, including 34 adrenal, 18 thyroid, and 27 other solid organ masses. Phone call follow-up was attempted in all patients, and completed in 288 (74.0\%) patients, of which 161 (55.9\%) had followed-up on recommendations. Level 1 and 2 recommendations were more likely to be completed ( $46.3 \%$ vs. $42.9 \%$ vs. $31.8 \%$, p 0.01 ) 26 ( $9.0 \%$ ) had expired by the time of telephone follow-up. The percent of patients who complied with recommendations was not affected by initial notification method (written vs. verbal vs. mailed, p 0.11 ). Those who did not adhere to recommendations, received additional formal communication via mail as a secondary reminder. 23 patients, $21.9 \%$ of those identified with a neoplastic process, had either undergone surgical resection or medical therapy at time of follow up.
Conclusion: Most incidental findings require a form of follow-up. A methodical process for identification and patient notification of incidental findings in acute care surgery can reach beyond the acute phase, and positively impact care for patients with undiagnosed and potentially lethal medical problems. Recommendation compliance is unaffected by method of initial communication.

# The Limitations of Hospital and Law Enforcement Databases in Characterizing the Epidemiology of Firearm Injury. 

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Introduction: Comprehensive data regarding the epidemiology of firearm injury in the United States do not exist. Current estimates extrapolate data predominately from inpatient hospital or law enforcement databases but both databases in isolation have limitations and exclude certain subgroups of patients. We hypothesized that a comprehensive effort to include inpatient, outpatient, and law enforcement data would more accurately describe the burden of firearm injury in our county.

Methods: We constructed a collaborative database merging firearm injuries (Jan 2017 to Dec 2018) including all patients admitted to the hospital, patients treated and released from the hospital (outpatient), and law enforcement from our county. Outcomes and injury patterns from individual databases were then compared to those of the collaborative database. Chi square analysis was performed.

Results: The trauma registry, total hospital (registry and outpatient) and law enforcement databases failed to include 54, 22 and 16 percent of all firearm injuries respectively when compared to the collaborative database. The hospital encountered $94 \%$ of survivors but failed to detect a third of non-survivors whereas law enforcement encountered $94 \%$ of non-survivors but failed to include 20\% of survivors. Two percent of injuries were managed at non-trauma centers. Cause of injury and mortality were significantly different dependent upon which database was utilized, ranging from 10\% (hospital) to almost 30\% from law enforcement.

| Database Comparison | Registry |  | Hospital |  | Law |  | Collaborative |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |
| Total Patients | 492 |  | B38 |  | 895 |  | 1078 |
| Cause of Injury (\% Total) |  |  |  |  |  |  |  |
| Assault | 80.6 | NS | 79 | NS | 82.3 | <, 05 | 76.4 |
| Accidental | 9.6 | N5 | 117 | NS | 7.4 | s0s | 10.5 |
| Intentional Self-inficted | 7.8 | N5 | 4.7 | <. 05 | 9.4 | NS | 9.6 |
| Failed Injury Detection Rate |  |  |  |  |  |  | NA |
| All Patients | 64.3 |  | 22.1 |  | 16.8 |  | NA |
| By Survival |  |  |  |  |  |  |  |
| Survivors | 49.9 |  | 6.3 |  | 20.3 |  | NA |
| Non-survivors | 66.8 |  | 68.8 |  | 6.1 |  | NA |
| By Cause of Injury |  |  |  |  |  |  |  |
| Assault | 51.8 |  | 19.5 |  | 10.1 |  | NA |
| Accidental | 58.5 |  | 13.3 |  | 41.6 |  | NA |
| Interntional Self-inflicted | 62.2 |  | 61.2 |  | 18.4 |  | NA |
| Mortality by Database |  |  |  |  |  |  |  |
| Mortality (\% Dead) | 173 | $<.05$ | 10.1 | <. 05 | 27.7 | NS | 24.5 |
| Assault | 14.4 | <,05 | 86 | $<.05$ | 22.4 | NS | 20.9 |
| Accidental | 2.1 | NS | 1 | NS | 3 | NS | 1.8 |
| Intertional Self-inflicted | 66.4 | <, 05 | 55 | $<.05$ | 90.6 | NS | 82.5 |

Conclusion:The utilization of hospital or law enforcement databases alone do not accurately reflect firearm injury epidemiology and may misrepresent areas in need of greater injury prevention efforts. Mortality differs significantly dependent upon database. Collaboration to include hospital and law enforcement data sources is critical to accurately describe the societal burden of firearm injury.

## Poster \# 30

## VERIFYING STOP THE BLEEDTM SKILLS: EVALUATING INSTRUCTOR CONSISTENCY

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Background: Stop the Bleed is a national initiative to teach hemorrhage control skills (tourniquets and wound packing) to the lay public. There are currently no standards to assess whether Stop the Bleed TM participants are performing these skills correctly upon completion of training.
Methods: Using SMARTER methodology we created checklists of skill completion guided by criteria from Tactical Combat Causality Course for two separate hemorrhage control skills: tourniquet application and wound packing. The tourniquet application assessment was constructed using seven tasks across two latent dimensions including verbal communication ( 3 tasks) and tactile ( 4 tasks). The wound packing assessment was constructed with six tasks across the same dimensions: verbal communication (3 tasks) and tactile (3 tasks). All tasks were measured using a binary scale where 0 - "Not Observed/Failed to Perform Correctly" and 1 = "Observed/Performed Correctly." Five videos were created for each skill demonstrating a range of appropriate skill completion from a control to multiple missing components. Seven experienced Stop the Bleed ${ }^{T M}$ instructors evaluated each video. Initial measures of evaluator consistency were estimated using Fleiss' Kappa to assess the reliability of agreement among instructors.
Results: Seven evaluators completed all assessments for ten videos. Evaluator background ranged from paramedic to physician. Kappa values ranged from 0.51 to 1.00. Correlation for the control videos was good at 0.90 and 1.00. For the remaining videos except one, kappa values ranged from 0.51 to 0.62 .
Conclusion: Notable heterogeneity exists in evaluation of Stop the Bleed ${ }^{T M}$ skill assessment even when a checklist is utilized. The need for a comprehensive and valid instrument to evaluate the skill transfer acquired during hemorrhage control education.

## Poster \# 31

## ADOLESCENTS: BIG KIDS OR SMALL ADULTS? AN ANALYSIS OF ISOLATED SPLENIC INJURIES USING THE TRAUMA QUALITY IMPROVEMENT PROGRAM (TQIP) DATABASES.

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Introduction: Adolescents are a unique patient population. Physically they often look like adults, but physiologically and psychologically they may be more similar to younger children. Current literature demonstrates that injured children have improved outcomes when treated under pediatric specific protocols; likewise studies in adults show improvement in outcome when targeted guidelines are followed. In this study we sought to examine the characteristics, treatments and outcomes of isolated splenic injuries in adolescent trauma patients and compare them to younger children and adults. Methods: A retrospective review of the Trauma Quality Improvement Program (TQIP) and the Pediatric TQIP databases was performed for the years 2014-2015. Patients with a diagnosis of isolated splenic injury were identified. Variables, including demographics, mechanism of injury, treatment center type, injury grade, complications, procedures, transfusions, imaging studies, ICU and total lengths of stay, mortality and discharge information were abstracted. Comparisons were made among children (ages 0-12 years), adolescents (13-18 years), and adults (19 years and greater). Univariate analyses were performed using chi-squared tests and Fisher's exact tests when appropriate.
Multivariate logistic regression analyses examined the influence of age group and injury severity on various outcomes.
Results: A total of 6605 patient were identified: 672 children, 1157 adolescents, and 4776 adults. Adolescents fell in between children and adults, with significant ( $p<0.05$ ) differences in the majority of categories: mortality, incidence of VTE, VTE prophylaxis, total complications, length of stay (LOS), ICU admissions, discharge locations, splenic embolization, imaging, and operative rates (Table 1). Multivariate logistic regression analysis, controlling for injury severity, demonstrated significant differences across the age groups for these outcomes. Differences were also noted between adolescents treated at pediatric centers compared to those treated at adult centers, with rates of VTE prophylaxis, operations, splenic embolizations, CT scans, blood transfusions, and total lengths of stay all being significantly higher at the adult centers.
Conclusion: With regards to isolated splenic injury, although their characteristics are often more similar to children, adolescents are neither "big kids" nor "small adults," and demonstrate differences in their injury mechanisms, treatments and outcomes. Future management strategies for this population require careful consideration of this fact and subsequent research is needed in order to better characterize the unique place of the adolescent population in trauma.

|  | Children | Adolescents | Adalts |
| :---: | :---: | :---: | :---: |
| Median Splenic Injury Grade (Interquartile Range) | 3 (1-3) | 3 (1-4) | 3 (1-4) |
| VIE | $0(0 \%)$ | $1(0.03 \%)^{\text {k } \dagger}$ | 59 (1.3\%) |
| Received VTE Prophylaxis | 5 (0.74\%) | $227(19.6 \%) *$ + | 2171 (45.5\%) |
| PRBC Transfusion on Admission | 16 (2.4\%) | $49(4.2 \%)^{*}+$ | 757 (159\%) |
| Embolization | 1 (0.15\%) | $18(1.6 \%)^{\text {k }} \dagger$ | 180 (3.3\%) |
| Operations | 14 (2.1\%) | $90(7.8 \%)^{*+}$ | 1281 (26.8\%) |
| CT Scans | 238 (35.4\%) | $497(43.0 \%)^{*} \dagger$ | $2478(51.9 \%)$ |
| Hospital LOS Avg. (d) | 3.63 | $4.53 *$ | 7.1 |
| ICU LOS Avg. (d) | 2.52 | 3.09** | 4.32 |
| Any ICU Admissicn | 274 (40.8\%) | $603(52.1 \%)^{*} \uparrow$ | 3127 (69.9\%) |
| Discharged Home | 659 (93.1\%) | 1099 (95\%)* $\dagger$ | 3696 (77.4\%) |
| Mortality | 0.30\% | 0.43\%* | 2.7\% |
| Total Complications | 57 (8.5\%) | $146(12.6 \%)^{*} \dagger$ | 1194 (25.0\%) |
| MCC of lnjuy | Accidental Falls (34.2\%) | Motor Vehicle Traffic Accicents (31.8\%) | Motor Vehicle Traffic Accidents (47.5\%) |

## PEDIATRIC HELICOPTER TRANSPORT: FLYING LESS BUT ALSO LESS INJURED

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Introduction: Helicopter-transport (HT) is used for up to $16 \%$ of pediatric traumas. However, no clear guidelines for the use of HT in pediatric trauma exist. The survival advantage of HT for pediatric trauma compared to ground-ambulance (GA) when controlling for transport time is not known. We hypothesized the rate of HT has decreased nationally and risk of mortality for HT to be similar when adjusting for transport time, compared to GA.
Methods: The Pediatric Trauma Quality Improvement Program (2014-2016) was queried for patients aged $\leq 16$-years-old transported by HT or GA. A multivariable logistic regression was used.

Results: HT was used in 4,527 (17.7\%) patients. The rate of HT from scene decreased from $21.2 \%$ in 2014 to $18.2 \%$ in 2016 ( $\mathbf{p}<0.001$ ) with a geometric mean annual decrease of $19.3 \%$. The rate of HT for minor (ISS<15) (overall, 13.9\%) and major (ISS>15) (overall, $36.8 \%$ ) trauma also decreased during this time. After controlling for pre-hospital transport time and known predictors of mortality, HT was associated with decreased risk of mortality for only those with major injuries transferred from scene (OR 0.48 , $0.26-0.88, \mathrm{p}<0.001$ ), compared to GA. Risk of mortality for HT vs. GA in minor trauma was similar (Table A).

Conclusion: The rate of HT in pediatric trauma has decreased. However, there is still room for improvement as $14 \%$ of those with minor trauma continue to be transported by HT. Given the similar risk of mortality in this group compared to GA, future research is needed to develop pediatric guidelines in the hopes of minimizing this high over triage rate.

Table A. Adjusted* risk of mortality for pediatric trauma patients transported by helicopter vs. ground-ambulance stratified by trauma severity

|  | Transport from Scene |  |  | Interfacility Transfer |  |  | Scene + Interfacility <br> Transfers |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | OR | Cl | p-value | OR | Cl | p-value | OR | CI | p-value |
| All trauma | 0.47 | $0.26-0.85$ | 0.01 | 1.61 | $0.68-3.79$ | 0.28 | 0.79 | $0.50-1.24$ | 0.30 |
| Minor | 0.07 | $0.01-5.51$ | 0.23 | 5.23 | $0.25-9.78$ | 0.96 | 0.74 | $0.11-4.98$ | 0.76 |
| Major | 0.48 | $0.26-0.88$ | 0.01 | 1.39 | $0.55-3.47$ | 0.48 | 0.79 | $0.50-1.25$ | 0.32 |

* controlled for: age, gender, injury severity score, severe grades for abbreviated injury scale of the head, thorax
and abdomen, hypotension on admission, respiratory rate on admission, heart rate on admission, motor component of Glasgow coma scale score, mechanism and total transport time including dispatch


## Poster \# 33

# CHARACTERIZATION OF TRAUMA-INDUCED COAGULOPATHY IN PEDIATRIC PATIENTS WITH SEVERE ABUSIVE COMPARED TO ACCIDENTAL HEAD TRAUMA 

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Introduction: Trauma-induced coagulopathy (TIC) is a well characterized phenomenon that has been shown to be associated with severe head trauma (HT). Pediatric HT, and particularly abusive head trauma (AHT), is a frequent cause of severe injury in children. Differences in patterns of TIC between abused and accidental HT patients may help explain the disparate levels of morbidity and mortality seen in these populations.
Methods: We queried our institution's Level 1 pediatric trauma center registry and selected patients who had undergone rapid thromboelastography (TEG) from 6/1/2015 to $2 / 1 / 2019$ and sustained blunt accidental or abusive severe HT (head AIS $\geq 3$ ). Variables of interest were collected: demographics, injury-related data (GCS, ISS, head AIS), admission TEG parameters and traditional tests of coagulopathy (PT, PTT, INR, platelets), and mortality. Abnormal patterns of coagulopathy were defined: abnormal clot strength ( $\mathrm{MA} \leq 55, \mathrm{~K} \geq 2.5$, and/or platelets $\leq 150$ ), abnormal fibrinolysis ( $\mathrm{LY} 30 \geq 3 \%$ or $\leq 0.8 \%$ ), and elevated INR (INR $\geq 1.3$ ). Statistical analyses including Wilcoxon rank-sum, $\chi^{2}$, Fisher exact, and logistic regression were utilized.
Results: 181 children were included in our analysis, 35 with AHT and 146 with accidental HT. The overall HT group was severely injured (median ISS (interquartile range (IQR)) 22 (14-29), median head AIS 4 (3-5) with a mortality rate of $10.7 \%$. The AHT group was significantly younger (median age $0.4 \mathrm{yr}(0.17-1.5) \mathrm{v}$. 7 yr (3-13), $\mathrm{p}<0.0001$ ), more severely injured (median ISS $26(18-30)$ v. 19 (11-29), $\mathrm{p}=0.015$ ), with a lower worst GCS (median GCS 3 (3-12) v. 11 (3-15), p=0.025), and a higher mortality rate ( $21.2 \%$ v. $8.28 \%$, $\mathrm{p}=0.03$ ). Compared to the accidental HT group, the AHT group more frequently had an elevated LY30 ( $37.5 \% \mathrm{v} .13 .4 \%, \mathrm{p}=0.019$ ) and an elevated INR ( $42.9 \%$ v. $25.5 \%$, $p=0.042$ ). On univariate analysis (Table 1), patterns associated with an increased odds of mortality include abnormal clot strength (low platelets, elevated K, and/or low MA) in the AHT group and an abnormal LY30 (elevated or low LY30) in the accidental HT group. Elevated INR was associated with increased odds of mortality in both groups (Table 1).
Conclusion: Victims of AHT have a different pattern of coagulopathy as compared to those with accidental HT. Furthermore, only abnormalities in platelet count and clot strength in AHT patients are associated with death, representing a difference in prognostic value for this abnormality between abused and accidental HT patients. Further investigation is required to explain the mechanism which drives these differences in coagulopathy and their relationship with the pathophysiology of HT in children.

|  | AHT ( $\mathrm{N}=35$ ) |  | Accidental HT ( $\mathrm{N}=146$ ) |  |
| :---: | :---: | :---: | :---: | :---: |
|  | Death (OR) | P value | Death (OR) | P value |
| Abnormal Clot Strength | 22 | 0.010 | 3.59 | NS |
| - low platelets | 10 | 0.081 | 1.62 | NS |
| - low MA | 11 | 0.097 | 3.14 | NS |
| - Elevated K | 48 | 0.029 | 1.68 | NS |
| Abnormal Fibrinolysis | 2.66 | NS | 9.5 | 0.035 |
| - Elevated LY30 | 0.8 | NS | 2.4 | NS |
| - Low LY30 | 4.5 | NS | 2.82 | NS |
| Elevated INR | 38 | 0.001 | 102.7 | <0.0001 |
| Table 1: Univariate associations between coagulopathy patterns and death; NS = not significant. |  |  |  |  |

## THE TRUE COST OF PEDIATRIC GUN SHOT WOUNDS

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Introduction: Gunshot wounds (GSW) are the second leading cause of trauma-related death among U.S. children 1-17 years old. Injury prevention has been shown to reduce blunt forms of injury. We sought to determine the magnitude, health impact and costs associated with pediatric GSWs, as a first step to developing an injury prevention strategy to reduce firearm related injuries and deaths among children in our state and region of the U.S.

Methods: Children 1-17 years old who sustained gunshot wounds between 2008-2018 were identified from the trauma registries at two pediatric trauma centers (ACS Level 2 and ACS Level 1). Both centers serve different patient populations, with the Level 2 serving an urban area and the Level 1 serving a seven-state region. Demographics, operative intervention, complications, follow-up, readmission rates, hospital charges, and costs of care at both centers were analyzed.
Results: Patients were predominately male ( $86 \%$, 203/236) and the mean age was $14 \pm$ 4.8 years. One fifth $(20 \%, 47 / 236)$ required RBC transfusion, with 30 patients ( $13 \%$ ) resuscitated in a 1:1:1 fashion and 10 patients ( $4 \%$ ) requiring massive transfusion protocol activation. Nearly half underwent a major operation ( $47 \%, 111 / 236$ ), including 30 (12.7\%) who had an exploratory laparotomy and 25 ( $10.5 \%$ ) who had repair of a major vascular injury. Twelve had an ED thoracotomy, of which four survived. The average ICU length of stay (LOS) was $2.3 \pm 5.5$ days and the average hospital LOS was $4.2 \pm$ 7.3 days. Median Injury Severity Score (ISS) was 10.6 (1-75) and the overall mortality rate was $8.9 \%(21 / 236)$. Helicopter transport was utilized for $13.1 \%$ (31/236) with an estimated cost of $\$ 40,000$ per patient trip, or $\$ 1.2$ million during the study period. Cost of surgical care was $\$ 11$ million. Those with Medicaid coverage (67\%) had a longer average LOS ( 17.4 days) compared to those with private insurance ( 6.1 days). The 30-day readmission rate was $3.3 \%$ ( $8 / 236$ ). The overall cost for patient care was $>\$ 21$ million or $\$ 93,130$ per patient, with an estimated loss of $\$ 3$ million for both institutions.

Conclusion: Firearm-related injuries are a significant cause of childhood death and disability in the U.S. Nearly half of the patients in our study required a major operation and $9 \%$ succumbed to their injuries. Many who survived are hampered by lifelong physical and/or psychological disabilities. These injuries impart significant costs to our communities and trauma centers. By bringing these costs to light we aim to educate our legislators and partner with our communities, to identify and fund injury prevention strategies that will reduce the economic and societal costs of pediatric firearm-related injuries.

# LAPAROSCOPY COMPARED TO LAPAROTOMY FOR THE MANAGEMENT OF PEDIATRIC BLUNT ABDOMINAL TRAUMA 

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Introduction: In hemodynamically stable injured children with a concerning abdominal exam and non-diagnostic imaging, operative intervention is warranted to diagnose and manage potential intra-abdominal injuries. However, there is minimal evidence evaluating the risks and benefits of laparoscopy compared to laparotomy in this group of patients. The objective of this study was to evaluate post-operative outcomes in a large cohort of hemodynamically stable pediatric patients with blunt abdominal injury and without severe traumatic brain injury or severe multi-system trauma, who underwent either laparoscopy or laparotomy.
Methods: Using the 2015-2016 NTDB, all patients age $<18$ years with ISS $\leq 25$, GCS $\geq 13$, and normal blood pressure who underwent an abdominal operation for blunt abdominal trauma were included in the study cohort. Patients were grouped into three treatment groups: laparotomy, laparoscopy only, and laparoscopy converted to an open operation. The outcomes of interest were hospital length of stay, ICU length of stay, ventilator days, number of abdominal procedures, in-hospital mortality, and a predetermined list of complications. Multinomial logistic regression with inverse probability weighting to account for confounding by indication (including age, mechanism of injury, Glasgow Coma Scale, heart rate, intubation status, injury severity score, hospital trauma level, hospital teaching status, and number of facility pediatric abdominal trauma operations performed per year) was used to determine the association between treatment group and the outcomes of interest.
Results: Of 720 patients, 506 underwent laparotomy, 132 laparoscopy only, and 82 laparoscopy converted to open. Median age of the cohort was 10 (IQR: 7-15) years and median ISS was 9 (IQR: 5-14). Mean hospital length of stay was 2.1 days shorter ( $95 \%$ CI: 0.9-3.2 days) and mean ICU length of stay was 1.0 day shorter ( $95 \% \mathrm{CI}$ : 0.6-1.5 days) for the laparoscopy group compared to the laparotomy group. There was no difference in post-operative complications, except the laparoscopy group had a $1.9 \%$ lower mean probability of surgical site infection than the laparotomy group ( $95 \% \mathrm{CI}$ : $0.1-3.0 \%$ ). There was no difference in ventilator days, number of abdominal procedures, and in-hospital mortality between the laparoscopy and laparotomy group and there were no differences in any outcomes between the laparoscopy converted to open and the laparotomy group.
Conclusion: In this cohort of hemodynamically stable pediatric patients with blunt abdominal injury, laparoscopy was associated with shorter hospital and ICU length of stay and lower risk of surgical site infection. This is the first study to compare outcomes after laparoscopy and laparotomy in a cohort of pediatric patients with similar baseline injuries, demonstrating that laparoscopy may have improved outcomes over laparotomy.

# PEDIATRIC TRAUMA ARRIVAL TIMES AND THE SWING SHIFT 

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Introduction: Exposure to a high number of pediatric trauma cases is necessary to learn trauma management of the pediatric patient, gain comfort with a variety of injuries requiring emergency management, and gain exposure to uncommon patient care scenarios. Trauma center staff and trainees are often assigned to a day and night shift in many teaching hospitals. However, for adult trauma, the swing shift has been found to offer superior clinical exposure compared to a standard day or night shift for trainees. We characterized patterns in pediatric trauma arrival times according to the hour of the day, day of the week, and month, and studied whether or not the swing shift also maximizes opportunities to manage pediatric trauma.
Methods: We performed a retrospective review of the trauma registry at our urban, Level 2 pediatric trauma center. We identified all the pediatric trauma activations in the last 13 years (2006-2018). Hourly volumetric trends were modeled using a negative binomial regression. We included in this analysis models for 4 age groups: age $0-1,2-5,6-10$, and 11-15. A retrospective shift log of the last 13 years was created, which included day (7:00 AM to 7:00 PM), night (7:00 PM to 7:00 AM), and swing (noon to midnight) shifts. The shifts were compared using the Wilcoxon match-pairs signed rank test. P values were multiplied by 3 for Bonferroni correction of multiple comparisons. To determine whether weekends yielded higher volume of pediatric trauma than weekdays, a Poisson regression model was used, and the $\chi 2$ statistic calculated to determine goodness of fit. A Poisson regression model was also used to compare months of the year. Similar analyses were utilized to compare data of pediatric patients with Injury Severity Scores (ISS) >15, using a Wilcoxon test to compare shifts, and Poisson regression modeling to compare weekdays versus weekends, as well as months of the
year.

|  | Total | Blunt | Penetrating | IS5 $>15$ | Fall $<$ 10 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Al patients $(\mathrm{N})$ | 3532 | 3322 | 210 | MVC |  |
| Age (IQR) | $7.2(3-12)$ | $7.1(3-12)$ | $\mathbf{8 . 5}(4-13)$ | 693 | 1158 |
| Males (\%) | $2231(63.2)$ | $2075(62.4)$ | $156(74.3)$ | $439(63.3)$ | $5.0(1-8)$ |

Results: 3532 pediatric patients were identified for our study. Peak arrival time was between the hours of 3:00 PM and 9:00 PM. Patient age, ISS, and whether the mechanism was blunt or penetrating did not have a significant effect on patient arrival times. The swing shift had 1.98 times more activations than the night shift, and 1.33 more than the day shift ( $\mathrm{p}<0.001$ ). The swing shift was also superior to both the day (odds ratio: 1.26, p $<0.001$ ) and night shifts (odds ratio: 1.79, p $<0.001$ ) for patients with ISS $>15$. Weekend days had 1.28 times more trauma than the weekdays (p $<0.001$ ), with Saturday the single day with the highest volume. Our Poisson regression model did not demonstrate that any particular months of the year had more trauma.
Conclusion: At institutions with training programs, it is helpful to be aware of the times with the highest trauma volume. Our study suggests that the hours between 3:00 PM and 9:00 PM represent a time of particularly high likelihood of pediatric trauma arrivals. These hours are included by the swing shift. Trauma activations for patients with ISS $>15$ also peak during these hours. The increased volume and higher acuity of patients during the swing shift can be utilized to provide important opportunities for trainees to develop competence in pediatric trauma. In addition, the hours between 3:00 PM and 9:00 PM on weekends may represent a time of particularly high likelihood of pediatric trauma arrivals, which may require extra staff and hospital resources.


Poster \# 37

## PLATELET TRANSFUSIONS ARE ASSOCIATED WITH IMPROVED MORTALITY IN PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY.A SECONDARY ANALYSIS OF THE PRAGMATIC, RANDOMIZED OPTIMAL PLATELET AND PLASMA RATIOS (PROPPR) TRIAL

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## Introduction:

Patients with severe traumatic brain injury (sTBI) develop an acquired coagulopathy that is associated with poor outcomes. Platelet transfusions have been suggested to decrease mortality in patients with sTBI who develop an acquired coagulopathy. The objective of this study was to examine the effect of platelet transfusions on mortality in patients with severe TBI.

## Methods:

We analyzed the data from the PROPPR trial. In this trial subjects at 12 North American level 1 trauma centers were randomized into either a 1:1:1 or 1:1:2 (plasma:platelets:red blood cells) transfusion ratio intervention for massive transfusion. During the randomization the first cooler of blood products either did or did not contain platelets. We identified a subgroup of patients with sTBI (AIS Head $\geq 3$ ) who received only the first cooler of blood products, which did not did not contain platelets. We then compared those who received platelets to those that did not. Variables were compared using univariate analysis, Cox regression and Kaplan-Meier method to estimate mortality. Our primary outcomes were 24 -hour and 30-day mortality.

## Results:

A total of 40 sTBI patients were included (Platelet transfusion n=22; No platelet transfusion $\mathrm{n}=18$ ). There were no significant differences in demographics, admission physiology, ISS, Head AIS, or coagulation parameters between the groups. Patients who received platelet transfusions had a significantly lower mortality rate than those who did not receive platelet transfusions ( $27 \%$ vs. $61 \%$; $p=0.023$ ). A Cox regression analysis for 30-day mortality demonstrated that both platelet transfusions (HR 0.23, 0.09-0.62 95\% CI, $\mathrm{p}=0.004$ ) and a GCS $>3$ (HR 0.10, 0.01-0.79 $95 \% \mathrm{CI}, \mathrm{p}=0.029$ ) were associated with improved survival. Kaplan-Meier curve analysis demonstrated a significant reduction in cumulative incidence of early and late death in patients who received platelets (Figure 1)

## Conclusion:

In patients with severe TBI platelet transfusions appear to be associated with decreased early and late mortality.


Figure 1. (Left) Cumulative incidence of death within first 24 hours after randomization. (Right) Cumulative incidence of death within 30 days of randomization.

# EFFECT OF PLATELET TRANSFUSIONS ON MORTALITY AND NEUROSURGICAL INTERVENTION IN TRAUMATIC INTRACRANIAL HEMORRHAGE ON PRE-INJURY ANTIPLATELET THERAPY 

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Introduction: Traumatic intracranial hemorrhage (tICH) is a significant cause of mortality in trauma patients, with a worse prognosis in patients on pre-injury antiplatelet medication (APM). Currently several studies with poorly matched cohorts exist with no randomized control studies or practice management guidelines regarding the utility of platelet transfusions in these patients. We hypothesize that platelet transfusions will have no significant effect on mortality or need for neurosurgical intervention in patients with tICH on APM.
Methods: We analyzed all tICH patients on APM admitted to a Level 1 Trauma center from $1 / 1 / 14$ to $12 / 31 / 18$. A hospital-wide protocol change occurred on $9 / 1 / 17$ to discontinue platelet transfusions in tICH on pre-injury APM. The cohorts were matched based on AIS head, ISS, Demographics, MOI, GCS, type of APM and coagulopathy. The primary outcome was mortality and secondary outcomes; rate of neurosurgical intervention, hospital length of stay, critical care days, and discharge destination. Statistical analyses include Chi-square, T-test statistics and a population that fulfilled the power analysis.
Results: 610 patients were included (449 platelets (P), 161 no platelets (NP)). Differences between $P$ and NP groups were not significant based on age ( $p=0.055$ ), gender ( $p=0.59$ ), race ( $p=0.281$ ), ISS $(p=0.161)$, GCS $(p=0.461)$, and $\operatorname{INR}(p=0.406)$. AIS head between $P$ and NP was significant ( $p=0.013$ ), however AIS specific to the tICH was not ( $p=0.21$ ). APM type was not different between P and NP groups ( p -values for ASA=0.8, ASA+Plavix $=0.09$, Plavix $=0.13$, Other= $=0.98$ ). No differences were found between the P and NP groups for mortality ( $\mathrm{p}=0.34, \mathrm{CI}=95 \%$ ), rate of neurosurgical intervention ( $p=0.072, C I=95 \%$ ), length of stay ( $p=0.567, C I=95 \%$ ), critical care days ( $p=0.54$, $\mathrm{CI}=95 \%$ ) and discharge destination ( $\mathrm{p}=0.36, \mathrm{CI}=95 \%$ ). Subgroup analyses specific for type of tICH also revealed no difference in primary or secondary outcomes.
Conclusion: This is one of few studies investigating administration of platelets for antiplatelet reversal in patients with tICH with matched cohorts. Platelet transfusions do not significantly improve mortality, need for neurosurgical intervention, length of stay, or discharge destination in tICH patients on pre-injury APM. Further studies should focus on volume expansion and multi-center trials to help establish better trauma management guidelines.

Poster \# 39

# THE PREDICTIVE ABILITY OF THE GLASGOW COMA SCALE FOR SEVERE TRAUMATIC BRAIN INJURY DECLINES WITH AGE 

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Introduction: The Glasgow Coma Scale (GCS) measures the severity of neurologic deficit (coma and impaired consciousness). We first reported that older age $\geq 65$ years affects the association between the GCS and the severity of the intracranial injury, as measured by the Abbreviated Injury Scale [AIS] score, in patients with traumatic brain injury (TBI). This confirmatory study sought to investigate further the effect of age on the association between GCS and AIS. We hypothesized that as we age, the presenting GCS becomes less associated with the severity of the TBI.
Methods: We included all patients in the National Trauma Data Bank from 2010-2015 with a TBI, defined by ICD9-CM diagnostic codes 850 through 854. We compared older ( $\geq 65$ years) vs. younger (18-64 years) adults with TBI; we also examined age by decile. Logistic regression was used to identify the association between age and GCS for severe TBI (AIS $\geq 3$ ), adjusting for sex, presenting systolic blood pressure $<90 \mathrm{mmHg}$, mechanism, and isolated TBI.
Results: There were 106,581 patients with TBI (aged <65 years, 68\%). There was a significant interaction ( $\mathrm{p}<0.001$ ) between age, GCS and head AIS when age was examined by decile and stratified into $<65$ and $\geq 65$ years. The odds of presenting with GCS 3-8 was 2.1-fold greater for younger vs. older patients with a severe TBI (AIS $\geq 3$ ), after adjustment ( $\mathrm{p}<0.001$ ). These results were more striking when age was examined by decile (figure 1); GCS 3-8 had decreased odds of identifying severe TBI (AIS $\geq 3$ ) with increasing age decile. The area under the ROC curve was greater in patients with isolated TBI (AUROC=0.78).

Figure 1. Odds ( $95 \% \mathrm{CI}$ ) of presenting with Glasgow Coma Scale $3-8$ by age decile, for patients with severe TBI (AIS $\geq 3$ )


Conclusion: This study confirms our previous findings in a large National sample and further demonstrates that the relationship between the presenting GCS and severity of the intracranial injury is modified by age incrementally; that is, this relationship is not limited to the elderly population, as the presenting GCS becomes less predictive of severe TBI with increasing age decile. These results may represent a blunted physiological response to injury with increasing age. Further study might examine whether GCS is a valid measurement in trauma activation.

## Poster \# 40

## Primary blast-induced mild traumatic brain injury shows changes in MRI and immunohistology in a rat model of blast-induced behavioral abnormality

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Introduction: Victims of blast-induced mild traumatic brain injury (mTBI) are increasing worldwide due to terrorism, and many suffer from after-effects of physical or mental impairment. Diagnosing primary blast-induced mTBI is difficult due to few findings on imaging. This study aimed to detect new findings for therapeutic intervention in a rat model of behavioral abnormality after blast-induced mTBI.
Methods: We used a bench-top blast wave generator with the blast wave exiting through a $20-\mathrm{mm}$ I.D. nozzle aimed at the focused target. The blast wave was directed at the head of male SLC:Wistar rats weighing $247 \pm 3.9$ g under general anesthesia positioned prone 2.5 cm below the nozzle. Peak shock wave pressure at this point was $646.2 \pm 70.3 \mathrm{kPa}$. Our previous study showed post-blast behavioral abnormality in this rat model in a forced swim test and Y-maze test. We assess this rat model with specialized magnetic resonance imaging (MRI) modalities (11.7-T scanner) and immunohistochemically at day 3, 2 weeks and 6 weeks after blast injury.
Results: The blast-induced mTBI model showed no macroscopic findings of brain hemorrhage or contusion. However, food intake decreased significantly in the blast group rats, and they lost weight compared to control rats ( -18 vs. +10 g on day $3 ; \mathrm{P}=0.001$ ) in the early post-injury phase. Behavioral analysis in the blast group showed increased immobility time in the forced swim test at 2 ( 165 vs. $125 \mathrm{~s} ; \mathrm{P}=0.006$ ) and 6 weeks (199 vs. $162 \mathrm{~s} ; \mathrm{P}=0.01$ ), and the percentage of spontaneous alternation in the Y -maze test was significantly smaller than that of the control group ( $82 \%$ vs. $60 \%$; $\mathrm{P}=0.03$ ) at 2 weeks. Specialized MRI showed bilateral inflammation of the oriented layers of the hippocampus at 3 days and 2 weeks. Immunohistochemical analysis by Iba1 showed microglial accumulation in the same region, and detected activated microglia at 3 days and 2 weeks. Anti-neuronal nuclei ( NeuN ) antibody immunostaining showed a gradual decrease in NeuN-positive neurons over time in the pyramidal cell layer of the hippocampus.
Conclusions: Specialized MRI and immunohistochemical analysis enabled visualization of new abnormal findings of depressive-like behavior and short-term memory disturbance in a rat model of blast-induced behavioral abnormality.

## Poster \# 41

# PROSPECTIVE EVALUATION OF DELIRIUM IN GERIATRIC PATIENTS UNDERGOING EMERGENCY GENERAL SURGERY 

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## Introduction:

Delirium is a potentially preventable geriatric complication. The prevalence of delirium and its impact on outcomes following emergency general surgery (EGS) remains unexplored. The aims of our study were to assess the impact of frailty on delirium and the impact of delirium on outcomes in geriatric patients after emergency general surgery.

## Methods:

We performed a 1-year (2017) prospective cohort analysis of all geriatric (age $\geq 65$ ) patients who underwent EGS at our institution. Frailty was calculated using the emergency general surgery specific frailty index (ESFI). Delirium was assessed using the confusion assessment method (CAM), based on which patients were classified dichotomously as delirious or non-delirious. We performed regression analysis controlling for demographics, admission vitals, ASA score, comorbidities, and the diagnosis and type of surgery.

## Results:

A total of 145 patients underwent emergency general surgery and were included. Mean age was $71 \pm 7$ years, and $59 \%$ were male. Overall, the incidence of frailty was $38 \%$ and the incidence of postoperative delirium was $26 \%$. Patients who developed postoperative delirium were more likely to be frail ( $40 \%$ vs. $14 \%, p=0.01$ ), on more than 3 medications ( $29 \%$ vs. $18 \%, p=0.03$ ), and were more likely to have 3 or more comorbidities ( $32 \%$ vs. $21 \%, p=0.03$ ). On regression analysis, frail status (OR: 4 [2.2-6.8], $p<0.01$ ) and receiving $\geq 3$ medications (OR: 2.1 [1.3-4.8], $p<0.02$ ) were independent predictors of developing postoperative delirium. An episode of delirium was associated with longer hospital LOS ( 6 days vs. 3 days, $\mathrm{p}<0.01$ ), higher odds of ICU admission (OR: 2 [1.3-4.5], $p<0.01$ ), longer ICU LOS ( 2 days vs. 1 day, $p<0.03$ ) and higher odds of unplanned intubation (OR: 1.8 [1.2-3.4], $p<0.02$ ).

## Conclusion:

One in every 4 geriatric patients developed postoperative delirium after an EGS procedure. Frailty and polypharmacy were associated with increased risk of delirium. Delirium appears to be associated with higher rates in-hospital adverse events. Frail patients should undergo postoperative monitoring and interventions to prevent delirium and improve outcomes.

## Osteopenia is associated with poor physical function one year post-injury in elderly trauma patients

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Introduction:It is important to evaluate the physical fragility of elderly trauma patients admitted to the trauma surgical intensive care unit (TSICU). One of the physical fragilities can be evaluated based on absolute osteopenia that is measured using computed tomography (CT) on admission. We aimed to clarify the relationship between osteopenia and physical function (PF) one year post-injury in elderly patients.
Methods:This single-institutional prospective study included 116 injured patients (aged $\geq 65$ years) who were admitted to the TSICU and survived until discharge between 2016 and 2017. The average radio-intensity in Hounsfield units per 1.5-2.0 cm2 of L3 vertebral cancellous bone on admission CT (bone fragility index [BFI]) was used as a bone loss indicator. BFI $<100$ indicated osteopenia. Activities of daily living (ADLs) one year post-injury were evaluated using SF-36®, which contains eight items, including PF. We defined poor ADLs as $<25$ percentile of the national standard for the same age. We divided the patients into the osteopenia and control (without osteopenia) groups and compared these two groups.
Results:All patients experienced blunt injuries, including pedestrian injuries (25.0\%) and falls (34.5\%). Mean age was 73.4 years (men, $63.8 \%$ ), median injury severity score (ISS) was 18 (interquartile range: 14-26), and median Charlson comorbidity score was 1 (0-1). The osteopenia group included 42 patients ( $36.2 \%$ ); median BFI values were 77 (12.028.5) and 138 (118-154) in the osteopenia and control groups, respectively. Mean age ( 75.6 vs 72.2 years) and proportion of females ( $54.8 \%$ vs $25.7 \%$ ) were higher in the osteopenia group than in the control group. Clinical frailty scales at the time of admission
 were comparable between the two groups. No differences were observed in injured sites, treatment, and hospital stay duration between the two groups. The osteopenia group was more transferred to a rehabilitation facility and their ADLs after 1 year were also lower than the control group (Figure). Multivariate analysis, which was adjusted for age, severity, and gender, revealed that osteopenia was an independent factor for poor physical function one year post-injury (odds ratio, 2.59; 95\% confidence interval, 1.08-6.19;
$\mathrm{P}=0.03$ ).
Conclusion:In elderly trauma patients, osteopenia observed on CT at admission was associated with poor ADLs, especially physical function, one year post-surgery.
Treatment for bone loss may be important for improving ADLs in elderly trauma patients.

## Poster \# 43

## NATIONAL READMISSION PATTERNS FOR TRAUMATIC RIB FRACTURES AMONG ELDERLY PATIENTS

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Introduction: Rib fractures in elderly trauma patients are associated with serious complications and increased mortality. Long-term healthcare utilization among geriatric rib fracture patients, particularly readmission rates, are not well understood. We hypothesized that older adults with rib fractures would experience poor outcomes including high rates of mortality and frequent readmissions. Furthermore, we hypothesized that readmission would be associated with conditions associated with their initial rib fractures.
Methods: We used the 2014 National Readmissions Database (NRD) from the Healthcare Cost and Utilization Project (HCUP). The NRD is a nationally representative database containing longitudinal inpatient data such that individuals can be followed for readmissions over the course of one year. We included all patients over the age of 65 with a primary diagnosis of trauma and identified patients with any diagnosis of rib fractures by ICD-9CM codes. Patients admitted between February-June 2014 were analyzed over a 6 -month follow-up period. Demographic, injury and hospital characteristics, as well as readmission rates for rib fracture patients were evaluated. The primary outcome was readmission rate. Secondary outcomes included rates of complications that may be seen with rib fractures. Weighted data are presented to provide national estimates.
Results: Of 274,796 elderly trauma patients admitted during the 6-month study time period, 22,176 (8.1\%) had a diagnosis of rib fractures. Rib fracture patients had a mean age of 78.9 years (SD: 0.1) and were more often female ( $\mathrm{n}=11,816,53.3 \%$ ). Injuries in patients
 with rib fractures were severe. Compared to other trauma patients, those with rib fracture patients had higher rates of severe injury (ISS>15: $25.3 \%$ vs. $10.2 \%, \mathrm{p}<0.001$ ) and were 3.6 times more likely to have multiple injuries ( $60.3 \%$ vs. $16.6 \%$, $p<0.001$ ). Flail chest was present in $10.8 \%(n=2,388)$ and $41.6 \%$ had an associated sternal fracture $(\mathrm{n}=9,221)$. Overall mortality rate at the index admission for rib fracture patients was $4.9 \%$ (vs. $3.1 \%$ in other trauma patients). For rib fracture patients who survived the index admission, the 6 -month readmission rate was $6.3 \%$ and mortality at readmission remained high at $3.6 \%$. While rib fractures are associated with other injuries, nearly half of readmitted patients ( $\mathrm{n}=612,44.5 \%$ ) were patients with isolated thorax injuries. Readmissions for patients with rib fractures were complicated by high rates of rib-fracture-related complications and need for procedures. (see figure)

Conclusion: Rib fractures in older adults are increasingly common, can be lethal, and have long-term healthcare utilization needs. Mortality rates are high during index and readmissions, but these are likely underestimates given deaths that occur out-of-hospital. Furthermore, readmissions are associated with complications likely associated with the initial rib fracture injury, suggesting there is an opportunity to better address these injuries during the index admission.

## Poster \# 44

# DOES TIMING OF PALLIATIVE CARE INTERVENTIONS AFFECT HOSPITAL LENGTH OF STAY? A CROSS-SECTIONAL STUDY AT TWO LEVEL I TRAUMA CENTERS 

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Introduction: Providing early communication interventions to older adult trauma patients, including family meetings on goals of care (GOC) and palliative care consultations (PCC), has been suggested to improve quality of care and decrease hospital length of stay (HLOS). There are a paucity of studies examining palliative care in parallel to trauma care, and prior to November 2017, no American College of Surgeons (ACS) palliative care guidelines had been published. The purpose of this study was to compare timing of palliative care interventions, and their effect on HLOS, before and after implementation of the ACS Palliative Care Best Practice Guidelines.

Methods: This was a prospective, cross-sectional, pre-post study on trauma patients ( $\geq 55$ years) before (pre, 11/16-12/17) and after (post, $1 / 18-11 / 18$ ) implementation of the ACS TQIP Palliative Care Best Practice Guidelines across two ACS-verified Level I Trauma Centers. Data on patient characteristics were collected from the trauma registry, physician rounds, family meetings, and medical records. The primary outcome was total HLOS (days). Secondary outcomes included time from admission to: PCC, GOC, and proportion of patients with PCCs within $\leq 24$ hours of admission, and GOC meetings within $\leq 72$ hours of admission. Data on patient characteristics and palliative care interventions were compared univariately between pre- and post-groups. Stepwise generalized mixed modeling (entry 0.1 ; exit 0.05 ) was used to adjust for differences in mean HLOS between groups by covariate. Statistical significance was defined as $\mathrm{P} \leq 0.005$.

Results: There were 718 patients enrolled across both sites during the study (54\%, pre; $46 \%$, post). The majority were female (55\%), with a mean (SD) age of 75.2 (11.1), had a median (IQR) injury severity score (ISS) of 9 (8-11), and a median HLOS of 4 (3-6) days. Compared to the pre-group, the post-group had a significantly shorter median HLOS (4 (3-6) vs. 4 (3-5), $p=0.003$ ). In the post-period, significantly more patients had a PCC within 24 hours of admission ( $8 \%$ vs. $15 \%, \mathrm{p}<0.001$ ) and a GOC meeting within 72 hours of admission ( $50 \%$ vs. $54 \%, \mathrm{p}=0.005$ ), and median (IQR) hours from admission to GOC was significantly shorter (60.3 (39.2-76.2) vs. 44.6 (26.0-65.1), p=0.005). After adjusting for ISS, hours from admission to GOC, and hours from admission to PCC, HLOS was not significantly different between the pre-post period.

Conclusion: Our study suggests that two components of the ACS Palliative Care Guidelines: earlier PCC and GOC meetings, as well as lower ISS, were driving the significant decreases in the mean HLOS, independently of the pre-post time period. Having early communication interventions for less critically-injured, older adult trauma patients may decrease HLOS. More studies are warranted to better understand the relationship of these interventions on HLOS.

# RIB FRACTURE PROTOCOL INCREASES VENTILATOR FREE DAYS AND DECREASES PNEUMONIA IN GERIATRIC TRAUMA PATIENTS 

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Introduction: Chest trauma associated with rib fractures contributes to significant morbidity and mortality in the geriatric population. Rib fracture protocols (RFPs) with clinical and radiographic scoring systems have been developed to guide the allocation of intervention strategies. However, few studies have analyzed the outcome and impact of these protocols. Our level I trauma center RFP recommends that patients with high risk scores be admitted to the ICU and receive epidural analgesia. In this study, we hypothesized that implementation of the RFP would improve outcomes in geriatric trauma patients.
Methods: All patients (age $\geq 60$ ) admitted with one or more rib fractures to our level I trauma center with an Abbreviated Injury Score $\leq 2$ for other regions from January 2010 to May 2018 were included in the study. Patient demographics, mechanism of injury, injury severity score, comorbidities, and clinical outcomes were analyzed. The study period was divided into two phases: Pre-RFP phase (2010 to June 2015), and Post-RFP phase (2016 to 2018). Our RFP were established based on age, radiographic evidence, and clinical evaluation. In our study, the rib fracture scores were assigned only using hard points of age and radiographic evidence as clinical evaluation could not be retrieved consistently. Data was analyzed by students $t$ test and $X^{2}$ test. Multivariate regression was used as required.
Results: A total of 416 patients who scored $\geq 3$ in the RFP were included. 227 patients were in the Pre-RFP phase, and 189 patients were in the Post-RFP phase. There was no significant difference in demographics, injury severity and mechanism, or comorbidities between the two phases. Comparing the Post-RFP to Pre-RFP phase, there were significantly higher ICU admission rates (adjusted OR 5.84, CI 3.63-9.41, p<0.001), higher epidural usage (adjusted OR 1.69, CI 1.13-2.53, $\mathrm{p}=0.01$ ), more ventilator-free days ( 1.91 vs. $1.32, \mathrm{p}=0.02$ ), and a lower rate of pneumonia (adjusted OR 0.17 , CI $0.03-0.87, \mathrm{p}=0.03$ ) following RFP implementation. No significant differences were found in all-cause mortality ( $3.7 \%$ vs. $2.6 \%, \mathrm{p}=0.54$ ), hospital length of stay ( 6.96 vs .6 .5 , $\mathrm{p}=0.48$ ), ICU length of stay ( $2.76 \mathrm{vs} .1 .88, \mathrm{p}=0.07$ ), and intubation rate ( $13.8 \% \mathrm{vs}$. $15.4 \%, \mathrm{p}=0.63$ ).
Conclusion: Implementation of the RFP increased the number of ventilator-free days and decreased the incidence of pneumonia in geriatric rib fracture patients. Correct utilization of the RFP appropriately triaged patients to ICU admission and epidural usage more frequently.

# THE WHOLE IS GREATER THAN THE SUM OF ITS PARTS: GCS VERSUS GCS-MOTOR FOR FIELD TRIAGE OF GERIATRIC TRAUMA PATIENTS 

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Background: Accurate field triage is required to match injured patients to the appropriate level of care. Ideal triage criteria are simple and readily available to EMS providers. Prior work suggests the Glasgow Coma Scale (GCS) motor component (GCSm) is at least as accurate as the full GCS for field triage while being easier and more reliable to use. Older patients present with higher GCS values for a given level of head injury. Thus, it is unclear how substituting GCSm for GCS will perform in triage of geriatric patients. Our objective was to evaluate diagnostic performance of GCS versus GCSm in field triage for geriatric patients.
Methods: Patients $\geq 16 y e a r s$ in the NTDB 2007-15 transported from the scene were included. GCSm $\leq 5$ was defined as positive field triage criterion. Presence of physiologic and anatomic triage criteria from the National Field Triage Guidelines (NFTG) were also identified. The primary outcome was trauma center need (TCN), defined as ISS $>15$, ICU admission, ED disposition to the OR, or death in the ED. Diagnostic test characteristics including sensitivity, specificity, and area under the curve (AUC) were compared for NFTG including current criterion of GCS $\leq 13$ or substituting GCSm $\leq 5$ as would be applied in the field. Severe head injury (AIS $\geq 3$ ) and craniotomy for patients with GCS $\leq 13$ that have only a motor component deficit versus only a non-motor component deficit were compared. Logistic regression determined the association between TCN and GCS $\leq 13$ or GCSm $\leq 5$ while adjusting for other NFTG criteria. Analyses were performed for adult (age 16-65) and geriatric patients (age $>65$ ) separately.
Results: 4,480,185 patients were analyzed, including $1,258,190$ geriatric patients. Geriatric patients had higher ISS ( 9 vs $6, \mathrm{p}<0.01$ ) and mortality ( $5.1 \%$ vs $3.5 \%, \mathrm{p}<0.01$ ). TABLE shows diagnostic performance in adult and geriatric patients for NFTG using GCS $\leq 13$ vs GCSM $\leq 5$ to identify TCN. In adults the AUC was similar for GCS $\leq 13$ vs $\operatorname{GCSM} \leq 5(\mathrm{p}=0.06)$. In geriatric patients the AUC was higher for $\mathrm{GCS} \leq 13$ vs GCSM $\leq 5$ ( $\mathrm{p}<0.01$ ). Adults with motor-only deficits had higher severe head injury ( $28.4 \%$ vs $27.0 \%$, $\mathrm{p}<0.01$ ) and craniotomy ( $5.5 \%$ vs $4.4 \%, \mathrm{p}<0.01$ ) vs non-motor deficits. Conversely, geriatric patients with only non-motor deficits had higher severe head injury ( $40.3 \%$ vs. $36.7 \%$, $\mathrm{p}<0.01$ ) and craniotomy ( $5.8 \%$ vs $5.1 \%, \mathrm{p}<0.01$ ) vs motor-only deficits. For TCN in adults, the effect size of GCSm $\leq 5$ (OR $5.96 ; 95 \%$ CI $5.90-6.02, \mathrm{p}<0.01$ ) was significantly greater than that of GCS $\leq 13$ (OR 5.38 ; $95 \%$ CI $5.33-5.44$, p $<0.01$ ). For TCN in geriatric patients, the effect size of GCS $\leq 13$ (OR 4.82; 95\%CI 4.74-4.90, $\mathrm{p}<0.01$ ) was similar to that of $\mathrm{GCSm} \leq 5$
(4.82; 95\%CI 0.4.72-4.91, $\mathrm{p}<0.01$ ).

Conclusion: Substituting GCSm $\leq 5$ for GCS $\leq 13$ in the NFTG for adult patients has similar diagnostic performance and greater

| Sensitivity (\%) |  |  |  |  |  |  | Specificity (\%) | Accuracy (\%) | AUC |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Adult Patients |  |  |  |  |  |  |  |  |  |
| GCS 513 | 54.7 | 75.2 | 68.0 | 0.644 |  |  |  |  |  |
| GCSm $\leq 5$ | 53.4 | 76.2 | 68.0 | 0.643 |  |  |  |  |  |
| Geriatric Patients |  |  |  |  |  |  |  |  |  |
| GCS 513 | 33.1 | 83.4 | 68.1 | 0.583 |  |  |  |  |  |
| GCSm $\leq 5$ | 31.0 | 84.0 | 67.9 | 0.575 |  |  |  |  |  | effect on TCN, while motor-only deficits were associated with greater rates of severe head injury and craniotomy. However, in geriatric patients, GCS $\leq 13$ has better diagnostic performance and similar effect on TCN, while non-motor deficits were associated with greater rates of severe head injury and craniotomy. Thus, while use of GCSm for field triage may be appropriate for adult patients, the full GCS appears to be necessary for field triage in geriatric patients.

# PREFERENCES AND PREDICTIONS REGARDING END-OF-LIFE AND PALLIATIVE CARE IN THE INTENSIVE CARE UNIT 

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Introduction: With an increasingly aging population the number of trauma patients 50 years and older admitted to the intensive care unit (ICU) continues to rise. In this population it is common to have to make decisions about end-of-life goals of care and the need for palliative care consultants. We sought to better elucidate the degree of uncertainty about end-of-life decisions and provider feelings about palliative care.
Methods: Our study is a prospective observational study of patients 50 years and older admitted to the ICU at our level one trauma center. ICU patients or their surrogates were approached, consented, and completed a survey which included questions with regards to prior discussions about end-of-life care and whether the patient would want to live ventilator-dependent. Additionally the nurse, resident, and attending were surveyed with their expectation for patient outcome and whether palliative care teams or comfort care order sets should be added. Patients were followed through to determine eventual outcomes. Data were compared using chi-square analysis and fisher's exact test.
Results: One hundred patients had data available for analysis. Surveys were completed by the patient for 39 while a surrogate completed the survey for the other 61 patients. When the patient answered $13 \%$ would want a ventilator long-term, $82 \%$ would not want a ventilator long-term and $5 \%$ were unsure; if the surrogate answered $5 \%$ thought the patient would want the ventilator long-term, $74 \%$ thought the patient would not want the ventilator long-term, and $21 \%$ were unsure. Sixty-four of those being surveyed had had a prior discussion while 36 had not. When a prior discussion had been had 5\% would want a ventilator long-term, $86 \%$ would not, and $9 \%$ were unsure, this differed from when there was no prior discussion when $14 \%$ would want a ventilator long-term, $61 \%$ would not, and $25 \%$ were unsure.
Nurse, resident and attending predictions about hospital survival were very similar with all groups predicting survival in $82 \%$. There were differences due to some being unsure such that nurses were unsure about $7 \%$, residents were unsure about $5 \%$ and attendings were unsure about $9 \%$. The differences between predictions were not statistically significant. Nurses, residents, and attendings had similar ideas about the appropriateness of comfort care with $18 \%, 17 \%$, and $16 \%$ saying yes respectively. There was more variation in ideas about the appropriateness of a palliative care consult with nurses saying yes $27 \%$ of the time while residents and attendings only said yes $18 \%$ and $17.5 \%$ of the time.
Conclusions: One of the greatest difficulties in making end-of-life decisions lies in the uncertainty about what the patient would want. The significantly higher rates in being unsure for both surrogate decision makers or in cases where no prior discussion had been had highlights the importance of having more conversations about end-of-life and documentation of advance directives prior to traumatic events. The difference in nurse and physician ideas about the appropriateness of a palliative care consult was striking. It is possibly due to more interaction between nurses and the patients and families showing a greater need for further discussion and palliation than the physicians appreciate or to a bias by physicians against involving another service. Teasing out reasons for this difference is an area for further study.

Poster \# 48

## GERIATRIC TRAUMA MORTALITY - DOES TRAUMA CENTER LEVEL MATTER?

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Introduction: The geriatric population has unique challenges that require a specialized approach. It is a demographic reality that as the population ages it tends to situate itself in mostly rural and suburban environs. Given their mostly rural/suburban location Level II trauma centers (TCs), may offer greater exposure to and experience in managing geriatric patients. We hypothesized that geriatric patients would have decreased mortality at Level II TCs compared to their Level I counterparts.
Methods: The Pennsylvania Trauma Outcome Study database was retrospectively queried from 2003-2017 for geriatric (age $\geq 65$ ) trauma patients admitted to Level I and II accredited TCs in Pennsylvania. Patient demographics, injury severity and clinical outcomes were compared to assess differences in geriatric care between Levels I vs. II TCs. A multivariate logistic regression model assessed the adjusted impact of care at Level I vs. II trauma center on mortality.
Results: 167,733 patients met inclusion criteria [Level I: 113,870 (67.9\%); Level II: 53,863 (32.1\%)].The proportion of geriatric trauma patients across all Level I ( $\mathrm{n}=18$ ) \& Level II $(\mathrm{n}=15$ ) TCs was determined to be 29.1\% and 36.3\% ( $\mathrm{p}<0.001$ ), respectively. In adjusted analysis, care at Level II TC was associated with significantly improved mortality (AOR $0.773,95 \%$ CI: $0.615-0.972, \mathrm{p}=0.027$ ) (Table 1).
Conclusion: The higher proportion of geriatric patients at Level II TCs may contribute to the improved mortality observed at Level II vs. Level I TCs. While the underlying reason is likely multifactorial, availability of specialized geriatric care and consistent exposure to geriatric patients at Level II TCs may contribute to improved care. Future consideration for location of centers of excellence in geriatric trauma should include Level II trauma centers.

|  |  | Mortality |
| :---: | :---: | :---: |
| Variable | AOR (95\% CI) | $p$ |
| Level II vs. I | 0.773 [0.615-0.972] | $<0.027$ |
| Age |  |  |
| 65-74 | Reference | --- |
| 75-84 | 1.77 [1.675-1.869] | -0.001 |
| 85-94 | 2.21 [2.081-2.338] | co.001 |
| 95 and above | 3.22 [2.888-3.597] | $<0.001$ |
| Male gender | $1.600\|1.533-1.669\|$ | 40.001 |
| ISS |  |  |
| Mild: 0-9 | Reference | --- |
| Moderate: 10-16 | 229 [2.173-2.503] | <0.001 |
| Severe: 17-25 | $6.72 \mid 6.540-7.455]$ | 0.001 |
| 1'rofound: 26-75 | $24.64\|24.158-27.741\|$ | < 0.001 |
| Admission SBl | 0.99 \|0.985-0.986| | 40.001 |
| Hospital I.OS | $0.96[0.952-0.959]$ | 40.001 |
|  |  | C: 0.8097 |
| ISS = injury scverity score; SBP = systolic blood pressure; $\mathrm{LOS}=$ length of stay |  |  |

# THE IMPACT OF INTRACRANIAL PRESSURE MONITORING ON OUTCOMES IN GERIATRIC PATIENTS WITH TBI 

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Introduction: Traumatic brain injury (TBI) remains a significant cause of morbidity and mortality in the geriatric population. Intracranial pressure (ICP) monitoring has been considered the standard of care following severe TBI. Although many studies have assessed ICP monitor usage in adults, few have examined the impact of ICP monitoring in the elderly TBI patient. The aims of this study were to determine the association between ICP monitoring and outcomes in the geriatric TBI patient population and to examine the effect of age on outcomes among patients with an ICP monitor.
Methods: We conducted a prospective multi-center study of geriatric patients with TBI across 43 trauma centers. Inclusion criteria were age $\geq 40$ and computed tomography (CT)-verified TBI. Patients with injury to any other body region with an Abbreviated Injury Scale (AIS) score $>2$ or presentation $>24$ hours after injury were excluded. Information on demographic, injury, hospital course, and outcomes was collected. Age was categorized based on distribution. The primary outcomes were in-hospital mortality, length of hospital stay (LOS) and ICU LOS and functional outcome at discharge. We compared distributions of the outcomes across age categories overall and among individuals with ICP monitoring using Chi-square Goodness of fit and the Kruskal-Wallis test.Regression modeling (linear for continuous outcomes and logistic for binary outcomes) was used to estimate the effect of ICP-monitoring on outcomes in the entire sample, adjusting for age and potential confounders.
Results: Of 3081 patients, 135 (4\%) had an ICP monitor placed. With increasing age patients were less likely to undergo ICP monitor placement ( $\mathrm{p}<0.001$ ). Among those receiving ICP monitors, $70 \%$ were male, $69 \%$ had a Glasgow Coma Scale (GCS) score $<9$, and $96 \%$ had a head AIS $>2$. Older patients with an ICP monitor were more likely to receive palliative interventions ( $\mathrm{p}=0.02$ ).(Table1) Controlling for age, AIS-head, and GCS categories, and compared to patients who did not receive ICP monitoring, those with ICP monitors had an increased mean LOS (8.7 days, 95\% confidence interval (CI)
7.4-10.1) and increased mean ICU LOS (5.8 days, 95\%CI 4.7-6.9), decreased odds of good functional evaluation at discharge (odds ratio (OR) 0.49, 95\% CI 0.27-0.89) and increased odds of mortality, but this was not statistically significant (OR 1.3, 95\% CI $0.82-2.1, \mathrm{p}=0.3$ ).

| Age | $\begin{gathered} 49-59 \\ (n-69) \end{gathered}$ | $\begin{aligned} & 60-81 \\ & (n-55) \end{aligned}$ | $\begin{aligned} & >81 \\ & (n-11) \end{aligned}$ | puvatue |
| :---: | :---: | :---: | :---: | :---: |
| Hospital rcos | $19 \pm 14.2$ | $15.9 \pm 12$ | $11.6 \pm 11.1$ | 0.12 |
| TCULOS | 1319.9 | 11,7土7,4 | 7.915 .1 | 0.26 |
| Palliarive intervention (pallative care consults, dixcontinuation of ilro sumtaining menwwres and hosples cara) | 29\% | 42\% | 73\% | 0.02 |
| Morriality | $36 \%$ | 45\%\% | 53\% | 0.38 |
| Oucpatient follow-up (eompletely alisintsled) | 10\% | 22\% | 27\% | 0.16 |

Conclusion: Although ICP monitoring is standard of care in adult patients with severe TBI, there are no available recommendations based on age. This study demonstrated that ICP monitoring is not frequently utilized in the 'very old' geriatric trauma patient, outcomes may be worse among these patients who undergo ICP pressure monitoring, and among those who survive, disability is worse. Based on these data, the use of ICP monitoring should be reconsidered in geriatric patients with TBI.

# A TALE OF TWO STROKES: THE CHALLENGES OF DIAGNOSIS AND MANAGEMENT OF BCVI AND NON-BCVI STROKES AT A LEVEL 1 TRAUMA CENTER 

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Introduction: While there has been much interest in the early diagnosis and treatment of blunt cerebrovascular injury (BCVI) to decrease stroke rates, there is a paucity of research addressing non-BCVI strokes. We have perceived an increase in non-BCVI strokes at our center. The purpose of this study is to evaluate the incidence, treatment, and etiology of strokes in our trauma population in order to identify preventive strategies. Methods: This study was a retrospective review of all adult trauma patients admitted to a level 1 trauma hospital who suffered a stroke during trauma admission from 2010 to 2017. Data was collected from the prospectively maintained trauma and stroke databases. Chi-square was used to compare categorical variables, which are presented as N (\%). Mann Whitney U test was used to compare continuous variables, which are presented as median (IQR).
Results: Of the 43,674 adult trauma patients admitted during the study period, 99 (0.2\%) were diagnosed with a stroke during the index admission. Twenty-one (21\%) strokes were due to BCVI, of which, $79 \%$ received appropriate anti-thrombotic therapy at a median of 7 hours from time of arrival. Seventy-eight (79\%) strokes were due to nonBCVI etiologies. Patients with non-BCVI strokes were older, less severely injured, and had more medical comorbidities compared to patients with a BCVI stroke (Table). While BCVI stroke patients were more likely to suffer multiple traumatic injuries from MVC ( $76 \%$ vs $28 \%, \mathrm{pp}<0.001$ ), non-BCVI strokes had more isolated extremity injuries from fall mechanism ( $55 \%$ vs $10 \%, \mathrm{p}<001$ ). Over the study period, the age and volume of trauma patients admitted increased. Additionally, the rate of stroke ( $\mathrm{p}<0.001$ ) and BCVI increased ( $\mathrm{p}<0.001$ ). However, the rate of BCVI strokes decreased while the rate of nonBCVI strokes increased.

|  | BCVI stroke <br> Median, $\mathrm{N}(\%)$ <br> $\mathrm{N}=21$ | Non-BCVI stroke <br> Median, N (\%) <br> $\mathrm{N}=78$ | P-value |
| :--- | :---: | :---: | :---: |
| Age | $44(27,55)$ | $71(58,82)$ | $<0.001$ |
| ISS | $26(20,34)$ | $11(8,18)$ | $<0.001$ |
| GCS in ED | $8(3,15)$ | $14.5(9,15)$ | 0.028 |
| Any medical comorbidity | $12(57.1 \%)$ | $66(84.6 \%)$ | 0.013 |
| Atrial fibrillation | $0(0 \%)$ | $14(18.0 \%)$ | 0.037 |
| Stroke or TIA | $0(0 \%)$ | $17(21.8 \%)$ | 0.020 |
| Pre-hospital ASA or Plavix | $1(4.8 \%)$ | $12(15.4 \%)$ | 0.29 |
| Pre-hospital oral anticoagulant | $0(0 \%)$ | $10(12.8 \%)$ | 0.11 |
| Mortality | $8(38.1 \%)$ | $17(21.8 \%)$ | 0.16 |

Conclusion: Strokes are rare in the trauma population but are increasing as the trauma population ages. While BCVI strokes are decreasing at our level 1 trauma center despite an increased BCVI incidence, the majority of strokes are non-BCVI strokes. Furthermore, the patient population experiencing BCVI strokes are distinctly different from that with non-BCVI strokes; the latter are older, have more medical comorbidities, and are hospitalized after low mechanism traumatic injury. Medical optimization of comorbid conditions during trauma hospitalization will become increasingly important for stroke prevention as the population ages.

## Poster \# 51

# IS ANTICOAGULATION REVERSAL NECESSARY PRIOR TO SURGICAL TREATMENT OF GERIATRIC HIP FRACTURES? 

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Introduction: Geriatric hip fracture surgery for patients on pre-injury anticoagulants may increase the risk for blood loss and subsequent blood transfusions. Anticoagulation reversal is thought to lower these risks, however, data on blood loss and transfusions for patients whose anticoagulant was reversed is limited. In addition, not all direct oral anticoagulants (DOACs) have approved reversal agents; these patients often "watch and wait" for natural elimination of the anticoagulant, delaying surgery. The study objective was to compare outcomes between 1) patients not on anticoagulants 2) patients whose pre-injury anticoagulants were reversed, and 3 ) patients whose pre-injury anticoagulants were not reversed.
Methods: This was a multicenter retrospective observational study at four level 1 trauma centers. Patients ( $\geq 65$ years old) who sustained an isolated fragility hip fracture requiring surgery (January 2014-January 2018) were included. The primary outcome was the total volume of blood loss during hospitalization. Secondary outcomes included hospital length of stay (HLOS) and total volume of blood transfusions for: fresh frozen plasma (FFP), packed red blood cells (pRBC), cryoprecipitate, and platelets. All blood volumes are reported as $\mathrm{cm}^{3}$. Statistical analyses included: Fisher's exact, chi-squared, and Kruskal-Wallis tests; linear mixed-effect (by facility), and logistic regression. Bonferroni adjustment for multiple testing was used for all between group comparisons; alpha=0.025.
Results: Of the 381 patients included in the study, 144 (39\%) were not on anticoagulants, 147 (40\%) underwent anticoagulant reversal, and 75 (20\%) were not reversed. The median (IQR) age was 83 (77-88) years old and $65 \%$ of patients were female. Pre-injury anticoagulants were DOACs (40\%) and warfarin (60\%). Anticoagulation reversal methods were vitamin K ( $32 \%$ ), FFP ( $22 \%$ ), factor VIIa ( $<1 \%$ ), and "watch and wait" (53\%). There were fewer reversed patients who walked without an assistive device (57\%) than patients not on anticoagulants (75\%), and not reversed (63\%) patients, $\mathrm{p}<0.001$. There were a higher proportion of reversed patients (22\%) who had congestive heart failure (CHF) than patients not on anticoagulants (6\%), and not reversed patients (9\%), $\mathrm{p}<0.001$. There were fewer reversed patients (8\%) than patients not on anticoagulants (24\%), and reversed patients (20\%) who had a hemiarthroplasty p=0.01. The LS mean (SE) volume of blood loss was 141 (20) for not reversed patients, 152 (17) for patients not on anticoagulants, and 174 (16) for reversed patients, after adjusting for bipolar and unipolar hemiarthroplasty, however this was not significant. The LS mean (SE) volume of FFP transfusions was also not significantly different being 565 (130) for patients not reversed, 464 (81) for reversed patients, and 631 (217) for patients not on anticoagulants, after adjusting for enrolling facility. There was no difference in the HLOS, total volume of pRBC, cryoprecipitate, and platelet transfusions between groups.
Conclusions: Patients whose anticoagulant was not reversed prior to hip fracture surgery did not experience any significant increases in blood loss, blood transfusions, or HLOS. Our data suggests that patients taking pre-injury anticoagulants, with or without reversal, seem to have a similar risk of blood loss compared to patients not on anticoagulants.

Poster \# 53

## EVALUATING THE DECADE OF ACTION FOR ROAD SAFETY IN A RAPIDLY DEVELOPING COUNTRY: ARE WE USING THE RIGHT INDICATORS?

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Introduction: Qatar is a rapidly developing country with a population growth of $4 \%$ per annum driven by the influx of migrant workers needed for infrastructure development. Road traffic injuries [RTIs] are the leading cause of death; consequently, the country has participated in the Decade of Action for Road Safety [DoARS] coordinated by the United Nations Road Safety Collaboration, since 2011. Its goal is to reduce the number of road traffic deaths by $50 \%$ from 2011-2020. This study will evaluate the DoARS in Qatar, to date, linking publicly accessible national RTI data and globally accepted indicators.
Methods: Data, on road traffic deaths and injuries, from the Traffic
Department, Ministry of Interior, the National Traffic Safety Committee and the Hamad Medical Corporation National Trauma Registry for the years 201116 were collected and analyzed. The absolute number of RTI deaths, the main DoARS indicator, was analyzed and compared with other, population-based, indicators.
Results: For the over-all DoARS indicator, the number of RTI deaths, Qatar has only improved by $13.2 \%$; but death rates have dropped by $42.9 \%$. There have been more RTIs, by $14.3 \%$, but a $25.1 \%$ drop in their incidence rate. A reduction in the number and rate of pre-hospital deaths were the highest among all indicators analyzed. And the number of in-hospital deaths increased during the study period [see Table 1].
Conclusion: Qatar has made dramatic improvements in road safety since 2011, most notably in pre-hospital mortality. In similar settings, with rapidly transforming populations.

|  | 2011 | 2016 | Absolute Change | Percent Change |
| :---: | :---: | :---: | :---: | :---: |
| RTI Deaths | 205 | 178 | -27 deaths | -13.2\% |
| RTI Death Rate | 12.6 | 7.2 | -5.4 per 100,000 | -42.9\% |
| RTIS | 791 | 904 | +113 RTIs | +14.3\% |
| RTI Rate | 48.7 | 36.5 | +12.2 per 100.000 | -25.1\% |
| Pre-Hospital RTI Deaths | 167 | 134 | -33 deaths | -19.8\% |
| Pre-Hospital RTI <br> Dealh Rate | 10.3 | 5.4 | -4.9 per 100.000 | -47.6\% |
| In-Hospital RTI Deaths | 34 | 37 | +3 deaths | +1.1\% |
| In-Hospital RTI Deaths | 2.1 | 1.5 | -0.6 per 100,000 | -28.6\% |

# INCREASING SMARTPHONE AND SOCIAL MEDIA PENETRATION STRONGLY CORRELATED WITH MASS SHOOTING INCIDENTS AND DEATHS IN THE UNITED STATES 

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Introduction: Mass shootings in the United States have risen significantly. The cause for this recent increase in violence is multifactorial and complex. Newly recognized risk factors for the development of mass shooters are increasing social isolation and media contagion. Omnipresent smartphones in society may increase media consumption while decreasing human social interaction. As such, we hypothesize that increasing smartphone penetration and social media in the United States may correlate with the rise in mass shooting events.
Methods:Data on US firearm commerce and homicides were obtained from federal agencies. The incidence and casualties from mass shootings, defined as $\geq 4$ non-shooter individuals killed or wounded, were obtained from referenced, open-sourced datasets. Social media penetration was determined from annual corporate investor reports. Smartphone penetration was identified using national survey data from consumer and technology assessment companies and research centers. Graphical assessment and Pearson correlations were performed to identify trends correlated with the increase in mass shooting events.
Results: Mass shooting events and casualties remained constant prior to a noted increase in 2014. Smartphone penetration and the mean number of monthly active users of social media in the US market appear to follow a similar increase during the same timeframe. In contrast, new firearm delivery to the US market, regardless of weapon type, has steadily increased since 1996, without a 2014 spike as seen in both mass shootings and social media. Total firearm homicides, while increasing, demonstrate less change in frequency and remain below their height seen in the early 1990s. Over the last decade, mass shooting events and casualties were strongly correlated with mean monthly active users of Twitter (rho=0.97; $p<0.001$ and rho=0.98; $p<0.001$ ), Facebook (rho $=0.97 ; p<0.001$ and rho=0.87; $p=0.001$ ), and smartphone penetration (rho=0.73; $p=0.040$ and $r h o=0.93 ; p=0.001$ ). New firearm production was not correlated to mass shooting events or casualties (rho $=0.60$; $\mathrm{p}=0.088$ and $\mathrm{rho}=0.53 ; \mathrm{p}=0.14$ ).
Conclusion: Smartphone and social media penetration timelines strongly correlate with mass shooting events. However, it remains to be determined if these technological influences are causative. Further research is needed to identify any causal relationships and /or the existence of media contagion on the incidence of mass shooting events.


## RATES OF SUICIDE WITH FIREARMS SIGNIFICANTLY ASSOCIATED WITH NEW HANDGUN DELIVERY TO THE UNITED STATES MARKET

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Introduction: Firearm violence is increasingly recognized as national public health priority. While assault and homicide with firearms are the focus of most research and policy efforts, suicide is the predominant cause of firearm death. Suicidality is often multifactorial and complex. Although typically presumed secondary to mental health, large proporations of victims have no evidence of either mental illness or depression. Further efforts to limit firearm violence must include identification of the risk factors associated with suicide. One recognized risk factor is individual access to firearms. It remains unclear though, if there is any relationship between new firearm production and suicide rates. We hypothesize that rates of suicide by firearm are correlated to increased firearm delivery to the US market.
Methods: We performed a review of data from 1981-2018. Annual rates of suicide by firearm were obtained using the CDC WISQARS database. Firearm delivery to the US market was calculated as weapons manufactured plus imports minus exports. Data on firearm commerce was identified from annual ATF firearm commerce reports. Mental health data was obtained from the Substance Abuse and Mental Health Services Administration national survey results. Spearman's correlations and graphical analyses were performed over the available timeframes. Stepwise linear regression was used to identify significant risk factors for rates of firearm related suicide.
Results: Rates of suicide by firearm initially decreased in 1999 before steadily increasing starting in 2007. Rates of new handgun delivery to the market closely mirror the rate of suicide by firearm. From 2005-2017, handgun (rho $=0.93, \mathrm{p}<0.001$ ) and total firearm ( $\mathrm{rho}=0.88, \mathrm{p}<0.001$ ) delivery were strongly correlated with rates of suicide by firearm. The US unemployment rate (rho=0.13, $\mathrm{p}=0.68$ ) and prevalence of major depression ( $\mathrm{rho}=0.49, \mathrm{p}=0.10$ ) were not correlated with suicide rates while the proportion of adults with severe mental health disorders (rho=0.70, p=0.04) were weakly correlated. Only new handgun delivery to the US market was significantly associated with rates of suicide with firearms on multivariate linear regression ( $\mathrm{R}=0.93, \mathrm{p}<0.001$ ).
Conclusion: Rates of new handgun delivery to the US market are strongly correlated with rates of suicide in the United States. Further research and injury prevention strategies are needed to limit further suicide by firearm.


# ASSOCIATION OF INTERFACILITY HELICOPTER VERSUS GROUND AMBULANCE TRANSPORT AND IN-HOSPITAL MORTALITY AMONG TRAUMA PATIENTS 

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Introduction: Relatively few studies have compared helicopter transport (HT) to ground transport (GT) for the inter-facility transport of trauma patients. Mixed results have been reported from these studies ranging from a slight increase in odds of survival for the severely injured to no evident benefit for HT patients. Previous studies did have notable limitations, the most significant being a lack of data from the transferring non-tertiary center (NTC) and no direct measure of distance between the NTC and tertiary trauma center (TTC). We sought to improve on existing studies by addressing these limitations. We hypothesized there was no adjusted difference in mortality between patients transported interfacility by HT or GT taking into account distance from TTC.
Methods: This was a retrospective cohort study of adult (18+ years old) trauma patients who initially presented to a NTC before subsequent transfer by HT or GT to a TTC. Data from 2005 to 2014 were obtained from an inclusive state-wide trauma registry. Records from the NTC and TTC were linked. Patients initially seen at a NTC closer than 21 miles and patients whose primary injury was burns were excluded. A total of 9,880 linked records were available for analyses. A propensity score using NTC demographic and clinical variables was developed to balance factors impacting selection to the HT and GT groups. We used propensity adjusted, multivariable Cox proportional hazards models to assess the association of HT on mortality at 72 -hour and within the first 2 weeks of arrival at a TTC; these multivariable analyses were stratified by distance (miles) between NTC and TTC: 21-59, 60-90, and greater than 90.
Results: HT ( $\mathrm{N}=3424$ ) and GT ( $\mathrm{N}=6456$ ) patients were similar with respect to age and race however HT were slightly more often male. HT patients more often had penetrating injury and were more frequently injured in traffic-related incidents. Longer distance to the TTC was associated with increased length of stay at the NTC for HT patients, however this association was not observed for GT patients. Mean distance between NTC and TTC was greater for HT patients, 96.7 miles versus 69.9 miles for GT. Time from NTC arrival to TTC arrival was shorter for the HT group at each distance. A higher proportion of patients among the HT group had an ISS of 16 or higher ( $24.6 \%$ vs $10.9 \%$ ), an initial SBP $<90 \mathrm{mmHg}$ ( $7.3 \%$ vs $2.8 \%$ ), and GCS $<10$ ( $12.5 \%$ vs $3.7 \%$ ) than the GT group. HT was associated with significantly decreased 72 -hour mortality (HR 0.61, $95 \%$ CI $0.40-0.93$ ) for patients transferred from a NTC $<60$ miles from the TTC. No association was seen for patients transferred more the 60 miles to the TTC. No significant association of HT and 2-week mortality was seen at any distance from the TTC.
Conclusion: Only for patients transferred from an NTC <60 miles from the receiving TTC was HT associated with a significantly decreased hazard of mortality in the first 72 hours. It appears the farther away the NTC the lower the threshold for using HT resulting in a large proportion of lesser injured patients being flown. A large proportion of HT patients, especially from the most distant NTCs, had minor injuries and normal vital signs at both the NTC and TTC suggesting the decision to use HT for these patients was resource-driven rather than clinical.

# BLEEDING TO DEATH IN A BIG CITY: AN ANALYSIS OF ALL TRAUMA DEATHS FROM HEMORRAGE IN A METROPOLITANAREA OVER ONE YEAR 

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Introduction: Hemorrhage is the most common cause of potentially preventable (PP) trauma death, but no studies have focused on PP deaths from hemorrhage (PPH) across a large metropolitan area. We hypothesized that PPH deaths frequently occur too early for currently available resuscitation and hemorrhage control techniques.
Methods: All trauma-related deaths in a large US county were reviewed and patients were excluded if hemorrhage was not their primary cause of death. Deaths were categorized as PPH or non-preventable (NP). These categories were compared across mechanism of injury, death locations, anatomic locations of hemorrhage to determine significant differences using chi square test.
Results: 1848 deaths were reviewed and 258 (14\%) were from uncontrolled hemorrhage. Half (129) of the 258 hemorrhagic deaths were PPH. There were 140 pre-hospital deaths, 47 (34\%) of which were PPH. Of the 129 PPH, 47 (36\%) occurred prehospital and an additional 25 (19\%) died within 1 hour of arriving at an acute care setting. Isolated truncal bleeding was the cause of death in 102 (79\%) of the PPH. Of those who died from PPH of the trunk, there was a nearly equal distribution among chest, chest/abdomen, abdomen, and all other truncal sources and combinations. 21 (27\%) of the 77 PPH who died at their initial acute care setting were treated at non-level 1 trauma center.
Conclusion: The majority of PPH deaths in a large urban center occur in the pre-hospital setting or very early after hospitalization. Earlier, more effective prehospital resuscitation and truncal hemorrhage control strategies are required to improve outcomes in patients with potentially preventable deaths from hemorrhage.

| Preventability by IIemorrhage Location <br> Total <br> $n(\%)$ |  |  |  |
| :--- | :---: | :---: | :---: |
| Preventable/ <br> Potentially Preventable <br> $\mathrm{n}(\%)$ | Non-Preventable <br> $\mathrm{n}(\%)$ |  |  |
| Total | 258 | $129(50.0)$ | $129(50.0)$ |
| Truncal | 219 | $102(46.6)$ | $117(53.4)$ |
| Chest | 89 | $28(31.5)$ | $61(68.5)$ |
| Abdominal | 30 | $25(83.3)$ | $5(16.7)$ |
| Pelvis | 3 | $3(100.0)$ | $0(0.0)$ |
| Combined Cavity | 97 | $46(47.4)$ | $51(52.6)$ |
| Truncal/Neck | 5 | $3(60.0)$ | $2(40.0)$ |
| Truncal/Junctional | 7 | $5(71.4)$ | $2(28.6)$ |
| Neck | 2 | $0(0.0)$ | $2(100.0)$ |
| Junctional | 3 | $3(100.0)$ | $0(0.0)$ |
| Truncal/Extremity | 12 | $6(50.0)$ | $6(50.0)$ |
| Extremity | 9 | $9(100.0)$ | $0(0.0)$ |
| Extremity/Junctional | 1 | $1(100.0)$ | $0(0.0)$ |

# COMPARISON BETWEEN GEOGRAPHIC INFORMATION SYSTEMS (GIS) BASED ESTIMATES OF TRAUMA CENTER ACCESS AND TRAUMA REGISTRY DATA TO ASSESS EFFECTS OF CHANGES IN TRAUMA SYSTEM STRUCTURE 

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Introduction: Geographic information systems (GIS) are often used to analyze trauma systems. GIS-based approaches can model access to a trauma center (TC), including estimates of transport time and population coverage, when accurate trauma registry and EMS data are not available or are not shared for various reasons. Our hypothesis is that estimates of trauma system performance calculated using a standard GIS method with public data will be comparable to those calculated using trauma registry data.
Methods: A standardized GIS-based method was used to estimate metrics of TC access in a regional trauma system in which the number of TC increased from 1 to 3 over a 3 -year period. Registry data from a single TC in the system was evaluated for different time periods during this evolution. The number of admissions to the TC in different time periods was compared to changes in trauma patient distribution predicted by the GIS-based model, and the distribution of observed ground-based transportation times was compared to the predicted distribution.
Results: With the addition of 2 TC to the system, the volume of patients transported by ground to the index TC decreased by $30 \%$, while the model predicted a $68 \%$ decrease in population having the shortest predicted transport time to the index TC. The model predicted the geographic trend seen in the registry data, but many patients were transported to the index TC even though it was not the closest center, so the impact was substantially less than predicted. The figures below illustrate the origin of admitted patients, and a heat map reflecting volume for each configuration. Observed transport times were uniformly shorter than predicted times, with a difference of about $20 \%$ for transport times < 20 minutes increasing to over $30 \%$ for transport times $>40$ minutes. The observed probability distribution of transport times was also significantly narrower and skewed toward shorter times than the model prediction. There was a slight decrease in transport times to the index TC in the 3 center model compared to the 1 center model. Conclusion: The GIS-based model qualitatively predicted changes in distribution of trauma patients, but registry data highlight that field triage decisions are more complex than model assumptions. Similarly, the model predicted transport times moderately well, but systematically overestimated, with the difference increasing with longer transports. This suggests that model assumptions, such as vehicle speed, based on normal traffic may not fully reflect EMS operations. There remains great need for metrics to guide policy based on widely available data. These observations provide guidance for the interpretation of GIS-based metrics in areas where registry and EMS data do not exist, and suggest ways that GIS-based models may be improved for trauma system use.


# Predictors of Patient No-Shows to Post-Discharge Clinic Appointments Following Traumatic Injury 

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Introduction: Patients not presenting to clinic appointments increase healthcare costs with the average no-show rate across medical specialties around $23 \%$. Little research has been done specifically for the trauma patient population. A study of orthopedic trauma patients found that $33.1 \%$ of patients did not attend their first clinic appointment after injury. The aim of this study was to evaluate risk factors for missing post-discharge, hospital follow-up appointments in a trauma population.

Methods: This was a retrospective chart review of patients who underwent exploratory laparotomy for traumatic injury by the trauma surgery service at an urban, Midwestern, level 1 trauma center and had a follow up scheduled in clinic after discharge. Clinically relevant demographic characteristics, patients' distance from hospital and the presence of staples, sutures, and drains requiring removal were collected. Home zip code was queried from US census data to identify the \% of population living below the poverty line as a marker of socioeconomic status. Descriptive statistics of categorical variables were calculated as totals and percentages and compared with a $\chi$-squared test or Fischer's exact when appropriate. Aggregate rates were compared using one-way ANOVA. Logistic regression was preformed using R 3.5.2.

Results: The sample included 243 patients who were largely assaultive trauma survivors (69.5\%), male (81.9\%), African American (54.7\%) with an mean age of $30.0 \pm 17.8$. Overall, $35.8 \%$ no-showed for their follow-up appointment. Risk factors on univariate analysis for no-show included African American ( $\mathrm{OR}=2.55$ [1.39-4.68], $\mathrm{p}=0.003$ ), assaultive/violent trauma ( $\mathrm{OR}=3.98[1.83-8.65$ ], $\mathrm{p}<0.0005$ ), non-private insurance, non-married $(\mathrm{OR}=5.057[1.81-14.14], \mathrm{p}=0.002)$ and lack of need for suture, staple or drain removal ( $\mathrm{OR}=2.21$ [1.24-3.95], $\mathrm{p}=0.007$ ). On multivariate logistic regression modeling only assaultive/violent trauma ( $\mathrm{OR}=1.15, \mathrm{p}=0.0105$ ), non-private insurance $(O R=1.78, \mathrm{p}=0.005)$, non-married status $(O R=1.22, \mathrm{p}=0.03)$ remained significant.

Conclusion: Trauma patients are at high risk of no-show for follow-up appointments. Insurance type, marital status and mechanism of injury are associated with increased likelihood of no-show. Future work is needed evaluating interventions to improve follow-up and should focus on single assaultive trauma survivors with non-private insurance.

Poster \# 61

# PLACEMENT OF BLEEDING CONTROL KITS BASED ON LOCATION OF MASS CASUALTY EVENTS 

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Introduction: Mass shootings and terrorist attacks in the United States pose a significant threat to public health. The Stop the Bleed campaign has worked to reduce the number of deaths from external hemorrhage. Although public bleeding control education has been well received, financial challenges have hampered the desired placement of bleeding control (Bcon) kits in all public spaces. Given a limited resource environment, the most effective placement of BCon kits in public spaces has yet to be determined. We sought to characterize the locations of mass shootings and terrorist incidents to better predict where public access BCon kits could potentially provide the greatest benefit and prevent loss of life from preventable hemorrhage.
Methods: This retrospective review examined mass casualty events of at least four shooting victims or terrorist events such as bombings or vehicular assault in the United States from January 2002 to December 2018. Shootings in public streets, residences and those without sufficient information were excluded. Information was sourced from public databases and records, including data from Mother Jones' Investigation, Global Terrorism Database, Gun Violence Archive, LA Times Deadliest US Mass Shootings, and Stanford Libraries Mass Shootings in America. Details regarding number of fatalities, casualties, weapon and location of event were elucidated. Location was further characterized based on ICD-10 location codes. Descriptive statistics were completed for analysis. Results: 2411 events were reviewed and 730 events met inclusion criteria. The most frequent location was trade or service area at $69 \%$, specifically private businesses at $34 \%$ and bar/nightclubs at $33 \%$. The most frequent weapon was unspecified firearm, $65 \%$, followed by handguns, $22 \%$. Of those events for which specific location details were elucidated, $51 \%$ of casualties occurred inside, $44 \%$ outside, and $3 \%$ at entrance areas. $88 \%$ of incidents occurred between 2014-2018 which is likely attributable to increased tracking from the Gun Violence Archive.

| ICD-10 Location Codes | $\begin{gathered} 2002-2018 \\ 730(100 \%) \end{gathered}$ | Inside | Outside | Entrance | Unknown |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Trade and service area (Y92.5) | 505 (69\%) | 217 (43\%) | 258 (51\%) | 16 (3\%) | 14 (3\%) |
| Private commercial establishments Theater | 250 6 | $\begin{gathered} 107 \\ 2 \end{gathered}$ | $\begin{gathered} 127 \\ 3 \end{gathered}$ |  | $\begin{aligned} & 5 \\ & 1 \end{aligned}$ |
| Bar/nightelub | 238 | 101 | 125 | 3 | 9 |
| Transportation service areas | 17 | 9 | 6 | 2 | 0 |
| Aipport | 7 | 3* | 2 | $2^{* *}$ | 0 |
| School, other institution and public administrative area (Y92.2) | 118 (16\%) | 66 (56\%) | 47 (40\%) | 5 (4\%) | 0 (0\%) |
| School, private/public/state | 41 | 22 | 17 | 2 | 0 |
| Religious institution | 24 | 13 | 10 | 1 | 0 |
| Hospital | 11 | 7 | 4 | 0 | 0 |
| Public administrative building | 34 | 17 | 15 | 2 | 0 |
| Protest/Demonstration | 8 | 7 | 1 | 0 | 0 |
| Recreation area, park (Y92.8) | 61 (8\%) | 58 (95\%) | 3 (5\%) | 0 (0\%) | 0 (0\%) |
| Mass gathering event (Y92.3) | 42 (6\%) | 27 (64\%) | 13 (31\%) | 2 (5\%) | 0 (0\%) |
| Concert | 9 | 8 | 1 | 0 | 0 |
| Unspecified or Unknown (Y92.9) | 4 (1\%) | 4 (100\%) | 0 (0\%) | 0 (0\%) | 0 (0\%) |

Conclusion: The two-pronged Stop the Bleed approach of education and equipment availability to help reduce death due to preventable hemorrhage has seen challenges as it relates to placement of Bcon kits in public spaces. This study demonstrates that for those with limited funding, BCon kits would be most advantageous if placed at private businesses near points of egress. This study is limited by the availability and accuracy of previously collected data and news reports, and the public availability of data regarding events of this nature. Studies examining those injured on public streets and in private residences are needed.

# INSTITUTION OF VISION ZERO IN A MAJOR URBAN CITY: DOES IT REALLY WORK? 

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Background: In 2013 in New York City (NYC), there were nearly 300 traffic fatalities, of which $60 \%$ resulted in a pedestrian death. In January 2014, the NYC government implemented the Vision Zero (VZ) Strategy, a multi-pronged approach to end all traffic fatalities, including increased patrol and enforcement, criminal charges for traffic violations, decreased city wide speed limits and improvements in traffic technology. The goal of this study was to evaluate the impact these strategies had on traffic mortality and injury.
Methods: Data from the City of New York, New York Police Department (NYPD) from 2013-2015 were analyzed. The study population consisted of all motor vehicle collisions (MVC) in all five boroughs of NYC. Populations were evaluated in two groups; those before the inauguration of the Vision Zero laws and policies in January 2014 and those after. Rates of MVCs involving non-fatal and fatal injuries to cyclists and pedestrians as well as overall mortality were compared.
Results: There were 627,449 MVCs in NYC during the study period, involving 157,700 injured people. Of the MVCs with documented causes, $0.11 \%$ were attributed to an "unsafe speed". 55,123 people were injured in the year pre-VZ (2013), 51,219 in 2014 and 51,358 in 2015 (post-VZ). Of

|  | Pre-VZ <br> $(2013)$ | Post-VZ <br> $(2014-2015)$ |  |
| :--- | :---: | :---: | :---: |
| Total MVC (n) | $\mathbf{2 0 3 , 7 2 7}$ | 423,722 |  |
| Collisions associated with: (\%) |  |  |  |
| - Injured persons | 20 | 18 | $\mathbf{p}<0.00001$ |
| - Injured pedestrians | 5.6 | 4.8 | $\mathbf{p}<0.00001$ |
| - Injured cyclists | 1.99 | 1.94 | $\mathbf{p}<0.222$ |
| -Any fatality | 0.14 | 0.12 | $\mathbf{p}<0.01$ |
| - Pedestrian fatality | 0.09 | 0.06 | $\mathbf{p}<0.001$ |
| - Cyclist fatality | 0.005 | 0.008 | $\mathbf{p}<0.215$ | the collisions where there was a fatality, the rate declined from $0.14 \%$ to $0.12 \%$ ( $p<0.01$ ). Collisions involving killed or injured pedestrians represented the majority, these rates decreased from pre to post-VZ (0.09\%, 0.06\% fatalities; 5.6\%, 4.8\% injured). Collisions involving killed or injured cyclists did not significantly change from pre to post-VZ (1.99\%, $1.94 \%$ injured; $0.005 \%, 0.008 \%$ fatalities).

Conclusion: The implementation of a multipronged government program which includes criminal charges for traffic violators, decreases in city wide speed limits, increased enforcements and patrol, as well as changes to traffic technology were associated with an overall decreased MVC related mortality and injury rate in a large urban city. This benefit was isolated to collisions involving pedestrian mortalities and injuries, as the rates were associated with a significant decrease after institution of VZ. This advantage did not translate to cyclists as the changes seen were not significant. Further research is needed to better understand how these changes impact the different types of injury and mortality associated with MVCs.

# Saving Lives in Low- and Middle-Income Countries: Repairing the Trauma Registry 

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Introduction: Trauma systems are effective in lowering injury-related death and disability in high income countries, through the evolution of costly and complicated care structures. Existing data is insufficient and irrelevant to limited resource settings, where over ninety percent of the world's injured are managed under very different circumstances. Registries are critical to measure the efficacy of interventions to improve injury related deaths. However, practical implementation of these registries in low- and middle-income countries (LMICs) is complicated by resource limitations. This study aims to identify the barriers to data collection, as well as solutions to overcome those challenges.
Methods: In October of 2015, the Panamerican Trauma Society Registry was implemented at six hospitals, 5 public and 1 private, in Santa Cruz de la Sierra, the capital city of Santa Cruz, Bolivia (population of 1.6 million). Three years after implementation, focus groups of attending and resident physicians were conducted at each hospital to evaluate the logistics of form completion, online data entry, and data download.
Results: Twenty-two individuals participated in the study. Barriers to the trauma registry data collection process included 1 . Doubled workload: registry sheet is separate from medical record, 2. Short-staffing of nurses and physicians in the Emergency Department (ED), 3. Insufficient staff to upload completed forms, 4. Lack of recent trainings on data collection, entry, and upload, and 5. Lack of provider motivation to complete forms. Specific barriers to provider motivation involved 1. Lack of financial reimbursement, 2. Paucity of feedback received on the input data, and 3. Little to no change on resource allocation or distribution. Based on the feedback received and in collaboration with the local Ministry of Health (MoH), the following systemic improvements were proposed and implemented: 1. Incorporation of trauma registry items into existing medical record forms to create a standardized emergency medical record form, 2 . Development of a new registry utilization training course and manual, 3. Written instructive and mandate from the government requiring the use of the new form at all second- and third-level hospitals, 4. Written and approved legislation to create a branch of government dedicated to the trauma registry and the emerging trauma system, and 5. Institution of quarterly hospital and MoH presentations on the data analyzed. (See Table 1)
Conclusion: Resource restrictions in LMIC's limit the effective implementation of trauma registries which are critical to understanding patient outcomes. Collaboration with governmental leadership can lead to systematic changes that will facilitate improved data collection. Moreover, coordination with all stakeholders involved leads to sustainable improvements. Future work will analyze the impact of the changes implemented in this program.

Table 1. Focus Group Feedback

| Barriers to Implementation | Barriers to Provider <br> Motivation | System Improvements |
| :--- | :--- | :--- |
| Lack of hicrarchical mandate | No financial reimbursement | Standardized Emergency <br> Medical Record form |
| Double the workload; separate <br> forms | Lack of feedback on collected <br> data | Government mandate for form <br> utilization |
| Lack of ongoing registry <br> utilization training and resident <br> turnover | Unchanged resource allocation | New registry utilization course <br> development |
| Short staffing in the ED |  | Formation of MoH branch <br> dedicated to the trauma registry |
| Lack of registrars to upload <br> information |  | Quarterly feedback <br> presentations |

## Poster \# 64

## FACTORS ASSOCIATED WITH HOSPITAL DISCHARGE DELAYS IN PATIENTS WITH TRAUMATIC BRAIN INJURY

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Introduction: Hospital length of stay (HLOS) is affected by clinical and non-clinical

| Factors independently associated with experiencing discharge delay ${ }^{*}$ |  |
| :---: | :---: |
| Total $\mathrm{N}=1,065$ | OR (95\% CI)** |
| Clinical Factors |  |
| GCS | 0.93 (0.88-0.98) |
| Cirrhosis | 5.95 (1.11-31.78) |
| Psychiatric disorder | 4.23 (2.11-8.49) |
| Non-Clinical Factors |  |
| Discharge destination |  |
| Home | Ref |
| Hospice | 0.88 (0.17-4.46) |
| ICF | 16.20 (6.91-38.00) |
| LTC | 6.60 (5.51-17.35) |
| Psych facility | 49.02 (4.14-581.07) |
| SNF | 12.40 (5.74-26.80) |
| Rehab | 7.01 (3.56-13.80) |
| Primary insurance |  |
| Commercial/private | Ref |
| Medicaid | 1.12 (0.51-2.47) |
| Medicare | 0.30 (0.17-0.54) |
| Other | 0.91 (0.33-2.50) |
| Uninsured/self-pay | 0.81 (0.32-2.03) |
| ICF, intermediate care facility; LTC, longterm care or nursing home; SNF, skilled nursing facility |  |
| *Only variables significant at $\alpha=0.05$ are included in the table. |  |
| **Model Hosmer-Lemeshow goodness of fit test $=0.54$, area under the ROC curve $=0.82$. |  |

factors. Patients with traumatic brain injury (TBI) may experience longer HLOS because of injury severity; additional discharge delays can lead to worse outcomes. We investigated clinical and non-clinical differences in TBI patients with and without a discharge delay. Methods: A multicenter retrospective study was conducted on patients age $\geq 18$ with TBI and Injury Severity Score (ISS) $\geq 9$ admitted to one of two level 1 trauma centers from $1 / 2015$ to $3 / 2018$. Discharge delay was discharge occurring $\geq 24$ hours after case management notes indicated a patient was ready for discharge. Adjusted logistic regression analyses were used to explore the associations between discharge delay and patient demographics, Glasgow Coma Scale (GCS) score, ISS, time between admission and delay start (in delayed patients) or discharge (in non-delayed patients), undergoing a neurosurgical intervention prior to delay start or discharge, primary insurance type, secondary insurance utilized (yes/no), discharge destination, and comorbidities (substance abuse, bleeding disorder, cancer, cardiovascular disease, cirrhosis, respiratory disease, stroke, dementia, diabetes, kidney disorder, psychiatric disorder, obesity, current smoking). The two-way interactions between GCS/ISS and discharge destination were also considered for inclusion. Stepwise selection was used for final model selection, with entry and exit criteria of $\alpha=0.05$. SAS 9.4 was used for all analyses. Results: Of 1,065 patients, 115 (10.8\%) had a discharge delay. Among delayed patients, the median (IQR) delay was 86 (51-161) hours. In the final regression model, lower GCS score, cirrhosis, psychiatric disorder, discharge destination, and primary insurance were significantly associated with discharge delay. Patients discharged to a psychiatric facility or intermediate care facility and those with Medicaid or commercial/private insurance had increased odds of delay. Conclusion: Discharge delays occur in a portion of patients with TBI and are due to clinical and non-clinical factors. Although approximately one-tenth of patients experienced a delay in the current study, this represented $\sim 247$ days of delay per year. The two covariates that most influenced delay in adjusted models were presence of a psychiatric disorder and discharge destination. Non-clinical delays, especially those associated with discharge destination, should be targeted to reduce lengthened HLOS among TBI patients.

# THE IMPACT OF E-SCOOTER INJURIES ON A LEVEL I TRAUMA CENTER DURING INTIATION OF AN E-SCOOTER RENTAL PROGRAM: A CASE SERIES 

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Introduction: Electric motorized scooter (e-scooter) sharing programs have rapidly become a national and international phenomenon since being introduced in 2017.
E-scooters are now available in 132 US cities and are easy to use, requiring only an app to get started. The popular press has heavily reported on e-scooters and subsequent injuries, but little research exists on potential injury risks and public safety. This study examined the burden of injuries resulting from e-scooter use on our trauma center by characterizing the number and severity of injuries in an extended case series.
Methods: Included patients sought treatment at our Level I trauma center ED for an e-scooter injury from July 1, 2018-the date e-scooters were introduced in our city-to January 31, 2019. Patients were identified using injury etiology keywords and chart review. Patient records and the trauma registry were queried for clinical variables and treatments rendered.
Results: 96 patients presented to the ED with e-scooter injuries, the first on July 4, 2018. None (0) wore a helmet, and $30.2 \%$ (29) reported alcohol use before riding or screened positive. Weekend (Fri, Sat, or Sun; 55.2\%; 53) and at/after dark (1800-0600 hrs; 67.7\%; 65) injuries predominated. Ages ranged 13-61. Most were $<30$ (52\%; 50 ), and $7.3 \%$ (7) were $<18$. The total injuries by body region are outlined in the top table, with $50 \%$ (48) sustaining multiple injuries, and admission and treatment variables are outlined in the bottom table, where delayed presentations to the ED ranged from hours to a day post-injury. The injuries account for 66 hospital days and 9 ICU days total. Most ICU admits, including the death, were due to intracranial hemorrhage. 2 of the 3 abdominal injuries were Grade IV injuries. The most common treatments were laceration repair ( $37.5 \%$; 36) and dislocation reduction (11.5\%; 11).
Conclusion: While generally considered safe, e-scooters

| Injuries by Body Region | Patients |
| :--- | :---: |
| Extremity | 62 |
| Face | 43 |
| Head (TBI) | 34 |
| Hand or wrist | 24 |
| Extremity fractures | 22 |
| Isolated skin/soft tissue (not face) | 18 |
| Extremity dislocations | 6 |
| Head (SAH/SDH) | 6 |
| Spine | 3 |
| Chest | 2 |
| Abdomen | 3 |
| Variable |  |
| EMS Transport | Patients |
| Inpatient Admission | 33 |
| Inpatient Surgery | 24 |
| Delayed Presentation to ED | 10 |
| Traurna Team Activation | 9 |
| ICUAdmission | 8 |
| Ontpatient Surgery | 8 |
| Emergency Surgery on Admission | 5 |
| Mortality | 1 | can pose a significant health risk. This case series likely represents only the tip of the iceberg as minor injuries likely bypass the ED and present to smaller, non-emergent clinics. These data relay the very real potential for serious injury with e-scooter use and emphasize the need for further study and injury prevention campaigns.

# PARAMEDIC JUDGMENT FOR TRAUMA TEAM ACTIVATION: DOES IT IDENTIFY AT-RISK PATIENTS THAT ARE MISSED BY STANDARDIZED PRE-HOSPITAL TRIAGE PROTOCOLS? 

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Introduction: ACS-COT defines standard minimum criteria for full trauma team activation (TTA). In our system, discretion of pre-hospital personnel ('Paramedic Judgment' [PJ]) can initiate TTA in the absence of ACS-COT criteria. The goal of this retrospective cross-sectional study is to characterize the role of PJ for TTA in our hospital system when compared with standardized pre-hospital protocols.

Methods: All adult TTA transported by ground EMS to our Level I trauma center for the years 2015 and 2016 were included in data acquisition. Descriptive and bivariate comparisons were conducted between the two groups: 'Judgment'(J) vs 'Standard Criteria (SC) using a Wilcoxon sign-rank test for continuous measures (Age, ISS, LOS, Hospital Charges) and Fisher's exact test for categorical outcomes (Sex, Final Outcome, Disposition, and Injury Type). Overtriage rates, defined as full TTA with an ISS $\leq 15$, were calculated for each group.
Results: A total of 1977 patients were included in the final analysis. There was a significant difference between groups for gender, ISS, overtriage, mortality, discharge disposition and injury type amongst the J and SC groups. SC ISS was 1.31 times higher than the J group ( $95 \%$ CI: 1.14, 1.50), with overtriage 3.36 times greater in the J group ( $95 \%$ CI: 2.68, 4.23). The odds of survival were 46.8 times greater in the J group ( $\mathrm{p}<0.0001 ; 95 \% \mathrm{CI}: 19.2,114.1$ ). The odds of a discharge disposition to home were 2.95 times greater in the J group ( $95 \%$ CI: 2.41, 3.62). The odds of having a blunt injury were calculated to be 9.10 times greater in the J group ( $95 \% \mathrm{CI}$ : 6.66, 12.44). In contrast, there was not a significant difference in distribution between groups for median age, length of stay or total hospital charges.
Conclusions: Patients triaged for full TTA by PJ experienced less significant injuries and substantially lower mortality than those activated by standard criteria. Despite this, there was no difference in total hospital charges between the groups suggesting that a significant portion of these charges occur during this initial phase of hospital evaluation. These notable differences suggest that the use of paramedic judgment as the sole rationale for TTA may place an undue financial burden on individual paramedic-triaged patients, and an overuse of resources for the hospital system.

|  | Paramedic Judgment | Standard Criteria | p value |
| :--- | :--- | :--- | :--- |
| Injury Type (Blunt [vs Penetrating]) | $700(\mathrm{n}=749,93.5 \%)$ | $719(\mathrm{n}=1177,61.1 \%)$ | $\mathrm{p}<0.0001$ |
| Over-Triage Rate (ISS $\leq \mathbf{1 5})$ | $633(\mathrm{n}=751,84.3 \%)$ | $743(\mathrm{n}=1209,61.5 \%)$ | $\mathrm{p}<0.0001$ |
| Mortality | $5(\mathrm{n}=759,0.7 \%)$ | $273(\mathrm{n}=1215,22.5 \%)$ | $\mathrm{p}<0.0001$ |
| Discharge Disposition to Home or Jail | $528(\mathrm{n}=715,73.8 \%)$ | $562(\mathrm{n}=1150,48.9 \%)$ | $\mathrm{p}<0,0001$ |
| Injury Severity Score (Median ISS) | 8 | 10 | $\mathrm{p}=0.005$ |
| Length of Stay (Median days) | 3 | 3 | $\mathrm{p}>0.05$ |
| Total Hospital Charges (Median Dollars) | $\$ 35,780.70$ | $\$ 36,840.63$ | $\mathrm{p}=0.3750$ |

## Poster \# 67

# MAPPING THE INCREASING INTEREST IN ACUTE CARE SURGERY WHO, WHY AND WHICH FELLOWSHIP? 

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## Introduction:

Interest in Acute Care Surgery (ACS) has increased over the past 10 years as demonstrated by the linear increase in fellowship applicants. Fellowships facilitating entry into ACS careers include: one-year surgical critical care (SCC) and two year programs with the second year either accredited by the American Association for the Surgery of Trauma (AAST) or a non-AAST-accredited second year. It is unclear why the overall interest in ACS has increased, whether these three fellowships attract different applicants or whether fellowship choice correlates with practice patterns after graduation.

## Methods:

An online survey was distributed to individuals previously registered with the Surgical Critical Care and Acute Care Surgery Fellowship Application Service (SAFAS). Collected data included demographics, clinical interests and career motivations as well as post-fellowship work setting, work load and type and publication volume. Program directors of SCC, ACS and non-AAST two-year fellowships were asked to forward the survey to current and former fellows to increase the response rate. The survey was open for 2 months. Pearson's chi-square and Fisher's exact tests were conducted to analyze differences across fellowship types. Responses to open-ended questions were analyzed, grouped and reported using frequency data.

## Results:

Trauma surgery was the primary clinical interest for all fellowship types ( $\mathrm{n}=273$ ), although SCC fellows were equally interested in surgical critical care. Career motivations were nearly identical across fellowship types with the most popular responses being "ability to care for the sickest patients" ( $97.1 \%$ ) and "enjoy complex problem-solving" ( $92.3 \%$ ). Fellowship trainees within the past 10 years were more likely to indicate "predictability of schedule" as having a strong influence on career choice $(9.7 \%$ vs 42.6\%), a trend which continues when looking only at respondents currently in training (51.9\%). Regardless of fellowship type, respondents reported the same benefits for a second year of fellowship: graduated progression to full responsibility, further exposure to trauma care and additional operative technical training. Most respondents who have completed fellowship work in Level 1 trauma centers though fewer than $20 \%$ spend more than half of clinical time on trauma. Most reported 36 or more weeks of clinical service per year. Few had time reserved for scholarly activities and elective surgery was uncommon. Type of fellowship had no impact on these clinical or scholarly activities.

## Conclusion:

Current trainees in ACS are more likely to consider predictability of schedule as a significant factor in career choice. Otherwise, there were no differences in clinical interests, career motivations, clinical practice or scholarly output between 1-year SCC, and 2-year AAST, and non-AAST fellowships. Future research should focus on variability in trauma training and operative experience during residency to better inform how a second fellowship year would improve training for a career in ACS.

# PREDICTING THE FUTURE IN GERIATRIC TRAUMA: COMPARISON BETWEEN THE GERIATRIC TRAUMA OUTCOMES SCORE III(GTOSIII), ASCOT, AND TRISS IN ESTIMATING LONG-TERM MORTALITY RISKIN THE ELDERLY 

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Introduction: The GTOS score was originally designed to predict inpatient geriatric trauma mortality and has been validated in a multicenter trial. Recently the GTOSIII was created to predict 1-year mortality. We hypothesized GTOSIII would have superior test characteristics to predict 1-year mortality than similar trauma specific predictive scores: TRISS and ASCOT.
Methods: Our ACS verified level 1 trauma center registry was queried from 2001-2013 for patients age $\geq 65$ years, who were then matched to the Social Security Death Index. GTOSIII is the formula: [GTOS III=Age+(0.55*ISS)+37.7(if initial GCS $\leq 10$ ) +11.3 (if transfused in first 24 hours) +67.8 (if adverse discharge)]. Tests were compared for 1-year mortality prediction by misclassification rates, Brier scores, Tjur-R2, receiver operator curves, and area under the curve (AUC).
Results:There were 3,262 patients in the population. Inpatient mortality was 9.8\% (322) and increased each year: 516(15.8\%) one, 581(17.8\%) two, and 738(22.7\%) five years. GTOSIII had superior test characteristics (AUC of 0.868, Brier score of 0.09 , Tjur R2 of 0.46 and misclassification rate of $12.6 \%$ ), compared to TRISS (AUC of 0.744, Brier score of 0.12 , Tjur R2 of 0.11 and misclassification rate of $14.7 \%$ ) and ASCOT (AUC of 0.758 , Brier score of 0.11 , Tjur R2 of 0.20 and misclassification rate of $13.5 \%)$. The overlay of test ROC is displayed in the figure. GTOSIII had statistically better discrimination compared to ASCOT (Estimate 0.124, 95\% CI 0.098-0.150; p<0.0001) and TRISS (0.110, 0.085-0.135; $\mathrm{p}<0.0001$ ).
Conclusion: Geriatric patients have high rates of mortality following trauma both in and out of the hospital. GTOSIII is the optimal prediction tool for giving patients and families guidance on long-term outcomes.

Poster \# 69

## The Impact of Historical Racism on Modern Gun Violence: Redlining in the City of Louisville, KY

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Introduction: The Home Owner's Loan Corporation (HOLC) was created in 1933 to support real estate investment during the Great Depression. Residential security maps were created to guide investment in over 200 US cities. Neighborhoods were assigned grades of 'A' through 'D' (with corresponding color coding of green, blue, yellow and red) to indicate desirability for investment. African American, immigrant, and low-income neighborhoods were frequently assigned grades of 'C' or 'D', effectively eliminating access to credit for investment. This process has since become known as "redlining", owing to the color-coding on the security maps (now referred to as "redlining maps"). The impact of disinvestment endures in areas of many US cities today. We hypothesized that there would be a correlation between redlined areas on the 1937 map of Louisville, KY to the prevalence of gun violence today.

Methods: Gunshot victims (GSV) and their residential addresses within the city of Louisville were examined between 2010-2017. GSVs were aggregated within census blocks to approximate neighborhoods. The spatial distribution of GSVs was analyzed against the original HOLC neighborhood grade. Additional control variables adapted from the 2013-2017 American Community Survey were included to account for other possible explanations for the spatial distribution of GSVs. A zero-inflated negative binomial regression was used to determine incidence rate ratios (IRR) for the relative likelihood of GSVs within neighborhoods.

Results: IRRs for the HOLC grades as well as the control variables are seen in the table. The 1937 HOLC map with super-imposed GSVs from 2010-2017 can be seen in the figure. Relative to green-graded neighborhoods, yellow-graded neighborhoods had 5 times as many GSVs and red-graded neighborhoods had more than 6 times as many GSVs. Both of these differences were statistically significant.

Conclusion: Redlined neighborhoods within Louisville, KY in 1937 had significantly more GSVs today. The impact of historical and institutional racism on modern gun violence merits acknowledgement and further study.


Table 1: Results of binomial regression

| Table 1: Results of binomial regression |  |  |
| ---: | :---: | :---: |
|  | IRR | z-score |
| HOLC Grade |  |  |
| Green (A) | (ref) | (ref) |
| Blue (B) | 2.89 | $(1.71)$ |
| Yellow (C) | $5.00^{* *}$ | $(2.64)$ |
| Red (D) | $6.24^{* *}$ | $(2.97)$ |
| \% Age 15-24 | $0.99^{* *}$ | $(-0.85)$ |
| \% Non-Hispanic Black | $1.02^{*}$ | $(10.29)$ |
| \% Hispanic | $1.03^{*}$ | $(2.30)$ |
| \% in Poverty | 1.01 | $(1.40)$ |
| \% Vacant Housing | $1.02^{*}$ | $(2.42)$ |
| Population Density | 1.00 | $(1.01)$ |
| Number of | 312 |  |
| Observations |  |  |
| p $<0.05,{ }^{* *}$ p<0.01, ${ }^{* * *} \mathrm{p}<0.001$ |  |  |

# DOES THE PRESENCE OF 24-HOUR IN-HOUSE TRAUMA SURGEON COVERAGE HAVE A MEASURABLE IMPACT ON TRAUMAPATIENTS TREATED AT A COMMUNITY HOSPITAL? 

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## Introduction:

The initiation of level II trauma centers in urban areas may optimize resource utilization in the care of trauma patients. We examined the impact of 24-hour in house trauma surgeon coverage at a community hospital in active pursuit of level II status to determine if improved coverage affected overall trauma volume, injury severity of patients admitted, and transfers to a higher level of care (HLOC). Prior to this, trauma patients were cared for by community general surgeons taking call at this facility.

## Methods:

A retrospective review of consecutive trauma patients admitted to a community hospital before (Pre: 11/1/2016-10/31/2017) and after (Post: 11/1/2017-10/31/2018) initiation of 24-hour in-house trauma surgeon coverage. Patients <18 years of age and burns were excluded. Continuous data are presented as median (IQR) and compared using a Wilcoxon rank sum test. Categorical data were compared using Chi-Square. The rate of transfers for HLOC was evaluated using an interrupted time series to account for secular trends.

Results: Overall adult trauma volume increased by 24\%, from 1,422 (119 patients/month) to 1,935 (149 patients/month). There was an increase in patients with penetrating injuries (Pre $10 \%$ vs. Post $16 \%, \mathrm{p}<0.001$ ) and in the Injury Severity Score for admitted patients (Pre $5[4,10]$ vs. Post $9[4,10], \mathrm{p}=0.002$ ). The number of operative interventions directly from the emergency department also increased (Pre 8\% vs. Post $11 \%, \mathrm{p}=0.004$ ). The percentage of transfers decreased (Pre $11 \%$ vs. Post $5 \%, \mathrm{p}<0.001$ ) as did the number of transfers for a HLOC (graph).

Conclusion: We report a significant increase in the number and severity of injury of trauma patients admitted to our community hospital after initiation of 24-hour in-house trauma surgeon coverage. Additionally, there was a significant increase in the number of operative interventions direct from the ED and a concomitant decrease in the number of patients transferred for a HLOC-indicating that placement of trauma programs in high volume community hospitals results in patients receiving care sooner and in their local area.

# TOO MUCH TXA? FIBRINOLYSIS IS NOT COMMON AT PRESENTATION FOR PATIENTS IN AN URBAN LEVEL 1 TRAUMA CENTER 

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Introduction: Recent studies have advocated for tranexamic acid (TXA) for all trauma patients early in their injury timeline. However, TXA has known complications, especially thromboembolic events. Our aim in this study was to assess the true incidence of fibrinolysis in an urban Level 1 trauma center where transport times are often short, but also includes rural transfers.

Methods: We queried our Level 1 trauma database for all admitted or deceased blunt or penetrating patients that had a finished rotational thromboelastography measured at the time of activation since introduced in 2013. In addition we collected available data on ISS, mortality and other outcomes. We used Lysis Index 30 - Extrinsic (LI30) less than $85 \%$ as evidence of fibrinolysis. Data was compared using standard statistical methods.

Results: There were 2215 patients who had a LI30 with activation. Only 47 (2.2\%) had evidence of fibrinolysis. All but 6 of those had ISS $\geq 15$. Comparing those who were fibrinolytic (FIB) to those were not (NOFIB), we found that FIB had a much higher mortality rate ( $10 \%$ vs $68 \% \mathrm{p}<0.0001$ ) and ISS ( 28 vs $16, \mathrm{p}<0.0001$ ). There was no statistical difference in percent penetrating trauma ( 49 vs $42, \mathrm{p}=.36$ ) in the two groups.

Conclusion: hMost patients presenting to an urban level 1 trauma center are not fibrinolytic and may not benefit from TXA for treatment of fibrinolysis. Treatment of fibrinolysis should be focused on those with highest risk, such as those with the highest injury burden or severity of bleeding. Further studies should be done to best determine which patients may benefit from its use, but routine TXA use should be carefully considered given the low rate of fibrinolysis in this population.


# NOVEL APPLICATION OF A DATA ADAPTIVE 'VIRTUAL CLINICAL TRIAL': STATISTICAL MODELING OF TEG GUIDED TRANFUSION INTERVENTIONS 

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Introduction: The American College of Surgeons TQIP Best Practice Guidelines for the management of transfusion in trauma recommend thromboelastography (TEG) guided transfusion of plasma, platelets, and cryoprecipitate where TEG is available. However, given the paucity of randomized controlled trials of TEG guided resuscitation combined with significant barriers and little equipoise to pursue such trials, there remains variable adoption of TEG guided transfusion protocols across trauma centers. We sought to perform a data adaptive 'virtual clinical trial' using statistical modeling to intervene on a large population of trauma patients from a Level 1 Trauma Center in whom TEG was not used clinically. We hypothesized that statistical intervention with modeled transfusions based on TEG parameters would improve predicted hemostasis and mortality in this population. Methods: Computational modeling was performed on data from 1671 trauma patients who were enrolled in a prospective observational cohort study and had TEG performed for research purposes only. Hypothetical transfusions based on TEG parameters were modeled (controlling for injury [ISS], shock [SBP, base deficit, heart rate], gender, age, race, and mechanism). A semiparametric dataadaptive modeling procedure that combines machine learning and causal inference (Targeted Learning) estimated the average treatment effect (ATE) for hemostasis (defined as no further blood transfusion) and mortality at 6hrs. TEG guided transfusion was pre-defined as: 2 units of plasma for activated clotting time $(A C T)>128,10$ units of cryoprecipitate for alpha-angle $<65$ degrees, and 1 unit of platelets for maximum amplitude (MA) $<55 \mathrm{~mm}$.
Results: The cohort was moderately injured (median ISS 14, IQR 4-27) with a 5\% mortality at 6hrs. Protocolized platelet transfusion resulted in an adjusted $13 \%$ increase in 6 hr hemostasis $\nless<0.01$ ), but no significant decrease in mortality. Protocolized plasma transfusion resulted in an adjusted 11\% increase in 6hr hemostasis and a $17 \%$ decrease in 6 hr mortality (both $p<0.01$ ). Protocolized cryoprecipitate transfusion resulted in an adjusted 20\% increase in 6h hemostasis and a $16 \%$ decrease in 6 hr mortality (both $p<0.01$; Table).

|  | ATE for 6h Hemostasis | $p$ | ATE for 6h Mortality | $p$ |
| :---: | :---: | :---: | :---: | :---: |
| 2 units of plasma for activated clotting time (ACT) $>128$ | 11\% | 00.01 | -17\% | c0.01 |
| 1 unit of platelets for maximum amplitude (MA)<55mm | $13 \%$ | $\leqslant 0.01$ | $-14 \%$ | 0.15 |
| 10 units of cryoprecipitate for alpha-angle < 6.5 degreen | 20\% | $<0.01$ | -16\% | $<0.01$ |

Conclusion: Using a data adaptive 'virtual clinical trial', we identified that institution of TEG guided transfusion in a large population of trauma patients markedly improves hemostasis and survival at 6hrs after injury. This novel technique of targeted machine learning fit toward specific parameters related to interventions allows adaptive estimation under very few assumptions producing robust inference, and may be the in-silico future of clinical trials.

## LIQUID PLASMA: A SOLUTION TO OPTIMIZING EARLY AND BALANCED PLASMA RESUSCITATION IN MASSIVE TRANSFUSION

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Introduction:Early and balanced plasma resuscitation, plasma to red blood cell (RBC) ratio $>1: 2$, for major trauma victims in hemorrhagic shock is associated with decreased mortality. With a narrow window to optimize resuscitation parameters and mitigate preventable trauma mortality, timely plasma administration is imperative. However, in the actively hemorrhaging patient, a 20 minute thaw time for fresh frozen plasma (FFP) can result in delayed administration, and the 5 day shelf life of thawed FFP limits supply and incurs wastage if it cannot be repurposed. Liquid plasma (LP) offers an attractive alternative as it can be immediately transfused and has a 26-day shelf-life. As such, we hypothesized that the use of LP in the massive transfusion protocol would improve optimal plasma:RBC ratios in the traumatically injured.
Methods: Using Trauma Quality Improvement Program data from our level one trauma center we evaluated patients with massive transfusion protocol (MTP) activations from 2016-2018. Implementation of type A LP as the initial resuscitation plasma was instated April 2017. Prior to this, thawed FFP was solely used. Plasma:RBC ratios at 4 hours and 24 hours from hospital arrival were compared in MTP patients pre-LP and post-LP implementation. Baseline demographics, mechanism of injury (blunt vs penetrating) and injury severity score were accounted for using regression analysis. Secondary outcomes included mortality, length of stay and complications (acute kidney injury, acute respiratory distress syndrome, venous thromboembolism, and infectious).
Results: A total of 96 patients were included (pre-LP=39; post-LP=56). Post-LP plasma:RBC ratios at 4 hours and 24 hours were improved compared to pre-LP ratios, even after adjusting for potential confounders. Hospital length of stay and incidence of acute kidney injury were reduced in the post-LP group by $47 \%$ and $89 \%$, respectively. This effect remained even on multivariate analysis. Hospital mortality was not different between groups. Importantly, no post-LP patients with blood group type B or AB (n=9) demonstrated evidence of hemolysis within 24 hours of transfusion with type A LP.

|  | $\begin{gathered} \text { Pre-LP } \\ (\mathbf{n}-39) \end{gathered}$ | $\begin{gathered} \text { Post-LP } \\ (\mathrm{n}-56) \\ \hline \end{gathered}$ | $\mathbf{P}$-value |
| :---: | :---: | :---: | :---: |
| Age, mean [SEM] | 34 [2.2] | 35 [2.1] | 0.77 |
| Gender, \% male ( n ) | 90 (35) | 86 (48) | 0.76 |
| ISS, mean [SEM] | 29 [2.2] | 33 [2.0] | 0.17 |
| Injury Mechanism, \% penetrating (n) | 85 (33) | $70 \text { (39) }$ | 0.14 |
| 4-Hour Transfusion |  |  |  |
| Plasma:RBC, mean [SEM] | $1: 2.0$ [0.051] | 1:1.5 [0.055] | 0.037 |
| 24-Hour Transfusion |  |  |  |
| Plasma:RBC, mean [SEM] | $1: 1.9[0.055]$ | $1: 1.3$ [0.062] | 0.014 |
| Hospital LOS (d), mean [SEM] | 32 [2.4] | $17[2.4]$ | 0.004 |
| ICU LOS (d), mean [SEM] | 15.4 [3.57] | 11.3 [2.14] | 0.31 |
| Complications \% (i) |  |  |  |
| AKI | 18 (7) | 2 (1) | 0.0076 |
| ARDS | 13 (5) | 5 (3) | 0.27 |
| VTE/PE | 8 (3) | 2 (1) | 0.30 |
| Infectious | 26 (10) | 11(6) | 0.09 |
| Hospital Mortality \% ( n ) | 36 (14) | 43 (24) | 0.53 |

Conclusion: Initial resuscitation with LP optimizes early plasma administration and improves adherence to transfusion ratio guidelines. Furthermore, LP offers a solution to inherent delays with FFP obviates ABO incompatibility and improves outcomes (reduced hospital LOS, AKI). LP should be considered as an alternative to FFP in MTPs.

# ACTIVE CPR IS THE BIGGEST PREDICTOR OF NEED FOR CUT-DOWN DURING REBOA PLACEMENT 

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Introduction: While resuscitative endovascular balloon occlusion of the aorta (REBOA) has emerged as a less-invasive alternative to open aortic occlusion, the procedure requires swift and safe insertion of the cannula into the common femoral artery. This study seeks to identify the independent risk factors of the need for cut-down compared to percutaneous access in REBOA.
Methods: This retrospective observational study includes all patients in the American Association for the Surgery of Trauma (AAST) Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) Registry who underwent REBOA from November 2013 to June 2018. We examined predictors of utilization of and outcomes between open cut-down versus percutaneous techniques (with or without ultrasound guidance). High-volume centers were defined as $20+$ REBOAs during the study period.
Results: Of 396 patients who underwent REBOA, 88 (22.2\%) had initial placement via a cut-down. There was no difference in mean patient weight ( $85.5 \mathrm{vs} .82 .9 \mathrm{~kg}, \mathrm{p}=0.402$ ) or mean body mass index ( 27.8 vs. $27.4, \mathrm{p}=0.731$ ) among patients with percutaneous vs. cut down. On logistic regression, predictors of cut-down access included active CPR (OR $11.5, \mathrm{p}<0.001$ ) and attending vs. trainee placement (OR 4.1, $\mathrm{p}=0.043$ ), while patients age $40+$ had lower odds compared to patients age $<26$ (OR $0.4, \mathrm{p}=0.023-0.036$ ). On logistic regression, active CPR was predictive of failure of balloon occlusion (OR $0.23, \mathrm{p}=0.005$ ), as was BMI $25-30$ compared to $\mathrm{BMI}<25$ (OR $0.17, \mathrm{p}=0.039$ ); method of REOBA access, age, sex, BMI, center volume, and trainee status were not predictive of failure of balloon occlusion.
Conclusion: Although high-volume centers and attendings seem to perform more cut-downs than percutaneous approaches, the biggest predictor was active CPR. Weight and BMI did not factor in the decision or success to place a REBOA via an open or percutaneous approach.

# IN FLIGHT EARLY DECISION MODEL PREDICTS THE NEED FOR CRITICAL ADMINISRRATION THRESHOLD (CAT) AND MASSIVE TRANSFUSION (MT) FOLLOING TRAUMA 

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INTRODUCTION: It is critical to recognize the need of large volume blood transfusion such as CAT ( $\geq 3 \mathrm{U}$ of blood in 1 st hour) or MT ( $\geq 10 \mathrm{U}$ of blood in the 1 st 24 hour) especially for trauma patient. The photoplethysmographic PPG waveform has been show reasonable prediction results. We hypothesized that combination the field PPG with ECG would be more accurately predict the emergency blood transfusion needs.
METHODS: Helicopter transferred adult trauma patients admitted to a Level I trauma center from 2014-2017 were retrospectively enrolled. The real-time continuous in flight (field) PPG and ECG waveforms were collected at 250 Hz . Over 100 waveform features such as heart rate variability, entropy, etc. were calculated for the first 10 min and the entire helicopter transfer. PPG or ECG alone and PPG+ECG based decision tree models were evaluated for prediction of CAT and MT. Area under receiver operating characteristic curve (AUROC) was used to evaluate predictive power. Delong's method compared AUROCs; $\mathrm{p}<0.05$ was considered statistically significant.
RESULTS: We analyzed 2364 patients with over 886 million continuous in-flight ECG and PPG data points. Patients were predominantly male (60.2\%), with mean age of 46.9 $\pm 20$ years. Average air transfer time was $28.3 \pm 9.3 \mathrm{~min}$. Among all patients $7.6 \%$ received CAT, and $4.2 \%$ received MT. The model that used PPG and ECG was significantly better than individual PPG or ECG models. Models based on PPG were significantly better than models of ECG in predicting CAT and MT. AUROCs for using 10 min in flight combination of PPG+ECG, PPG, ECG for predicting CAT were $0.80,0.72,0.64$; predicting MT with AUROCs $0.81,0.730 .63$. Using entire in-flight duration data of PPG+ECG, PPG, ECG, AUROCs for predicting CAT were $0.82,0.75,0.66$; predicting MT with AUROCs $0.84,0.760 .70$. Predictive power (AUROC) were significantly improved with longer duration of waveform monitoring for both outcomes.
CONCLUSION: Automated analysis of combined field PPG and ECG waveform will further improve transfusion prediction and assist early identification of hemorrhage.

Poster \# 77
Is "golden hour" still a cornerstone of trauma care for hemodynamically unstable patients?
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Introduction: Elapsed time from the occurrence of injury to definitive care is considered as a determinant for mortality in patients with trauma. The concept of the "golden hour", suggesting that critically injured patients are required to receive definitive care within 60 min , has been global consensus since the 1970s 1 . However, there is conflicting evidence to support it. Moreover, trauma care has been remarkably developed for the last two decades. Thus, we hypothesized that 60 min was not an appropriate cut-off time in the current trauma care settings. The objective of this study was to revise the exact association between time from injury to definitive care and mortality, particularly in hemodynamically unstable patients.
Methods: We analyzed the Japan Trauma Data Bank, which is a nationwide hospital-based registry of patients with trauma who were admitted to emergency hospitals in Japna, between 2004 and 2015. The inclusion criteria were adult patients who presented with hemodynamically unstable status (systolic blood pressure [SBP] < 90 mmHg and heart rate [HR] > 110 beats/ min , or SBP $<70 \mathrm{mmHg}$ ) who underwent definitive care within five hours from the onset of injury. The outcome measure was in-hospital mortality. First, patients who received definitive care at 60 min or less were matched with those who received care after 60 min using propensity score (PS) matching. The survival outcome of two groups were compared using a chi-square test and log rank test. Second, we evaluated the relationship between time to definitive care and outcome with the generalized additive model (GAM) in all participants. Further analysis was conducted after stratifying the patients according to severe shock status ( $\mathrm{SBP}<70 \mathrm{mmHg}$ ) and moderate shock status ( $70 \leq \mathrm{SBP}<90 \mathrm{mmHg}$ and $\mathrm{HR}>110$ beats $/ \mathrm{min}$ ) status.
Results: A total of 804 patients were enrolled in this study. After PS matching, no significant difference was observed in terms of mortality between patients who received definitive care $\leq 60 \mathrm{~min}$ and those who received care $>60 \mathrm{~min}$ (odds ratio 0.96; $95 \%$ confidence interval $0.34-2.4 ; P=0.92$ ). In addition, the log-rank test showed no significant difference between the curves of the two groups ( $\mathrm{P}=0.90$ ) (Fig 1). The GAM models in all participants showed that the odds of mortality remained stable for the first 150 min (Fig 2A). In the subgroup analysis, the severe shock group presented with a paradoxical decline of mortality with increasing time (Fig 2B), whereas the moderate shock group had a time-dependent increase in mortality up to 180 min (Fig 2C). No threshold effect at 60 minutes was observed in all analyses.
Conclusion: Initiating definitive care within 60 min did not have a significant effect on the survival outcome of hemodynamically unstable patients. However, this was likely an offset result of severe and moderate shock groups. A shortened time to definitive care may be most beneficial for patients with moderate shock.

Figure 1. Kaplan-Meier survival curves for patients who had time to definitive care more than 60 minutes and less than 60 minutes.


Figure 2. Nonparametric curves for trend of log odds of in-hospital mortality by the time to definitive care

(A, total patients, $\mathrm{n}=804$; B, severe shock patients, $\mathrm{n}=421$; C , moderate shock patients, $\mathrm{n}=383$ ).

## Reference:

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# Delaying Intubation Until Operating Room Arrival Reduces Transfusion Needs 

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Introduction: Post intubation hypotension occurs in hypovolemic trauma patients. We compared emergency department intubation (EDI) to operating room intubation (ORI) in trauma patients requiring surgery hypothesizing ORI could improve outcomes.
Methods: Retrospective analysis performed at a Level I Trauma Center between Dec/14

| Variable | ERI ( $n=58$ ) | ORI ( $\mathrm{n}=265$ ) | $p$-value |
| :---: | :---: | :---: | :---: |
| Age, median (IQR) | 25 (33-44) | 22 (27-35) | 0.003 |
| Penetrating Trauma |  |  | <0.001 |
| Gsw, n (\%) | 28 (48.3\%) | 190 (71.7\%) |  |
| $s \mathrm{~W}, \mathrm{n}(\%)$ | 9 (15.5\%) | 55 (20.7\%) |  |
| Initial SBP, median (IQR) | 85 (50-113) | 105 (80-122) | 0.001 |
| Initial HR, median (IQR) | 102 (78-123) | 98 (80-116) | 0.4 |
| Patients with SBP<90, $\mathrm{n}(\%)$ | 29 (50\%) | 85 (32\%) | 0.01 |
| Severe TBI**, $n(\%)$ | 26 (44.8\%) | 20 (7.5\%) | <0.001 |
| 1SS, mean (SD) | 25 (25-33) | 25 (16-25) | $<0.002$ |
| PRBCs first 6 h , median (IQR) | $4(2-7)$ | $2(0-4)$ | <0.001 |
| Massive Transfusion ${ }^{\text { }, ~} \mathrm{n}$ (\%) | 10 (17.2\%) | 17 (6.4\%) | 0.007 |
| Laparotomy, n (\%) | 38 (65.5\%) | 206 (77.7\%) | 0.05 |
| Abdominal Damage Control, $\mathrm{n}(\%)$ | 20 (34.5\%) | 87 (32.8\%) | 0.8 |
| Thoracie Indision, $\boldsymbol{n}(\%)$ | 24 (41.4\%) | 75 (28.3\%) | 0.05 |
| Thoracic Damage Control, n (\%) | 11 (18.9\%) | 19 (7.1\%) | 0.005 |
| Solid Organ Injury zgrade 4, $n$ (\%) | 23 (39.6\%) | 56 (21.1\%) | 0.003 |
| Mortality at the OR, $n$ (\%) in-hospital mortality, $\mathrm{n}(\%)$ | 11 (18.9\%) | 17 (6.4\%) | 0.002 |
|  | 25 (43.1\%) | 27 (10.2\%) | $<0.001$ |
|  | ER1 ( $\mathrm{n}=58$ ) | ORI ( $\mathrm{n}=58$ ) | $p$-value |
| Age, median (IQR) | 33 (25-44) | $32(26-42)$ | 0.59 |
| Penetrating Traums |  |  | 0.3 |
| Gsw, n (\%) | $28(48.2 \%)$ | 29 (50\%) |  |
| SW, $\mathrm{n}(\%)$ | 9 (15.5\%) | 14 (24.1) |  |
| Initial SBP, median (IQR) | 85 (50-113) | 85 (52-112) | 0.89 |
| Initial HR, median (IQR) | 102 (78-123) | 101 (79-118) | 0.5 |
| Patients with SBP $<90, n(\%)$ | 29 (50\%) | 33 (56.9\%) | 0.4 |
| Severe TBI**, $n(\%)$ | 25 (44.8\%) | 18 (31.1\%) | 0.1 |
| ISS, mean (SD) | 25 (25-33) | 25 (22-29) | 0.6 |
| PRBCs first 6 h , median (IQR) | $4(2-7)$ | 3 (0-5) | 0.03 |
| Massive Transfusion ${ }^{\text {t }} \mathrm{n}$ (\%) | 10 (17.2\%) | 7 (12.1\%) | 0.4 |
| Laparotomy, n (\%) | 38 (65.5\%) | 38 (65.5\%) | 1 |
| Abdominal Damage Control, $\mathrm{n}(\%)$ | 20 (34.5\%) | 21 (36.2\%) | 0.8 |
| Thoracic Incision, $\mathrm{n}(\%)$ | 24 (41.4\%) | 25 (43.1\%) | 0.8 |
| Thoracic Damage Control, $\mathrm{n}(\%)$ | 11 (18.9\%) | 6 (10.3\%) | 0.1 |
| Solid Organ Injury ¿grade 4, n (\%) | 23 (39.6\%) | 19 (32.7\%) | 0.4 |
| Mortality at the OR, n (\%) | 11 (18.9\%) | 13 (22.4\%) | 0.6 |
| In-hospital mortality, $\mathrm{n}(\%)$ | 25 (43.1\%) | 15 (25.8\%) | 0.051 |
| ${ }^{* *}$ Glasgow 88 , ">10 units of PRBC5 |  |  |  | and Jan/18 of all adult torso trauma patients who underwent surgery. We excluded patients intubated prior to ED arrival. ERI patients were propensity score (PS) matched to ORI patients based on age, severity of brain and chest injuries (AIS>3), blunt trauma and the presence of tachypnea. The PS estimated the probability that a patient would have had ERI given baseline characteristics. The primary outcome, in-hospital mortality was examined using multivariable logistic regression (MLR). The secondary outcome was the amount of packed red blood cells transfused in the first six hours after arrival which was assessed by multivariable quantile regression (MQR).

All regression analyses were performed within matched cohorts. Results: A total of 323 patients were included. ERI- and ORI patients were similar after matching (Table1). In non-matched cohorts, mortality was significantly higher in the ERI group (43.1\% vs. $10.2 \%$; $\mathrm{p}<0.001$ ); however, in-hospital mortality was not significantly different after PS matching (EDI: $43.1 \%$ vs. ORI: $25.8 \% ; \mathrm{p}=0.051$ ). MLR controlling for hypotension, units of PRBCs at six hours, need of aortic occlusion, and ISS showed no significant differences in the odds of death with ERI (OR 2.49, 95\% CI 0.89-6.97). MQR adjusted by hypotension, penetrating trauma and heart rate $>120$ showed that ERI was associated with a greater need for PRBC transfusion (coef: 2, 95\% CI 0.51-3.4). Conclusion: Delaying intubation until to allow for immediate hemorrhage control may reduce the need for PRBC's transfusion. Further prospective studies are required.

## THE TIMING AND VALUE OF AORTIC OCCLUSION IN TRAUMA PATIENTS IN PROFOUND HEMORRHAGIC SHOCK BUT NOT YET DEAD: 60 MMHG MIGHT BE TOO LATE

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Introduction: This study aimed to evaluate the optimal timing for application of Aortic Occlusion (AO) in all its forms in trauma patients in profound hemorrhagic shock.
Methods: All adult patients (age $>15$ years) undergoing AO via Resuscitative Balloon Occlusion of the Aorta (REBOA) and/or Emergency Department Thoracotomy (EDT) between 2014 and 2018 at a regional Level I Trauma Center were included. Patients who required CPR in the pre-hospital setting were excluded. A logistic regression analysis based on cardiac arrest, REBOA/EDT, mechanism of injury and systolic blood pressure (SBP) were conducted. Results: A total of 107 patients underwent AO, 84 ( $88 \%$ ) were males and the median age was 31 (IQR: 23-41). Sixty patients (56\%) who underwent AO developed traumatic cardiac arrest (TCA) and 47 ( $44 \%$ ) did not. EDT was performed in 57 (53\%) and REBOA in 50 (47\%). There was a higher proportion of penetrating trauma among both groups [TCA=54 (90\%), No-TCA=35 (74\%); p=<0.05] and their injury severity were similar [TCA=ISS: 25 (IQR: 25-33) vs No-TCA=ISS: 25 (IQR: 25-34); $\mathrm{p}=0.68$ ]. Vital signs on arrival to the ED were higher in the No-TCA group [No-TCA= SBP: 70 mm Hg (IQR: 58-88), Heart Rate (HR): 113 bpm (IQR: 97-132) vs TCA= SBP: 50 mmHg (IQR: 0-76), HR: 89 bpm (IQR: $0-120$ ); $\mathrm{p}<0.001$ ]. All patients were found to have profound acidosis [No-TCA=Base deficit: -10 (IQR: -17 to -5), TCA=Base deficit: -13 (IQR: -23 to -7); $\mathrm{p}=0.07$ ] and similar median intra-operative hemorrhage [TCA= 3500 mL (IQR: 2000-4100), No-TCA=3000 mL (IQR: 2000-4000); $\mathrm{p}=0.29$ ]. The overall 24-hour and 28-day mortality was 50 (47\%) and 56 (52\%), respectively. On sub-analysis using logistic regression adjusted for TCA we found that the type of aortic occlusion (REBOA vs EDT) was not associated with a significant reduction in the odds of 28 day mortality [OR=0.61, ( $95 \%$ CI: $0.15-2.46$ ); p=0.49]. Furthermore, TCA was found to be an independent variable associated with higher odds of 28 day mortality and notsignificantly modified by the presenc $\quad e$ of an AO [OR=15.72, (95\%CI: 5.07-48.68); p<0.001]. There were no significant differences when the analysis was adjusted by mechanism of injury [OR=0.28, (95\%CI: 0.07-1.11); $\mathrm{p}=0.07$ ]. However, we found that for each 10 mmHg that the SBP increased the odds of mortality decreased significantly by $20 \%$ [OR=0.98, (95\%CI: 0.97-0.99); $\mathrm{p}<0.05$ ] and that when the declining SBP reached the value of 60 mmHg or less, the probability of death is greater than $50 \%$ in each case.


Conclusion: A SBP of 60 mmHg or less indicates that AO must be performed immediately prior to the development of TCA. We found that even with AO, the risk of death after TCA is not reduced in trauma patients suffering from profound hemorrhagic shock.

## SHOCK INDEX AS A PREDICTOR OF MASSIVE TRANSFUSION AND EMERGENT SURGERY ON THE MODERN BATTLEFIELD

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Introduction: Shock Index (SI) has been used to predict need for massive transfusion (MT) and emergent surgical procedures (ESP) in civilian trauma. SI has not been evaluated in the battlefield setting, where penetrating and blast injuries predominate and rapid triage decisions are critical. We hypothesize that SI can reliably identify casualties that will require MT and ESP when applied to the resource-constrained, combat environment.
Methods: Retrospective review of the DoD Trauma Registry (2008 to 2016). SI was calculated using heart rate and systolic blood pressure upon arrival to the initial facility with surgical capabilities. A threshold value of 0.8 was used to stratify patients into two groups (Group I, SI<0.8 and Group II, $\mathrm{SI} \geq 0.8$ ). The need for MT ( $\geq 10 \mathrm{U}$ blood products in 24 hrs ), large volume transfusion (LVT, $4-9 \mathrm{U}$ in first 24 hrs ), ESP, and mortality were compared. Regression analyses were conducted to determine the independent association of SI with MT and ESP.
Results: 4,008 patients were included, mean age 25.5 years and predominately male ( $98 \%$ ). Mechanisms of injury were blunt/blast injury (62\%), penetrating injury ( $36.7 \%$ ) and burn injury (0.5\%). A total of $77 \%$ (3070) were stratified to Group I and $23 \%$ (938) Group II by SI. Group II patients had greater need for LVT, MT, and ESP and significantly higher mortality rates (Table 1). The negative predictive value of $\mathrm{SI} \geq 0.8$ for MT and ESP was $99.6 \%$ (Area under the Curve, AUC $=0.829$ ) and $93.5 \%$ (AUC=0.703), respectively. Regression analysis controlling for age, gender, ISS, and GCS confirmed that $\mathrm{SI} \geq 0.8$ was an independent risk factor for both MT and need for emergent surgical procedures ( $\mathrm{p}<0.001$ ).

| Variable | Group I (SI<0.8) | Group II (SI $\geq 0.8)$ | $\boldsymbol{p}$-value |
| :--- | :---: | :---: | :---: |
| Large Vol Transfusion, \% (n) | $1.1(33)$ | $14.0(131)$ | $<0.001$ |
| Massive Transfusion, \% (n) | $0.4(11)$ | $8.4(79)$ | $<0.001$ |
| Emerg Surg Procedure, \% (n) | $6.5(200)$ | $30.7(288)$ | $<0.001$ |
| Mortality, \% (n) | $0.7(20)$ | $4.6(43)$ | $<0.001$ |

Table 1. Comparison of Outcomes by Shock Index
Conclusion: Shock Index is a significant predictor of the need for massive transfusion and emergent surgical procedures in the military trauma population, representing a simple and potentially potent tool for triage and prediction of resource consumption in the resource-limited, austere setting.

# ENDOTHELIOPATHY, DAMP RELEASE AND LEUKOCYTE SIGNALING CHANGES IN SEVERE BURN PATIENTS 

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Introduction: Despite recent improvements in burn resuscitation, the endotheliopathy associated with burn injury remains poorly understood. In this pilot study, we analyzed the following characteristics in blood samples obtained from 14 severely burned patients: (i) release of Damage Associated Molecular Patterns (DAMPs);


Figure 1. ActivSignal IPAD analysis demonstrates the elevation of Src phosphorylation (A) and p21 level (B) in burned patients mononuclear leukocytes
syndecan-1 levels; and (iii) cell signaling in leuk ocytes. Methods: The citrated blood samples were obtained at <24h, 24-48h and 8d after burn. Blood from healthy donors served as a control. Platelet-free plasma was isolated from the samples. Mononuclear leukocytes were isolated by centrifugation of the buffy-coat over Lymphoprep. The plasma content of a major DAMP, mitochondrial DNA (mtDNA) was determined by qPCR. As a major characteristic of endotheliopathy, the plasma level of shed endothelial glycocalyx protein syndecan-1 was determined by ELISA. The signaling in leukocytes was studied using the ActivSignal IPAD platform that enables the simultaneous analysis of major cellular signaling pathways. Leukocytes from two randomly chosen patients at <24 h after burn injury, and one healthy donor were used for the signaling portion of the study. Results: All burn patients ( $n=14$, \%TBSA burn average $=31.6 \%$; Range $=19 \%$ - 56\%) exhibited significant increase of plasma mtDNA and syndecan-1 at all studied time points. mtDNA content increase varied from 2 to 130 times over the healthy level. Syndecan-1 increase was mostly between 2 and 15 times. Three of 14 patients died, and two of these three patients showed at day 8 an extremely high syndecan-1 plasma content, more than 30 times higher than healthy control. The IPAD signaling analysis demonstrated that at <24h after burn injury, the leukocytes of two studied patients (both survivors) had an increased level of Src protein phosphorylation and p21 expression which is indicative of inflammation and possibly leukocyte genome protection under stress conditions respectively. Conclusion: Severe burn injury in humans results in endotheliopathy, massive mtDNA release and characteristic changes in leukocyte cell signaling. Further study of severe burn patients with analysis of additional DAMPs and glycocalyx components, and more extensive analysis of lymphocyte signaling is warranted.

Poster \# 82

## NOT JUST AN ACADEMIC VARIABLE: SHOCK INDEX IS A PREDICTOR OF INJURY PATTERN, SEVERITY AND LIKELIHOOD OF BLOOD PRODUCT TRANSFUSION IN AUTO-PEDESTRIAN TRAUMA

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Introduction:Auto-pedestrian traumas comprise a wide spectrum of trauma admissions and require rapid triage. Shock index (SI) has been studied as a physiologic variable in trauma and has been correlated with outcomes and mortality. We sought to determine the ability of early SI following autopedestrian trauma to identify injury patterns, severity and blood product use.
Methods:A single level 1 trauma center's trauma registry was retrospectively reviewed for auto-pedestrian trauma for a 5 year period (2014-2018). Patients were stratified by SI $>0.9$ or $\leq 0.9$. Injuries, mortality, injury severity score (ISS), anatomic injury score (AIS), blood product use, ICU length of stay (LOS) and Hospital LOS were compared between SI groups. Results are reported as median or percent incidence, statistical analysis was done using Kruskal-Wallis or Pearson's $\chi 2$ with $\mathrm{p}<0.05$ as significant.
Results: 107 patients were identified and analyzed. Patients with SI $>0.9$ had more thoracic injuries ( $33 \%$ vs. $11 \%, \mathrm{p}=.02$ ) and a higher median ISS ( 19.5 vs. 8.5, $p=.009$ ), higher incidence of AIS $>3$ ( $40 \%$ vs. $12 \%, p=0.009$ ), higher incidence of transfusion ( $47 \%$ vs. $8 \%, \mathrm{p}<.0001$ ), and longer hospital length of stay ( 9 vs. 3 days, $\mathrm{p}=.015$ ) than patients with $\mathrm{SI} \leq 0.9$.
Conclusion: These results indicate the ability of early shock index $>0.9$ to discern injury pattern and, more importantly, injury severity, blood product use and hospital LOS in auto-pedestrian trauma. These findings warrant further elucidation and we are actively investigating the use of shock index in the traige and trauma level determination of auto-pedestrian trauma at our institution.

|  | Subjects with Shock <br> Index $>\mathbf{0 . 9}(\mathbf{n}=\mathbf{1 5})$ | Subjects with Shock <br> Index $\leq \mathbf{0 . 9}$ | P Value |
| :--- | :---: | :---: | :---: |
| ISS (median) | 19.5 | 8.5 | 0.009 |
| AIS $>\mathbf{3}$ | $40 \%$ | $12 \%$ | 0.006 |
| Incidence of Transfusion | $47 \%$ | $8 \%$ | $<0.0001$ |
| ICU LOS (median) | 8.5 days | 3 days | 0.145 |
| Hospital LOS (median) | 9 days | 3 days | 0.015 |
| Mortality | $7 \%$ | $2 \%$ | 0.328 |

# TRANSFUSING THROUGH THE YEARS: HOW AGE AND NEED FOR BLOOD TRANSFUSION RELATE TO MORTALITY 

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Introduction: Age and the need for massive transfusion are independent predictors of morbidity and mortality in trauma patients. We hypothesized the combination of increasing age and high volume transfusion results in progressively elevated mortality rates. Methods: The Trauma Quality Improvement Program (TQIP) database was queried from 2013-2016 to evaluate the mortality rates based on age and blood transfusion. Subsequently, a retrospective review of a level I trauma center registry for all trauma patients from 2013-2017 was performed. Patients were grouped by decade of life and packed red blood cell (pRBC) transfusion within 4 hours of admission: zero units, 12 units as minimal requirement, or $\geq 4$ units as massive transfusion. Demographics, laboratory values, mortality and length of stay (LOS) were compared. These variables were analyzed independently as well as in a multivariate logistic regression model to predict mortality. Results: Mortality rates from the TQIP database demonstrated a significant increase with age regardless of 24 hour pRBCs transfusion. In multivariate analysis, 24-hour mortality risk demonstrated reduced risk of death in age group 40-49, but increased risk of death in age groups 70-79 and 80+. The 24-hour mortality risk was increased by each unit of pRBCs given in the first 24 hours and increased heart rate, but higher systolic blood pressure ( 10 mmHg increments) and GCS were protective. By contrast, the 30-day mortality risk demonstrated a linear relationship with increasing age and the administration of pRBCs, vital signs and GCS demonstrated a similar relationship to risk of death at 24 hours. (Table) Due to the lack granularity in the TQIP database, we reviewed 7240 patients from our institution. $88 \%$ of patients did not require pRBCs, $7 \%$ required 1-2 units pRBCs, and $5 \%$ received $\geq 4$ units pRBCs within 4 hours of admission. Mortality rates were significantly increased in older adults in both the cohort that did not receive any pRBCs ( $\mathrm{p}<0.0001$ ) and in the group that received $\geq 4$ units of pRBCs ( $\mathrm{p}<0.0001$ ). Among patients that received $\geq 4$ units pRBCs at our institution, younger patients had significantly higher heart rates and lactate levels, and worse base deficits compared to older patients, while there were no differences among age groups in GCS, ISS, total blood product transfusion, or LOS. Conclusion: Although 30-day mortality increases with age in massively transfused patients, a significant proportion of older adults are successfully resuscitated. Therefore, age alone should not be considered a contraindication to high volume transfusion. Physiologic and lab criteria of hemorrhagic shock may have reduced reliability with increasing age. However, these data demonstrating increased risk of death by decade with transfusion after injury can utilized to help counsel patients and families regarding mortality risk after trauma.

|  | 24 Hour Mortality | 30 Day Mortality | Mortality for $\geq 4$ units local data |
| :---: | :---: | :---: | :---: |
| Variable | OR (95\% CI) | OR (95\% CI) |  |
| Age Range |  |  |  |
| 18-29 (reference) | 1.00 | 1.00 | 31.6\% |
| 30-39 | 0.91 (0.82-101) | 0.98 (0.91-1.07) | 28.4\% |
| 40-49 | 0.86 (0.77-0.95)* | 1.16 (1.07-1.26) ${ }^{\text {x }}$ | 31.7\% |
| 50-59 | $0.95(0.85-1.05)$ | 1.50 (1.39-1.62) | 37.2\% |
| 60-69 | 1.11 (1.00-1.24) | 2.00 (1.85-2.17)* | 44.0\% |
| 70-79 | 1.37 (1.22-1.54)* | $2.85(2.62-3.10)^{x}$ | 45.5\% |
| 80 and up | $1.42(1.26-1.60)^{4}$ | $3.38(3.12-3.68)^{*}$ | 62.5\% |
| SBP (10 mmHg increment) | $0.92(0.91-0.93)^{*}$ | $0.95(0.94-0.95)^{*}$ |  |
| HR (10 beat increment) | $1.07(1.06-1.08)^{*}$ | $1.06(1.05-1.07)^{*}$ |  |
| GCS Iotal | $0.82(0.82-0.83)^{*}$ | $0.82(0.82-0.82)^{*}$ |  |
| pRBCs in first 24 hours (1 unit increment) | 1.08 (1.08-1.08) ${ }^{\text { }}$ | 1.10 (1.10-1.10) ${ }^{\text {x }}$ |  |

Data presented as Odds ratio ( $95 \%$ confidence interval); ${ }^{x}=p<0.05$

## Poster \# 84

## LIFE THREATENING HEMORRHAGE WHOLE BLOOD VOLUME REPLACEMENT UTILIZING THE W.A.T.C.H.E.R. METHOD

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Introduction: Massive transfusion protocols (MTP) classically focus on replacing a specific quantity of units of blood but not on addressing volume of hemorrhage. Focusing on "units" transfused over an arbitrary timeframe can be extremely variable as unit volume differs by center and product type. Massive Transfusion (MT) is currently undefined when using whole blood (WB) for resuscitation. Our aim was to examine all trauma patients in our facility who underwent MT involving the use of WB looking for a more specific cutoff for defining life threatening hemorrhage.
Methods: A retrospective review of all trauma patients at our urban level one trauma center transfused between January 1, 2015 and December 31, 2018 was performed. Data collected included patient demographics, vital signs, transfusion volumes/times, disposition times/locations and all lab values collected at our facility. Prisoners, pregnant patients and pediatric patients were excluded. Patients receiving primarily WB were then compared to patients receiving component based therapy (CBT) alone.
Results: Review of our data revealed a rate of MT which was lower than expected after initiation of our WB program. Patients had similar vitals signs, shock index, hematocrit and 30 day mortality rates (Table 1). Sixty percent of WB MTP mortalities occurred at 4 units or 2000 ml transfused in the first 24 hours. Sixty percent of CBT MTP mortalities occurred at 6 units or 2000 ml in that time period. After expanding our definition of MT to include $>3 \mathrm{U}$ of whole blood or $>1500 \mathrm{ml}$ of combined products in 24 hours our total number of MTP patients increased to the expected level based on historic data.

Conclusion: Severity of hemorrhage may be underrepresented when applying the classic definition of MT to patients receiving WB. Though our net units of WB transfused compared to CBT was lower, the actual volume of transfusion was equal. The

|  | COMPONENT ( $\mathrm{N}=270$ ) | WHOLE BLOOD ( $\mathrm{N}-62$ ) | P-VALUE |
| :---: | :---: | :---: | :---: |
| AGE (yrs) | 385 | 44 | 0.256 |
| WEIGHT (kg) | 81.6 | 83.1 | 0.002 |
| GENDER (M/F) | 183/820 | $39 / 1$ | 0 |
| RACE (wi/blk/asian/other) | 297/22/3/7 | $55 / 2 / 0 / 5$ | 0.101 |
| SHOCK INDEX | 2.14 | 118 | 0.955 |
| HEMATOCRIT | 35.9 | 36.4 | 0.599 |
| HOSPITAL DAYS | 3.5 | 85 | 0.1357 |
| OVERAL MORTALTY | 139 (5:596] | $28(45.17)$ | 0.350 |

Table 1. Comparison of patient demographics and mortality rates using the new (W.A.T.C.H.E.R.) definition of massive transfusion. mortality associated with $>3 \mathrm{U}$ of whole blood or $>1500 \mathrm{ml}$ of total product is equivalent to the mortality seen with the classic definition of MTP. The use of this definition should help eliminate survivor bias in early mortality for future studies. With the resurgence of whole blood we propose the adoption of a new nomenclature: the Whole Blood Approach to Transfusion in Critical Hemorrhage and Emergency Resuscitation (W.A.T.C.H.E.R.) method. This is the first study in the modern whole blood era to redefine classic MTP.

# COAGULOPATHY CORRECTION WITH FRESH FROZEN PLASMA: HOW MUCH DO WE REALLY NEED TO TRANSFUSE? 

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Introduction: Thromboelastography (TEG) had been used to assess coagulopathy in order to guide transfusion of fresh frozen plasma (FFP), platelets, and cryoprecipitate. However, the effect of FFP on the correction of TEG R time is not well established, leading clinicians to correct coagulopathy without a predictable response on subsequent TEG studies. We sought to quantify the effect of plasma administration on the correction of the TEG R time to serve as a guide for future coagulopathy correction.
Methods: All surgical ICU patients between Aug 2017 and Feb 2019 with at least two TEGs performed over three consecutive days that noted R time correction due to FFP were included in the analysis. An improvement was defined as a decrease in the initial R time by 1.8 min or greater, with initial abnormal R time ranging between 9.5 and 17 min . The medical records were reviewed for plasma administration between the TEGs. The association of FFP administration on R time was then assessed.
Results: Thirty-six surgical ICU patients over the 17-month study period who met inclusion criteria were identified. The mean age of the group was 59 years, $63.9 \%$ were male, mean APACHE score was 81.3 , and the mortality rate was $52.8 \%$. The majority of patients (72.2\%) consisted of cirrhotic pre-liver transplant patients. The mean interval between TEGs was $830 \pm 598$ minutes, the mean initial R time was $10.93 \pm 1.69$ minutes, the mean FFP transfused was $1.88 \pm 0.97$ units, and the mean R time correction was 3.54 $\pm 1.54$ minutes. We determined that for every unit of FFP provided the R time was reduced by $1.89 \pm 1.01$ minutes.
Conclusion: TEG can successfully guide blood component replacement when attempting to correct coagulopathy. The administration of FFP leads to a predictable response in subsequent TEG studies with one unit of FFP improving $R$ time by about 2 minutes. This finding may help optimize the administration of FFP for coagulopathy correction.

## Gender Differences in the Massively Transfused Trauma Patient

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Introduction: Recent studies have suggested the female hypercoaguable state may have a protective effect in trauma. However, whether this hypercoagulable profile confers a survival benefit in massively transfused trauma patients has yet to be determined. We hypothesized that females would have better outcomes than males after traumatic injury that required massive transfusion protocol (MTP). Methods: All trauma patients that underwent MTP at an urban, level 1, academic trauma center were reviewed from November 2007 to October 2018. Female MTP patients were compared to their male counterparts.
Results:There were a total of 643 trauma patients undergoing MTP. Of these, 90 (13.8\%) were female and 563 (86.2\%) were male. Presenting blood pressure, heart rate, shock index, and injury severity score (ISS) were not significantly different. Overall mortality and incidence of venous thromboembolism (VTE) were similar. Complication profile and hospital stay were similar. On logistic regression, female gender was not associated with survival (HR: 1.04, 95\%CI: 0.56-1.92, $\mathrm{p}=0.91$ ). Variables associated with mortality included age (HR: 1.02, $95 \% \mathrm{CI}$ : $1.05-1.09, p=0.03$ ) and ISS (HR: 1.07, 95\%CI: 1.05-1.09, $\mathrm{p}<0.001$ ). Increasing GCS was associated with survival (HR: $0.85,95 \%$ CI: $0.82-0.89, \mathrm{p}<0.001$ ). On subset analysis, pre-menopausal women (age<50) did not have a survival advantage in comparison to similar aged males (HR: 0.68, 95\%CI: 0.36-1.28, $\mathrm{p}=0.24$ ). However, on subset analysis, each unit of blood transfused, conferred a mortality risk for males, but not females (table).
Conclusion: Gender differences in coagulation profile may result in lower mortality risk for females per unit of blood when MTP is required.

| Logistic Regression Examining Variables Associated with Mortality |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Odds Ratio | 95\% Confidence Interval | p Value |
| Subset Analysis of Females Only |  |  |  |
| Age | 0.99 | $0.96-1.03$ | 0.59 |
| Injury Severity Score | 1.04 | $0.99-1.08$ | 0.06 |
| Presenting Systolic BP | 1.01 | $0.98-1.04$ | 0.55 |
| Presenting Shock Index | 2.35 | $0.36-15.20$ | 0.37 |
| GCS | 0.85 | $0.76-0.96$ | 0.01 |
| Each Unit pRBC | 1.02 | $0.99-1.01$ | 0.24 |
| Subset Analysis of Males Only |  |  |  |
| Age | 1.02 | $1.01-1.04$ | 0.004 |
| Injury Severity Score | 1.07 | $1.05-1.10$ | $<0.001$ |
| Presenting Systolic BP | 0.99 | $0.99-1.01$ | 0.62 |
| Presenting Shock Index | 0.65 | $0.32-1.30$ | 0.22 |
| GCS | 0.84 | $0.80-0.88$ | $<0.001$ |
| Each Unit pRBC | 1.02 | $1.01-1.04$ | 0.004 |

# TRANSFUSION OF WHOLE BLOOD FOR CIVILIAN TRAUMA PATIENTS: PRELIMINARY REPORT ON COAGULATION CAPACITY AND OUTCOMES 

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Introduction: Military services have found that whole blood (WB) offers a survival advantage over component therapy (CT). Initial civilian studies and preclinical work suggest hemostatic capacity of WB may be superior to CT, though it remains to be seen whether this will translate into clinical relevance. Here we report preliminary findings from an ongoing single-institution prospective observational study of WB vs CT for initial resuscitation of civilian trauma patients.
Methods: Adult male trauma patients presenting with systolic blood pressure $<$ 100 triggering massive transfusion protocol activation were eligible to receive up to 4 units of low titer (anti-A/B) group O+ WB leukoreduced with a plateletsparing filter (WB group). Adult trauma patients meeting the same inclusion criteria who received CT as initial resuscitation served as controls. Blood for thromboelastography (TEG) was drawn on admission and after resuscitation was complete with either medical or surgical hemostasis. All hypothesis tests were two-sided with alpha $=0.05$.
Results: Twenty-three male patients received WB as initial resuscitation followed by additional CT as needed, compared to 27 controls who received CT alone (18 male, 9 female; sensitivity analysis showed no significant differences in coagulation profile when females were excluded). There were no significant differences in age, injury mechanism, ISS, ABC score, or BMI between groups. There were no transfusion reactions or positive direct antibody tests.
Conclusion: Initiating resuscitation for traumatic hemorrhage with WB leukoreduced with a platelet-sparing filter resulted in post-resuscitation TEG profiles which were normal on average and similar to those seen with CT as initial resuscitation. Patients transfused with CT and WB received similar total volumes of blood product and had similar clinical outcomes.

| Variable | $\begin{aligned} & \mathrm{CT}, 0 \mathrm{~h} \\ & (\mathrm{n}=23) \\ & \hline \end{aligned}$ | $\begin{aligned} & \mathrm{WB}, 0 \mathrm{~h} \\ & (\mathrm{n}=22) \end{aligned}$ | p | $\begin{aligned} & \text { CT, AR } \\ & (\mathrm{n}=22) \end{aligned}$ | $\begin{aligned} & \text { WB, AR } \\ & (\mathrm{n}=19) \end{aligned}$ | p |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \mathrm{R}(\mathrm{~min}, \mathrm{nml} 5- \\ & 10) \end{aligned}$ | 4 (3.3-4.6) | 3.8 (3.1-4.4) | 0.74 | 4.6 (3.8-6) | 5 (4.4-5.8) | 0.30 |
| K (min, nml 1-3) | 1.8 (1.2-2.1) | 2 (1.2-2.2) | 0.44 | 2.3 (1.8-2.7) | 2 (1.4-2.6) | 0.48 |
| Angle (deg, nml 53-72) | 65.9 (64.2-70.9) | $\begin{aligned} & 67.7(62.7- \\ & 73.4) \end{aligned}$ | 0.60 | $\begin{aligned} & 63.5(57.1- \\ & 64.2) \end{aligned}$ | $\begin{aligned} & 63.4(55.4- \\ & 72.3) \end{aligned}$ | 0.56 |
| MA (mm, nml 50-70) | 62.9 (56.4-66.1) | $\begin{aligned} & 60.7(52.7- \\ & 68.3) \end{aligned}$ | 0.79 | $\begin{aligned} & 55.2(51.9- \\ & 59.5) \end{aligned}$ | $\begin{aligned} & 56 \text { (51.5- } \\ & 61.9) \end{aligned}$ | 0.62 |


| Blood Product Transfusion 4h after Admission and Clinical Outcomes, median (IQR) |  |  |  |
| :--- | :--- | :--- | :--- |
|  | Component therapy <br> $(\mathrm{n}=27)$ | Whole blood <br> $(\mathrm{n}=23)$ | p |
| Variable | $0(0-0)$ | $2(1-3)$ | $<0.001$ |
| WB units (n) | $0.6(0-1.2)$ | $0.5(0-1.2)$ | 0.88 |
| Platelets/PRBC ratio | $0.7(0-0.8)$ | $0.7(0-0.8)$ | 0.776 |
| FFP/PRBC ratio | $3050(1187.5-4512.5)$ | $2287.5(1612.5-3400)$ | 0.748 |
| Total Volume of Products (mL) | $5(18.5 \%)$ | $1(4.5 \%)$ | 0.204 |
| 30 day Mortality (n) | $7(4-11)$ | $4.5(2.2-9.8)$ | 0.146 |

## REFINING THE MASSIVE TRANSFUSION PROTOCOL PHENOTYPE: IMPLICATIONS FOR PERSONALIZED RESUSCITATION

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Introduction: Massive transfusion protocol (MTP) activation usually occurs based upon physician gestalt despite the availability of multiple massive transfusion prediction scores. The aim of this study was to compare all MTP activations resulting in significant transfusion (MTP+) to MTP activations ultimately not receiving significant transfusion (MTP-) to determine if there was a predictable phenotype to allow refinement of activation criteria.
Methods: A prospective cohort of highest level trauma activations from 2010-2016 were analyzed for demographics, initial vital signs, standard coagulation labs, rotational thromboelastometry (ROTEM: EXTEM and FIBTEM), and outcomes between MTP+ and MTP-. MTP activations were cross referenced with the blood bank records.
Results: 1378 patients were enrolled with 257 (18.7\%) having MTP activated and 83/257 (32.3\%) receiving $>10$ units of blood products in 24 hours (MTP+). Comparing all MTP activations, the MTP+ group were more likely female, bluntly injured, with worse ISS and BD and lower SBP. All clotting parameters by ROTEM were also worse (Table). Overall mortality for MTP activations was $33.5 \%$ with $64 \%(55 / 86)$ of

| Parameter | MTP- | MTP+ | p-value |
| :--- | :---: | :---: | :---: |
| Female | $15.0 \%$ | $25.3 \%$ | 0.045 |
| Blunt | $40.8 \%$ | $60.2 \%$ | 0.004 |
| ISS | 22 | 38 | 0.0001 |
| GCS | 14 | 12 | 0.0001 |
| BD | 5.3 | 7.3 | 0.0197 |
| SBP | 123 | 111 | 0.0075 |
| HR | 107 | 115 | 0.06 |
| PTT | 28.3 | 37.5 | 0.0001 |
| INR | 1.2 | 1.4 | 0.0001 |
| EXTEM CT | 60.5 | 79 | 0.0014 |
| EXTEM CFT | 93 | 123 | 0.0014 |
| EXTEM Alpha | 72 | 68 | 0.0257 |
| EXTEM MCF | 62 | 55 | 0.0004 |
| FIBTEM MCF | 13 | 42 | 0.0049 | the deaths occurring in <24 hours. There were no differences in hospital days, ICU days, or pneumonia; however, MTP+ patients were more likely to have MOF ( $\mathrm{p}=0.009$ ) and fewer vent-free days ( $\mathrm{p}=0.0001$ ).

Conclusion: Approximately $1 / 3^{\text {rd }}$ of all MTP activations result in significant transfusion volumes. Laboratory assays that can be obtained rapidly at point-of-care including viscoelastic clot initiation parameters and blood gas base deficit differentiates those activations most likely to require significant transfusion from those resulting in fewer transfusions, and may be useful in improving massive transfusion prediction scores.

## GIVE THE SURGEON A CHANCE: INCREASED LENGTH OF SURVIVAL AND RATE OF TRANSFER TO THE OPERATING ROOM AFTER RESUSCITATION WITH WHOLE BLOOD

Douglas Pokorny DO, Phillip Edmundson MD, Maxwell Braverman DO, David Bittenbinder MD, Christian McEvoy MD, Mallory Wampler MD, Ashley McGinityMD, Leslie Greebon MD, Michael Shiels RN, Rachelle Babbitt Jonas RN, Susannah Nicholson MD, Brian Eastridge* MD, Ronald Stewart* MD, Donald Jenkins* MD, University of Texas Health Science Center at San Antonio
INTRODUCTION: An effective massive transfusion protocol (MTP) has been shown to decrease mortality in the setting of life-threatening hemorrhage. In January of 2018, our hospital began transfusing whole blood (WB) in our trauma resuscitation unit (TRU). Analysis of our first year of WB transfusion suggests that in addition to an overall mortality benefit, WB transfusion may be associated with prolonged time to death (TTD) among patients who ultimately succumb to their injuries allowing more opportunities for life saving interventions.
METHODS: A retrospective review of all trauma patients at our urban level one trauma center transfused between January 1, 2015 and December 31, 2018 was performed. The population group was then narrowed to include only those patients that received emergency release blood in massive transfusion quantities initiated in the TRU. Prisoners, pregnant patients and pediatric patients were excluded.
RESULTS: A total of 268 patients were included. Age, Shock Index (SI), Injury Severity Score (ISS) and mechanism of injury were similar among both groups. 43 patients received WB as part of their resuscitation; 225 received component based therapy (CBT) alone. Median TTD in the WB group was significantly longer than CBT (5.38hrs vs 1.63hrs, $\mathrm{p}=0.034$ ). Although WB patients had similar mortality in the TRU (11.6\% vs $24.4 \%$, $\mathrm{p}=0.06$ ), similar rate of disposition to the operating room (OR) ( $65 \%$ vs $50 \%, \mathrm{p}=0.07$ ), and similar 30 day mortality (48.8\% vs $53.8 \%$, $\mathrm{p}=0.55$ ), the trends suggest further accrual of patients may yield statistical

|  | COMPONENT $(\mathrm{N}=225)$ | WHOLE BLOOD $/ \mathrm{N}=43)$ | p-VALUE |
| :---: | :---: | :---: | :---: |
| AGE (yrs) | 37 | 44 | 0.578 |
| WEIGHT (kg) | 81.6 | 36.18 | 0.006 |
| GENDER (M/F) | $161 / 64$ | $41 / 2$ | 0 |
| RACE (wt/blk/asian/other) | $198 / 17 / 3 / 6$ | $38 / 2 / 0 / 3$ | 0.4 |
| MECHANISM (P/B) | $76 / 149$ | $20 / 23$ | 0.111 |
| ISS | 26 | 22 | 0.147 |
| SHOCK INDEX | 1.14 | 1.2 | 0.603 |
| GCS | 3 | 10 | 0.073 |
| HCT | 35.6 | 36.2 | 0.868 |
| pH | 7.22 | 7.28 | 0.075 |
| HOSPITAL DAYS | 2 | 7 | 0.324 |
| 30 DAY MORTALITY | $121(53.8 \%)$ | $21(48.8 \%)$ | 0.552 |
| TRU MORTALUTY | $55(24.4 \%)$ | $5(11.6 \%)$ | 0.065 |
| DISPO TO OR | $113(50.2 \%)$ | $28(65.1 \%)$ | 0.073 |
| TTD (hrs) | 1.63 | 5.38 | 0.034 |

Table 1. Comparison between those receiving whole blood in their resuscitation and those receiving component based therapy alone. significance (Table 1).
CONCLUSION: The addition of WB to our program shows prolonged patient survival (TTD), trends toward a reduction in post operative, TRU and 30 day mortality rates and an increased rate of disposition to the OR compared to patients who received CBT alone. Type II error does not allow definitive mortality conclusions at our current sample size. These findings suggest that introducing WB has given our surgeons almost four additional hours to combat the injuries and lethal hemorrhage with which they are faced and supports the implementation of a prospective, randomized, controlled trial.

## Poster \# 90

# EFFECTS OF RESUSCITATION WITH FIBRINOGEN CONCENTRATE AND PLATELETS ON COAGULATION IN PIGS WITH REDUCED PLATELET COUNTS AND TRAUMATIC HEMORRHAGE 

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When creating your abstract, the only section headers to be used are listed below, and they need to be in this format (please remove this line before creating your abstract):

Introduction: Damage control resuscitation emphasizes reducing crystalloids and providing hemostatic products, such as platelets and fibrinogen concentrate (FC), to treat patients with severe bleeding. This study compared resuscitation effects of platelets and FC on coagulation in pigs with traumatic hemorrhage and reduced platelet counts.

Methods: Thirty pigs ( $40 \pm 1 \mathrm{~kg}$ ) were anesthetized and catheterized with an apheresis catheter in the femoral vein to remove platelets using Haemonetics 9000. Afterwards, a femur fracture was induced using a captive bolt stunner, followed by hemorrhage of 35\% of the estimated blood volume ( $24.5 \mathrm{ml} / \mathrm{kg}$ ). Pigs were then randomized to be resuscitated with $5 \%$ human albumin (as control, $12.5 \mathrm{ml} / \mathrm{kg}, \mathrm{n}=10$ ), FC (RiaSTAP, 250 $\mathrm{mg} / \mathrm{kg}, 12.5 \mathrm{ml} / \mathrm{kg}, \mathrm{n}=10$ ), or platelets collected from apheresis ( $\mathrm{n}=10$ ). Animal were then monitored for 2 h or until death. Blood samples were collected before apheresis (baseline, BL), after apheresis, hemorrhage, and resuscitation to assess changes in coagulation, using Rotem ${ }^{\circledR}$ thrombelastogram. Hemodynamics were recorded during the sampling times.

Results: MAP, heart rate (HR) or cardiac output (CO) was not changed by platelet apheresis. Hemorrhage reduced MAP to $57 \% \pm 5 \%$ and CO to $55 \% \pm 2 \%$ of BL and elevated HR to $212 \pm 20 \%$ of BL (all p<0.05). Resuscitation with albumin, FC or platelets did not return MAP or HR to BL. Resuscitation with albumin returned CO to BL, but not with FC or platelets. Platelet counts were reduced by apheresis from BL $383 \pm 201 母 / \mathrm{L}$ to $141 \pm 1410^{9} / \mathrm{L}$ ( $\mathrm{p}<0.05$ ), and were reduced further after resuscitation with albumin ( $88 \pm 1810^{9 / L}$ ) or FC ( $97 \pm 1310^{9} / \mathrm{L}$, both $\mathrm{p}<0.05$ ), but improved with platelet resuscitation ( $307 \pm 2410^{9} / \mathrm{L}$ ). Plasma fibrinogen concentration was reduced by apheresis from BL $225 \pm 9 \mathrm{mg} / \mathrm{dL}$ to $194 \pm 8 \mathrm{mg} / \mathrm{dL}$ ( $\mathrm{p}<0.05$ ), fell more after albumin infusion ( $134 \pm 11 \mathrm{mg} / \mathrm{dL}$ ), increased to $269 \pm 10 \mathrm{mg} / \mathrm{dL}$ after FC resuscitation ( $\mathrm{p}<0.05$ ), and was not affected by platelet resuscitation ( $203 \pm 8 \mathrm{mg} / \mathrm{dL}$ ). Rotem ${ }^{\circledR}$ Alpha angle (clotting speed) decreased from $79 \pm 2^{\circ}$ to $69 \pm 1^{\circ}$ by apheresis and hemorrhage ( $\mathrm{p}<0.05$ ), and recovered similarly by resuscitation with FC ( $87 \pm 1^{\circ}$ ) or platelets ( $78 \pm 2^{\circ}$ ), but not by albumin $\left(63 \pm 3^{\circ}\right)$. Similar response were observed in Rotem ${ }^{\circledR}$ Maximum clot firmness. There were no differences in changes Hct, RBC counts, or survival time among the 3 groups.

Conclusion: In this traumatic hemorrhage swine model of reduced platelet counts, low volume resuscitation with fibrinogen concentrate or platelets was similarly effective in restoring coagulation, compared to albumin.

# MULTI-ORGAN STRESS INDICATORS SIGNAL INCREASED LATE MORTALITY 

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Introduction: Though hemorrhage and brain injury are the leading causes of immediate and early death following injury, late deaths are most commonly related to multi-organ failure and infection. Subtle clinical indicators may provide an early warning to clinicians of pending deterioration. We hypothesized that changes in ventilatory mechanics and lab values early in a patient's hospital course would be predictive of later decompensation leading to mortality.

## Methods:

This study involved a retrospective review of injured patients admitted to an intensive care unit at a Level 1 trauma center over a two year period. Ventilation, (Lung compliance (LC)) and Oxygenation (PaO2:FiO2 (P:F)), and metabolic stress (bicarbonate) were recorded daily for one week. As these values vary directly with metabolic stress, a Multi-organ Stress Index (MoSI) was derived as follows

| $(\mathrm{L} / \mathrm{cmH} 2 \mathrm{O}) \times \mathrm{P}: \mathrm{F} \mathrm{x}$ $250$ | Fig 1. Multi-Organ Stress Index by Hospital Day |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| bicarbonate. |  |  |  |  |  |  |  |  |
| Wilcoxon Rank Sum was 200 |  |  |  |  |  |  |  |  |
| used to associate admission MoSI with | 200 | * | * |  | * |  |  |  |
| overall mortality and |  |  |  |  |  |  |  |  |
| associated with |  |  |  |  |  |  |  |  |
| corresponding daily 100 |  |  |  |  |  |  |  |  |
| mortality. |  |  |  |  |  |  |  |  |
| Results: 100 patients 50 |  |  |  |  |  |  |  |  |
| were included. There |  |  |  |  |  |  |  |  |
| were no differences in |  |  |  |  |  |  |  |  |
| patient demographics, |  | Day 1 MSI | Day 2 MSI | Day 3 MSI | Day 4 MSI | Day 5 MSI | Day 6 MSI | Day 7 MSI |
| injury mechanism, |  |  |  | -Survivor | -Non- | vivors |  |  |
| thoracic trauma or shock |  |  |  |  | 001 |  |  |  | index between survivors and non-survivors. Overall mortality was $34 \%$. Admission MoSI was significantly lower for non-survivors (343.1 vs. 554.1,p<0.001). Daily MoSI remained significantly lower in non-survivors, and trended downward, compared to survivors (figure). Early decrements in MoSI, especially below 75, were associate with increased mortality compared to patients who maintained a higher MoSI ( $51.4 \%$ vs. $22.6 \%, p=0.003$ ).

Conclusion: Subtle changes in ventilatory mechanics and bicarbonate levels early in a patient's hospital course indicate increased multi-organ stress and increased potential for clinical deterioration. Low MoSI was highly associated with mortality. Identification of low MoSI may be a trigger for earlier initiation of aggressive rescue therapies such as continuous renal replacement therapy or extra-corporeal membrane oxygenation.

# Direct measurement method is unreliable for proper placement of resuscitative occlusion balloon into the target zone of the aorta 

Shokei Matsumoto* MD, Tomohiro Funabiki MD, Taku Kazamaki MD, Taku Akashi MD, Motoyasu Yamazaki MD, Mitsuhide Kitano MD, Saiseikai Yokohamashi Tobu Hospital Background: Resuscitative endovascular balloon occlusion of the aorta (REBOA) should be deployed at Zone 1 or 3 depending on the location of the hemorrhage. Ideally, the catheter position in REBOA deployment should be confirmed via fluoroscopy, but it is not common for trauma bays to be equipped with fluoroscopy. Therefore, some researchers have analyzed the aortic geometry and developed a fixed-distance model for using REBOA without fluoroscopy (ex: Zone 1 approx. 46 cm ). Our hospital is one of the major trauma centers in Japan and has frequently used REBOA without fluoroscopy. The aim of this study is to describe our experience and evaluate the accuracy of positioning REBOA without fluoroscopy in a Japanese major trauma center.
Methods: A retrospective review identified all trauma patients who underwent a REBOA procedure and were admitted to our urban trauma center from 2008 to 2018. We do not use the fixed-distance method for determining REBOA positioning because there is significant variation within the population in terms of vascular anatomy. Instead, balloon positioning is determined with direct measurement of the sheath to the target zone part using the REBOA catheter (Fig. 1). The positioning, complications, and the bleeding source for REBOA were reviewed based on the radiological and surgical results. The decision and target zone in which to deploy REBOA was made by the attending emergency physician, a Japanese Association for Acute Medicine certified faculty member.
Results: During the study period, 38 patients met our inclusion criteria. The in-hospital mortality was $57.9 \%$. Among the three patients who developed REBOA-related complications, one was critical. Nine patients switched from open aortic clamp to REBOA. With respect to the bleeding source, REBOA was frequently used in the abdominal ( $46.3 \%$, $\mathrm{n}=19$ ) and pelvic ( $34.1 \%, \mathrm{n}=14$ ) regions. Overall, the positioning rate of REBOA was $68.4 \%$ in Zone 1, $26.3 \%$ in Zone 2, and $5.3 \%$ in Zone 3. The concordance rate for the target zone was $79.2 \%$ in Zone 1 and 7.1\% in Zone 3 (Table 1).

Conclusions: In many cases, the balloon was deployed at an untargeted zone using the direct measurement method, especially in Zone 3. The direct measurement method is therefore unreliable. For improving proper placement into the target zone, further studies including the fixed-distance model are needed.


Fig 1.

|  | Target zone |  |  |  |
| :--- | :--- | :--- | :--- | :---: |
| Deployment <br> zone | Zone 1 | Zone 3 | Total |  |
| Zone 1 | $\mathbf{2 3 ( 8 2 . 1 \% )}$ | $\mathbf{3 ( 3 0 . 0 \% )}$ | $\mathbf{2 6 ( 6 8 . 4 \% )}$ |  |
| Zone 2 | $\mathbf{4 ( 1 4 . 3 \% )}$ | $\mathbf{6 ( 6 0 . 0 \% )}$ | $\mathbf{1 0 ( 2 6 . 3 \% )}$ |  |
| Zone 3 | $\mathbf{1 ( 3 . 6 \% )}$ | $\mathbf{1 ( 1 0 . 0 \% )}$ | $\mathbf{2 ( 5 . 3 \% )}$ |  |
| Total | $\mathbf{2 8 ( 1 0 0 \% )}$ | $\mathbf{1 0 ( 1 0 0 \% )}$ | $\mathbf{3 8 ( 1 0 0 \% )}$ |  |

Table 1.

## Poster \# 93

## EARLY PREDICTORS OF MASSIVE TRANSFUSION IN PENETRATING TRAUMA

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## Introduction:

The presence of penetrating trauma and a positive FAST have been incorporated in the ABC score as independent parameters to predict the need for transfusion (MT). Other scores have been derived from military series or civilian cohorts with a low proportion of penetrating trauma. In order to more accurately determine the need for MT in penetrating trauma we sought to identify specific parameters in a civilian population with $100 \%$ penetrating torso injuries (TPI).

## Methods:

Patients with TPI, 18 years and older, managed in a level-I trauma center were included. Variables obtained during the evaluation in the trauma bay were registered prospectively. The ability to predict MT was evaluated with simple, multiple logistic regressions (MLR) and ROC curves.

## Results:

We included 162 subjects; 137 (84.6\%) received fire-arm wounds, and 144 (88.9\%) were male. Twenty-one (13\%) received MT.
Compared with the no-MT patients, those who received an MT were intubated more frequently in the pre-hospital, had lower SBP, higher HR, lower GCS and received more frequently vasopressors ( $\mathrm{p}<0.05$ ).
Trauma mechanism, localization, number the wounds, and positive FAST, could not discriminate MT ( $\mathrm{p}>0.05$ ).
Models were created with the variables identified as independent predictors of MT. They showed better discriminative ability than ABC score and adequate goodness to fit (table).

Table. Evaluated Predictors of Massive Transfusion in Torso Penetrating Trauma

| Model | AUROC (95\% C.I.) | Goodness of fit p |
| :---: | :---: | :---: |
| ABC score | 0.7435 (0.64199-0.84501) | 0.3291 |
| SBP ( mm Hg ) + HR (beats/min) +GCS | $0.8207(0.73790-0.90344)$ | 0.9614 |
| SBP $\leq 90 \mathrm{~mm} \mathrm{Hg}+\mathrm{HR} \geq 120$ beats/min $+\mathrm{GCS} \leq 14$ | $0.8315(0.75062-0.91233)$ | 0.5011 |
| $\begin{aligned} & \text { SBP }(\mathrm{mm} \mathrm{Hg})+\text { HR }(\text { beats } / \mathrm{min})+\text { Best Motor } \\ & \text { Response } \end{aligned}$ | 0.8237 (0.74121-0.90621) | 0.9639 |
| $\text { SBP } \leq 90 \mathrm{~mm} \mathrm{Hg}+\mathrm{HR} \geq 120 \text { beats/min + Best }$ <br> Motor Response $\leq 5$ | 0.8318 (0.75200-0.91163) | 0.3139 |
| AUROC Area under the ROC curve SBP Systolic Blood Pressure | HR Heart Rate GCS | sgow Coma Scale |

Conclusion:Early identification of the risk of MT can accurately be made in TPI by a combination of SBP, HR and a clinical measurement of neurological impairment.

Poster \# 94

## INTEGRATION OF RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA FOR HEMORRHAGE CONTROL IN THE SETTING OF PLACENTA ACCRETA SPECTRUM AND PERI-PARTUM HEMORRHAGE

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INTRODUCTION: Pregnancy-related mortality continues to increase throughout the US, with rates in several states surpassing that of third-world countries and reaching the level of a public health crisis. One of the causes of this increasing mortality is placenta accreta spectrum (PAS). PAS, an abnormal attachment of the placenta to the myometrium, places the mother at an increased risk of severe hemorrhage at the time of delivery. Given our experience with REBOA in the setting of non-compressible torso hemorrhage for trauma, we recently implemented a protocol for its use in cases of PAS. We present a review of the largest case series to date in the US of the implementation of the 7FR REBOA for hemorrhage control in the setting of PAS and peri-partum hemorrhage.
METHODS: We performed this descriptive case series of all REBOA (January 2018 January 2019) placements at our center in scenarios of planned elective cesarean delivery in patients with known PAS and emergent REBOA deployment in the setting of acute peri-partum hemorrhage due to PAS. Baseline data, pathology, and outcomes were abstracted from our hospital's electronic medical record and our multidisciplinary performance improvement registry. Our Acute Care Surgery (ACS) Faculty placed all REBOA catheters. All patients had common femoral artery duplex 48-hours after sheath removal and clinic follow-up with the ACS team.
RESULTS: REBOA was performed in the setting of elective PAS delivery ( $\mathrm{n}=10$ ) and acute peri-partum hemorrhage ( $n=2$ ). Average maternal age in years at the time of delivery was 34.5 (+/- 4.38 ), average gestational age in weeks was 33.55 (+/- 3.31 ), average gravidity was $5(\min 2$, max 11 ) and parity $4(\min 1$, $\max 9)$. Average estimated blood loss at the time of delivery was 2.1L. Overall survival was $92 \%$, with the one death in an emergent setting from abruption and DIC. There was one access site complication requiring thrombectomy of the external iliac artery and one common femoral artery thrombus that subsequently resolved on repeat duplex. All surviving patients had normal pulse examinations at the time of their clinic follow-up.
CONCLUSION: Implementation of REBOA by Acute Care Surgeons as a part of a multidisciplinary team is feasible and facilitates hemorrhage control in patients with peripartum hemorrhage related to PAS. REBOA use may lead to decreases in morbidity and mortality in the at-risk pregnant patient with PAS. Further studies are necessary to identify patient specific characteristics for the implementation of the 7FR REBOA for known PAS and in the event of peri-partum hemorrhage.

| PATIENT | AGE | RACE | GRAVIDITY | PARITY | $\begin{gathered} \text { GESTATIONAL } \\ \text { AGE (WKS) } \end{gathered}$ | BMI | EBL <br> (cc) | $\begin{aligned} & \text { FINAI } \\ & \text { PATH } \end{aligned}$ | COMPLICATION | EMIERGENT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A | 43 | WHITE | 3 | 2 | 34.85 | 269 | 2000 | DNCEETA | NOME | so |
| 5 | 34 | WHITE | 3 | 2 | 32.14 | 21.97 | 4500 | Increta | Pight Eatemsl ilise utrey thronbus nequing trantetomy | YES |
| c | 36 | BLACK | 2 | 1 | 34.1 | 37,06 | 1500 | ENCRETA | NONE | N0 |
| D | 34 | FISPANIC | 4 | 3 | 31. | 30 | 1500 | micreta | Cemanon Fenoral Atteny Clot an as beur diplex that resolved on repeat deplex witheur intervention | No |
| E | 12 | WHITE | 6 | 4 | 3571 | 3201 | 500 | ENCRETA | NONE | No |
| F | 31 | WHITE | 3 | 1 | 3512 | 27.1 | 2500 | ACCRETA | Nove | No. |
| 6 | 41 | WHITE | 11 | 5 | 36.19 | 36.19 | 3000 | tNCFETA | NONE | NO |
| H | 29 | WFITE | 7 | 3 | 34.72 | 373 | 2000 | ENCRETA | Noke | N0 |
| 1 | 2 | White | 3 | 1 | 35.4 | 15 | 2200 | nicreta | NONE | No |
| 1 | 38 | BLACK | 10 | 9 | 34.99 | 43.58 | 6000 | PERCRETA | NOAE | NO |
| K | 33 | BLACK | 4 | 3 | 348 | 53.34 | 1200 | DICRETA | NONE | No |
| 1 | 34 | WHIIE | 9 | 7 | 24.14 | 24,41 | 25050 | [NCREIA | Death | Yes |

# TRANEXAMIC ACID ADMINISTRATION DOES NOT COMPROMISE EARLY GRAFT PATENCY IN TRAUMA PATIENTS UNDERGOING ARTERIAL REPAIRS: AN ANALYSIS OF PATIENTS FROM THE AAST PROSPECTIVE OBSERVATIONAL VASCULAR INJURY TREATMENT (PROOVIT) REGISTRY 

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Introduction: Since 2010, there has been increased use of tranexamic acid (TXA) to reduce mortality in trauma patients with major bleeding. Previous studies with perioperative transfusions of TXA in coronary artery bypass grafts have shown no reduction in graft patency or increased thrombotic complications. However there have not been any studies investigating TXA and the rate of thrombosis in trauma patients undergoing vascular repairs. Our study investigated the relationship between TXA and in-hospital graft patency for trauma patients with vascular injuries undergoing arterial repairs.
Methods: We analyzed a subset of patients from the PROOVIT registry who underwent open or endovascular definitive arterial repair using a graft or stent. Patients who received TXA were compared to those who did not. The primary outcome of the study was in-hospital graft patency. Graft occlusion was defined by the need for repeat operations or interventions due to either thrombosis or stenosis of initial arterial repair. Data were analyzed using students t-test and $\mathrm{X}^{2}$ test.
Results: There were 898 cases of arterial injuries identified over 755 patients (4.6\% cervical injuries, $30.4 \%$ torso injuries, 27.5\% upper extremity injuries, and 37.5\% lower extremity injuries). There were 100 cases in the TXA group, and 798 cases in the non-TXA group. There was no significant difference in the rate of graft thrombosis/stenosis between the TXA and non-TXA groups ( $10 \%$ vs $7 \%, \mathrm{p}=0.26$ ). TXA administration was also not associated with an increased rate of distal ischemia (stroke, bowel ischemia, or extremity amputation) ( $10 \%$ vs $8.5 \%, \mathrm{p}=0.62$ ). In the TXA group, graft occlusions most commonly occurred after repairs of brachial or femoral artery injuries. In the non-TXA group, graft occlusions most frequently occurred after popliteal artery repair. Arterial graft occlusion was only significantly associated with the need for immediate perioperative revision during the initial surgery ( $42 \% \mathrm{vs} .7 \%, \mathrm{p}<0.0001$ ) and was unrelated to the use of TXA.
Conclusion: The administration of TXA did not compromise early graft patency in trauma patients undergoing arterial repairs. Although this study does not take into consideration time and dose of TXA in these high risk patients, clinicians should be comfortable administering TXA to trauma patients with arterial injuries without concern for increased risk of graft occlusion. Future research should factor in the time and dose of TXA in this high risk population.

# OUTCOMES COMPARISON BETWEEN ENDOVASCULAR AND OPEN REPAIR (OR) FOR BLUNT THORACIC AORTIC INJURY (BTAI): A CONTEMPORARY ANALYSIS 

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Introduction: Thoracic endovascular aortic repair (TEVAR) results in improved outcomes compared to OR for BTAI, but information regarding cost and outcomes for patients treated without surgical intervention (NOP) are limited. Using a comparative effectiveness strategy, we aim to analyze outcomes, demographics and cost comparisons between TEVAR, OR, and NOP in a large, contemporary group of patients with BTAI. Methods: The National Inpatient Sample (NIS) 2012-2014 was queried to identify patients with diagnosis and procedure codes corresponding to BTAI. Primary outcomes were mortality, length of stay (LOS), cost, and complications. Chi square, t-test, and multiple logistic regression analyses were used to identify differences between groups and risk factors for mortality.
Results: 3455 patients with the diagnosis of BTAI were identified; 1390 underwent TEVAR, 110 OR, and 1955 patients were treated non-operatively (NOP). Mean age was 42 ( $\pm 18.75$ ) years, most patients were male ( $74 \%$ ), mean hospital length of stay was 14 ( $\pm 19.9$ ) days, and mean total cost was $\$ 79,913( \pm \$ 77673)$ covered by private insurance (including HMO) in $46 \%$. The most common chronic medical diagnosis was hypertension (23\%) followed by obesity (6.5\%). 74\% patients had an extreme likelihood of dying as calculated by the All Patients Refined Diagnosis Related Groups (APDRG) risk mortality scale. There was no difference in age, gender, and presence of co-morbid conditions between TEVAR and OR. TEVAR patients had higher rates of hemothorax ( $p=0.045$ ) and orthopedic injuries ( $\mathrm{p}=0.014$ ) compared to patients treated by OR. There was no difference in rates of stroke, paraplegia, acute renal failure (ARF), or pulmonary complications between TEVAR and OR. Total cost was similar between groups, but TEVAR patients had a longer length of hospital stay than OR ( $p=0.02$ ). Total cost was significantly higher in OR and TEVAR patients compared to NOP ( $\mathrm{p}<0.001$ ). Mortality was significantly higher in patients treated OR compared to TEVAR ( $36 \%$ vs $6 \%$, $\mathrm{p}<0.001$ ). Advanced age, female gender, and OR were all significant predictors of mortality. On regression analysis OR was associated with a 17 -fold increase in mortality compared to TEVAR ( $\mathrm{p}<0.001$ ). Using age, gender, associated injuries and co-morbidities in the regression model, TEVAR had a lower mortality rate ( $\mathrm{p}<0.001$ ) compared to NOP patients, while OR repair had a higher mortality rate compared to NOP ( $\mathrm{p}=0.036$ ).
Conclusion: Most BTAI are managed non-operatively. For those who receive surgical treatment, the use of TEVAR has surpassed the use of OR and has become the standard of care. Even with a higher burden of thoracic and musculoskeletal injury in TEVAR patients, the survival rate for endovascular treatment of BTAI is significantly higher than OR, with comparable cost and complication rates. TEVAR also results in higher survival rates compared to patients managed non-operatively. It is unknown whether these significant outcomes are related to improvements in technology, operator experience, timing of interventions, critical care of patients with BTAI, or other factors.

# PREDICTION OF VENOUS THROMBOEMBOLISM USING CLINICAL AND SERUM BIOMARKER DATA FROM TRAUMA PATIENTS 

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Introduction: Venous thromboembolism (VTE) is a frequent complication of trauma associated with high mortality and morbidity. Thromboprophylaxis has been shown to be effective at reducing VTE incidence. However, clinicians lack appropriate tools for stratifying trauma patients into risk cohorts for VTE. We aimed to compare two predictive models for VTE incidence using both clinical and serum cytokine biomarkers.

Methods: Data was collected from 73 military trauma patients with at least one extremity wound $\geq 75 \mathrm{~cm}^{2}$ who were prospectively enrolled in an observational study between 2007 and 2012. Clinical data was collected from point of injury through to discharge. Initial serum cytokine data collection began at the first surgical debridement at a US treatment facility, which occurred a median of 5 days after injury. Modeling was performed with Random forests (RF) and Logistic regression (LR) based on the presence or absence of deep vein thrombosis (DVT) and/or pulmonary embolism (PE). RF modeling was performed, using backwards variable elimination as a feature selection method. LR was also performed on the final variables from the RF model. Model performance was assessed using leave-one-out cross-validation. Sensitivity/specificity were reported at the threshold where their product was maximized.
Results: Of 73 patients ( $100 \%$ male, median age=22 years, median ISS=16), nine patients (12.3\%) developed VTE, including four (5.5\%) with DVT, four (5.5\%) with PE, and one (1.4\%) with both. The incidence of VTE in our population is notably higher than male civilians of similar age ( $\sim 4 \%$ ). VTE was diagnosed at a median of eight days from injury. The final RF model included five variables (serum IL15, serum MIG, serum VEGF, units of total blood products at initial resuscitation, and presence of soft tissue injury) and had an area under the curve (AUC) of 0.946 , sensitivity of 0.992 , and specificity of 0.838 . The LR model underperformed the RF model by comparison, with an AUC of 0.713 , sensitivity of 0.672 , and specificity of 0.776 .
Conclusion: VTE may be predicted by clinical and molecular biomarkers in trauma patients. The current study requires subsequent external validation. This will allow for the development of clinical decision support tools (CDSTs) which can help inform the management of high-risk patients for VTE.

| Table 1. VTE Predictive Model Performances |  |  |  |
| :--- | :--- | :--- | :--- |
| Modeling Method | AUC | Sensitivity | Specificity |
| Random Forest | 0.946 | 0.992 | 0.838 |
| Logistic Regression | 0.713 | 0.672 | 0.776 |

# VAGUS NERVE STIMULATION REGULATES ARACHIDONIC ACID PRODUCTION IN THE MESENTRIC LYMPH AFTER INTESTINAL ISCHEMIA REPERFUSION INJURY. 

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Introduction: Previous studies have shown that mesenteric lymph (ML) samples obtained after hemorrhagic shock contain lipid mediators, such as lysophospathidylcholine and arachidonic acid (AA), which induce the systemic inflammatory response to injury. We have previously demonstrated the ability of vagal nerve stimulation (VNS) to prevent gut barrier failure after injury. We hypothesized that VNS would regulate the biological activity of ML and the production of AA in the ML after intestinal ischemia reperfusion (IR) injury.
Methods: Male Sprague Dawley rats underwent cannulation of the mesenteric lymph duct. Animals were then subjected to 60 minutes of superior mesenteric artery (SMA) clamping followed by 120 minutes of de-clamping to induce gut IR injury. ML was collected before IR and during each hour after IR for to 2 hours. A separate cohort of animals underwent electrical cervical VNS ( $5 \mathrm{~V}, 0.5 \mathrm{~Hz}, 1 \mathrm{~ms}, 10 \mathrm{~min}$ ) after intestinal ischemia. Sham animals underwent an identical procedure but without SMA clamping. The biological activity of ML in each phase was measured based on the monocyte NF-к B activation. The lipids in ML were extracte d using the method of Bligh and Dyer and liquid chromatography electrospray ionization mass spectrometry.
Results: The NF-кB activation of the ML of the IR group was significantly increased ( $\mathrm{p}<0.05$ ). VNS significantly limited the IR-induced increase in NF-кB activation in comparison to that in the IR group ( $p<0.05$ ). A lipid analysis of ML showed that AA was significantly increased in the ML of IR groups in comparison to the sham and IR+VNS groups ( $\mathrm{p}<0.05$ ). Performing

Arachidonic Acid (Mesenteric Lymph) VNS after intestinal ischemia prevented the IR-induced increase in AA in ML ( $\mathrm{p}<0.05$ ).
Conclusions: VNS altered the biological activity in the ML and prevented the IR-induced increase in AA in the ML. Vagus nerve stimulation may attenuate the systemic inflammation that occurs after intestinal IR by altering the production of AA in ML.

# ENTERO-HEPATIC AXIS INJURY FOLLOWING HEMORRHAGIC SHOCK: A ROLE FOR URIC ACID. 

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Introduction: Organ failure following hemorrhagic shock (HS) is responsible for late morbidity among trauma patients. Uric acid (UA), released from direct tissue damage and ischemia-reperfusion injury, activates the inflammatory cascade through the TLR-4/NLRP-3 signaling pathway and enhances ICAM-1 expression in vascular endothelium. We recently demonstrated an active role for UA in lung and kidney secondary injury following HS (1). We hypothesized that UA could also contribute to entero-hepatic injury following HS.

Methods:Male Wistar rats were randomly assigned to three groups following general anesthesia and femoral vessels cannulation: 1)Sham with cannulation alone; 2)HS (MAP target of 30 mmHg for 1 h ) with RL-blood resuscitation alone (HS); 3)HS with RL-blood + Rasburicase ( $1.5 \mathrm{mg} / \mathrm{kg}$ ) resuscitation (HS+R). Rats were monitored and sacrificed 72 hours after HS. UA levels were measured in plasma and liver tissue using an assay (Cell-Biolabs). Liver injury was assessed using caspase $3 / 8$ activity (enzymatic assay), TUNEL coloration and ICAM-1 expression (western blot). Intestinal injury was assessed using ex-vivo epithelial resistance measurement and intestinal cells (HT-29 cells) expression of junctional proteins (Zonula-occludin 1, E-cadherin, Claudin-4) following UA exposure. One-way ANOVA with Bonferroni or Games-Howell post-hoc analyses were performed depending on variance homogeneity.

Results:The addition of Rasburicase to resuscitation prevented HS-mediated elevation in plasma UA levels (Sham vs HS vs HS + R: $1.9 \mu \mathrm{M}$ vs $10.2 \mu \mathrm{M}^{*}$ vs $3.7 \mu \mathrm{M}^{* *}$ ). Despite no difference in liver UA levels between groups, the addition of Rasburicase to resuscitation prevented liver apoptosis after HS (Caspase 3 activity, sham as reference: $100 \%$ vs $178 \% *$ vs $85 \%^{* *}$; Caspase $8: 100 \%$ vs $164 \%^{*}$ vs $111 \% * *$; TUNEL, $\%$ of apoptotic cells: $3.1 \%$ vs $19.5 \%^{*}$ vs $2.9 \%^{* *}$ ). Increased ICAM-1 expression after HS was also prevented by Rasburicase ( $100 \%$ vs $178 \%^{*}$ vs $110 \% * *$ ). With respect to small bowel injury, ex-vivo intestinal resistance was decreased in the HS group compared to sham; the intervention on UA in vivo prevented this phenomenon ( $114 \Omega$ vs $82 \Omega^{*}$ vs $112 \Omega^{* *}$ ). Intestinal cells (HT29) exposed to UA in vitro showed decreased junctional protein expression (Zonula-Occludin 1: $100 \%$ vs $64 \%$ \#; E-Cadherin: $100 \%$ vs $70 \%$ \#; Claudin-4: $100 \%$ vs 78\% ${ }^{\#}$ ).

Conclusion:After resuscitated HS, UA is involved in liver injury. HS-induced increased small bowel permeability through decreased adhesion proteins could be an indirect mechanism that is UA-mediated. Further investigation is needed to better understand this mechanism and ultimately target UA in patients with traumatic HS.
*HS vs Sham, $\mathrm{p}<0.05$; **HS vs HS + R, $\mathrm{p}<0.05$; \#Control vs AU $10-4 \mathrm{nM}, \mathrm{p}<0.05$
(1) K. Gilbert et al, Journal of Trauma and Acute Care Surgery, 2019

# SHIFT IN NEUTROPHIL PHENOTYPES DETECTED BY 24/7 ANALYSIS IN THE SHOCKROOM: A NEW BIOMARKER ASSOCIATED WITH TISSUE DAMAGE. 

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## Introduction:

Traumapatients are at risk for severe infections after trauma. The risk for these infections is associated with the severity of tissue damage and the amplitude of the following immune response. Injury Severity Score (ISS) and New Injury Severity Score (NISS) only grossly score the cumulative amount of tissue damage. Moreover, they do not correlate with the individual immune response of trauma patients. Neutrophils act as important cells in the common final pathway of the immune response after trauma. Previous studies showed that shifts in neutrophil phenotypes are promising in the prediction of inflammatory complications. However, technical and logistical difficulties preclude application of such test in the clinical setting. Now, these can be circumvented by application of a fully automated point-of-care flow cytometry system. The aim of this study was to find biomarkers that correlates with the amplitude of the immune response after trauma.

## Methods:

A prospective mono-center cohort study was performed in our level one trauma center from November 2018 until February 2019. All trauma patients $>18 y$ initially presented at the shock room were included by the trauma team. An extra tube of blood was obtained during standard diagnostic workup and was placed in the 24/7 available load-and-go flowcytometer, AQUIOS CL, co-located in the shock room. This machine measured the blood samples automatically within 20 minutes after sampling. The markers Fc $\gamma$ RIII (CD16) and L-selectin (CD62L) were used to identify different neutrophil phenotypes. All patient characteristics and follow-up data were collected from the electronic medical record.

## Results:

Data was analyzed in 159 patients. A total of 38 patients had an ISS $\geq 16$. Traumapatients with an ISS $<16$ showed a significant higher percentage of CD16dim neutrophils (range 0 $-4.1 \%$ ), compared to healthy controls (mean (SD) $0.9 \pm 0.8$ vs. $0.2 \pm 0.1, \mathrm{P}=0.001$ ). Poly trauma patients had a significant higher percentage of CD16dim neutrophils (range $0.1-21.1 \%$ ) compared to traumapatients with an ISS $<16$ ( $5.7 \pm 5.6$ vs. $0.9 \pm 0.8, \mathrm{P}<0.001$ ). All patients with an ISS $\geq 24$ have more than $5 \%$ CD16dim neutrophils.

## Conclusion:

The percentage of CD16dim neutrophils appears to be associated with the amount of tissue damage. This quick 24/7 applicable bedside analysis of CD16dim neutrophils used as read out for tissue damage might proof a valuable tool for clinical decision making in trauma surgery.

# EXTRACORPOREAL MEMBRANE OXYGENATION USE IN TRAUMA: TEMPORAL TRENDS AND FUTURE DIRECTIONS 

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Introduction: While early studies of extracorporeal membrane oxygenation (ECMO) reported poor outcomes, greater clinical experience and the decreased need for systemic anticoagulation on modern circuits has renewed interest in the use of ECMO for post-traumatic respiratory and cardiopulmonary failure. The objectives of this study were to characterize contemporary patterns of ECMO utilization at trauma centers across North America and to describe the outcomes of trauma patients undergoing ECMO.
Methods: Data were derived from the American College of Surgeons Trauma Quality Improvement Program (TQIP) dataset. We included adults with at least one severe injury (Abbreviated Injury Scale $\geq$ 3) admitted to a level I or II trauma center between 2012 and 2016 who received at least one day of mechanical ventilation. Patients were categorized based on whether or not they received ECMO during their admission. The primary outcome of interest was the change in the incidence of ECMO across study years. An annual average growth rate, standardized to the size of the cohort in a given year was calculated, representing the geometric mean of the growth rate over the entire study period. Furthermore, we evaluated variation in ECMO volumes across centers and unadjusted patient outcomes.
Results: Out of 194,314 severely injured patients requiring mechanical ventilation across 450 centers, 269 ( $0.14 \%$ ) received ECMO. Patients who received ECMO were younger and had fewer comorbidities than those who did not receive ECMO. Patients with severe head injuries were underrepresented in the ECMO group, whereas patients with severe torso injuries were overrepresented. ECMO patients had a significantly higher mortality rate than non-ECMO patients (32\% vs. 19\%). The
 standardized rate of ECMO increased significantly from 2012 to 2016, growing from 75.2 to 179.0 ECMO cases per 100,000 severely injured patients requiring mechanical ventilation. The average annual growth rate was $24 \%(\mathrm{p}=0.02)$. Of the $82(18 \%)$ centers reporting at least 1 ECMO case, the median number of cases over the study period was 2 . Thirty-four ( $41 \%$ ) ECMO centers reported only a single case, and only 5 centers reported more than 10 cases.

Conclusions: The use of ECMO for trauma, although rare, is rapidly increasing in frequency. Moreover, approximately two thirds of patients who receive ECMO following traumatic injury survive their hospitalization. Taken together, these data suggest that ECMO may represent a potential treatment strategy for trauma patients with respiratory or cardiopulmonary failure. However, given the rarity of the procedure, there exists an opportunity to develop practice guidelines regarding the indications for, and approach to, ECMO in the setting of trauma.

# CIRCULATING MITOCHONDRIAL DNA IS ASSOCIATED WITH FIBRINOLYTIC SHUTDOWN AFTER INJURY 

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Introduction: Mitochondrial DNA (mtDNA) is a damage-associated molecular pattern released in response to trauma, and is correlated with later acute lung injury and multiorgan failure. We aimed to identify associations between elevated mtDNA levels and coagulation abnormalities after severe injury.

Methods: Critically injured patients meeting highest-level trauma activation criteria were prospectively enrolled under waiver of consent, and blood sampled within 6 h of arrival. Real-time quantitative PCR for the ND6 mitochondrial DNA sequence was performed. Citrated kaolin thromboelastography (TEG) was performed. Fibrinolytic phenotype was divided into shutdown, normal, and hyperfibrinolytic ranges based on Lysis Index at 30min (LY30).

Results: Blood samples were obtained from 35 injured patients ( 22 males and 16 females) with mean injury severity score 15 . Traumatic brain injury (median 7.8 vs . $2.3 \mathrm{ng} / \mathrm{mL}$, $\mathrm{p}=0.045$ ) and prehospital transfusion (median 21.5 vs . $2.3 \mathrm{ng} / \mathrm{mL}, \mathrm{p}=0.048$ ) were associated with elevated levels of mtDNA. With the exception of TEG-LY30, TEG parameters and standard laboratory coagulation assays did not correlate with mtDNA levels. In terms of fibrinolytic phenotype, 29\% of injured patients demonstrated fibrinolytic shutdown, 68\% had normal-range fibrinolysis, and 3\% had hyperfibrinolysis. Median mtDNA concentration was $4.0 \mathrm{ng} / \mathrm{mL}$ (interquartile range $2.3-12.0$ ) in patients with shutdown, compared to $1.9(1.1-2.9)$ in those with normal or hyperfibrinolysis (Kruskal-Wallis $p=0.033$; see figure). When adjusted for age and injury severity, mtDNA level remained a significant predictor of admission fibrinolytic shutdown (odds ratio $1.18, p=0.024$, model area under the curve 0.762 ).

Conclusion: Circulating mtDNA is specifically associated with traumatic brain injury, transfusion, and early fibrinolytic shutdown. In addition to its known proinflammatory signaling, mitochondrial DNA may modulate fibrinolysis, leading to microvascular thrombosis and multiple organ failure after severe injury.


# IMPACT OF SERIOUS MENTAL ILLNESS ON OPIOID MEDICATION USE AND OUTCOMES IN PATIENTS ADMITTED TO A LEVEL 1 TRAUMA CENTER 

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Introduction: The incidence of serious mental illness in trauma patients is not well described. However, previous studies suggest that patients with serious mental illness have an increased risk of mortality and morbidity compared to the general population. The aims of this study are to describe the incidence of serious mental illness in trauma patients, their outcomes, and their opioid, antipsychotic, and sedative medication requirements compared to patients without serious mental illness.
Methods: Following IRB approval, all patients entered in the Trauma Registry from 1/1/2016-12/31/2017 were identified. Patients 18 years or older and who were admitted to the trauma service were included. Patients who were pregnant, incarcerated, admitted to other services, or direct transfers that bypassed the emergency room were excluded. Two groups were created: SMI for patients with a documented history of major depressive disorder, bipolar disorder, schizophrenia, or anxiety, or admission due to selfinjury, and Non-SMI. Univariate analysis was performed using Wilcoxon rank sum, Chisquare, and Fisher's Exact test, and are reported as medians with 25th75th inter-quartile range and means with standard deviation, where appropriate. A purposeful logistic regression model was created to assess mortality as well as medication requirements. All analyses were performed using STATA 12.1.
Results: Over the study period 3,708 patients met inclusion criteria, of which 390 (11\%), were in the SMI group. No differences were found in age, ISS, arrival GCS, or rates of traumatic brain injury. The SMI patients were more likely to be women ( $45 \%$ vs. $27 \%$, $\mathrm{p}<0.001$ ), white ( $62 \%$ versus $40 \%, \mathrm{p}<0.001$ ), and to sustain penetrating injury ( $24 \%$ vs. $16 \%, p=0.001)$. The SMI group also had fewer hospital-free days [24 (16, 27) vs. $25(20$, $28)$ ], and required more doses of sedatives [ $5( \pm 16)$ vs. $2( \pm 7)]$ and antipsychotics [7 $( \pm 29)$ vs. $2( \pm 10)]$, all $p<0.001$. There were no significant differences in mortality, morbidity, or morphine milligram equivalents (MME) per day. However, when controlling for age, ISS, and male gender, SMI group status was associated with a reduction in mortality and an increase in daily MME (Table 1), sedatives (OR 1.7, 95\% C.I. 1.37-2.16), and antipsychotics (OR 4.1, 95\% C.I. 3.14-5.34).

Conclusion: Serious mental illness is three times more common among patients admitted for trauma when compared to the 12-month prevalence of $4 \%$ in the United States general population. Although trauma patients with serious mental illness had similar injury severity and lower mortality, their increased utilization of resources, and sedative and opioid medications highlight potential areas for improvement in their care.

| In-hospital Mortality | Odds Ratio | $95 \%$ C.I. | p-value |
| :--- | :---: | :---: | :---: |
|  | 0.34 | $0.16-0.70$ | 0.004 |
| SMI group status | 1.03 | $1.02-1.04$ | $<0.001$ |
| Age | 1.13 | $1.11-1.14$ | $<0.001$ |
| ISS | 1.02 | $0.72-1.45$ | 0.905 |
| Male gender | Odds Ratio | $95 \%$ C.I. | p-value |
| Morphine Milliequivalents/day |  |  |  |
|  | Odds |  |  |
| SMI group status | 2.54 | $1.10-5.87$ | 0.028 |
| Age | 0.98 | $0.97-0.99$ | $<0.001$ |
| ISS | 0.96 | $0.95-0.97$ | $<0.001$ |
| Male gender | 1.30 | $0.89-1.89$ | 0.166 |

Table 1.

# VASOPRESSOR CHOICE DURING CRITICAL CARE MANAGEMENT OF BRAIN DEAD ORGAN DONORS AND THE EFFECTS ON KIDNEY GRAFT FUNCTION 

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Introduction: Delayed graft function (DGF), the need for dialysis in the first week following kidney transplant, affects one-quarter of deceased-donor recipients. DGF is associated with increased resource utilization and risk of adverse transplant outcomes, including acute rejection, chronic allograft nephropathy, and graft loss. Donor demographics and serum creatinine, as well as graft cold ischemia time, have been previously associated with DGF. However, there have been limited studies examining the impact of donor critical care parameters and treatments on the development of DGF in the recipient. There is also no consensus on the optimal vasopressor to support the hemodynamic instability that follows brain death. Therefore, our objective was to determine the relationship between vasopressor usage during donor management and the development of DGF.
Methods: Prospective observational data were collected for all organ donors after brain death (DBDs) managed by 17 Organ Procurement Organizations (OPOs) from 9 UNOS Regions between 2012 and 2018. Donor critical care parameters, including vasopressor doses, were recorded at three time points during donor management: (1) after authorization for donation, when the OPO assumes responsibility for care of the donor, (2) at the time of organ allocation, and (3) at the conclusion of donor management, just prior to organ recovery. Deidentified recipient outcome data were linked with the donor data via the UNOS donor identification numbers. Only donors who received at least one vasopressor at all three time points were included in the analysis. The primary outcome measure was DGF. To compare the relative impact of each vasopressor on the occurrence of DGF, vasopressor doses were converted to norepinephrine equivalent doses and analyzed as continuous variables. Univariate analyses were conducted to determine the association between donor variables and DGF. Results were adjusted for known predictors of DGF using binary logistic regression to determine independent predictors with $p<0.05$.
Results: During the study period, complete data were available for 5,554 transplanted kidneys from 2,985 DBDs. The mean (SD) donor age was 40.6 (14.1) years, kidney donor profile index (KDPI) was 46.0 (27.8), and serum creatinine prior to organ recovery was 1.4 (1.1) mg/dL. Of the kidney transplant recipients, 27.1\% developed DGF. On univariate analysis, age, cold ischemia time, donor subtype, kidney donor profile index, serum creatinine, phenylephrine dose, and dopamine dose were associated with DGF. After multivariate analysis, increased age, cold ischemia time, kidney donor profile index, serum creatinine, and phenylephrine dose remained independent predictors of DGF.
Conclusion: Compared with other vasopressors, higher doses of phenylephrine in the DBD were an independent predictor of DGF in the recipient. Except for phenylephrine, vasopressor usage during donor management did not predict the development of DGF in kidney transplant recipients.

# HOLD OFF ON THAT ANTIFUNGAL! POSITIVE FUNGAL CULTURES IN THE PERITONEUM FROM PERFORATED PEPTIC ULCERS DO NOT INCREASE THE RISK OF ORGAN SPACE INFECTION 

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Introduction: The association between fungal isolates in peritoneal cultures of perforated peptic ulcer (PPU) patients with subsequent organ space infection (OSI) is unknown. The hypothesis of this study was that fungal isolates do not increase the risk of OSI and empiric administration of antifungals does not decrease this risk.

Methods: A secondary analysis of a multicenter study of patients treated for PPU at 9 institutions, between 2011 \& 2018, was conducted. Patients with fungal isolates were compared to those without and patients receiving antifungals perioperatively were compared to those who did not. The primary outcome was OSI. Cohorts were compared using $\chi^{2}$ test.

Results: 633 patients were reviewed with $53 \%$ receiving an antifungal agent perioperatively for a median of 4 days. Intraperitoneal cultures were obtained from 126 patients (20\%), comprising the study cohort. The median age and Charlson Comorbidity Index were 60 years and 4 respectively. The most commonly isolated microorganism was Candida (48\%), followed by Streptococci (21\%). Patients with Candida (n=60/126) had a lower incidence of OSI ( $17 \%$ vs. $27 \%$; OR: 0.53 ; $p=0.15$ ). Patients who received antifungals ( $n=92 / 124$ ) had a higher incidence of OSI ( $24 \%$ vs. $16 \%$; OR: $1.70 ; \mathrm{p}=0.33$ ), including those who had Candida in their intraperitoneal cultures (17\% vs. 9\%; OR: 2.05; $\mathrm{p}>0.99$ ).

Conclusion: The presence of fungi in intraperitoneal cultures of patients undergoing surgery for PPU was not associated with an increased risk for OSI; administration of antifungals had no impact on this risk. Routine use of antifungals in this setting may be unnecessary.

## THE MORE YOU HAVE-THE MORE YOU LOSE: MUSCLE MASS DETERIORATION IN SEVERELY INJURED TRAUMA PATIENTS

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Introduction: Sarcopenia is a clinically relevant loss of muscle mass and function that can be objectively quantified with CT imaging. It has implications of increased morbidity and mortality in adult trauma populations and poor surgical outcomes. Our study aimed to evaluate loss of muscle mass change in adult trauma patients with prolonged hospital stays.

Methods: A retrospective analysis was performed using our trauma registry to identify all adult trauma patients admitted to our urban, academic Level 1 Trauma center between 2010 and 2017. Inclusion criteria were patients with a hospital length of stay greater than 14 days. All CT images were reviewed, and the cross-sectional area ( $\mathrm{cm}^{2}$ ) of the left psoas muscle was measured for each patient at the level of the third lumbar vertebral body to determine total psoas area (TPA). The TPA was then normalized for patient stature by dividing by patient height squared ( $\mathrm{m}^{2}$ ) to determine the Total Psoas Index (TPI). Sarcopenia was defined as a TPI on admission below gender specific thresholds of $5.45\left(\mathrm{~cm}^{2} / \mathrm{m}^{2}\right)$ in men and $3.85\left(\mathrm{~cm}^{2} / \mathrm{m}^{2}\right)$ in women. The TPA, TPI, and rates of change in TPI were then evaluated and compared between sarcopenic and non-sarcopenic adult trauma patients.

Results: There were 81 adult trauma patients who met inclusion criteria. Patients were on average 43 years old, $70 \%$ male, $64 \%$ Caucasian, $90 \%$ sustained blunt trauma, and had an ISS=29. The average change in TPA was $-3.8 \mathrm{~cm}^{2}$ and TPI was $-1.3 \mathrm{~cm}^{2}$. On admission, $23 \%(\mathrm{n}=19)$ of patients were sarcopenic while $77 \%$ ( $n=62$ ) were not. The two groups were similar for demographics and injury severity, but sarcopenic patients were older ( 59 vs. $39, \mathrm{p}<0.0001$ ). Non-sarcopenic patients had a significantly greater change in TPA ( -4.9 vs. $-0.31, \mathrm{p}<0.0001$ ) and TPI ( -1.7 vs. $-0.13, \mathrm{p}<0.0001$ ). In addition, $37 \%$ of patients who were admitted with normal muscle mass subsequently developed sarcopenia during hospital admission. Older age was the only risk factor independently associated with developing sarcopenia while hospitalized (OR: 1.04, 95\%CI 1.00-1.08, p=0.045). Furthermore, the rate of decrease in muscle mass was significantly greater ( $\mathrm{p}=0.0002$ ) for non-sarcopenic patients during their hospital stay (Figure1, non-sarcopenic patients shown as dotted line).


Conclusion: Adult trauma patients lose significant muscle mass during prolonged hospitalization. Over a third of patients with normal muscle mass at admission subsequently develop sarcopenia and older age is the primary risk factor to develop sarcopenia while hospitalized. Patients with normal muscle mass (non-sarcopenic) at admission have greater decreases in TPA and TPI and have a significantly accelerated rate of muscle mass loss when compared to sarcopenic patients.

## A SURGICAL CRITICAL CARE LED PROGRAM INCREASES VOLUME AND IMPROVES OUTCOMES IN EXTRACORPOREAL CARDIOPULMONARY RESUSCITATION

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Introduction: Extracorporeal life support (ECLS) has emerged as a potentially life saving adjuvant to conventional ACLS. Cardiopulmonary resuscitation (CPR) is associated with poor survival with a $8-19 \%$ survival rate for out-of-hospital cardiac arrest with conventional CPR. The acute care surgery (ACS) and surgical critical care (SCC) model provides a unique opportunity for timely cannulation in this highly critical subset of patients. Starting in 2018, the ACS and SCC service assumed leadership of the extracorporeal CPR (E-CPR) program at our institution.

Methods: We performed a retrospective review of patients at our urban tertiary hospital that underwent E-CPR. We utilized our internal database to evaluate our experience from 2012 to 2017 and then compared that to 2018 which represents the transition of leadership of the E-CPR program.

Results: From 2012 to 2017, 25 patients were treated with E-CPR. All were peripherally cannulated by the cardiothoracic surgery team. Twelve (48\%) were weaned from ECLS with 7 (28\%) surviving to discharge. In 2018, 22 patients were treated with E-CPR. Fourteen (64\%) were weaned from ECLS with 11 (50\%) surviving to discharge. Cannulation and initiation of ECLS was performed in the ED following out of hospital arrest in 11 of the 22 patients. The SCC service performed 9 (81.8\%) of these ED cannulations and the remaining 2 were done in combination with CTS. Survival from ED cannulation was $63.6 \%$ (7/11). Of the eleven patients who survived E-CPR, 9 had normal neurologic recovery with the remaining two returning to baseline status. Two patients (9\%) had limb ischemia requiring amputation, one performed by SCC alone and one in combination with CTS.

Conclusion: An acute care surgery and surgical critical care team can increase access to ECLS and can improve outcomes in those with out-of-hospital cardiac arrest.

# ECMO IN TRAUMA: DO TRAUMA CENTER LEVEL AND ECMO VOLUME IMPACT OUTCOMES? 

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Introduction: The use of extracorporeal membrane oxygenation (ECMO) for injured patients nationwide is unknown. We sought to examine ECMO use and patient outcomes using a large national database. We hypothesized that trauma center American College of Surgeons (ACS) verification level, ECMO volume, and patient injury severity are associated with the rate of mortality for ECMO in trauma patients.
Methods: Adult patients who received ECMO from 2013 to 2016 were identified in the National Trauma Data Bank. Patient demographic and injury data were analyzed in addition to ACS verification level and ECMO volume for trauma patients during the study interval. Associations between patient, procedural, and institutional factors with mortality were assessed using multivariable logistic regression modeling.
Results: 448 patients were included in the analysis. ECMO use increased at Level I and Level II trauma centers each year (Fig. 1). Overall, survival after ECMO for trauma was $62 \%$ ( $58 \%$ at Level I, $82 \%$ at Level II, and $63 \%$ at other centers; $\mathrm{p}=0.016$ ). Although survival was higher at Level II versus Level I centers ( $p=0.001$ ), patients at Level II centers were significantly less injured than those at Level I centers (median ISS 11 vs. 26, $\mathrm{p}=0.017$ ).
Centers with less than 9 ECMO trauma patients had a two times higher mortality rate ( $\mathrm{p}=0.017$ ).
Conclusions: ECMO increased at Level I and Level II trauma centers. Survival was higher at centers that did at least 9 trauma ECMO procedures. Level II centers also had improved survival although their patients were less severely injured. Further study is warranted to clarify which trauma patients benefit from ECMO and to develop guidelines that ensure ECMO is reserved for patients who fail conventional management strategies.
Figure 1: National ECMO use for trauma by year and trauma center level.


# REAL-TIME VITAL SIGNS PREDICT ORGAN FAILURE ASSESSSMENT (SOFA) SCORE IN TRAUMA PATIENTS 

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Objectives: The Sequential Organ Failure Assessment (SOFA) at 24 hours is associated with a greater risk of death or prolonged intensive care unit (ICU) stay. The aim of this study is to determine whether autonomous continuous vital sign monitoring can predict SOFA scores in critically injured patients.
Methods: Included adult trauma patients with an Injury Severity Score (ISS) $\geq 16$ over a 3 -year period admitted to the ICU. Continuous vital sign data was used in a boosting tree model to predict the SOFA score from admission until 24 hours. Bland Altman plot assessed the difference between the model predicted and calculated SOFA score.

Results: 500 patients met the inclusion criteria. Mean age was 43 standard deviation (SD) $\pm 20$ years, $74 \%$ were male. $69 \%$ sustained blunt injury. $36 \%$ of patients had an Abbreviated Injury Scale (AIS) for body region head $\geq 3$. Of the traumatic brain injury patients, the mean motor Glasgow Coma Scale (GCS) at admission was 4. In the overall cohort mortality was $13 \%$ and the median length of ICU stay was 13.5 days. The continuous vital sign model predicted the SOFA score within 1, 2, 3, 4, and 5 points by $41 \%, 62 \%, 78 \%, 86 \%$ and $93 \%$ respectively. Bland Altman showed a bias of 0.06 and $95 \%$ confidence interval (CI) of $\pm 6$ (Figure 1).
Conclusion: An objective method implemented at the bedside to identify patients at risk of morbidity and mortality and increased length of ICU stay is possible through automated continuous capture of physiological data without provider input.


24 hour SOFA
Figure 1 (left): Bland Altman plot between calculated 24h and predicted SOFA score.

## DEFINING RISK AND RISK FACTORS FOR ICU READMISISON OF TRAUMA PATIENTS: DEVELOPING A PREDICTIVE RISK SCORE

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Introduction: Multiple studies demonstrate that ICU readmissions or 'bouncebacks' (ICUbb) are associated with worse clinical outcomes. However, there is a paucity of data defining the risk and factors associated with ICUbb. The current study aims at closing this gap in knowledge and developing a predictive risk score for ICUbb. We hypothesize that specific patient characteristics and injury patterns are associated with ICUbb.

Methods: Trauma patients admitted to ICU at a level-1 trauma center over a 10 -year period ending April 2018 were identified. Patient characteristics [age, Charlson Comorbidity Index (CCI)] and body-region injury severity (AIS scores) were analyzed. Patients with and without ICUbb were compared using multivariate logistic regression. Predictive risk score for ICUbb was developed by

| Table 1: Odds ratios of independently <br> significant variables |  |
| :--- | :---: |
| Characteristic | OR $(95 \%$ CI $)$ |
| Age (per 10yrs) | $1.36(1.23-1.52)$ |
| CCI (per 5pts) | $1.49(1.08-2.06)$ |
| Thorax AIS $\geq 3$ | $1.85(1.26-2.72)$ |
| Spine AIS $\geq 3$ | $2.20(1.31-3.69)$ |
| Low Extr. AIS $\geq 3$ | $2.13(1.40-3.24)$ |
| Burns AIS $\geq 3$ | $4.52(1.54-13.27)$ | assigning weighted values to independent variables using log-risk coefficients.

Results: 3,500 patients met criteria of which 134 (3.98\%) experienced ICUbb. Age, CCI, and severe injuries (AIS>=3)


# CONSEQUENCES OF DELAYED INTER-HOSPITAL TRANSFER OF CRITICALLY ILL PATIENTS WITH SURGICAL SEPSIS 

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Introduction: Suboptimal triage of critically ill patients with surgical sepsis may contribute to adverse outcomes. Patients transferred to a tertiary care center after spending $\geq 24$ hours at an outside facility were compared with patients who had early triage to a tertiary care center with the null hypothesis that management parameters and outcomes would be similar between groups.
Methods: This prospective observational cohort study included 308 critically ill septic patients treated at a tertiary care center. Patients transferred after spending more than 24 hours at an outside facility ( $\mathrm{n}=69$ ) were compared with patients who were directly admitted or transferred within 24 hours ( $\mathrm{n}=239$ ). Patient characteristics, management parameters, and outcomes were compared between groups.
Results: Average outside facility length of stay in the delayed transfer (DT) group was 43 hours. DT patients had higher SOFA ( $7.5 \mathrm{vs} .5 .8, p=0.004$ ) and APACHE II scores (20.2 vs. $17.2, p=0.007$ ) at admission. The interval between admission and source control was significantly longer in the DT group ( 5.9 vs. 0.9 hours, $p=0.009$ ). The incidence of secondary infection was significantly higher in the DT group ( $41 \%$ vs. $23 \%$, $p=0.005$ ). DT was independently associated with a 10-day increase in hospital length of stay. In-hospital mortality was two-fold higher in the DT group (14.5\% vs. 7.1\%, $p=0.056$ ). DT patients were less likely to be discharged home ( $22 \%$ vs. $59 \%, p<0.001$ ).
Conclusion: Septic patients who spent more than 24 hours at an outside facility prior to transfer had greater initial illness severity, longer intervals between admission and source control, more nosocomial infections, and were less likely to be discharged home compared with patients who had early triage to a tertiary care center.

# IMPACT OF DEPRIVATION AND COMORBIDITY ON OUTCOMES IN EMERGENCY GENERAL SURGERY 

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Introduction: Health inequalities exist between the most deprived and most affluent populations. However, whether socio-economic deprivation or comorbidities affects the outcome of Emergency General Surgery (EGS) admissions is unknown. The aim of this study was to examine the impact of deprivation and comorbidity on mortality, discharge destination and length of hospital stay in EGS patients in Scotland.
Methods: Prospectively collected data from all Scottish EGS admissions between 1997 and 2016, involving adults (aged >15), were obtained from the Scottish Government. Data included age, gender, Scottish Index of Multiple Deprivation (SIMD) deciles (1=most deprived; 10= least deprived), 5-year Charlson Comorbidity Index (CCI), and outcomes including mortality, discharge destination, and length of hospital stay (LOS). Binomial regression was used for mortality and discharge destination, while Poisson regression was used for LOS. Results: 1,586,461 EGS admissions were identified. 253,392 (16.0\%) were in SIMD decile 1, and 87,531 (5.5\%) in SIMD decile 10. 1,209,854 (76.3\%) have CCI=0, 351,926 (22.2\%) have CCI 1-4, and 24,681 (1.6\%) have CCI >4. 1,254,627 (79.1\%) were discharged home, while 331,834 (20.9\%) were not discharged home. 1,559,612 (98.3\%) were discharged and 26,849 (1.7\%) died. A heat table demonstrates that as deprivation and comorbidity increase, mortality increases. Regression analyses showed that, compared with those with $\mathrm{CCI}>8$, patients with $\mathrm{CCI}=0$ had lower mortality (incidence risk ratio (IRR) 0.072; 95\% confidence interval (CI) 0.061-0.084), were more likely to be discharged home (IRR 2.686; 95\% CI 2.429-2.970), and had shorter LOS (IRR 0.647; 95\% CI 0.634-0.659).
Compared to those living in SIMD decile 10 (least deprived), patients living in SIMD decile 1 (most deprived) had higher mortality (IRR 1.379; 95\% CI 1.2941.470), were less likely to be discharged home (IRR 0.959; 95\% CI 0.941-0.979), and higher LOS (IRR 1.103; 95\% CI 1.098-1.107). All p values $<0.001$.
Conclusion: Increased levels of socio-economic deprivation and comorbidity significantly affects EGS outcomes including mortality, discharge destination, and length of hospital stay.

| Mortality Rate | Charison Comorbidity Index (5 Year) |  |  |  |  |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | $>8$ |  |
| SIMD | 1 | 0.005 | 0.026 | 0.063 | 0.064 | 0.044 | 0.043 | 0.188 | 0.166 | 0.123 | 0.126 |
|  | 2 | 0.006 | 0.032 | 0.067 | 0.076 | 0.047 | 0.056 | 0.157 | 0.197 | 0.132 | 0.104 |
|  | 3 | 0.006 | 0.035 | 0.060 | 0.073 | 0.059 | 0.046 | 0.176 | 0.177 | 0.135 | 0.166 |
| 4 | 0.007 | 0.035 | 0.057 | 0.074 | 0.041 | 0.041 | 0.168 | 0.248 | 0.147 | 0.090 |  |
|  | 5 | 0.006 | 0.042 | 0.055 | 0.069 | 0.043 | 0.056 | 0.161 | 0.189 | 0.107 | 0.128 |
|  | 6 | 0.007 | 0.037 | 0.054 | 0.062 | 0.052 | 0.086 | 0.149 | 0.170 | 0.096 | 0.150 |
| 7 | 0.007 | 0.042 | 0.054 | 0.071 | 0.053 | 0.052 | 0.127 | 0.176 | 0.100 | 0.107 |  |
|  | 8 | 0.007 | 0.037 | 0.056 | 0.060 | 0.045 | 0.012 | 0.138 | 0.118 | 0.107 | 0.139 |
|  | 9 | 0.006 | 0.038 | 0.053 | 0.056 | 0.037 | 0.090 | 0.119 | 0.155 | 0.110 | 0.103 |
| 10 | 0.006 | 0.043 | 0.051 | 0.071 | 0.043 | 0.042 | 0.131 | 0.200 | 0.090 | 0.099 |  |

# VALIDATION OF THE AAST GRADING SYSTEM FOR ACUTE APPENDICITIS SEVERITY 

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Introduction: The American Association for the Surgery of Trauma (AAST) developed and published an anatomic grading system in 2014 to assess disease severity in emergent general surgery conditions. This grading system allows for assessment of the progression of disease severity through various grades of inflammation based upon clinical, imaging, operative, and pathology characteristics. Assignment of a grade could then be utilized in risk-adjustment and stratification of patient outcomes for clinical benchmarking. Our objective was to validate the AAST grading system for acute appendicitis by examining the association of AAST grade with clinical outcomes.
Methods: Surgical quality program data was abstracted and prospectively collected on all adult patients with the diagnosis of acute appendicitis treated at an academic medical center between $12 / 2013$ and $5 / 2018$. An AAST acute appendicitis grade from 1 to 5 was assigned by a clinical nurse reviewer for all patients who underwent open or laparoscopic appendectomy. Patients who did not undergo operative intervention were excluded from the analyses. Primary outcomes were occurrence of a major complication, any complications, and total length of stay for the index hospitalization. Multivariable models were constructed for each outcome without and with inclusion of the AAST grade as an ordinal variable. Other independent variables utilized in the risk-adjustment models were demographic information, insurance provider, surgical technique, and medical comorbidities.
Results: Our sample included 734 total patients who underwent appendectomy for acute appendicitis. The AAST score distribution included 561 (76\%) in Grade 1, 49 (6.7\%) in Grade 2, 79 (10.8\%) in Grade 3, 33 (4.5\%) in Grade 4, and 12 (1.6\%) in Grade 5. The mean age was 35.3 (SD 14.7), 346 (47\%) were female, 147 (20\%) were non-white, and 506 (69\%) had private insurance. Major complications, any complications, and length of stay were all positively associated with AAST grade (Table). Model fit improved after including AAST grade (for the major complications model, c-statistic increased from 0.81 to 0.89 ; for the any complications model, c-statistic increased from 0.68 to 0.76 ). AAST grade was significantly associated with length of stay among other covariates, and multivariable linear regression model fit was improved after including AAST grade ( $\mathrm{R}^{2}=15.3 \%$ vs $20.9 \%$ ).

|  | AAST Acute Appendicitis Severity Grade |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Outcome | $\mathbf{1}(\mathbf{n}=\mathbf{5 6 1 )}$ | $\mathbf{2 ( n = 4 9 )}$ | $\mathbf{3}(\mathbf{n}=79)$ | $\mathbf{4}(\mathbf{n}=\mathbf{3 3})$ | $\mathbf{5 ( n = 1 2 )}$ | p-value |
| Major Complication (n, \%) | $1(0.2 \%)$ | $2(4.1 \%)$ | $5(6.3 \%)$ | $0(0 \%)$ | $1(8.3 \%)$ | $<0.001$ |
| Any Complication (n, \%) | $13(2.3 \%)$ | $6(12.2 \%)$ | $13(16.5 \%)$ | $1(3.0 \%)$ | $2(25.0 \%)$ | $<0.001$ |
| Length of Stay (mean days, SD) | $1.1(0.9)$ | $1.8(2.6)$ | $2.9(2.9)$ | $5.6(11.4)$ | $5.3(3.4)$ | $<0.001$ |

Conclusion: Our results demonstrate that the progressive AAST grading system for acute appendicitis is a valid measure of disease severity. Increased AAST grade is associated with higher rates of complications and longer length of stay in patients with acute appendicitis. The AAST grading system should be implemented for data collection and clinical benchmarking in hospital systems. Future research should focus on validation of the AAST grades in other disease cohorts.

## Poster \# 114

## ACGME CASE LOG DATA DO NOT ADEQUATELY DESCRIBE GENERAL SURGERY RESIDENT EXPERIENCE WITH EMERGENCY GENERAL SURGERY CASES

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Introduction: Emergency general surgery (EGS) cases are complex and often technically difficult as compared to the same operations in non-emergent settings. While graduating general surgery residents must document minimum case numbers in a variety of categories, there are few data describing general surgery resident experience with EGS procedures. Thus it is unclear whether residents obtain adequate experience in EGS. We hypothesize that EGS experience is variable and unable to be adequately asessed based on currently available data.

Methods: National ACGME case log data from graduating surgery residents from 2013-2018 were queried for resident experience in the most commonly performed laparoscopic and open EGS procedures (colectomy, small bowel resection, cholecystectomy, repair of gastric and duodenal perforation, lysis of adhesions, appendectomy, and laparotomy). Yearly means and maximums were recorded. The ACGME tracked codes report was evaluated for codes specific to emergency surgery. Trauma codes and cases not for major credit were excluded.
Results: National ACGME case logs revealed highly variable experience with common EGS procedures. Repair of duodenal perforation was the least commonly performed case; laparoscopic cholecystectomy was the most common. For 11 of 13 case types reviewed, elective and emergency cases could not be differentiated. Further review of all ACGME tracked codes revealed that, of over 3000 codes, only 275 nontrauma codes referred specifically to emergency cases. Conclusions: Available case log data for general surgery residents reveal a variable experience with EGS procedures. A minority of non-trauma ACGME case log track codes are available to specify

2013-2018 ACGME case log numbers for common EGS procedures
$\left.\begin{array}{|r|r|r|}\hline \text { Case Description } & \text { Mean } & \text { Max } \\ \hline \text { Open colectomy } & 33.76 & 96.6 \\ \hline \text { Lap colectomy } & 29.66 & 116.8 \\ \hline \text { Open enterectomy } & 16.96 & 60.8 \\ \hline \text { Lap enterectomy } & 1.26 & 23.4 \\ \hline \begin{array}{r}\text { Open }\end{array} & 8.42 & 45.2 \\ \hline \text { cholecystectomy } & 112.38 & 295.4 \\ \hline \text { Lap cholecystectomy } & 2.44 & 15.2 \\ \hline \text { Repair gastric } \\ \hline \text { perforation }\end{array}\right)$ experience with emergency cases. In order to assure that graduating residents are adequately trained in this vital segment of general surgery, we suggest that an emergency designation be added to ACGME case logs to better quantify experience with complex EGS cases.

# VENOUS THROMBOEMBOLISM HAS HIGHER RATES OF MORTALITY IN EMERGENCY GENERAL SURGERY THAN TRAUMA PATIENTS 

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Introduction: Deep venous thrombosis (DVT) and pulmonary embolism (PE) are commonly referred to as venous thromboembolism (VTE). Acute care surgeons are constantly challenged by the adverse impact of VTE in both trauma and emergency general surgery (EGS) patients. There is a lack of comparative studies between these 2 high risk patient populations. We hypothesized that VTE patients have worse hospital outcome in trauma than EGS patients.
Methods: Prospectively collected EGS and trauma database from 2005 through 2018 were queried for patients diagnosed with acute DVT and PE. Demographics, diagnostic imaging (venous duplex ultrasound and chest CT with contrast), VTE prophylaxis, procedures (inferior vena cava filter placement) and outcomes were extracted. Student's T-test was used for continuous variables. Chi-square and Fisher exact test were used for categorical variables. Multivariable regression was applied. Statistical significance was set at p $<0.05$.
Results: A total of 1,135 patients (Trauma $=72 \%$, EGS $=28 \%$ ) with VTE ( 853 acute DVT, 144 PE, 138 both DVT and PE) were identified. There was no significant difference between the incidence of VTE between both groups ( $2.05 \%$ vs $2.19 \%, \mathrm{p}=0.3$ ). Males were more likely to have VTE in the trauma group ( $73.07 \%$ vs $55.35 \%$, $\mathrm{p}=$ 0.0001 ). EGS patients were also older ( $60.82 \pm 14.70$ vs $53.77 \pm 20.16, \mathrm{p}=0.0001$ ), with higher BMI ( $31.24 \pm 9.77$ vs $28.75 \pm 7.20, \mathrm{p}=0.0001$ ), and Charlson comorbidity index ( $4.95 \pm 3.09$ vs $2.85 \pm 2.68, \mathrm{p}=0.0001$ ). Venous duplex ultrasound screening for DVT ( $16.83 \%$ vs $4.05 \%, \mathrm{p}=0.006$ ), pharmacologic VTE prophylaxis ( $43.35 \%$ vs $19.65 \%$, $\mathrm{p}=0.001$ ), and inferior venous cava filter placement ( $4.67 \%$ vs $1.15 \%, \mathrm{p}=0.1$ ) were significantly higher in trauma patients. There was no difference in length of stay (LOS) between both groups ( $21.66 \pm 19.59$ vs $20.64 \pm 16.65, p=0.4$ ), however, trauma patients had longer intensive care unit (ICU) LOS (12.18 $\pm 13.81$ vs $9.63 \pm 13.20$, $\mathrm{p}=0.004$ ). Mortality in EGS patients was significantly higher when compared to trauma ( $16.0 \%$ vs $7.5 \%, \mathrm{p}=0.0001$ ). After adjusting for age, gender, BMI and Charlson comorbidity index, VTE was found to be an independent risk factor for increased mortality in both EGS and trauma patients. EGS patients, however, were found to be at an even higher risk of mortality when diagnosed with VTE (OR 5.4; 3.792-7.683, $\mathrm{p}=0.0001$ ) vs trauma group (OR 2.6, 1.990-3.469, $\mathrm{p}=0.0001$ ).
Conclusions: Although the incidence of VTE in trauma patients is slightly higher than EGS patients, this most likely is related to more aggressive VTE screening and prophylaxis protocols as EGS patients are not routinely screened nor aggressively prophylaxed. EGS patients with VTE have worse hospital outcomes with a 2-fold increased risk of mortality when compared to trauma patients. Therefore, we strongly recommend more aggressive VTE screening and prophylaxis in EGS patients. Further prospective research is required to justify these findings.

# IMPROVED ACCESS TO POST-HOSPITAL CARE AFTER ACA OPEN ENROLLMENT FOR EMERGENCY GENERAL SURGERY PATIENTS 

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Introduction: Patients undergoing Emergency General Surgery (EGS) are at high risk for post-operative morbidity including prolonged recovery and need for post discharge care. The Affordable Care Act Open Enrollment (ACA) began in 2014 and increased health insurance coverage. The effect of the ACA on access to post-acute care for EGS patients is largely unknown. We hypothesized that increased insurance coverage post-ACA would be associated with increased access to post-acute care services including skilled nursing facilities, long-term care facilities and home health care.

Methods: The Nationwide Inpatient Sample Database 2012 - 2015 was queried for all adult admissions age 18-65 with an abdominal EGS ICD-9 diagnosis code as defined by the AAST. Only patients who underwent one of seven common abdominal EGS operative procedures (colon resections, small bowel resections, open cholecystectomy, ulcer repair, lysis of adhesions, open appendectomy or laparotomy) were included. Analyses included demographics, hospital length of stay (LOS), payer type (Medicaid, Private, Self-pay), complications, Charlson comorbidity index and need for post-acute care services. Differences in differences (DID) analysis was used to assess for change post-ACA OE in 2014.

Results: There were 88,074 operative EGS admissions. The pre- vs post-ACA payer mix changed significantly; Medicaid coverage increased ( $27.7 \%$ to $32.4 \%, \mathrm{p}<0.001$ ), and Self-pay decreased ( $14.7 \%$ to $10.5 \%, \mathrm{p}<0.001$ ), while Private insurance did not change significantly ( $57.5 \%$ vs $57.1 \%, \mathrm{p}=0.159$ ). Discharges with post-acute care services significantly increased post-ACA for Medicaid ( $26.2 \%$ to $29.7 \% \mathrm{p}=0.002$ ) and Private groups ( $23.5 \%$ to $26.7 \%<0.001$ ) but not Self-pay payer types ( $11.2 \%$ to $12.3 \% \mathrm{p}=0.086$ ). For those discharged with post-acute care services the only payer type with significantly increased cost was Medicaid (pre-ACA \$35,290, IQR 21,052-71,529 \& post-ACA $\$ 39,528$, IQR 22,563-75,626, p=0.001), see Figure. Post-ACA DID analysis demonstrates significantly increased discharges to post-acute care services and over-all adjusted costs but no significant change in LOS.

Conclusion: The ACA improved access to post-acute care services, however did not reduce LOS or decrease costs for EGS admissions. Future studies should not just examine the role of healthcare insurance policies on access to inpatient EGS care but also on access to the continuum of care including post-acute care services.

## Poster \# 117

# USING AAST GRADE TO DETERMINE NEED FOR OPERATIVE INTERVENTION IN AMI 

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Introduction: Acute mesenteric ischemia (AMI) is highly mortal and may be difficult to diagnose. Treatment is based on etiology and severity of ischemia. AAST proposed a grading scale intended to determine treatment and predict outcomes based on clinical, imaging, operative and pathology findings. We have previously shown that overall AAST grade was not well correlated with outcomes, but operative grade strongly predicted of mortality. We have also shown that interrater agreement was low, presumably due to subjectivity in the clinical grading and the omission of specific findings in the imaging criteria. The aim of this study was to determine if AAST clinical and imaging grades could aid in identifying patients who need immediate operative intervention.
Methods: We conducted a single center retrospective chart review. Patients were selected using ICD 9 and 10 codes for acute mesenteric ischemia (ICD10-K55.0, ICD9-557.0). Inpatients >17 years old from the years 2008-2015 were included. AAST grades were assigned after review of clinical, imaging, operative and pathology findings. Clinical grades 4 and 5 had identical descriptions, so in these cases were given a grade of 5 . Two raters applied the scales independently after dialog with consensus on the correct grading of several difficult cases. Mortality was recorded.
Results: A total of 221 patients were analyzed. All patients requiring an operation presented with abdominal pain (clinical grades 1-5) (Figure 1). The percent of patients requiring bowel resections increased from 44-79\% with clinical grades 1-5 ( $\mathrm{r}=0.87, \mathrm{p}=0.13$ ). Clinical grade 5 (peritonitis) had the highest average operative grade (Figure 1). 10 patients with AMI had a negative CT (AAST imaging grade 0 ) and $60 \%$ of those required a bowel resection. All patients with AAST imaging grades


above 4 or 5 underwent an abdominal operation, and had increasing average operative grades ( $\mathrm{r}=0.38, \mathrm{p}<0.001$ ) (Figure 2)

Conclusions: AAST clinical grades below 3 do not rule out the need for operative intervention, but the absence of abdominal pain (AAST clinical grade 0 ) can provide reassurance that critical ischemia is not present. Clinical exam findings in AMI are not useful in quantifying disease severity except in clinical grade 5 (peritonitis). Normal CT imaging (AAST imaging grade 0 ) cannot rule out the need for operative intervention and only AAST imaging grades 3-5 indicate severe bowel wall injury requiring surgery. Changes allowing for better discrimination of AAST imaging grades 1-3 would aid in determining the need for operative intervention in patients with indiscriminate clinical findings in AMI.

## IMPACT OF OPERATIVE DELAY ON MORBIDITY AND MORTALITY AFTER COMMON EMERGENCY GENERAL SURGERY OPERATIONS

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Introduction: Little is known regarding the impact delay to definitive treatment may have on patient morbidity and mortality in the emergency setting. Frailty may impact operative timing in the emergency setting. Our objective was to determine the association between timing of operative intervention frailty on 30-day morbidity and mortality in adult patients undergoing emergency general surgery.

Methods: We performed a retrospective cohort study of patients older than 40 years of age from 2010-2014 in the National Surgical Quality Improvement Program (NSQIP) who underwent appendectomy, cholecystectomy, large bowel resection, small bowel resection or lysis of adhesions on an emergent basis. The modified frailty index (mFI) was used to stratify patients into low, intermediate and high frailty states. Patients were stratified by timing of operation (day of admission, within 24 hours, 1-4 days, 5-7 days and after 7 days). A multi-variable regression was performed to determine the association of operative timing, frailty and serious complication.

Results: A total of 57173 patients underwent appendectomy (46\%), cholecystectomy (14\%), large bowel resection (21\%), small bowel resection (11\%) or lysis of adhesions (8\%) on an emergent basis. Overall, $25 \%$ of patients experienced a complication, $3.2 \%$ died in hospital and $5.1 \%$ died within 30 days. Complications and 30 -day mortality increased based on timing of operation (Figure 1). On regression, the odds of 30-day mortality and complication were higher when surgery was performed further into the patients' admission, and this persisted accross all operations. For lysis of adhesions thirty-day mortality was significantly increased only when the operation was performed seven days after admission (OR 4.2, 95\%CI 2.8-6.4). There was no interaction between mFI and operative timing for any procedure.

Conclusion: Delays in definitive operative treatment are associated with worse outcomes in patients undergoing emergency general surgery. Frail patients were more likely to be delayed but not to suffer complications related to delay. Emergency surgery should not be delayed even in frail patients.


# OPERATING ROOM UTILIZATION FOR EMERGENCY GENERAL SURGERY CASES: ANALYSIS OF THE PATTERNS OF COMPLEX EMERGENCY GENERAL SURGERY IN CANADA STUDY 

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Introduction: Emergency General Surgery (EGS) patients represent a large cohort that requires acute hospital and operating room (OR)-based disease management. Access to ORs is variable amongst EGS services, with some having dedicated EGS ORs and others placing their patients in an Emergency OR queue that all specialties share. The operative burden of EGS and differences associated with differential access to ORs has not previously been described in Canada.
Methods: The Patterns of Complex Emergency General Surgery in Canada Study is a multicenter retrospective cohort study evaluating patients operated on by EGS services at seven Canadian centres. Adult patients ( $>18$ years) undergoing non-elective operative intervention for non-biliary, non-appendiceal disease were included. We used this cohort to: 1) describe booking priorities (2-8 hours; 8-24 hours; 24-48 hours) and timing of operative intervention; 2) to compare centers with and without access to a dedicated EGS daytime OR; and 3) to identify differences in morbidity and mortality based on timing of operative intervention. We excluded trauma cases and those booked with the highest priority ( $<2$ hours). Timing of operative intervention was classified as: weekday daytime (8am-5pm); weekday evening ( $5 \mathrm{pm}-11 \mathrm{pm}$ ), overnight (11pm-8am) and weekend day/evening ( $8 \mathrm{am}-11 \mathrm{pm}$ ).
Results: Overall, 1244 patients were included in this analysis, with operations performed during weekday daytime in 521 (42\%), weekday evenings in 279 (22\%), overnight in 151 (12\%), and weekend day/evening in 293 (24\%). The OR booking priority was 2-8 hours in 657 (53\%), 8-24 hours in 334 (27\%), and 24-48 hours in 253 (20\%). There was substantial variation in booking priority seen for patients with hernia (53\% 2-8 hours; 27\% 8-24 hours; 20\% 24-48 hours), small bowel obstruction (66\% 2-8 hours; 20\% 8-24 hours; 14\% 24-48 hours), and diverticular disease (50\% 2-8 hours; 31\% 2-8 hours; 19\% 24-48 hours). Centers with dedicated EGS ORs performed a greater proportion of cases during daytime hours than those without dedicated EGS ORs ( $p=0.009$ ). This difference was most pronounced for those cases booked with priority 8-24 hours ( $\mathrm{p}<0.001$ ), with no statistical difference in proportions for those cases booked with priority 24-48 hours ( $p=0.101$ ). Amongst operative cases booked with a priority of 2-8 hours and 8-24 hours, there were no significant differences between cases during the daytime, evening, and overnight with respect to mortality rate, complication rate, and length of stay.
Conclusion: The operative burden of EGS patients in Canada is significant. For EGS patients with pre-operative diagnoses of hernia, bowel obstruction, or diverticular disease, there exists considerable variation of OR booking priority. Centers with dedicated EGS ORs perform more of their cases during the daytime, however there is no evidence of compromised outcomes based on OR timing.

## CURRENT INDICATIONS, UTILIZATION AND LONG-TERM OUTCOMES OF DAMAGE CONTROL SURGERY AND TEMPORARY ABDOMINAL CLOSURE FOR INTRABDOMINAL SEPSIS

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## Introduction: Damage control surgery and temporary abdominal closure (DCS) has

 become standard of care for trauma patients with multi-system injuries in physiologic extremis. DCS has been subsequently applied to the surgical management of intra-abdominal sepsis (IAS), but the appropriate indications, current utilization and long-term outcomes of DCS in this setting remain unclear.Methods: We analyzed all IAS patients enrolled into a longitudinal, prospective cohort of critically ill surgical sepsis patients ( $\mathrm{n}=126 / 302$ ). IAS patients were classified as managed non-operatively (NO; n=34), with primary closure (PC; n=44), or with DCS ( $\mathrm{n}=48$ ). Patient characteristics, management parameters, and outcomes out to 12-months were compared between groups.
Results: Baseline demographics were similar between groups. Compared to PC, DCS had a higher incidence of septic shock ( 47.9 vs $15.9 \%, \mathrm{p}=0.0005$ ) and greater physiologic derangement within the first 24 hours (APACHE II; 20 vs $15.5, \mathrm{p}=0.0029$ ), as well as greater MOF incidence (Denver2; 83\% vs $34 \%$, $\mathrm{p}<0.0001$ ) and severity (Max. SOFA; 11 vs $5, \mathrm{p}<0.0001$ ). The primary indications for utilizing DCS were 'required $2^{\text {nd }}$ look' (43.8\%), 'excessive gross contamination' (25\%), and physiologic extremis (20.8\%). Subsequent fascial closure was achieved in $75 \%(n=36 / 48)$ of DCS. Inpatient mortality was significantly higher in DCS (23 vs $4.5 \%, \mathrm{p}=0.0154$ ). Additionally, resource utilization was higher in DCS regarding ICU LOS (13.5 vs 5 days, $\mathrm{p}<.0001$ ), Hospital LOS ( 20 vs 15 days, $p=0.0073$ ) and 'poor' discharge disposition (LTAC/SNF/hospice; 73 vs $36 \%$, $\mathrm{p}=0.0007$ ). Additionally, DCS patients had significantly fewer 12-month hospital-free days (298 vs 344.5 , $\mathrm{p}=0.0005$ ), higher 12-month mortality ( 43.8 vs $15.9 \%$, $\mathrm{p}=0.006$ ), and poorer physical functional status at 6-months (Figure; WHO/Zubrod score, 3.1 vs $2.2, \mathrm{p}=0.025$ ). Both groups failed to return to baseline functional status by 12 months.


Conclusion: Primary fascial closure rates remain suboptimal after DCS for IAS. Mortality at 12 -months after DCS is nearly double that at discharge. Functional deficits persists in DCS patients out to 1-year after surgical sepsis. Strategies to emphasize achieving fascial closure, assuring post-discharge rehabilitation, and diligent post-discharge follow-up is likely required to improve long-term outcomes among these patients.

# IMPACT OF INTERHOSPITAL TRANSFER ON PATIENT OUTCOMES IN EMERGENCY GENERAL SURGERY 

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INTRODUCTION: Emergency General Surgery (EGS) patients are at an increased risk for morbidity and mortality compared to their elective surgery counterparts. The complex nature of EGS conditions can challenge community hospitals which may lack appropriate systems of care. Outcomes related to transfer have not been well established. The aim of the current study is to compare outcomes of patients transferred to a center with dedicated acute care surgery (ACS) services with patients directly admitted to ACS Centers.
METHODS: We performed a secondary analysis of a previously collected national multi-center retrospective review of all emergency general surgery patients undergoing non-biliary, non-appendiceal EGS at five centers across Canada over one year (Jan 1 Dec 31, 2014). Demographic and baseline comorbidities were collected, as were details of admission and operative interventions. In-hospital mortality, intensive care unit length of stay, and hospital length of stay were also collected. For patients transferred from another center, procedures performed at the transferring center (including operative interventions) were also collected. The adjusted odds of post-operative complication, Intensive Care Unit (ICU) admission, and death were assessed using logistic regression to determine the independent effect of transfer status, controlling for age, comorbidities, American Society of Anesthesiologists (ASA) classification and booking priority.
RESULTS: A total of 1846 patients were included in the study, and 176 (9.5\%) were transferred. Of these $15 \%$ ( $\mathrm{n}=27$ ) underwent an operation at the transferring center. Transferred patients were more likely to have at least one comorbidity ( $68 \%$ vs. $57 \%$; $\mathrm{p}=0.004$ ), were classified as higher urgency for the OR at the ACS centre ( $<2 \mathrm{hrs}$ booking priority, $43 \%$ vs. $17 \% ; p<0.001$ ), had a higher ASA classification (ASA $\geq 3=81 \%$ vs. $65 \%$; $\mathrm{p}<0.001$ ), a longer OR length ( 119 vs. 110 minutes; $\mathrm{p}=0.004$ ), and were more likely to undergo a second operation ( $28 \%$ vs. $14 \%$; $\mathrm{p}<0.001$ ) compared to patients directly admitted to an ACS center. On univariate analysis, transferred patients had higher rates of complications ( $44 \%$ vs. $29 \%$, $\mathrm{p}<0.001$ ), mortality ( $14 \%$ vs. $7 \%$, $\mathrm{p}=0.005$ ) and admission to the ICU ( $22 \%$ vs. $12 \%$, $\mathrm{p}<0.001$ ). Transfer status remained an independent predictor of complication (OR 1.9 ( $95 \%$ CI 1.3-2.7); $\mathrm{p}<0.001$ ) and ICU admission (OR 2.2 ( $95 \%$ CI 1.4-3.3); $\mathrm{p}<0.001$ ), but not mortality (OR 1.1 ( $95 \%$ CI $0.6-1.9$ ); $\mathrm{p}=0.67$ ) on regression analysis.
CONCLUSIONS: Complex EGS patients transferred to ACS centers have worse outcomes and higher resource use compared to those directly admitted. This has significant implications for the design and regionalization of ACS services as well as resource allocation at ACS centers.

# A NOVEL ABDOMINAL DECOMPRESSION TECHNIQUE TO TREAT COMPARTMENT SYNDROME AFTER BURN INJURY 

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Introduction: In severely burned patients (TBSA $>20 \%$ ), the prevalence of abdominal compartment syndrome (ACS) is estimated to be $4-17 \%$, approaching $100 \%$ mortality if left untreated. Although decompressive laparotomy can be a life-saving measure for many patients with ACS, severe complications may be associated with this technique. Specifically, in the burn population open laparotomy incisions for ACS portend extremely high mortality (up to $100 \%$ ). This study outlines a new technique of releasing intraabdominal pressure without resorting to decompressive laparotomy.
Methods: A total of ten fresh tissue cadavers were treated, none of whom had had prior abdominal surgery. Escharotomy incisions were marked with ink and the fascial incision locations were identified for anterior component separation, subcostal and inguinal locations. The abdomen was then entered at the subxiphoid location using a Veress needle, confirmed to be in the peritoneal cavity via aspiration and saline drop test and secured with a U-stitch through the skin around the needle. The needle was connected to an arterial pressure transducer, zeroed at the anterior axillary line, and the abdomen was insufflated to a pressure of 30 mmHg . We used two techniques to incise fascia, first with the raising of large skin flaps from a midline incision ( $\mathrm{N}=5$ cadavers) and second, with direct small 2 cm cutdowns at the proximal and distal extent of the incisional sites, dissecting and tunneling in a subfascial plane using an Aortic clamp and then cutting the fascia underneath the skin through the grooves of a tunneled vein stripper ( $\mathrm{N}=5$ cadavers). Pressures were then recorded in after each of the fasciotomies, performed in sequence (bilateral anterior component separation 1st, bilateral subcostal 2nd and bilateral inguinal 3rd). Data is represented as mean $\pm$ standard deviation and compared using Mann Whitney U-Test.
Results : Using the open midline flap technique the abdominal pressure decreased from a mean pressure of $30 \pm 1.8 \mathrm{mmHg}$ to $6.9 \pm 5.0 \mathrm{~mm} \mathrm{Hg}$ (overall reduction of pressure from 23 mmHg to $12 \mathrm{mmHg}, \mathrm{p}<0.01$ ). Using the minimally invasive technique, a net decrease of intra-abdominal pressure from $30 \pm 0.9$ to $5.8 \pm 5.2 \mathrm{mmHg}$ was observed (overall reduction of 29 mmHg to $8.0 \mathrm{mmHg}, \mathrm{p}<0.01$ ). The results are shown in Figures 1-4 below.


Conclusion: We describe a novel technique to reduce intra-abdominal pressure via extraperitoneal component separation and fascial release at the subxiphoid and inguinal regions. This technique offers the benefit of not subjecting the patient to the morbidity and mortality of decompressive laparotomy and the complications associated with an open abdomen, which may be beneficial in the burn injury population. Future study is warranted.

Poster \# 123

# COMBATING THE OPIOID EPIDEMIC IN THE ACUTE CARE SURGERY PATIENT: REFRAMING INPATIENT ACUTE PAIN MANAGEMENT 

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Introduction: The devastating effects of the opioid epidemic have been well documented. Opioid reduction initiatives have focused primarily on the outpatient setting. Patients undergoing surgery in an acute setting are unique in that pre-operative counseling and enhanced recovery after surgery (ERAS) protocols are limited due to the emergent nature of the procedure. We attempted to reduce the number of total inpatient opioids prescribed by implementing a Surgeon/Pharmacist Opioid Reduction Initiative at a tertiary academic medical center by incorporating multi-modal pain therapy and focus on functionality. We hypothesized that significantly less opioids would be prescribed post-operatively without affecting pain scores or length of stay.
Methods: This is a single-center observational cohort analysis. Patients admitted to the acute care surgical service and underwent one of ten emergent general (non-trauma) surgical operations were included. Differences in daily oral morphine equivalents (OMEs), OMEs prescribed at discharge, average pain scores, and length of stay were compared between pre-initiative and post-initiative groups. Statistical analyses were performed using the Mann-Whitney U Test for non-parametric, non-normally distributed data.
Results: Eighty-five patients in the pre-initiative group and ninety-nine patients in the post-initiative group met inclusion criteria. Our preliminary results showed decreased opioid utilization in the post-initiative compared to the pre-initiative on all observed post-operative days. Average pain scores were similar on every post-operative day despite less opioid use (see figure 1). The median OME prescribed at discharge decreased significantly from 450 [ 378 - 731] in the pre-initiative vs. 400 [225-630] in the post-initiative $(\mathrm{p}=0.02)$ corresponding to a decreased number of days' supply of opioids from $7[5-10]$ to $6[3-8](p=0.03)$. Median length of stay was not significantly different between the two groups ( 4 [1-7] vs. $5[2-9] ; p=0.14$ ).

Comparison of Average Pain Scores in patients during 2014 vs 2017


Conclusions: An inpatient Opioid Reduction Initiative was successful in lowering the amount of opioids prescribed during hospitalizations and upon discharge without affecting pain scores or length of stay in patients undergoing unplanned general surgery procedures. Our multidisciplinary initiative can be easily implemented at other institutions to help combat the opioid epidemic.

# INCREASED RESOURCE UTILIZATION FOLLOWING ACUTE CHOLECYSTECTOMY IN MEDICAID PATIENTS: A PROPENSITY-SCORE-MATCHED ANALYSIS. 

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INTRODUCTION: Medicaid payer status has been shown to affect risk-adjusted outcomes and costs across multiple specialties. The Medicaid Expansion created by the Affordable Care Act has significantly increased Medicaid enrollees. The purpose of this study was to examine resource utilization via readmission rates, length of stay, and total cost specific to Medicaid payer status following cholecystectomy for acute cholecystitis.
METHODS: The Nationwide Readmissions Database (NRD) was used to identify patients who underwent cholecystectomy for acute cholecystitis in 2016, as well as "Medicaid" or "non-Medicaid" payer status. Demographic data, comorbidities, readmission rates, length of stay (LOS), hospital characteristics and adjusted costs were evaluated. A propensity score was utilized to control for confounding variables between payer groups on the basis of the available baseline demographic to match non-Medicaid control patients to Medicaid patients. Following propensity score matching, the chi-square test was used to compare readmission rates between the payer groups. The relative risk (RR) with $95 \%$ confidence interval (CI) was estimated to quantify readmission risks. LOS and adjusted cost comparisons were evaluated using the Wilcoxon signed-rank test.
RESULTS: A total of 6,056 Medicaid and 30,537 non-Medicaid patients receiving open or laparoscopic cholecystectomy for acute cholecystitis were identified. Propensity matching resulted in 2,798 pairs of Medicaid and non-Medicaid patients. 60-day readmission rates were higher for Medicaid compared to non-Medicaid payer status ( $8.1 \%$ versus $5.3 \%, \mathrm{p}=0.0001$ ); with a RR of readmission of 1.53 (CI: 1.25 to 1.87). Readmission at 60-days for a post-operative complication was more common in Medicaid patients ( $6.5 \%$ versus $3.9 \%, \mathrm{p}=0.0001$ ) with a RR of 1.69 (CI: 1.29 to 2.19). Mean total LOS was longer for Medicaid than non-Medicaid patients at 6.4 versus 5.3 days, $\mathrm{p}<0.0001$. Total adjusted costs were higher for Medicaid than non-Medicaid patients at $\$ 14,213$ (IQR: \$9,275-24,004) versus $\$ 11,230$ (IQR: \$7,619-17,985), p < 0.0001).

CONCLUSIONS: This study demonstrates that Medicaid payer status is independently associated with increased resource utilization, including readmission rates, LOS, and total adjusted costs following cholecystectomy for acute cholecystitis. Incorporating Medicaid payer status into risk adjustment models is needed to avoid access disparities and financial disincentives to hospitals and providers.

## Poster \# 125

## PAIN MANAGEMENT ON A TRAUMA SERVICE: A CRISIS REVEALS OPPORTUNITIES

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Introduction: The opioid crisis has forced an examination of opioid prescribing and usage patterns. Multimodal pain management and limited, procedure-specific prescribing guidelines have been proposed in general surgery. This has been less well studied in trauma, where multisystem injuries and multispecialty caregivers are the norm. We hypothesized that opioid requirements would differ by primary type of injury, and we sought to identify factors affecting opioid prescribing at discharge (DC).
Methods: Retrospective analysis of pain management was performed at a level II trauma center for January-November 2018. Consecutive patients (pts) with exploratory laparotomy (LAP); 3 or more rib fractures (fxs) (RIB); or pelvic (PEL), femur (FEM), or tibia (TIB) fxs were included, assigned to cohorts based on the predominant injury. Pts who died, or had head AIS $>2$ and GCS $<15$, were excluded. All pain medications were recorded daily; narcotic doses were converted to oral morphine equivalents (OMEs). OMEs administered over the final 72 hrs of hospitalization (OME72) and prescribed at DC (OMEDC) were calculated. Data presented as means. Categorical variables were analyzed using Fischer's Chi Square and continuous variables with an unpairedt-test. A p value $<0.05$ was considered significant (indicated by "*").
Results: 208 pts were included: 17 LAP, 106 RIB, 31 PEL, 26 FEM, and 28 TIB. 74\% were male. Females were older than males ( $65 \mathrm{vs} 51^{*}$ ) and had shorter length of stay (LOS) (4.5 vs 7.3*). 16 (8\%) were using opiates prior to admission. Injury cohorts varied by age but not ISS or LOS (Table). $67 \%$ of pts received multimodal (ie, 3 or

|  | N | Age | ISS | LOS | OME72 | OMEDC |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| LAP | 17 | $29^{*}$ | 12 | 7.2 | 211 | 199 |
| PEL | 31 | 56 | 12 | 9.5 | 267 | 263 |
| FEM | 26 | 39 | 15 | 7.0 | 185 | 252 |
| TIB | 28 | 41 | 13 | 11.1 | 191 | 260 |
| RIB | 106 | $65^{*}$ | 12 | 4.3 | $92^{*}$ | 237 |
| Total | $\mathbf{2 0 8}$ | $\mathbf{5 4}$ | $\mathbf{1 2}$ | $\mathbf{6 . 6}$ | $\mathbf{1 8 9}$ | $\mathbf{2 4 3}$ | more drugs) pain therapy. OME72 was lower for RIB compared with all other cohorts and did not vary based on number of rib fxs (3-8+). Older (>64 yrs) patients had similar ISS and LOS, but lower OME72 (74 vs 190*) and OMEDC, compared with age $<65$. There was no relationship between OME72 and OMEDC across injury groups, or by sex or injury severity. In fact, females and those with ISS $<16$ had slightly lower OME72 yet slightly higher OMEDC. Patients were discharged almost exclusively by trauma service advanced practice clinicians (APCs). There was no difference among APCs in number of pills or OMEs prescribed. 81\% of pts received opioids at DC; 69\% of them were prescribed an opioid/ acetaminophen (ACET) combination drug. Only 13\% were prescribed NSAIDs, $19 \%$ ACET, and 31\% gabapentin (GABA) at DC.

Conclusion: Pts with different injury types have varied opioid requirements. Opioid DC prescribing appears rote and does not correlate with actual opioid usage during the 72 hrs prior to DC. Paradoxically, OMEDC tends to be higher among females, pts with ISS<16, and those with rib fxs, despite a tendency toward lower OME72 usage among these groups. ACET, NSAIDs and GABA are underutilized. These findings highlight opportunities for improvement and further study.

# MULTI-SYSTEM ORTHOPEDIC INJURIES: A RISK FACTOR FOR PROTRACTED OPIOID USE IN OPIOID NAIVE TRAUMA PATIENTS 

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Introduction: Opioids are a mainstay in the management of pain in the injured and were until recently liberally prescribed. The emergence of opioid abuse as a public health crisis of epidemic proportions has led us to rethink this approach. Clinicians now face the challenging task of balancing the need to provide pain relief with that of preventing opioid addiction. There is an urgent need to identify patients at risk for protracted opioid use. We hypothesized that the pattern of injury would be predictive of protracted opioid use.

Methods: With IRB approval, a retrospective review of trauma registry data at our suburban level II trauma center for the period 2013-2016 was performed. Registry data was cross referenced with data in the state prescription drug monitoring program. Protracted opioid use was defined by ongoing use greater than 120 days after the injury. Univariable analysis followed by multivariable analysis was performed. A p value of $<0.05$ was deemed significant.
Results: Of 3970 patients, 1131 had complete data available, were opioid naive at the time of injury, and constituted the study population. Protracted opioid use was identified in 164 (14.5\%) and was significantly more frequent in those sustaining multisystem orthopedic injuries ( $51.83 \%$ vs. $41.05 \%$, $\mathrm{p}<0.002$ ). Prolonged use was not observed in patients with isolated vertebral column injuries or isolated pelvic fractures, traumatic brain injuries, or rib fractures (all $\mathrm{P}=\mathrm{NS}$ ). Female gender ( $\mathrm{p}=0.03$ ), older age ( $\mathrm{p}=0.02$ ) and having insurance ( $\mathrm{p}=0.01$ ) were also associated with protracted use. Post-discharge opioid prescriptions were more frequently obtained from a service other than the primary trauma Service ( $1.8 \%$ vs $82.0 \%$, $\mathrm{p}<0.0001$ ).
Conclusion: Opioid naïve trauma patients that sustain multi-system orthopedic injuries are significantly more likely to use opioids on a protracted basis. Women, older patients, and those with insurance are also at greater risk. Aggressive prevention measures including a multimodal opioid sparing approach to analgesia, and the coordination of opioid prescribing across services with aggressive review of state prescription drug monitoring program data appears to be warranted, especially in this patient population.

|  | Protracted opiolduse $\mathrm{N}=164(14.589)$ | Ne Protreitec apioiduse $\mathrm{N}, \mathrm{gs} 7 \mathrm{3} 8 \mathrm{~s} .5 \%$ | Pvalue |
| :---: | :---: | :---: | :---: |
| Aroitears) | \$2.43土18.51 | $48.87 \pm 21.14$ | 0.02 |
| Formile | 77(46.95\%) | 344(35.57\%) | 0.03 |
| Insured | 145(88.41\%) | 793(82.01\%) | 0.01 |
| Irjury Severify Score | $7.16 \pm 6.87$ | $7.18 \pm 7.01$ | 0.87 |
| Pie-lalury Schedule 2 Drue use | 11 (6.71\%) | 81 (8.38\%) | 0.17 |
| Mutitsvetem Orthepedicinut. | 85451.8393) | 397 (41.05\%) | 0.0002 |
| IspistedVertebral Eelumbiniury | $25\{15.24 \%)$ | 122(12.62\%) | 0.89 |
| tsolateó pelwitfacture | 41 (25.00\%) | $5(0.52 \%)$ | 0.61 |
| Traumatic Ercinindury | 26(15.85\%) | $112(11.5856)$ | 0.3 |
| Rib fractures: | $24(14.63 \%)$ | 152(15.72\%) | 0.6 |
| ICB3amistion | $38(23.17 \%)$ | 181(18.72\%) | 0.37 |
| Fwlonghof stay | $3.64 \pm 4.04$ | $4.02 \pm 5.35$ | 0.88 |
| Hosperallengthef stay | $4.01 \pm 4.48$ | $3.52 \pm 4.22$ | 0.18 |
| Number of Preseriotiona Filled | $25.36+28.26$ | $5.79 \pm 11.64$ | 0.0001 |
| Number of prexeribers | $10.5 \pm 18.92$ | 3.0443 .64 | 0.0001 |

## LOSS OF LYMPHOCYTES CAN PREDICT COMPLICATIONS

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Introduction: Lymphocyte responses following trauma have been shown to predict mortality. Clinicians use a multitude of factors to determine when a patient's clinical status is declining. We hypothesize that a drop in lymphocyte count will predict complications in trauma patients.
Methods: Retrospective review of our trauma registry from January 2010 through March 2015 for patients with at least two lymphocyte counts obtained within four days of traumatic injury. Their four day lymphocyte patterns were grouped by those who were always normal, those who became lymphopenic but recovered, and patients who remained lymphopenic. The primary outcomes of all-cause mortality, any complication, and any infection and any morbidity were assessed by Kaplan-Meier curves. Complications and infections were defined by those present in the trauma registry. Lymphocyte counts were also correlated with neutrophil counts from the same lab draw and then the highest count the next day.
Results: 9373 trauma patients demonstrated a three-tiered mortality based on lymphocyte response across all trauma patients regardless of ISS. Patients who were never lymphopenic had the lowest 30 day mortality (4.3\%), recovered lymphopenia higher mortality ( $13.4 \%$ ), and the persistent lymphopenia group the highest $(25.3 \%, \mathrm{p} \leq 0.0016$ for all comparisons). The complication rate in patients with recovered lymphopenia ( $48.7 \%$ rate) and persistent lymphopenia ( $50.4 \%$ rate) are similar, but both are significantly more than patients who had a normal lymphocyte count (29.3\%, $\mathrm{P}<0.001$ for both comparisons). A similar pattern was found for any infection on the Kaplan-Meier curves. Additionally, a drop in lymphocyte count predicted a rise in the neutrophil count one day later.
Conclusions: Clinicians use many tools to assess the severity of illness in patients and now a drop in lymphocytes can be utilized to predict a complication as well as mortality in all trauma patients. This lab finding should prompt clinicians to thoroughly re-evaluate their patients for factors that contribute to excess mortality.

## TRAUMA HIGH RESOURCE CONSUMERS - A DRAIN ON THE SYSTEM

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INTRODUCTION: Extended hospital length of stay (LOS) is widely associated with significant healthcare costs. Since LOS is a known surrogate for cost, we sought to evaluate outliers. We hypothesized that particular characteristics are likely predictive of trauma high resource consumers (THRC) and can be used to more effectively manage care of this population.
METHODS: The Pennsylvania Trauma Outcome Study database was retrospectively queried from 2003-2017 for all adult (age $\geq 15$ ) trauma patients admitted to accredited trauma centers in Pennsylvania. THRC were defined as patients with hospital LOS two standard deviations above the population mean or $\geq 22$ days ( $\mathrm{p}<0.05$ ). Patient demographics, comorbid conditions and clinical variables were compared between THRC and trauma non high resource consumers to identify potential predictor variables. A multilevel mixed-effects logistic regression model controlling for age, gender, injury severity, admission Glasgow coma score (GCS) and systolic blood pressure assessed the adjusted impact of clinical factors in predicting THRC status.
RESULTS: 489,027 patients met inclusion criteria [THRC: 17,544 (3.59\%); non-THRC: 471,483 ( $96.41 \%$ )]. Compared to non-THRC counterparts, THRC patients were significantly more severely injured (ISS: 10.58 vs. $22.53, \mathrm{p}<0.001$ ) and had a higher incidence of chronic alcohol abuse. In adjusted analysis, gunshot wound to the abdomen, undergoing major surgery and reintubation were significantly associated with THRC (Table 1). Penetrating injury overall was associated with decreased risk of being a THRC. CONCLUSION: Reintubation, major surgery and gunshot wounds to abdomen are strongly predictive of THRC. Understanding the profile of the THRC will allow clinicians and case management to proactively put processes in place to streamline care and potentially reduce costs and LOS.

|  | Trauma super-user |  |
| :---: | :---: | :---: |
| Variable | AOR (95\% CI) | $p$ |
| GSW (abdomen) | 1.509 [1.345-1.695] | $\leqslant 0.001$ |
| Penetrating MOI | 0.486 [0.448-0.527] | <0.001 |
| Major surgery | 3.117 [2.974-3.267] | $<0.001$ |
| Reintubation | 9.834 [9.193-10.529] | <0.001 |
| Age | 1.002 [1.001-1.003] | $<0.001$ |
| Male sex | 1.411 [1.351-1.474] | <0.001 |
| ISS |  |  |
| 0-8 | Reference | -- |
| 9-15 | 2.495 [2.328-2.674] | $<0.001$ |
| 16-25 | 4.709 [4.396-5.045] | $<0.001$ |
| 26-75 | $9.792[9.116-10.517]$ | $<0.001$ |
| Admission GCS | 0.937 [0.933-0.941] | $<0.001$ |
| Admission SBP | 1.000 [0.999-1.001] | <0.140 |
| AUROC: 0.865 |  |  |

# THE IMPACT OF THE AFFORDABLE CARE ACT ON TRAUMA OUTCOMES: AN INTERRUPTED TIMES SERIES ANALYSIS 

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Introduction:Trauma disproportionately affects those of lower socioeconomic status and the uninsured. Compared to those with insurance, uninsured patients have worse long-term functional outcomes and increased mortality. The Affordable Care Act (ACA) was signed into law in 2010 with the goal of increasing access to insurance. Three provisions of the ACA that have had significant impact on increasing insurance access: the extension of Medicaid eligibility, the increased access to private insurance via income-based tax credits, and new insurance regulations that both ban discrimination on the basis of pre-existing conditions and mandate that all individuals have health insurance. These provisions took effect in January 2014. We sought to analyze the impact of these ACA provisions on trauma outcomes and investigate their impact on identified at-risk subgroups.
Methods:Using Diagnostic Related Groups, a time series was created from the Healthcare Cost and Utilization Project (HCUP) database between 2011-2016. An interrupted times series (ITS) was conducted at the population level, examining mortality, mean length of stay (LOS), and probability of discharge home with or without home health care using monthly time intervals with January 2014 as the intervention time. Data was organized into subgroups by income quartile (\$1-\$42,999; \$43,000-\$53,999; \$54,000-70,999; and $\$ 71,000$ or more USD) and race. ITS was used to analyze each group, using the opposing group as control groups. Results were adjusted for statistically significant covariables. Each model was examined for autocorrelation, and a range of lag times were applied in sensitivity analysis.
Results:After the 2014 provisions came into effect, at a population level there was a reduction in mortality (monthly probability reduction of 0.0145\%: 95\% CI $0.0246 \%-0.0370 \%)$. There were monthly increases in the probability of discharge with home health ( $0.0247 \%$ : 95\% CI 0.0151\%-0.0343\%). The reduction in mortality was statistically significant in the non-white race group but was not significant in the white group. Both racial groups saw an increase in the probability of home health use; however, a discrepancy favoring the use of home health services amongst white persons was seen both pre- and post-intervention time (Figure). The lowest income quartile experienced no statistically significant change in the probability of being discharged home with or without home health, while the three highest quartiles all experienced increases. The greatest increases were demonstrated in the second income quartile.
Conclusion:The 2014 provisions have had an impact on mortality, which is driven by the effect in non-white racial groups. Markers of services, such as discharge home with home care, have increased across all racial groups, and specifically in middle and upper income quartiles. No changes were seen in the first income quartile, likely because these patients qualified for Medicare pre-ACA. There is a persistent discrepancy between racial groups in the use of home health services after traumatic injury.

# CALLING IT: FACTORS PRESENT WITHIN ONE HOUR OF ARRIVAL THAT PREDICT MORTALITY WITHIN THE NEXT FIVEHOURS 

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Introduction: Numerous studies have described predictors of overall mortality or early mortality within certain populations. However, this study aimed to identify variables present within 1 h of hospital arrival that predict all-cause trauma mortality within 6 h of hospital arrival. This may allow clinicians to better stratify risk of early mortality, which may be invaluable when debating the futility of care.
Methods: Using 2013-14 NTDB data, 1,225,903 encounters were analyzed after applying exclusions such as pre-hospital cardiac arrest, ED death within 15 m , active DNR, death after 6 h , and age $<15$. Using demographic, physiologic, anatomic, and procedural variables, we derived 485 potential predictors. Cross-validated variable selection was performed using binomial probit LASSO regression.
Results: 9,803 (0.80\%) died within 6 h . As shown in the table, initiating any of these five common procedures within 1 h was associated with increased risk of 6 h mortality. Major vascular injury to the trunk and respiratory assistance on arrival were also associated with higher

| Variable | B (95\% CI) | Clinical score |
| :--- | :---: | :---: |
| CPR within Ih | $2.44(2.37,2.50)$ | 24 |
| Resp. rate assisted on arrival | $1.05(1.02,1.07)$ | 11 |
| Exploratory thoracototoy within 1 lh | $0.90(0.80,1.00)$ | 9 |
| Insert ET tube within Ih | $0.62(0.59,0.65)$ | 6 |
| Any PRBC transfused within 1 lh | $0.61(0.56,0.65)$ | 6 |
| Supplemental 02 on arrival | $0.62(0.59,0.65)$ | 6 |
| Insert intercostal drainage catheter within 1 lh | $0.37(0.33,0.42)$ | 4 |
| Injury to major vessels of the abdomen | $0.93(0.86,0.99)$ | 9 |
| Injury to major vessels of the thorax | $0.72(0.66,0.79)$ | 7 | risk. The model slightly under-estimates risk for encounters with actual probabilities $40-80 \%$ and over-estimates risk by $<8 \%$ for encounters with actual probabilities $>85 \%$ (top figure). Despite these small prediction errors, the model performed very well (AUC=0.97). The clinical score also performed well, but rounding decreased precision slightly (AUC=0.85). A score $>6$ optimizes sensitivity ( 0.80 ) and specificity ( 0.76 ; AUC=0.81; post-test probability=27\%). As shown in the bottom figure, a score $>25$ reduces false-positives and achieves post-test probability=94\% (sensitivity=0.32; specificity=1.00; AUC=0.65).

Conclusion: Early withdrawal of care is a difficult decision. The ability to objectively support clinical intuition of futility during triage would be a valuable, practical tool. As all patients scoring $<25$ survived to 6 h, the model and clinical score are high-specificity (low false-positive) ways to inform such decisions in this population. A high clinical score at 1 h after arrival may

 thus signal futility and support limitation of care efforts when clinically indicated. This may be life-saving in mass casualty and other limited-resource situations.

# EARLY TRACHEOSTOMY IN SEVERE TRAUMATIC BRAIN INJURY IS ASSOCIATED WITH DECREASE IN RATE OF VENTILATOR-ASSOCIATED PNEUMONIA: AN ANALYSIS OF TQIP DATA 

Chelsea Hoenes MD, Joshua K. Burk MD, Kabir Jalal Ph.D., Jeffery M. Jordan MD,Ph.D., University At Buffalo, SUNY

## Introduction:

Patients with severe traumatic brain injury (sTBI) require intubation to ensure adequate oxygenation, and many progress to tracheostomy. However, tracheostomy timing is controversial. We have previously demonstrated that, in our institution, a lower incidence of ventilator-associated pneumonia in sTBI patients receiving early tracheostomy. Therefore, we sought to extend our results by evaluating the American College of Surgeons Trauma Quality Improvement Program (TQIP) database to determine if an association between tracheostomy timing and development of ventilator-associated pneumonia exists.

## Methods:

The 2015 data from the TQIP was accessed and 5,662,524 patients were screened for inclusion in our retrospective analysis. Patients included in the analysis were those in whom tracheostomy was performed, had an isolated, sTBI, and those ultimately developing ventilator-associated pneumonia. Patients were matched by age and injury severity score. Fischer's exact and multivariate analyses were used to observe the rate of pneumonia in TBI, the rate of tracheostomy in TBI, and impact of tracheostomy timing on the development of pneumonia. Hospital length of stay, number of days on a ventilator, and ICU length of stay were analyzed using a multivariate analysis.

## Results:

A total of 4,045 patients met the inclusion criteria for our analysis. Five-hundred-sixty patients received tracheostomy by day 3 of their hospital stay (mean 1.15, SD 1.06) and 3,485 after day 3 (mean 10.44, SD 6.03). There were no statistically significant differences in age, ISS, respiratory rate, or oxygen saturation between the two groups. Early tracheostomy was associated with a rate of pneumonia of 10.23 (CI 7.86-13.02) compared to 21.49 (CI 20.15-22.88) in patients receiving trach after day 3 (OR 2.624, p -value 0.02 ).

## Conclusion:

Early tracheostomy was associated with a significant decrease in the rate of pneumonia in patients with severe traumatic brain injury. Future prospective studies are needed to validate the impact of early tracheostomy on patient morbidity and mortality in severe traumatic brain injury.

# SCALPEL OR SHEATH? OUTCOMES COMPARISON BETWEEN PRE-PERITONEAL PELVIC PACKING (PPP) AND ANGIOEMBOLIZATION (AE) FOR DEFINITIVE HEMORRHAGE CONTROL AFTER RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA) 

Megan Brenner* MD, MS, Laura Moore* MD, Bishoy Zakhary MPH, Alexander Schwed MD, Alexis Cralley MD, Anna Romagnoli MD, Charles Fox* MD, Thomas Scalea* MD, Clay Cothren Burlew* MD, University Of California Riverside/Riverside University Health Systems

Introduction: The role of AE and PPP for pelvic hemorrhage control in the era of REBOA has not been well described. Our aim was to investigate outcomes of PPP and AE after REBOA.
Methods: Patients who received aortic occlusion (AO) at Zone 3 (distal abdominal aorta) plus PPP and/or AE for blunt pelvic fracture-related hemorrhage at 3 high-volume REBOA centers between February 2013 and December 2018 were identified. Demographics, physiologic variables, and outcomes were reviewed from prospectively collected institutional registries. Patients were divided into 3 groups based on procedures performed: REBOA with PPP only (RPPP), REBOA with angioembolization only (RAE), and REBOA with PPP and AE (RPPPAE).
Results: 58 patients underwent REBOA at Zone 3; 37 RPPP, 13 RAE, 8 RPPPAE. Mean age was $45 \pm 16$ years, mean injury severity score (ISS) $35 \pm 13$, mean SBP pre-AO was $71 \pm 19 \mathrm{mmHg}$, and post-AO SBP was $110 \pm 34 \mathrm{mmHg}$. Mean time from admission to AO was $48 \pm 41$ mins, and mean duration of AO was $60 \pm 40 \mathrm{mins}$. $52 \%$ of patients had a pelvic binder, and $59 \%$ received external fixation. $62 \%$ of RPPP patients and $31 \%$ of RAE patients received a 7 Fr sheath. Mean blood products transfused within the first 24 hours were $17 \pm 16$ UPRBC, $13 \pm 12$ FFP, $8 \pm 10 \mathrm{Pk}$ platelets, and $17 \%$ of patients received tranexamic acid (TXA). In-hospital mortality was $28 \%$, with the majority of deaths occurring in the intensive care unit (17\%). Overall, acute kidney injury (AKI) was the most common systemic complication (28\%) followed by acute respiratory distress syndrome/acute lung injury (ARDS/ALI) in 12\%, while distal embolism was the most common procedure related complication (12\%). Age, ISS, admission SBP, physiology on admission and at the time of AO, response to AO, admission hemoglobin, blood products transfused, and rate of local wound infections were not different between RPPP and RAE groups. Comparing RPPP to RAE groups, duration of AO was significantly lower in the RPPP group ( $45 \pm 34$ vs $81 \pm 37$ mins, $p=0.012$ ), while rates of AKI ( $14 \%$ vs $46 \%$ ) and distal embolism ( $8 \%$ vs $31 \%$ ) were higher in the RAE group ( $\mathrm{p}=0.015,0.04$ respectively). There was no difference in mortality between RPPP (22\%) and RAE patients (39\%), including on regression analysis controlling for duration of AO and ongoing CPR at the time of AO.
Conclusion: Despite a longer duration of AO and higher rates of ongoing CPR at the time of AO in RAE patients, mortality rates are similar whether hemostasis is achieved after REBOA with pelvic packing or angioembolization. RPPP results in significantly lower systemic and local complication rates which may be directly related to shorter durations of AO , size and duration of in-dwelling sheath, or other factors.

Poster \# 133

## AN ANALYSIS OF OVERTRIAGE AND UNDERTRIAGE BY ADVANCED LIFE SUPPORT TRANSPORT IN A MATURE TRAUMA SYSTEM

Eric H. Bradburn DO, Tawnya M. Vernon BA Penn Medicine Lancaster General Health

Introduction: While issues regarding triage of severely injured trauma patients are well publicized, little information exists concerning the difference between triage rates for patients transported by advanced life support (ALS). We sought to analyze statewide trends in undertriage and overtriage to address this question, hypothesizing that there would be no difference between the undertriage and overtriage rates for ALS compared to BLS over a 13-year period.
Methods: All patients submitted to Pennsylvania Trauma Outcomes Study database from 2003-2015 were analyzed. Undertriage (UT) was defined as not calling a trauma alert for patients with an Injury Severity Score (ISS) $\geq 16$. Overtriage (OT) was defined as calling a trauma alert for patients with an ISS $\leq 9$. Multilevel mixed-effects logistic regression models assessed the adjusted impact of ALS transport on undertriage and overtriage rates while controlling for ISS, age, Glasgow Comma Score (GCS) motor, systolic blood pressure (SBP), and injury type.
Results: A total of 462,081 patients met inclusion criteria, of which 116,633 had an ISS $\geq 16$ and 257,586 had an ISS $\leq 9$. Multivariate analysis revealed that patients transported by ALS had a decreased adjusted rate of undertriage (AOR: $0.28 \pm 0.005 ; \mathrm{p}<0.001$ ) and an increased adjusted rate of overtriage (AOR: $3.98 \pm 0.060 ; \mathrm{p}<0.001$ ) compared to patients transported by BLS.
Conclusion: ALS transport can significantly reduce the problem of UT in a trauma system. Unfortunately, it has the negative consequences of increased resource utilization secondary to OT. Further refinements of triage guidelines in the prehospital setting are necessary to achieve both lower UT and also OT.

|  | $\begin{gathered} \text { Undertriage Model } \\ (\mathrm{m}=110,033) \\ \hline \end{gathered}$ |  | $\begin{aligned} & \text { Overtriage Moxdel } \\ & (\pi=2.57,586) \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: |
| Variable | Aduusted Odds Ratio (95\% (1) | p-value | Adjusted Odds Ratio (95\% 11 (l) | p-value |
| A1.S | $0.28(0.27-0.29)$ | 50.001 | 3.98 (3.87-4.10) | 50,001 |
| Age | $1.102(1.02-1.03)$ | <0.001 | 0.98 (0.98-0.99) | <0.001 |
| GCSMotor | $1.38(1.36-1.41)$ | $<0,001$ | $0.61(0.59-0.62)$ | <0.001 |
| SEP | $100(1.00-1.01)$ | $50.001$ | $100(1.00-1.01)$ | $0.001$ |
| 1SS | $0.94(0.27-0.29)$ | 0.001 | $0.98(0.98-0.99)$ | 50.001 |
| Injury type (Penetrating) | $0.59(0.55-0.64)$ | c0.001 | $2.32(2.18-2.48)$ | c0.001 |
| ALROC\%078 |  |  | AIJROC:0.76 |  |

# CHANGES IN ERROR PATTERNS IN UNANTICIPATED TRAUMA DEATHS OVER 20 YEARS 

Lacey N. LaGrone MD,MPH, Lisa McIntyre* MD, Andrew Riggle MD, Bryce<br>Robinson* MD, Ronald V. Maier* MD, Eileen Bulger* MD, Joseph Cuschieri* MD, Harborview Medical Center

Introduction: A fundamental goal of continuous process improvement programs is to improve the ratio of actual to expected mortality. To study this, we evaluated aspects associated with error associated deaths during two consecutive periods from 1996-2004 (Period 1) and 2005-2014 (Period 2).
Methods: All deaths at a level I trauma center with an anticipated probability of death less than $50 \%$ and/or identified through process improvement committees were examined. Each death was critically appraised to identify potential error, with subsequent classification of error type, phase, cause, and contributing cognitive processes[JC1] [LL2] , comparison of outcomes made using chai squared test of independence. Demographics assessed for trend only, as Period 1 data only available in median, IQR, which does not permit significance testing.
Results: During Period 1, there were a total of 44,401 admissions with 2,594 deaths and 64 deaths ( $2.5 \%$ ) associated with error, compared to 60,881 admissions during Period 2 with 2,659 deaths and 77 (2.9\%) associated with error. Deaths associated with error occurred in younger and less severely injured patients in Period 1, and were likely to occur during the early phase of care, mostly from lack of hemorrhage control. In Period 2, deaths occurred in older more severely injured patients, and were likely to occur in the later phase of care due to aspiration (Table).
Conclusion: Despite injured patients being older and more severely injured, error associated deaths due to hemorrhage and early care in the ICU improved over time. Successful implementation of system improvements resolved issues in the early phase of care but shifted deaths to aspiration events during the recovery phase. This study demonstrates that ongoing evaluation is essential for continuous process improvement and alteration in focus of efforts, even in a mature trauma system.

|  | $\begin{gathered} 1996-2004 \\ \text { Period } 1 \end{gathered}$ |  | $\begin{gathered} \text { 2005-2014 } \\ \text { Period } 2 \end{gathered}$ |  | 1996-2014 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| DEMOGRAPHICS |  |  |  |  |  |  |  |
| Age (yr) [IQR] | 46 | 6-72] | 57 [3 | 4-78] |  |  |  |
| Male:Female (\%) | 69 |  | 71 |  |  |  |  |
| ISS [IQR] | 25.5 [ | 20-35] | 29 [2 | 5-48] |  |  |  |
| ERROR PATTERN | n | (\%) | n | (\%) | n | (\%) | $\mathrm{X}^{2} \mathrm{p}^{\prime}$ |
| Management of unstable patients | 9 | (14) | 11 | (14) | 20 | (14) | 1.0 |
| Early hemorrhage control and ICU care | 18 | (28) | 10 | (13) | 28 | (20) | 0.84 |
| Procedure Related | 8 | (13) | 6 | (8) | 14 | (10) | 0.93 |
| Airway management and aspiration | 10 | (16) | 25 | (32) | 35 | (25) | 0.84 |
| Prophylaxis | 4 | (11) | 5 | (6) | 12 | (9) | 0.92 |
| Missed or delayed diagnosis | 7 | (11) | 12 | (16) | 19 | (13) | 0.94 |

# IMPACT OF THE AFFORDABLE CARE ACT ON POST-DISCHARGE CARE AFTER PELVIC FRACTURE 

Todd W. Costantini* MD, Allison E. Berndtson MD, Alan Smith Ph.D., Jay J. Doucet*<br>MD, Laura N. Godat* MD, University of California, San Diego

Introduction: Pelvic fracture is associated with significant morbidity, prolonged recovery and need for post-discharge rehabilitation or skilled nursing care. With the launch of Open Enrollment (OE) in 2014, the Affordable Care Act (ACA) provided insurance coverage to previously uninsured Americans. Little data exists describing the effects of the ACA on access to post-discharge services for patients with commonly disabling traumatic injuries. We hypothesized that implementation of the ACA increased access to post-discharge healthcare facilities for patients with pelvic fracture resulting in decreased early readmission rates.

Methods: The Nationwide Readmission Database was queried to identify non-elderly (age <65) patients with an index admission for traumatic pelvic fracture using ICD-9 or ICD-10 codes. Pre-OE admissions, defined as 2013 Q1-Q3, were compared with post-OE admissions in 2016 Q1-Q3 to evaluate the impact of the ACA OE on discharge disposition, hospital length of stay (LOS), readmission rates at 30/60/90 days post-discharge and mortality. Logistic regression analysis was performed to identify predictors of discharge to a care facility (LTAC + SNF).

Results: We identified 18,739 patients (2013 n=8,124 \& $2016 n=10,615$ ) with pelvic fractures meeting inclusion criteria. In the post-OE period, Medicaid insurance increased from $17 \%$ to $27 \%$ ( $\mathrm{p}<0.001$ ) and discharge to a care facility increased from $26 \%$ to $31 \%$ ( $p<0.001$, see Figure), while there was no difference in hospital LOS between periods. There

|  | Pre-OE | Post-OE | p |
| :--- | :---: | :---: | :---: |
| Payer | $17 \%$ | $27 \%$ | $<0.0001$ |
| Medicaid | $48 \%$ | $44 \%$ | $<0.0001$ |
| Private Insurance | $12 \%$ | $8 \%$ | $<0.0001$ |
| Self-Pay |  |  |  |
| Discharge Disposition |  |  |  |
| Discharge to Care Facility | $26 \%$ | $31 \%$ | $<0.001$ |
| Routine Discharge Home | $50 \%$ | $47 \%$ | $<0.001$ |
| Home with Home Health Care | $20 \%$ | $18 \%$ | $<0.001$ |
| Mortality | $4 \%$ | $3 \%$ | ns | was no difference in 30- or 60-day readmission rates when comparing pre-OE and post-OE patients across all payers. However, a readmission within 90 days was more common post-OE ( $10 \%$ vs. $12 \%, \mathrm{p}=0.011$ ). There was no difference in mortality during readmission between groups. On multivariate regression analysis, patients discharged to a care facility were more likely to be female (OR 1.13, CI 1.1-1.9) and readmitted within 90 days (OR 1.79, CI 1.59-2.02). Self-pay patients were least likely to be discharged to a care facility (OR 0.29 , CI $0.25-0.34$ ), while patients with Medicaid insurance were as likely as those with private insurance to be discharged to a care facility.

Conclusion: ACA OE increased access to post-discharge care for patients admitted with pelvic fracture. This increase in access to skilled post-discharge care did not decrease hospital LOS or readmission rates. Further studies are needed to better define the impact of healthcare insurance policies on discharge disposition and outcomes for patients after traumatic injury.

# Poster \# 136 <br> SEVERE TRAUMATIC BRAIN INJURY: DOES TQIP NEED TO CHANGE ITS DEFINITION? 

Ronald Simon* MD, Catsim Fassassi DO, Heath Walden MD, Krishan Patel MD, Gerard Betro MD, Mehr Qureshi MD, Richard Savel MD, Maimonides Medical Center

Introduction: The TQIP report compares outcomes of a trauma center against national data. Although some outcomes are risk stratified for age, severe TBI (sTBI) is not. TQIP defines sTBI as a GCS $<9$ on admission. We hypothesized that the GCS may have limitations with regards to its ability to predict outcomes with increasing age. As such, we reviewed the outcomes of patients with sTBI, dichotomizing patients into older and younger cohorts.
Methods: This retrospective analysis from our trauma database on 540 adult patients presenting to our trauma center from August 2016 to September 2018 with a primary diagnosis of TBI. Data collected included: demographics, mechanism and type of injury, admission GCS(aGCS), AIS, ISS, and hospital mortality. Two groups were created using age=65 as the cutoff for the younger and older groups.
Results:

| Age/aGCS <br> Group | \# | Age | aGCS | Brain <br> AIS | ISS | $\%$ <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $<65,<9$ | 38 | $39.8 \pm 2.4$ | $4.6 \pm 0.3$ | $3.9 \pm 0.2$ | $24.1 \pm 2.3$ | 37 |
| $\geq 65,<9$ | 24 | $77.8 \pm 2.1$ | $4.5 \pm 0.4$ | $4.0 \pm 0.2$ | $21.1 \pm 2.4$ | 63 |
| $\geq 65,<11$ | 33 | $77.5 \pm 1.7$ | $5.9 \pm 0.5$ | $3.9 \pm 0.2$ | $19.9 \pm 2.0$ | 55 |
| $\geq 65,<13$ | 40 | $78.3 \pm 1.5$ | $6.9 \pm 0.5$ | $3.9 \pm 0.2$ | $19.9 \pm 1.7$ | 53 |
| $\geq 65,<15$ | 82 | $81.2 \pm 1.0$ | $10.4 \pm 0.5$ | $3.6 \pm 0.1$ | $17.4 \pm 1.1$ | 30 |

Conclusion: We noted a lack of correlation between aGCS and severity of brain injury as measured by AIS, in our older pts. Therefore, many older patients with significant brain injury are not included in our sTBI report group. Our data confirms that in older pts, an aGCS<9 does not identify patients with significant brain injury or predict death. We expected that in the older patient group mortality would be higher, unexpected was how poor aGCS and AIS were as predictors of death in older pts. In older pts, an aGCS $<9$ does not adequately capture patients with significant brain injury. We believe that when making sTBI comparisons, either age should be included in the risk stratification, separate categories for sTBI in younger and older populations should be created, or sTBI should be defined by another variable.

# COMPARISON OF FOUR RISK SCALES DESCRIBED FOR GRADING OF POLYTRAUMA PATIENTS - A DATA BASE VALIDATION 

Sascha Halvachizadeh MD, Larissa Baradaran MD, Paolo Cinelli Ph.D., Roman Pfeifer MD, Hans-Christoph Pape* MD, FACS University Hospital Zurich

Introduction: Early assessment of the clinical status is crucial for decision making and the surgical treatment strategy in multiply injured patients. Several scales, ranging from expert recommendations to scores developed by data base analyses, were described to differentiate risk categories (stable, borderline, unstable, in extremis), but none was validated. We compared and validated all scales in a separate data base.
Methods: Data base from a level I Trauma Center. Inclusion criteria: complete data set (admission, daily for 3 weeks), Injury severity score $\geq 16$ points; Four scales were tested: Clinical grading scale (CGS; includes acidosis, shock, coagulation, soft tissue injuries), modified clinical grading scale (mCGS; includes CGS with modifications), Polytrauma grading score (PTGS; includes shock, coagulation, ISS), Early appropriate care protocol (EAC; includes acid base changes). These scale cover one or several pathogenetic pathways (coagulopathy, acidosis, hem. shock, soft tissue injuries). Admission values were selected from each scale and the following endpoints were compared: mortality, pneumonia, sepsis, death from hem. shock or multiple organ failure. Statistics: Pearson Chi square, Odds ratios for all endpoints, $95 \%$ confidence intervals. Sensitivity and specificity, positive and negative likelihood ratio (PLR), Krippendorff for CGS vs mCGS, R Core Team (2018), $\mathrm{p}<0.05$.
Results: 3668 severely injured patients, age $45.8 \pm 20$, ISS $28.2 \pm 15.1$; mortality $26.8 \%$, pneumonia $19.0 \%$, sepsis $14.9 \%$, death from hem. shock $4.1 \%$, multiple organ failure $1.9 \%$. Our data show distinct different results in the rate of complications, and mortality within all scores. CGS vs mCGS: shift towards more stable patients (Table I). EAC was predictive for hemorrhage, but not for late complications (pneumonia, sepsis) (Table II), while PTGS was most predictive for late complications (PLR pneumonia: 8.4, sepsis: 3.2, MOF: 16.1).
Conclusion: PTGS was most predictive for complications during the hospital stay, while EAC only predicted shock. Inclusion of values from several physiological systems (coagulation, hemorrhage, acid-base), as performed in CGS leads to higher predictability of outcomes. The data support development of a validated, easier score than existing ones to cover multiple pathways.


# IMPROVED PATIENT SELECTION RESULTS IN INCREASED SURVIVAL RATES AFTER EMERGENCY DEPARTMENT THORACOTOMY - A NATIONAL TRAUMA DATA BANK ANALYSIS 

Vanessa Buie MD, James Oyeniyi MD, Adrian Camarena BS, Matthew Present BS,MPH, Jennifer Cone MD, MHS, Kenneth Wilson* MD, FACS, Selwyn Rogers* MD, MPH, David Hampton MD, MEng University Of Chicago
Introduction: An emergency department thoracotomy (EDT) can be a life-saving intervention in trauma patients presenting in extremis. Prior to 2012, there was a paucity of evidence-based EDT guidance directing its utilization. The 2012 Western Trauma Association (WTA) guidelines recommend EDT utilization based on pre-hospital CPR time and mechanism of injury (blunt: < 10 minutes and penetrating: < 15 minutes). We hypothesized the WTA guidelines would result in fewer EDTs performed and an increased survival to hospital discharge.

Methods: Data was abstracted from the National Trauma Data Bank (2011-2016). Adult trauma patients (age $\geq 18$ ) with an Injury Severity Score (ISS) $\geq 16$, undergoing an EDT (ICD-9 code: 34.02) were included. Inter-facility transfer patients were excluded. An EDT was defined as a procedure occurring within the first 60 minutes of the emergency department evaluation. Patient demographics, initial ED vitals signs, and ED and hospital outcomes were recorded. Patients were grouped by mechanism of injury. Inter-group and intra-year comparisons were performed using chi-squared analysis and ANOVA with Benjamini-Hochberg corrections. Significance was $p \leq 0.05$.

Results: 6022 patients (ED survival: 65\% (n=3935), ED mortality: 34.6\% (n=2087))were included. Survival was associated with a significantly increased age ( $35.9 \pm 15$ y.o. vs. 33.8 $\pm 13$ y.o.), heart rate ( $105 \pm 38$ beats $/ \mathrm{min}$. vs. $50 \pm 58$ beats $/ \mathrm{min}$.), SBP ( $100 \pm 47 \mathrm{mmHg}$ vs. 46 $\pm 58 \mathrm{mmHg}$ ) and GCS (13 (IQR:3,15) vs. 3 (IQR:3,3), ( $\mathrm{p}<0.001$ ). Survival to hospital discharge was associated with a significantly lower ISS (25 (IQR:17,33) vs. 29 (IQR:20,43), $\mathrm{p}<0.001$ ). After 2012, the EDT utilization rate (procedures/100,000 trauma patients) significantly decreased (2012: $\mathrm{n}=213$; 2016: $\mathrm{n}=58, \mathrm{p}<0.001$ ). A significant increase in survival to hospital discharge was not seen, (2012: 21.8\% ( $\mathrm{n}=213$ ); 2016: $23.4 \%$ ( $n=82$ ), $\mathrm{p}=0.386$ ). A subgroup analysis demonstrated blunt trauma patients had a significant increase in survival to hospital discharge (2012: 6\% ( $\mathrm{n}=17$ ), 2016: $16 \%(\mathrm{n}=15), \mathrm{p}<0.05$ ). This significant difference was not seen in penetrating trauma patients (2012: 25.6\% ( $\mathrm{n}=206$ ), 2016: 27.5\% ( $\mathrm{n}=58$ ), $\mathrm{p}=0.104$ ).

Conclusion: The 2012 WTA EDT guidelines may have contributed to improved patient selection and accounted for decreased EDT utilization rates and increased blunt trauma patient survival.


# THE IMPACT OF A STREAMLINED TRAUMA-FOCUSED SMARTPHONE APPLICATION ON PROTOCOL COMPLIANCE AND DELIVERY OF EVIDENCE-BASED TRAUMA CARE 

Lauren M. Sinik BS, Lauren Turco MD, Charlene Dekonenko MD, Tracy J. McDonald RN, MSN, CCRN-K, Robert D. Winfield* MD, University of Kansas Medical Center

Introduction: In November 2015, we created an institution-specific mobile app to provide rapid access to trauma policies and protocols. Beta testing indicated that the app was cumbersome and infrequently used. In June 2018, the app was redesigned to feature protocol infographics and treatment algorithms available offline, eliminating the need for internet access and scrolling through links to web pages and lengthy text fields to find information. Prior to introducing the new app into daily use, residents, nurse practitioners (NPs), and attending trauma surgeons were formally educated on app content, use, and the method for adding the app to mobile devices. We sought to evaluate the efficacy of the new version of the app to facilitate access to trauma-specific knowledge.

Methods: This was a prospective, randomized study of the effectiveness of a streamlined, institution-specific trauma app. Participants included general surgery residents, NPs, and attending trauma surgeons. The primary exposure of interest was access to the app during a multiple-choice exam consisting of questions regarding management of trauma scenarios, and participants were randomized 1:1 to have or not have app access during the exam. The primary outcomes measured were time to exam completion and number of questions answered correctly. Results were further compared to our historical cohort from testing of the 2015 version to assess improvement.

Results: 30 participants tested the current version of the app: 15 with app access to complete the quiz and 15 without app access. The group with access scored more accurately on the quiz compared to the group without access ( $70 \%$ vs $50 \%$, $\mathrm{p}=0.002$ ), and to the group that had access during the 2015 study ( $\mathrm{n}=15,55 \%$ correct, $\mathrm{p}=0.037$ ). Access to the current app version led to an increased amount of time for exam completion, with the access group taking longer than those without access in the current study (11:21 vs $5: 39, p<0.001$ ) and those with access in the historical cohort (9:09, NS).

Conclusion: The newest version of our institution-specific trauma app led to improved ability to apply knowledge correctly, but continued to do so at the expense of time. Further work is needed to optimize this tool, but it continues to show promise as an inexpensive, highly reproducible tool to aid trauma centers in applying evidence-based knowledge at the point of care.

## SCHOLARSHIP FUND

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Matthew Delano, M.D.
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2008-2009
2009-2011

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Mitchell Jay Cohen, M.D.
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2007-2012
2008-2013
2009-2013
2010-2013
2011-2013

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Alicia Mohr, M.D.
Mitchell Jay Cohen, M.D.
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Jason Sperry, M.D.
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AAST/ETHICON RESEARCH GRANT IN LOCAL WOUND HAEMOSTATICS AND HEMORRHAGE CONTROL

2007-2008
2008-2009
2009-2010
2010-2011

Kenji Inaba, M.D. Jose Pascual, M.D.
Jennifer Watters, M.D.
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## AAST/KCI RESEARCH GRANT IN WOUND CARE

2007-2008
2008-2009
2009-2010
2010-2011
2011-2012

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As of July 22, 2019

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## AMERICAN ASSOCIATION FOR THE SURGERY OF TRAUMA 25th ANNIVERSARY FUND DONORS

Thank you to all of those who contributed to our 25th Research and Education Fund Anniversary! Because of your efforts, AAST will be able to sponsor 19 medical stu-dents, in-training fellows, and residents to the 79th Annual Meeting of AAST.
We hope to also be able to sponsor one new study to use the MIT data collection tool.

Dr. Mary-MargaretBrandt<br>Dr. Omar Danner<br>Dr. Jody DiGiacomo<br>Dr. Douglas Fraser<br>Dr. Dennis Kim<br>Dr. Ajai Malhotra<br>Dr. Patricia O'Neill<br>Dr. Thomas Scalea<br>Dr. Donald Trunkey

IN MEMORY

# IN MEMORY 

Basil A. Pruitt, Jr.<br>San Antonio, Texas<br>(1930-2019)<br>Member Since 1966

Donald D. Trunkey<br>Portland, Oregon<br>(1937-2019)<br>Member Since 1975

# AAST WAS NOTIFIED IN 2019 THAT THE FOLLOWING MEMBERS ARE DECEASED 

J. Alex Haller, Jr.<br>Baltimore, Maryland<br>(1927-2018)<br>Member Since 1965

Thomas V. Berne<br>Los Angeles, California<br>(1936-2017)<br>Member Since 1981



Basil A. Pruitt, Jr., MD, FACS, FCCM, MCCM
(1930-2019)
Professor of Surgery and Dr. Ferdinand P. Herff Chair in Surgery, UT Health San Antonio

We are deeply saddened to announce that Basil A. Pruitt, Jr., MD died yesterday afternoon, March 17, 2019. Dr. Pruitt had a major and sustained international impact on the fields of surgery, burn care, trauma and critical care. His contributions in these fields were transformational and directly led to dramatic improvements in patient care marked by improved survival, decreased complications and improved health.

Dr. Pruitt graduated from Harvard College (1952) followed by Medical School at Tufts (1957). He completed his initial surgical training at the Boston City Hospital under the tutelage of C. Gardner Childs (1957-1962). From there he completed his surgical residency at Brooke General Hospital in San Antonio (1964).

From 1967-1968 Dr. Pruitt served as Chief of Surgery and Chief of Professional Services at the busiest evacuation hospital in Vietnam ( 400 to 500 major operations a month) and then Chief of the Trauma Research Team, where he studied the cardiopulmonary responses to injury in combat casualties. Dr. Pruitt became the Commander and Director of the U.S. Army Institute of Surgical Research where he served for the next 27 years. He went on to literally change history by revolutionizing the management of trauma, burn and critically ill or injured patients worldwide.

Dr. Pruitt retired from the US Army Medical Corps in 1995 and accepted a faculty position as Professor of Surgery at UT Health San Antonio, where he held the Dr. Ferdinand P. Herff Chair in Surgery. In his role at UT Health San Antonio, Dr. Pruitt has been a cherished, respected and loved mentor and colleague. He has supported the development of hundreds of residents, students, faculty, staff and leaders at UT Health San Antonio. As a faculty member at UT Health San Antonio, Dr. Pruitt remained an active contributor to the US Army Institute for Surgical Research (USA ISR), and also served as the Editor-in-Chief of the Journal of Trauma for 17 years.

Dr. Pruitt's work as a leader, surgeon and scientist with the USA ISR forged a model where rigorous scientific inquiry was followed by a dogged translation of this science into dramatic care improvements. This is the gem crafted by Dr. Basil A. Pruitt, Jr. This work transformed the fields of burn care, trauma and surgical critical care.

## Cumulative Innovative Achievements

Although Dr. Pruitt's research had a military beginning, the fruits of his labor have been assimilated into civilian medical practice worldwide with associated dramatic reductions in both death and complication rates.

Dr. Pruitt has been internationally recognized with appointments to the NIH study sections, the Veterans Administration Merit Review Board for Surgery, and the Shriners Hospitals Research Advisory Board and Clinical Outcomes Studies Advisory Board. He has also served as a reviewer for the Hong Kong Research Grants Council, the BC Health Research Foundation and Alberta Heritage Foundation, and the NIH for which he has functioned as a special panel member. Over the course of his career he authored over 470 peer reviewed publications, 181 textbook chapters and 15 books and monographs.

Perhaps Dr. Pruitt's most enduring legacy is his mentorship of a cadre of physicians and scientists who have become international leaders in Medicine. Among that group are 46 directors of burn centers and units in the United States and abroad, 23 department chairs (including departments of surgery, urology, anesthesiology, plastic surgery, pediatric surgery and medicine), 11 past presidents of the American Burn Association, 2 past presidents of the International Society for Burn Injury, past Presidents of the American Association for the Surgery of Trauma, the past Chair of the American College of Surgeons Committee on Trauma and at least six academic chairs in the Japanese fields of Acute Care Medicine and Surgery.

Dr. Pruitt served for twenty years as the Associate Editor of the Journal of Trauma. Following this he became the Editor-in-Chief of the Journal of Trauma for the next 17 years. Additionally, Dr. Pruitt served as a member of the Editorial Board of 13 other journals, including two published in China and one published in Turkey. He has served as an ad hoc reviewer for an additional 26 journals.

One measure of his stature as an innovator is the recognition by his peers. He was elected as the president of 12 surgical societies:

American Burn Association<br>Southern Surgical Association<br>Halsted Society<br>American Trauma Society<br>Western Surgical Association<br>Surgeons Travel Club

> American Association for the Surgery of Trauma
> American Surgical Association
> Surgical Infection Society
> North American Burn Society
> International Society for Burn Injuries
> Shock Society

His awards include 11 honorary memberships, the Metcalfe Award, the Curtis P.Artz Memorial Award, the Harvey Stuart Allen Distinguished Service Award, the Baron Dominique Larrey Award for Surgical Excellence, the National Safety Council's Surgeons' Award for Distinguished Service to Safety, an International Honorary Professorship of Surgery at the Third Military Medical College People's Republic of China, the Danis Award from the Société Internationale de Chirurgie, and the American Surgical Association's Medallion for Scientific Achievement. In 2000, Dr. Pruitt was recognized with the Distinguished Investigator Award from the American College of Critical Care Medicine along with the G. Whitaker International Burns Prize. The Tanner-Vandeput-Boswick Burn Prize was awarded to him in 2006. In 2007, he accepted the Roswell Park Medal and received a lifetime achievement award from the Society of University Surgeons. As a co-winner of the King Faisal International Prize in Medicine in 2008, Dr. Pruitt was honored in Riyadh, Saudi Arabia. In 2010, he received the Lifetime Achievement Award of the American Burn Association; later that same year, he was inducted as the first foreign honorary member of the Japanese Association for Acute Medicine. In 2015 Dr. Pruitt received the Association of Military Surgeons of the United States Lifetime Achievement Award. In 2017 he was selected as the 2nd Vice President of the American College of Surgeons and later in the same year, he was honored as an Icon in Surgery by the American College of Surgeons. In 2018 Dr. Pruitt received the BioMed SA Lifetime Achievement Award.

Of burn care peer reviewed articles over the past 55 years, Dr. Pruitt has had the largest number of top cited articles.

Over the past half century, Dr. Basil A. Pruitt, Jr., a great citizen, surgeon, innovator, mentor, and leader, transformed our world through his dogged commitment to science and his service to humanity. Dr. Pruitt's contributions live on through the work of surgeons, physicians, scientists and organizations he shaped and inspired. Dr. Pruitt's mentorship and support has made a real difference in my life and in the lives of our faculty, residents and students. We are forever grateful. Our thoughts and prayers are with his amazing family in this time of loss.

For all the patients who will be treated at a burn center or trauma center today, this week and into the future: each and every one of these patient's care has been impacted and improved through the lifetime work of Dr. Basil A. Pruitt, Jr.


Dr. Donald D. Trunkey, FACS<br>(1937-2019)

It is with sadness that we report the passing of one of Trauma Surgery's greatest icons, Dr. Donald D. Trunkey. Dr. Trunkey served as the Chair of the ACS Committee on Trauma from 1982-1986 and as President of the American Association for the Surgery of Trauma 1986-1987. In 1976, Dr. Trunkey led the COT's efforts to publish the Optimal Hospital Resources for the Care of the Seriously Injured- the first document aimed at defining and developing trauma centers and trauma systems. Dr. Trunkey, MD, FACS was a pioneer in trauma system development, publishing seminal work on the impact of trauma systems development on preventable death. A critical moment in Dr. Trunkey's career was when he published a paper in 1979 on death rates of trauma patients in the more rural Orange County, California compared to those in San Francisco County. It was one of the earliest, most persuasive pieces of evidence on the effectiveness of trauma centers. His message was unwavering: injured patients deserve the best trauma care available, and the best care includes an organized trauma system.

Dr. Trunkey grew up in rural Eastern Washington and was an alumni of the University of Washington Medical School. He did a rotating internship at the University of Oregon and then served in the US Army from 1964-1966. He completed his surgical training at UCSF and became a faulty member in 1972. He was Chief of the Burn Center at UCSF and had established a laboratory to study mechanisms of shock at the cellular level. In 1986, he was recruited back to Oregon Health Science University where he served as the Mackenzie Professor and Chair of the Department of Surgery from 1986 - 2001.

Five years into his term as Chair, Dr. Trunkey was activated from reserve status to active military to serve in the first Gulf War in 1991. He was stationed in Riyadh, Saudi Arabia during Operation Desert Storm and Desert Shield. He dealt with a number of operational and cultural obstacles that prompted him to publish a commentary in the March 1993 edition of Archives of Surgery called "Lessons Learned." This document paved the way for how the U.S. Department of Defense trains its trauma personnel today.

In 2008, he received the King Faisal prize in medicine for his research improving trauma care. He has many other awards including Distinguished Service Award of the American College of Surgeons, Washington State University College of Science Distinguished Alumnus Award, Barry Goldwater Service Award, International Society of Surgery Prize, Honorary Membership of the British Association for Accident and Emergency Medicine and Honorary Fellowships of the Royal Colleges of Surgeons of England, Ireland, Edinburgh, Glasgow, South Africa and Brazil, Medal of the Royal College of Medicine of England and Honorary Professorship of the Royal College of Surgeons of Edinburgh. In 1989, he delivered the Scudder Oration on Trauma entitled, "What's Wrong with Trauma Care?". In 2018, he received the Icons in Surgery award from the American College of Surgeons.

Above all, Dr. Trunkey is remembered for his kindness, support, and mentorship to an entire generation of trauma surgeons. We offer his wife Jane and their 2 children and grandchildren our heartfelt condolences.

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79th Annual Meeting of AAST \& Clinical Congress of Acute Care Surgery •

$78^{\text {th }}$ Annual Meeting of AAST and Clinical Congress of Acute Care Surgery
Dallas, Texas • September 18-21, 2019

| TUE. 9/17/2019 | FUNCTION | ROOM |
| :---: | :---: | :---: |
| 2:00 PM - 6:30 PM | Registration | Skybridge Registration |
| WED. 9/18/2019 | FUNCTION | ROOM |
| 6:30 AM - 5:30 PM | Registration | Skybridge Registration |
| 7:00 AM - 11:30 AM | Presession: Sponsored by the Military Committee | Lone Star Ballroom C1 |
| 7:00 AM - 11:30 AM | Presession: Sponsored by the Pallative Care Committee | Lone Star Ballroom C2 |
| 7:00 AM - 11:45 AM | Presession: Sponsored by the Education Committee | Lone Star Ballroom C3 |
| 7:00 AM - 11:30 AM | Presession: Sponsored by the ACS Committee/SAGES | Houston Room A |
| 10:00 AM | Silent Auction Opens | Lone Star Preconvene ABC |
| 10:30 AM - 12:00 PM | TSACO Editorial Board Meeting (Invitation Only) | Executive Boardroom |
| 11:00 AM -12:00 PM | Committee Meetings Session I | See Annual Meeting App |
| 12:30 PM - 1:00 PM | Welcome | Lone Star Ballroom A/B |
| 1:00 PM - 3:40 PM | Session I: Plenary Papers 1-8 | Lone Star Ballroom A/B |
| 3:40 PM - 4:10 PM | Session II: Master Surgeon Lecture: J. Wayne Meredith, MD | Lone Star Ballroom A/B |
| 4:10 PM - 5:25 PM | Session III: AAST Panel | Lone Star Ballroom A/B |
| 5:30 PM - 7:30 PM | Exhibits Open | Lone Star Preconvene ABC |
| 5:30 PM - 6:30 PM | Session IV: Poster Session I | See Annual Meeting App |
| 6:30 PM - 7:30 PM | Welcome Reception | Lone Star Preconvene ABC |
| 6:45 PM - 9:30 PM | JTACS Editorial Meeting (Invitation Only) | Houston Room A |
| THURS. 9/19/2019 | FUNCTION | ROOM |
| 7:00 AM -8:30 AM | Breakfast in the Exhibit Hall | Lone Star Preconvene ABC |
| 7:00 AM - 3:00 PM | Exhibits | Lone Star Preconvene ABC |
| 7:00 AM - 4:00 PM | Registration | Skybridge Registration |
| 6:15 AM - 7:30 AM | Committee Meetings Session II | See Annual Meeting App |
| 6:15 AM - 7:30 AM | Resident/Student/In-Training Fellow Breakfast (Ticketed Event) | Lone Star Ballroom C3 |
| 6:15 AM - 7:30 AM | International Attendee Breakfast (Ticketed Event) | Lone Star Ballroom C4 |
| 7:30 AM - 9:30 AM | Session V: Canizaro Papers 9-14 | Lone Star Ballroom A/B |
| 9:30 AM - 10:00 AM | Session VI: Scholarship Presentations | Lone Star Ballroom A/B |
| 10:00 AM - 10:20 AM | Break in Exhibit Hall | Lone Star Preconvene ABC |
| 10:20 AM - 11:20 AM | Session VII: Papers 15-17 | Lone Star Ballroom A/B |
| 11:30 AM - 12:30 PM | Session VIII: Presidential Address | Lone Star Ballroom A/B |
| 12:30 PM - 1:45 PM | Lunch Sessions I-VI | Room Location on Ticket |
| 2:00 PM - 5:00 PM | Session IXA: Papers 18-26 | Lone Star Ballroom A |
| 2:00 PM - 5:00 PM | Session IXB: Papers 27-35 | Lone Star Ballroom B |
| FRI. 9/20/2019 | FUNCTION | ROOM |
| 6:15 AM - 7:30 AM | Breakfast Sessions I-VI | Room Location on Ticket |
| 7:00 AM - 8:30 AM | Breakfast in Exhibit Hall | Lone Star Preconvene ABC |
| 7:00 AM - 2:00 PM | Exhibits | Lone Star Preconvene ABC |
| 7:00 AM - 3:00 PM | Registration | Skybridge Registration |
| 7:30 AM - 8:00 AM | Session X: Master Surgeon Lecture: Gregory J. Jurkovich, MD | Lone Star Ballroom A/B |
| 8:00 AM - 11:00 AM | Session XI: Papers 36-44 | Lone Star Ballroom A/B |
| 11:00 AM - 12:00 PM | Session XII: Fitts Lecture: Timothy C. Fabian, MD | Lone Star Ballroom A/B |
| 12:00 PM - 1:00 PM | Session XIII: Poster Session II | See Annual Meeting App |
| 1:00 PM - 1:45 PM | Lunch with Exhibitors | Lone Star Preconvene ABC |
| 1:00 PM - 2:00 PM | ACS Program Directors Meeting | San Antonio Room A |
| 2:00 PM - 5:00 PM | Session XIVA: Papers 45-53 | Lone Star Ballroom A |
| 2:00 PM - 5:00 PM | Session XIVB: Papers 54-63 | Lone Star Ballroom B |
| 3:00 PM | Silent Auction Closes | Lone Star Preconvene ABC |
| 5:20 PM - 7:00 PM | AAST Annual Business Meeting | Lone Star Ballroom B |
| 7:30 PM - 8:00 PM | Reception | Lone Star Preconvene ABC |
| 8:00 PM - 11:00 PM | Banquet/Experience cfotsT | Lone Star Ballroom A |
| SAT. 9/21/2016 | FUNCTION | ROOM |
| 7:00 AM - 8:00 AM | New Fellows Breakfast (Ticketed Event) | The Kitchen Garden |
| 7:30 AM - 10:00 AM | Registration | Skybridge Registration |
| 7:30 AM - 9:00 AM | Breakfast | Lone Star Preconvene A/B |
| 8:00 AM - 9:00 AM | Session XV: Sunrise Session: Papers 64-66 | Lone Star Ballroom B |
| 9:00 AM - 9:10 AM | Break | Lone Star Preconvene ABC |
| 9:10 AM - 10:28 AM | Session XVI: Quickshot Session I: Papers 1-13 | Lone Star Ballroom B |
| 10:28 AM - 10:38 AM | Break | Lone Star Preconvene ABC |
| 10:38 AM - 11:56 AM | Session XVII: Quickshot Session II: Papers 14-26 | Lone Star Ballroom B |
| 12:00 PM | Meeting Adjourned | Go Home! |

## SPEAKER READY ROOM: Press Club Room

| Tuesday, September 17, 2019 | 9:00 AM - 7:00 PM |
| :--- | :--- |
| Wednesday, September 18, 2019 | 6:00 AM - 6:00 PM |
| Thursday, September 19, 2019 | 6:00 AM - 6:00 PM |

Thursday, September 19, 2019
6:00 AM - 6:00 PM

Friday, September 20, 2019
Saturday, September 21, 2019

6:00 AM - 6:30 PM
7:00 AM - 11:00 AM


[^0]:    * Mean (SD); ~n(\%)

