PREHOSPITAL MANAGEMENT OF HYPOTENSIVE TRAUMA PATIENTS

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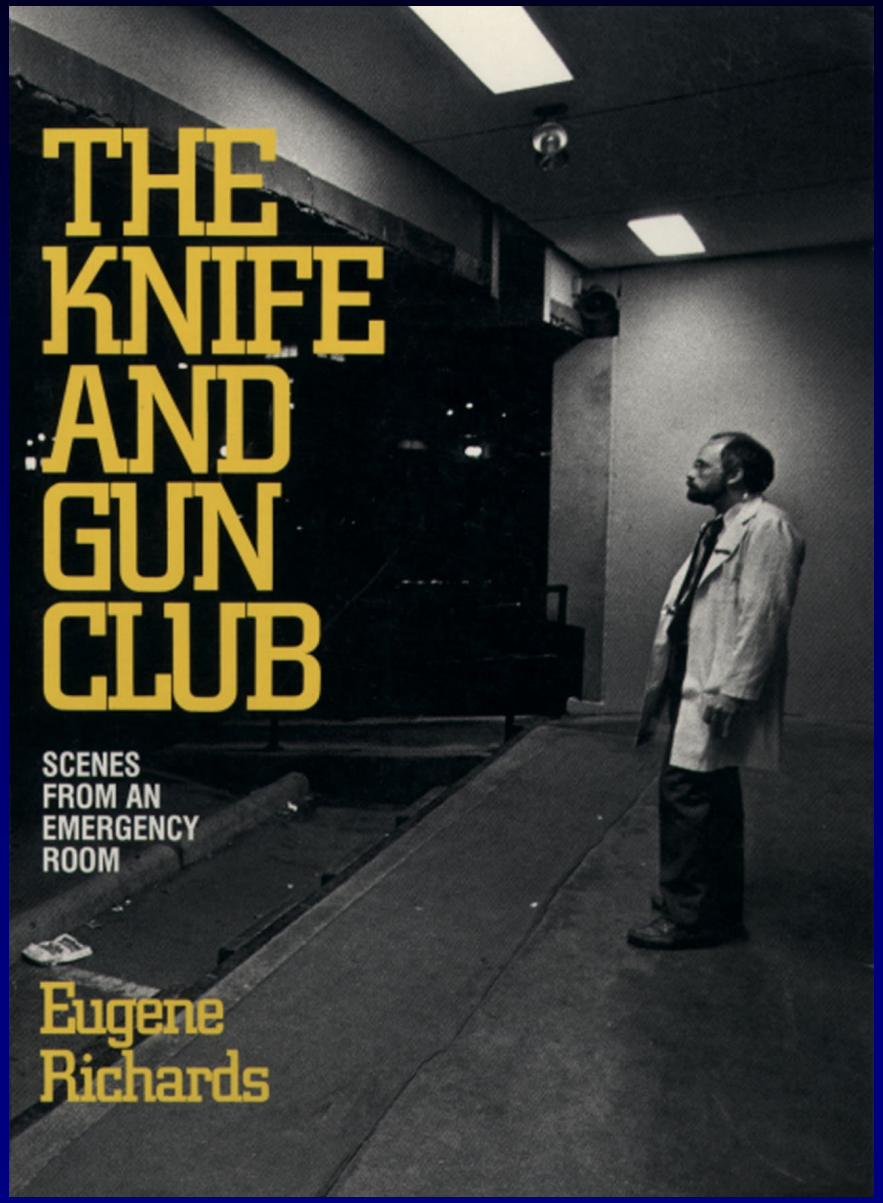
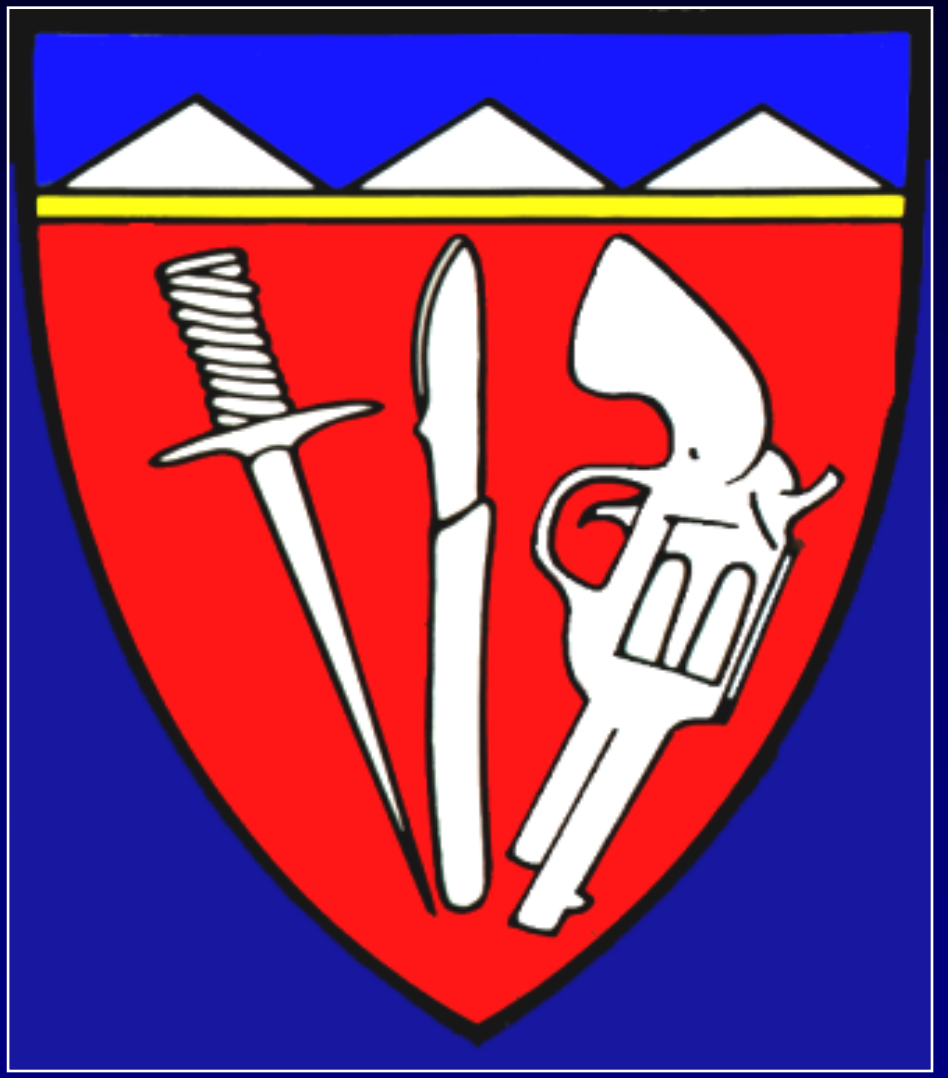
Scripps

DISCLOSURES

- No Financial Disclosures
- Discussing Adults Only

DENVER GENERAL HOSPITAL






Scripps
La Jolla
TRAUMA TEAM
EST. 1981

ATLS "C" - ETIOLOGIES OF SHOCK

- **Hemorrhagic**
- **Cardiac Compressive**
- **Cardiogenic**
- **Neurogenic**
- **Septic**

"Definitive control of hemorrhage and restoration of adequate circulating volume are the goals of treating hemorrhagic shock"

COUNTY OF SAN DIEGO
HEALTH & HUMAN SERVICES AGENCY
EMERGENCY MEDICAL SERVICES

COUNTY OF SAN DIEGO EMERGENCY MEDICAL SERVICES
POLICY / PROCEDURE / PROTOCOL

Number **S-139**
Page **1 of 2**

SUBJECT: **TREATMENT PROTOCOL**
TRAUMA

Date **07/01/2021**

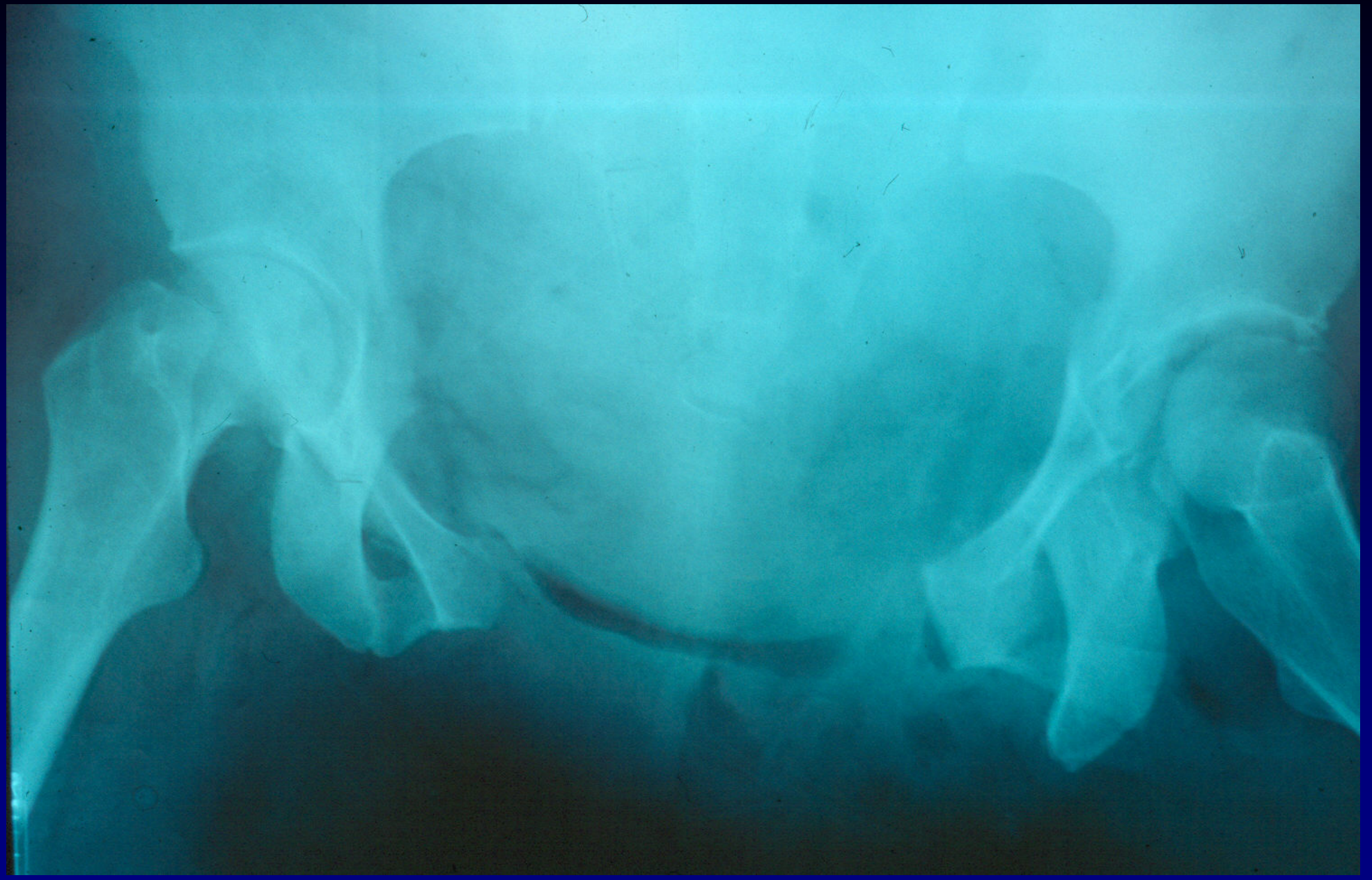
- Direct pressure to control external hemorrhage
- Apply gauze or hemostatic dressing PRN
- Tourniquet PRN

Systematic review of prehospital tourniquet use in civilian limb trauma

J Trauma Acute Care Surg 2018; 84:819

David S. Kauvar, MD, Michael A. Dubick, PhD,
Thomas J. Walters, PhD, *and* **John F. Kragh, Jr., MD**, *Houston, Texas*

later amputated. The rate of any complication was reported in three studies and averaged 24%. Limb-specific complications were reported, including extremity compartment syndrome (four studies, 4.0%), peripheral nerve dysfunction (three studies, 3.7%), and wound infection (three studies, 4.0%) (Table 3).



Current management of hemorrhage from severe pelvic fractures: Results of an American Association for the Surgery of Trauma multi-institutional trial

J Trauma Acute Care Surg 2016; 80:717

Todd W. Costantini, MD, Raul Coimbra, MD, PhD, John B. Holcomb, MD, Jeanette M. Podbielski, Richard Catalano, MD, Allie Blackburn, MD, Thomas M. Scalea, MD, Deborah M. Stein, MD, MPH, Lashonda Williams, MD, Joseph Conflitti, MD, Scott Keeney, DO, Ghada Suleiman, Tianhua Zhou, Jason Sperry, MD, Dimitra Skiada, MD, Kenji Inaba, MD, Brian H. Williams, MD, Joseph P. Minei, MD, Alicia Privette, MD, Robert C. Mackersie, MD, Brenton R. Robinson, Forrest O. Moore, MD, *and* the AAST Pelvic Fracture Study Group, *San Diego, California*

178 (13%) of 1339 Patients Admitted in Shock (SBP <90, HR >120, or BD >5)

32% Mortality

86:658

PELVIC STABILIZATION

Consider if Severe Shock and High-Risk Mechanism, e.g.:

- **Pedestrian Struck**
- **Motorcycle Crash**
- **30 ft Fall**

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SUBJECT: **TREATMENT PROTOCOL**
TRAUMA

Date **07/01/2021**

SBP <80 mmHg or signs of shock

- 500 mL fluid bolus IV/IO SO, MR x3 q15 min to maintain SBP ≥80 mmHg

TWO ISSUES

- Excessive Crystalloid
- Permissive Hypotension

Damage Control: Keep a Badly Damaged Ship Afloat After Major Penetrating Injury to the Hull

Damage Control: Keep a Badly Damaged Ship Afloat After Major Penetrating Injury to the Hull

Plug Gaping Holes

Extinguish Fires

"Dog Down" Watertight Doors

Keep Ship Afloat

- Assess Overall Damage
- Establish a Plan for Definitive Repair

DAMAGE CONTROL

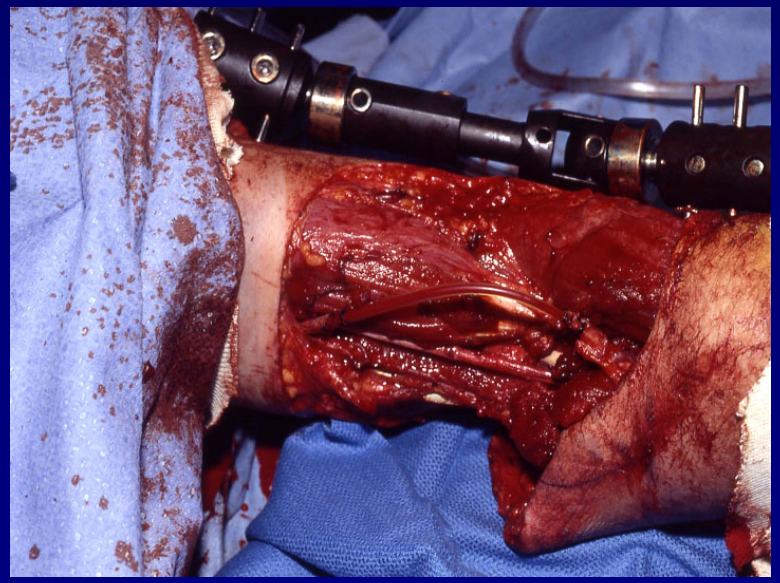
1976- Lucas & Ledgerwood
1981- Feliciano et al

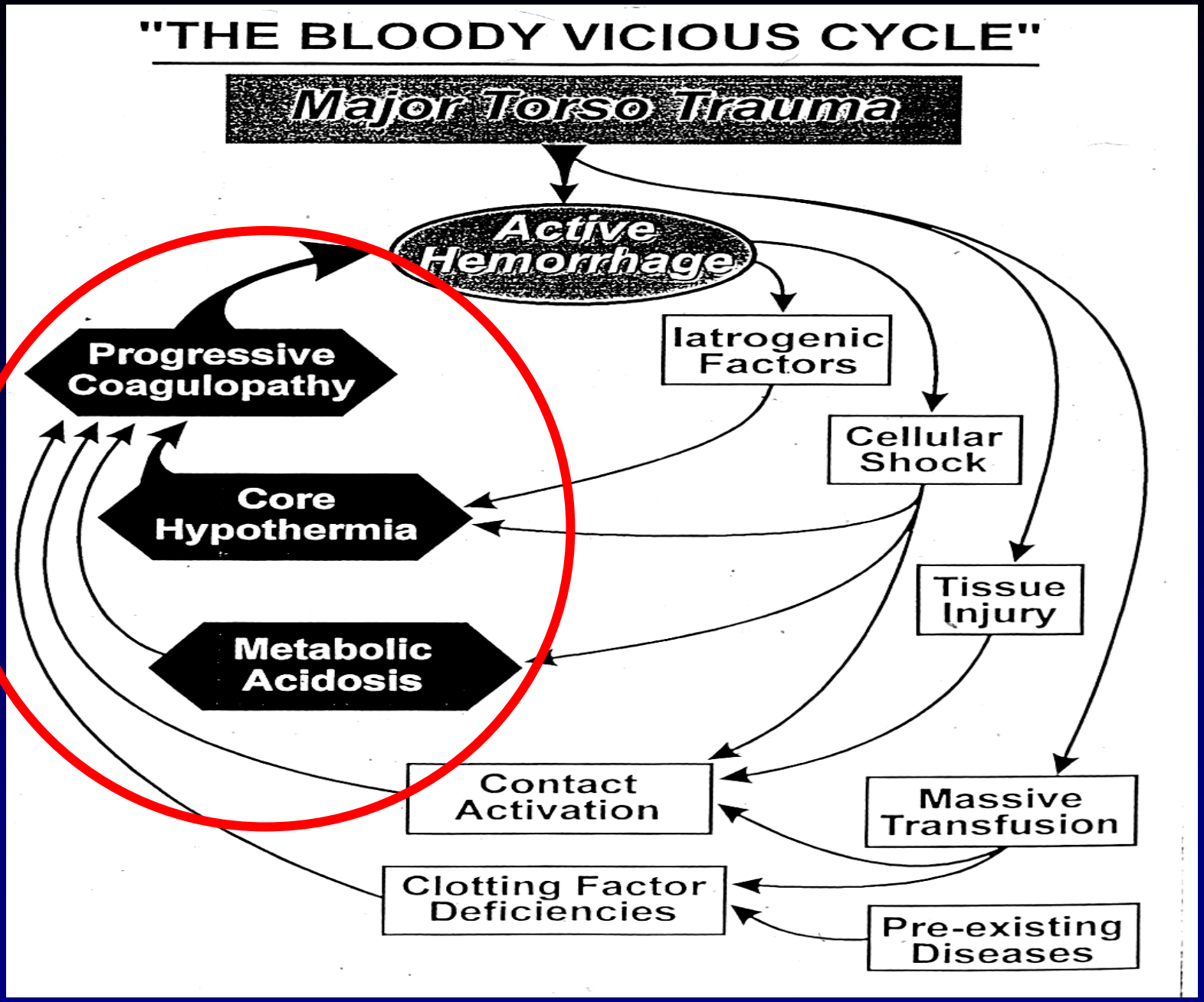
Liver Packing

1983- Stone et al

Multitrauma, Coagulopathy

1993- Rotondo et al





Kashuk J, Moore EE et al. J Trauma 1982; 22:261

Damage Control Resuscitation: Directly Addressing the Early Coagulopathy of Trauma

J Trauma 2007; 62:307

John B. Holcomb, MD, FACS, Don Jenkins, MD, FACS, Peter Rhee, MD, FACS, Jay Johannigman, MD, FS, FACS, Peter Mahoney, FRCA, RAMC, Sumeru Mehta, MD, E. Darrin Cox, MD, FACS, Michael J. Gehrke, MD, Greg J. Beilman, MD, FACS, Martin Schreiber, MD, FACS, Stephen F. Flaherty, MD, FACS, Kurt W. Grathwohl, MD, Phillip C. Spinella, MD, Jeremy G. Perkins, MD, Alec C. Beekley, MD, FACS, Neil R. McMullin, MD, Myung S. Park, MD, FACS, Ernest A. Gonzalez, MD, FACS, Charles E. Wade, PhD, Michael A. Dubick, PhD, C. William Schwab, MD, FACS, Fred A. Moore, MD, FACS, Howard R. Champion, FRCS, David B. Hoyt, MD, FACS, and John R. Hess, MD, MPH, FACP

"Damage control resuscitation addresses the entire lethal triad immediately upon admission to a combat hospital"

DAMAGE CONTROL RESUSCITATION

- Avoid / Treat Hypothermia
- Permissive Hypotension (Selective)
- Limit Isotonic Crystalloid
- Hemostatic Resuscitation
- Bleeding Control
- Aggressive Hemostatic Resuscitation, POC Testing
- Correction of Acidosis, Hypocalcemia

PERMISSIVE HYPOTENSION

- First Described 1918: Restrict Crystalloid, Maintain BP Below Normal, Until Hemostasis

  Cannon WB JAMA 1918; 70:618

- Aggressive Fluid May Increase Hydrostatic Pressure, Dislodge Clots, Lead to Dilutional Coagulopathy and Hypothermia
- Animal Studies- Survival Benefit
- Human Studies- ALI; ACS; Inc Vent Days, LOS

J Trauma Acute Care Surg 2018; 84:802

The New England
Journal of Medicine

Volume 331 OCTOBER 27, 1994 Number 17

IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS WITH PENETRATING TORSO INJURIES

WILLIAM H. BICKELL, M.D., MATTHEW J. WALL, JR., M.D., PAUL E. PEPE, M.D., R. RUSSELL MARTIN, M.D., VICTORIA F. GINGER, M.S.N., MARY K. ALLEN, B.A., AND KENNETH L. MATTOX, M.D.

Permissive hypotension versus conventional resuscitation strategies in adult trauma patients with hemorrhagic shock: A systematic review and meta-analysis of randomized controlled trials

Alexandre Tran, MD, Jeffrey Yates, MD, Aaron Lau, MD, Jacinthe Lampron, MD, *and* **Maher Matar, MD**, *Ottawa, Canada*

TABLE 2. Primary Outcome Data (Mortality)

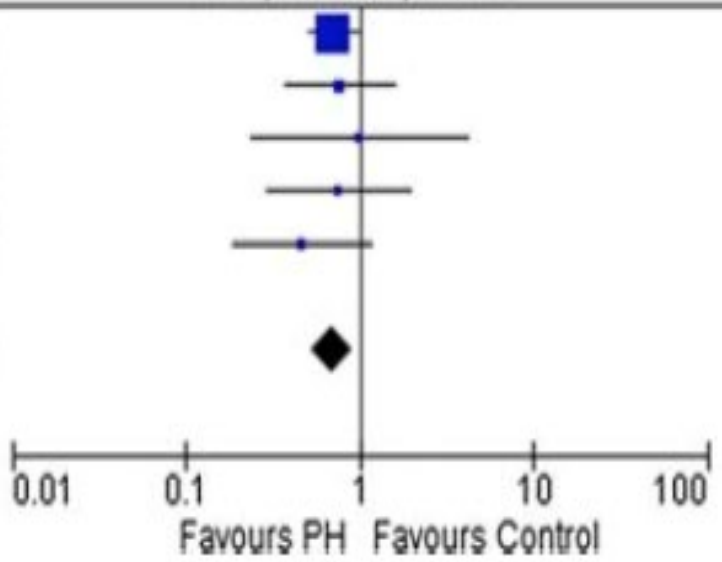
Study	Primary Outcome	Study Arm	Mortality	Significance
Bickell et al. (1994)[14]	In-hospital mortality	Control	116/309 (37.5%)	$p = 0.04$
		PH	86/289 (29.7%)	
Carrick et al. (2016)[16]	30-d Mortality	Control	21/72 (26.3%)	NS
		PH	18/86 (21.4%)	
Dutton et al. (2002)[21]	In-hospital mortality	Control	4/55 (7.3%)	NS
		PH	4/55 (7.3%)	
Morrison et al. (2011)[22]	30-d Mortality	Control	13/46 (28.2%)	NS
		PH	10/44 (22.7%)	
Schreiber et al. (2015)[17]	In-hospital mortality	Control	15/91 (16.5%)	NS
		PH	8/95 (8.4%)	

J Trauma Acute Care Surg 2018; 84:802

Study or Subgroup	Permissive Hypotension Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Bickell 1994	86	289	116	309	64.5%	0.70 [0.50, 0.99]
Carrick 2016	18	86	21	82	14.6%	0.77 [0.37, 1.58]
Dutton 2002	4	55	4	55	3.6%	1.00 [0.24, 4.22]
Morrison 2011	10	44	13	46	8.3%	0.75 [0.29, 1.94]
Schreiber 2015	8	95	15	91	9.0%	0.47 [0.19, 1.16]
Total (95% CI)		569		583	100.0%	0.70 [0.53, 0.92]
Total events	126		169			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.09$, $df = 4$ ($P = 0.90$); $I^2 = 0\%$

Test for overall effect: $Z = 2.55$ ($P = 0.01$)



of five randomized controlled trials, we demonstrate a survival benefit for lower blood pressure targets as compared with conventional resuscitation thresholds. However, the studies were generally underpowered and of poor to moderate quality, thus reflecting a need for further high quality, adequately powered trials. We additionally observe that patients receiving permissive hypotension have lower reported blood loss volumes, reduced blood product utilization and lower volumes of crystalloid administration. The ideal blood pressure target for such a strategy remains unclear.

J Trauma Acute Care Surg 2018; 84:802

ATLS 10e

Fluid resuscitation and avoidance of hypotension are important principles in the initial management of patients with blunt trauma, particularly TBI.

In penetrating trauma with hemorrhage, delaying aggressive fluid resuscitation until definitive control of hemorrhage may prevent additional bleeding.

A controlled resuscitation strategy is feasible and safe in hypotensive trauma patients: Results of a prospective randomized pilot trial

Martin A. Schreiber, MD, Eric N. Meier, MS, Samuel A. Tisherman, MD, Jeffrey D. Kerby, MD, PhD, Craig D. Newgard, MD, MPH, Karen Brasel, MD, Debra Egan, MSc, MPH, William Witham, MD, Carolyn Williams, RN, Mohamud Daya, MD, Jeff Beeson, DO, Belinda H. McCully, PhD, Stephen Wheeler, MD, Delores Kannas, RN, MS, MHA, Susanne May, PhD, Barbara McKnight, PhD, David B. Hoyt, MD, *and* the ROC Investigators, *Chicago, Illinois*

- Controlled (250 mL prn, SBP >70) vs Standard Resuscitation (2L +prn, SBP >110)
- Penetrating Trauma 9% vs 9%
- Blunt 3% CR vs 18% SR
- Worse Renal Function in CR

J Trauma Acute Care Surg 2015; 78:687

Trauma Hemostasis and Oxygenation Research Network position paper on the role of hypotensive resuscitation as part of remote damage control resuscitation

**Thomas Woolley, MD, Patrick Thompson, Emrys Kirkman, PhD, Richard Reed, Sylvain Ausset, MD, Andrew Beckett, MD, Christopher Bjerkvig, MD, Andrew P. Cap, MD, PhD, Tim Coats, MD, Mitchell Cohen, MD, Marc Despasquale, Warren Dorlac, MD, Heidi Doughty, Richard Dutton, MD, Brian Eastridge, Elon Glassberg, MD, Anthony Hudson, Donald Jenkins, MD, Sean Keenan, MD, Christophe Martinaud, PhD, Ethan Miles, Ernest Moore, MD, Giles Nordmann, Nicolas Prat, PhD, Joseph Rappold, MD, Michael C. Reade, MBBD D Phil, Paul Rees, MD, Rory Rickard, PhD, Martin Schreiber, MD, Stacy Shackelford, MD, Håkon Skogran Eliassen, Jason Smith, MD, Mike Smith, PhD, Philip Spinella, MD, Geir Strandenes, MD, Kevin Ward, MD, Sarah Watts, PhD, Nathan White, MD, *and* Steve Williams, *Birmingham, United Kingdom*

J Trauma Acute Care Surg 2018; 84(Suppl 1):S3-S13

HYPOTENSIVE RESUSCITATION CAVEATS

- Organ Hypoperfusion---Oxygen Debt
- Hemorrhagic Shock---Renal Failure (Lesson Learned in Wartime)

J Trauma Acute Care Surg 2018; 84(Suppl 1):S3-S13

HYPOTENSIVE RESUSCITATION

- **Late Use of Fluids**
  - Weak Evidence, Not Generalizable
- **Restrictive Volume Administration**
  - Weak Evidence
- **Hypotensive Targets**
  - No Proven Benefit

Principles may only apply in mature trauma systems with short transport times, rapid access to surgery, and only crystalloid is being used

J Trauma Acute Care Surg 2018; 84(Suppl 1):S3-S13

BLOOD PRESSURE TARGET

- **85 mmHg seems too low** for a prolonged period Emerson et al, Ann Surg 1945; 122:745
- **110 mmHg** may be "Lower Limit of Normal" Eastridge et al, J Trauma 2007; 63:291
- **Higher targets in TBI (>100-110 mmHg systolic)** Brain Trauma Foundation 2016
- **90 mins** may be Upper Limit Li et al, Anesthesiology 2011; 114:111

Further Research is Needed

Goal-directed resuscitation in the prehospital setting: A propensity-adjusted analysis

J Trauma Acute Care Surg 2013; 74:1207

Joshua B. Brown, MD, Mitchell J. Cohen, MD, Joseph P. Minei, MD, Ronald V. Maier, MD, Michael A. West, MD, Timothy R. Billiar, MD, Andrew B. Peitzman, MD, Ernest E. Moore, MD, Joseph Cuschieri, MD, Jason L. Sperry, MD, MPH,
and The Inflammation and the Host Response to Injury Investigators, *Pittsburgh, Pennsylvania*

If Not Hypotensive, >500 mL Crystalloid Assoc w/ Higher Mortality and Coagulopathy

JAMA Surgery | Original Investigation

Association of Prehospital Plasma Transfusion With Survival in Trauma Patients With Hemorrhagic Shock When Transport Times Are Longer Than 20 Minutes

A Post Hoc Analysis of the PAMPer and COMBAT Clinical Trials

Anthony E. Pusateri, PhD; Ernest E. Moore, MD; Hunter B. Moore, MD, PhD; Tuan D. Le, MD, DrPH; Francis X. Guyette, MD, MPH; Michael P. Chapman, MD; Angela Sauaia, MD, PhD; Arsen Ghasabyan, MPH; James Chandler; Kevin McVaney, MD; Joshua B. Brown, MD; Brian J. Daley, MD; Richard S. Miller, MD; Brian G. Harbrecht, MD; Jeffrey A. Claridge, MD; Herb A. Phelan, MD, MSCS; William R. Witham, MD; A. Tyler Putnam, MD; Jason L. Sperry, MD, MPH

Findings This post hoc analysis was performed using harmonized data from 2 randomized clinical trials, Control of Major Bleeding After Trauma and Prehospital Air Medical Plasma, which included 626 patients with trauma and hemorrhagic shock. Patients who received prehospital plasma transfusion had significantly reduced 28-day mortality compared with standard care when prehospital transport times were longer than 20 minutes.

JAMA Surg. 2020;155(2):e195085. doi:10.1001/jamasurg.2019.5085
Published online December 18, 2019.

Mortality after emergent trauma laparotomy: A multicenter, retrospective study

J Trauma Acute Care Surg 2017; 83: 464

John A. Harvin, MD, Tom Maxim, Kenji Inaba, MD, Myriam A. Martinez-Aguilar, MD, David R. King, MD, Asad J. Choudhry, MD, Martin D. Zielinski, MD, Sam Akinyeye, MD, S. Rob Todd, MD, Russell L. Griffin, PhD, Jeffrey D. Kerby, MD, PhD, Joanelle A. Bailey, MD, David H. Livingston, MD, Kyle Cunningham, MD, Deborah M. Stein, MD, Lindsay Cattin, MPH, Eileen M. Bulger, MD, Alison Wilson, MD, Vicente J. Undurraga Perl, MD, Martin A. Schreiber, MD, Jill R. Cherry-Bukowiec, MD, Hasan B. Alam, MD, *and* John B. Holcomb, MD, *Houston, Texas*

12 Level I Trauma Centers

Laparotomy <90 Minutes

Mortality after emergent trauma laparotomy: A multicenter, retrospective study

J Trauma Acute Care Surg 2017; 83: 464

John A. Harvin, MD, Tom Maxim, Kenji Inaba, MD, Myriam A. Martinez-Aguilar, MD, David R. King, MD,
Asad J. Choud . Griffin, PhD,
Jeffrey D. ham, MD,
Del MD,
Vic MD,

TABLE 4. Outcomes

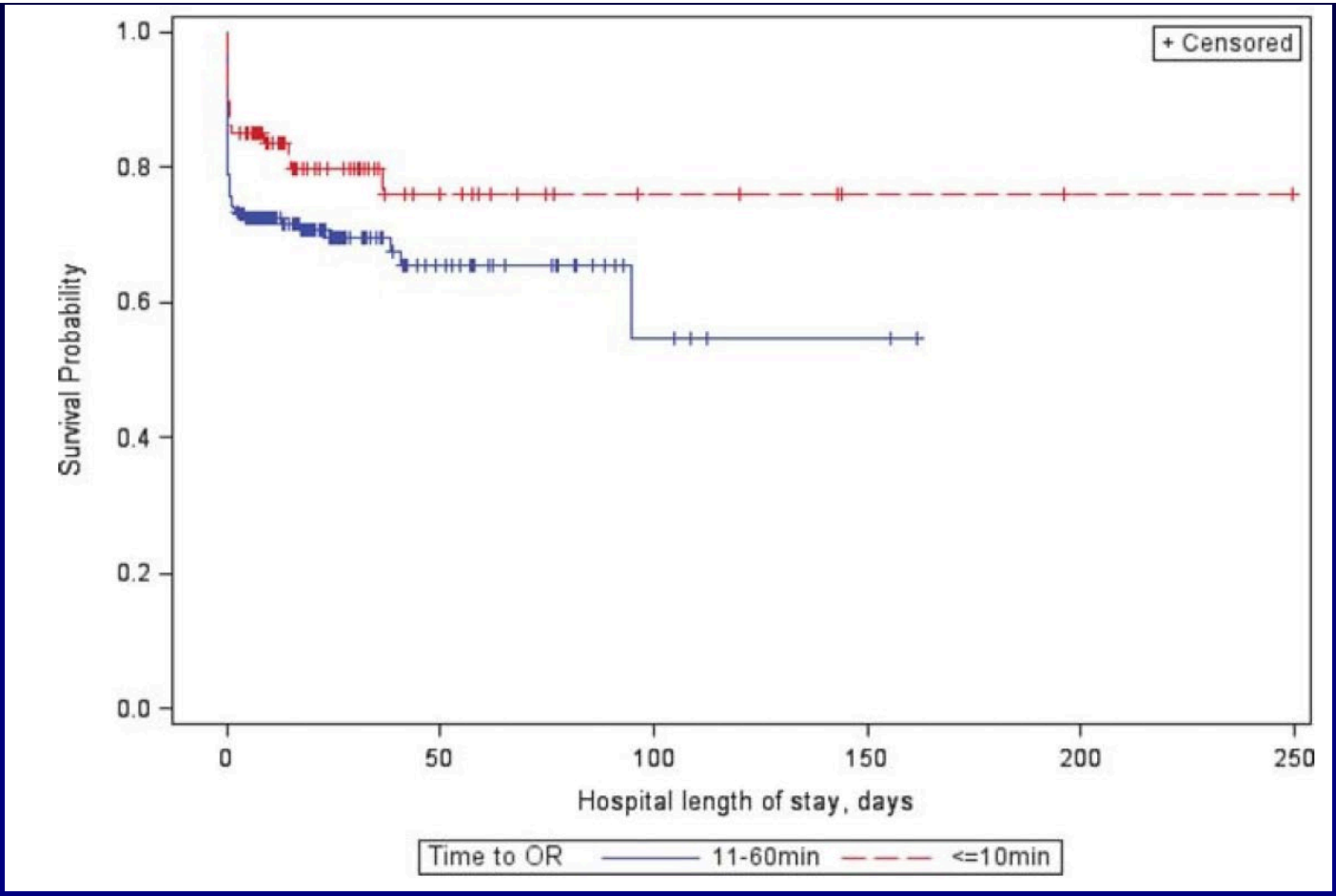
Outcomes	All Patients (n = 1,706)	ED SBP >90 (n = 1,253)	ED SBP ≤90 (n = 394)	*p*
Deaths	350 (21%)	145 (11%)	182 (46%)	<0.001
Time to death, h	4 (2–33)	5 (2–83)	3 (1–8)	<0.001
Cause of death				
Hemorrhage	210 (60%)	77 (53%)	119 (65%)	0.016
Traumatic brain injury	56 (16%)	22 (15%)	31 (17%)	
Multiorgan failure	28 (8%)	16 (11%)	11 (6%)	
Cardiac arrest	12 (3%)	4 (3%)	8 (4%)	
Respiratory failure	12 (3%)	9 (6%)	3 (2%)	
Sepsis	3 (1%)	3 (2%)	0 (0%)	
Other/unknown	29 (8%)	14 (10%)	10 (5%)	
Hospital-free days	15 (0–23)	19 (1–24)	0 (0–12)	<0.001

Continuous variables: median (IQR).

Effect of time to operation on mortality for hypotensive patients with gunshot wounds to the torso: The golden 10 minutes

J Trauma Acute Care Surg 2016; 81: 685

Jonathan P. Meizoso, MD, MSPH, Juliet J. Ray, MD, MSPH, Charles A. Karcutskie, IV, MD, MA, Casey J. Allen, MD, Tanya L. Zakrison, MD, MPH, Gerd D. Pust, MD, Tulay Koru-Sengul, PhD, Enrique Ginzburg, MD, Louis R. Pizano, MD, MBA, Carl I. Schulman, MD, PhD, MSPH, Alan S. Livingstone, MD, Kenneth G. Proctor, PhD, *and* **Nicholas Namias, MD, MBA**, *Miami, Florida*



Scripps Memorial Hospital La Jolla

Trauma OR Pit Stop

Alert Criteria for Trauma OR Pit Stop:

Blunt trauma SBP <80, penetrating trauma with hypotension (SBP <90), Amputation/mangled extremity with major bleeding, Airway compromise without control, evisceration/impalement

YES

MICN to notify TNTL

TNTL to notify TS & OR Charge RN

Direct to OR-NO

Proceed with major trauma activation based on criteria

Direct to OR-YES

Patient to trauma room. Follow Pitstop guidelines

TS/designee to call Anesth. Czar @6170

MICN to page out: "Trauma Team # OR Pit Stop"

If < 5 min ETA and unable to get confirmation from TS, MICN to page out: "Trauma Team # OR Pit Stop"

Significant neck trauma

Pit stop: Airway control, chest x-ray; FAST; ?Whole blood/MTP; ?CT (if blunt)

Blunt torso trauma with SBP <80

Pit stop: Primary survey, Xray Chest/Pelvis; FAST; MTP/Whole blood; ? REBOA

Mangled extremity

Pit stop: Tourniquet; Xray Chest/Pelvis; FAST; Whole blood/MTP; ?CT scan head torso +/-extremity runoff if bleeding controlled

Penetrating trauma with SBP <90

Pit stop: Primary survey; Xray Chest/Abdomen +/- Neck; FAST; MTP/Whole blood

STABLE ≠ NORMAL

Tachycardia is NOT normal; Sign of Class II hemorrhage (15-30% blood volume loss)