# Fluid resuscitation in Trauma

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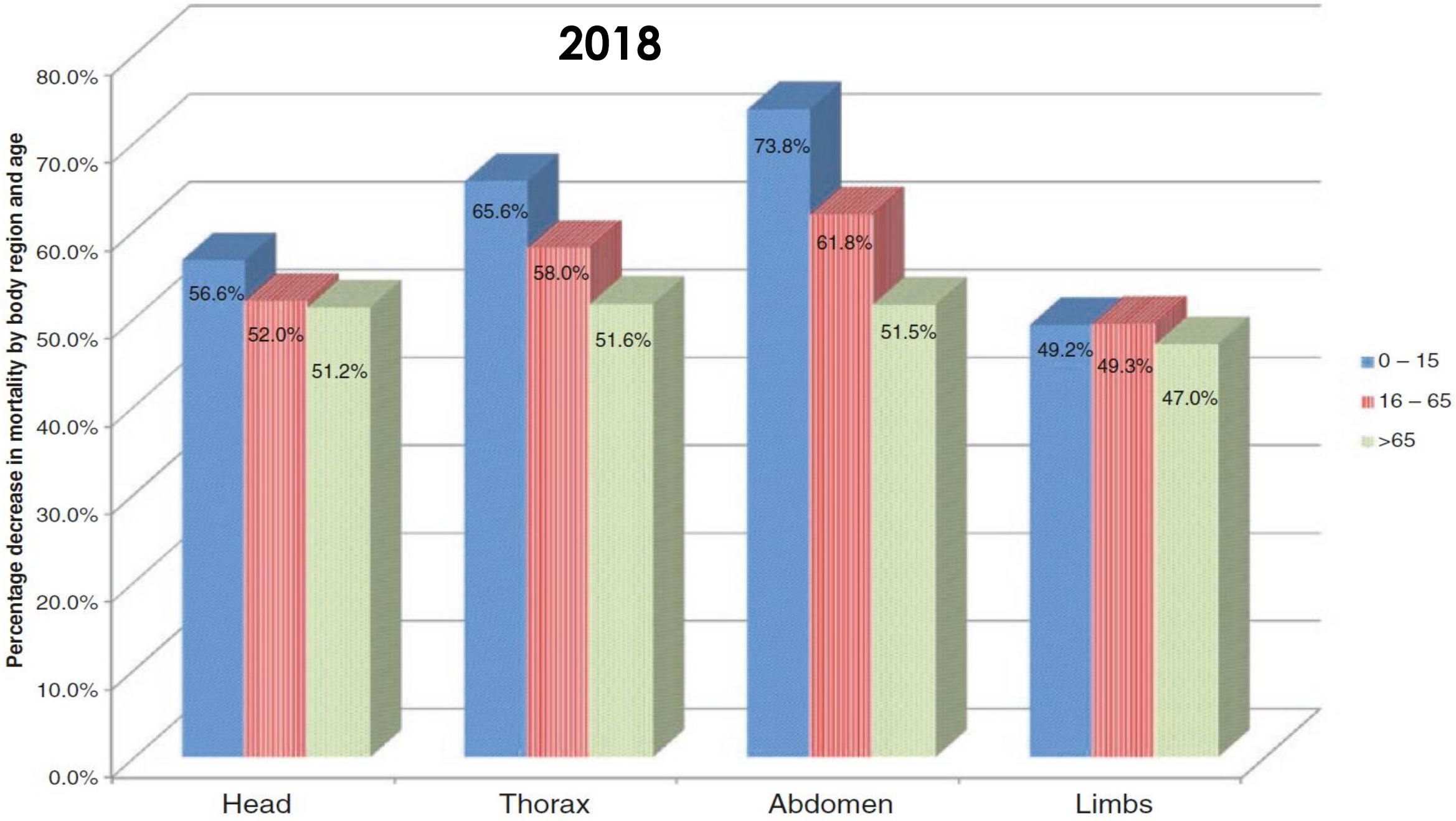
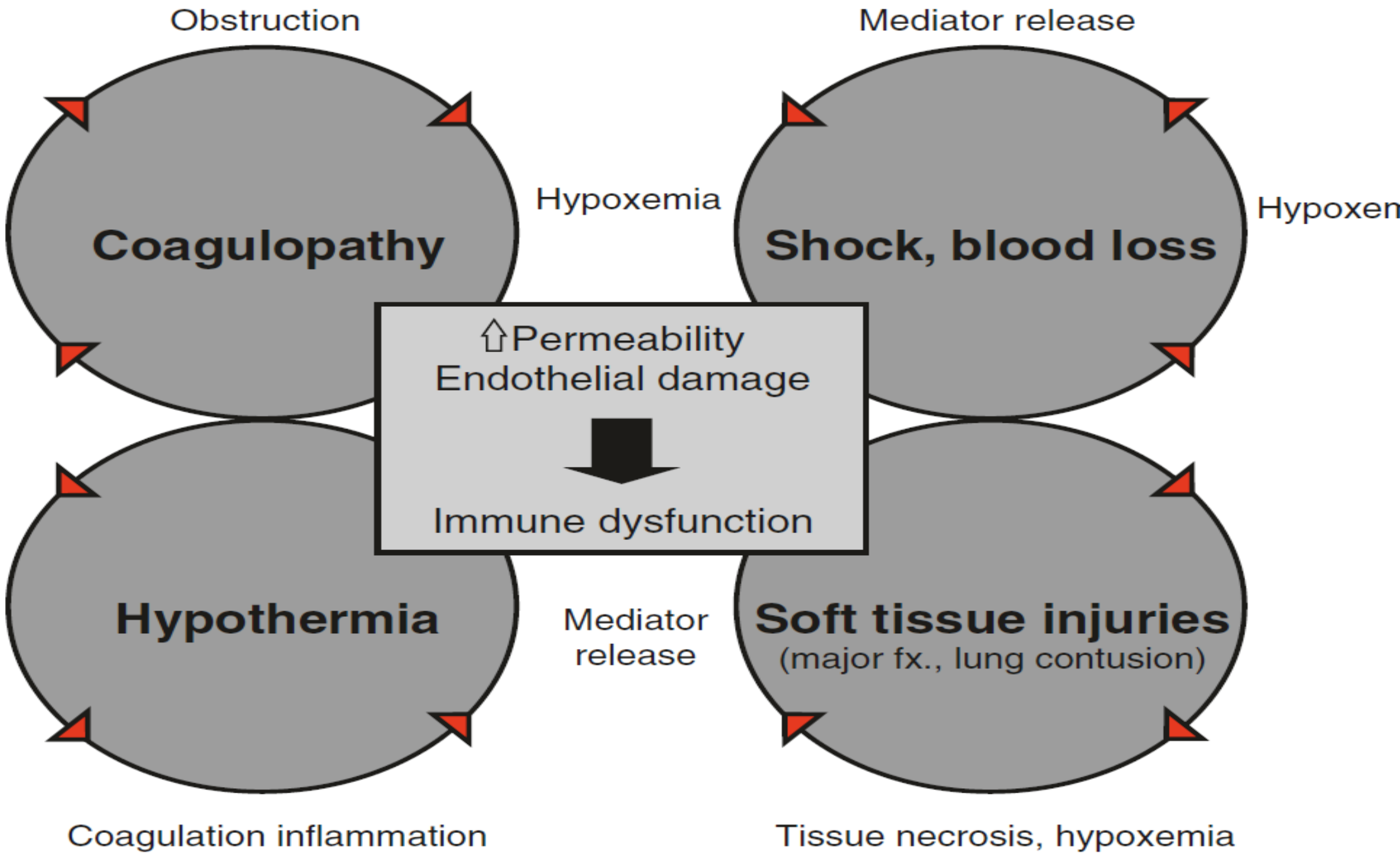

2018
Percentage decrease in mortality by body region and age
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
56.6%
52.0%
51.2%
65.6%
58.0%
51.6%
73.8%
61.8%
51.5%
49.2%
49.3%
47.0%
Head
Thorax
Abdomen
Limbs
0 – 15
16 – 65
>65

2018


Obstruction
Mediator release
Coagulopathy
Hypoxemia
Shock, blood loss
Hypoxem
⇧Permeability
Endothelial damage
Immune dysfunction
Hypothermia
Mediator
release
Soft tissue injuries
(major fx., lung contusion)
Coagulation inflammation
Tissue necrosis, hypoxemia

Top 10

## The 2 leading causes of death after trauma

- Blood loss and
- Neurologic injury,
- 50% of early deaths (<24 h) are due to hemorrhage.

*Lilitsis E, et al. J Emerg Trauma Schock.* 2018 ;11(2):80-87.

World, 2016, Both sexes, ages

and other dementias

- Blood loss remains a leading cause of preventable death in the initial 24 hours of hospital admission.

Holcomb, John B et al. J Trauma and Acute Care Surg, 2011, 71(2): 15-17

10 Tuberculosis


# Soft tissue injury, even without severe hemorrhage, can result in shifts of fluid to the extracellular compartment.

# The key components is DCR

Martin A, J Trauma Acute Care Surg, 2015; 78(4): 687-95.

- Permissive Hypotension
- Hemostatic Resuscitation
- Damage Control Surgery,
- **The prevention and correction of TIC.**

Haris T, et al. Emerg Med Clin North Am. 2018; 36(1):85-106

| Do this approach |
| --- |
| ➢*Decrease in mortality,* |
| ➢ *Reduced duration stay in ICU, and hospital* |
| ➢ *Improved coagulation profile* |
| ➢ *Reduced crystalloid/vasopressor use.* |

Martin A, J Trauma Acute Care Surg, 2015; 78(4): 687-95.

# The most effective resuscitation fluid is patients' own blood;

Thus, preserving circulating volume and minimizing blood loss is a key component of trauma resuscitation.

- **S**topping the hemorrhage

  Direct pressure,
  Using tourniguets,

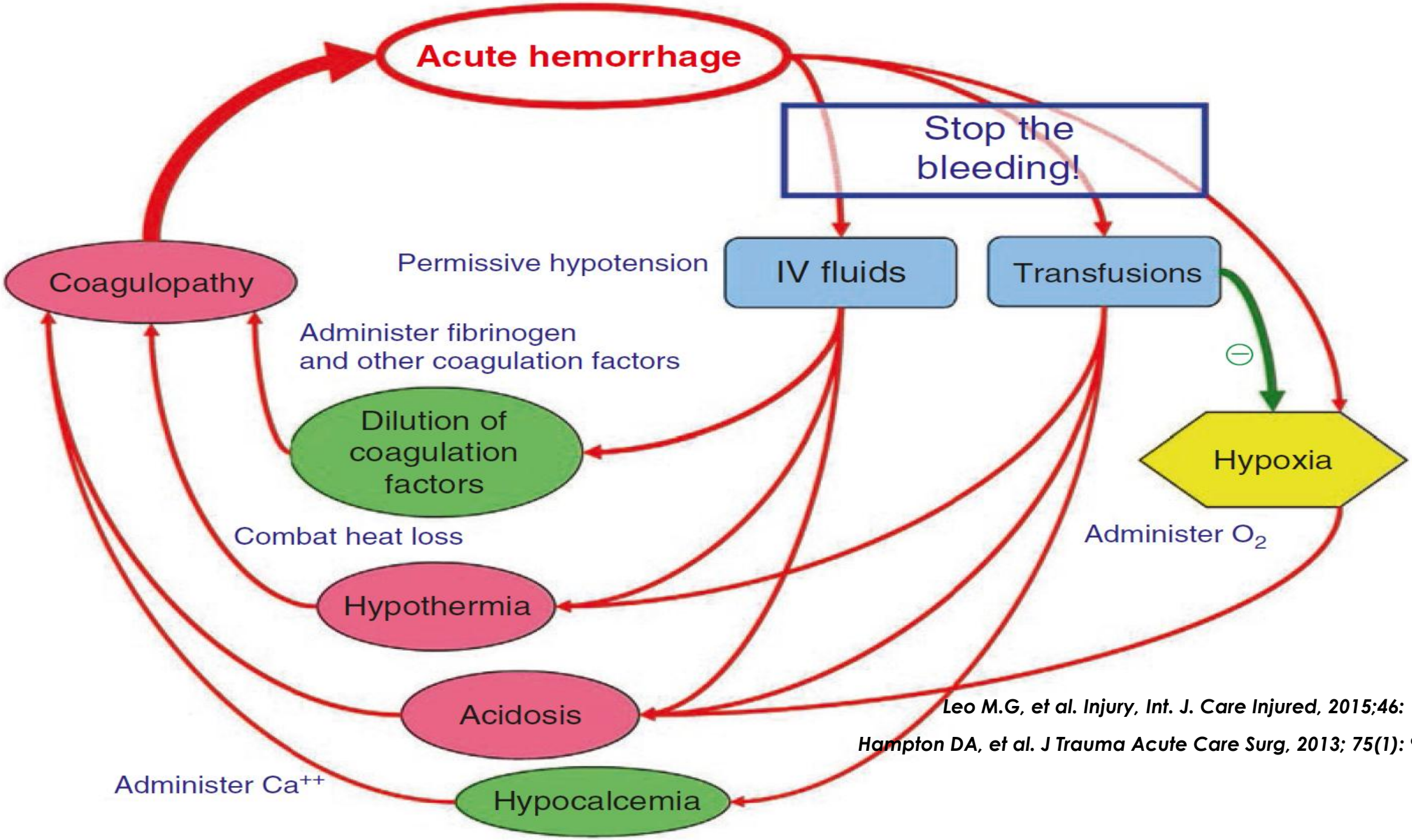
  But there are few data on tourniquets effectiveness

  S. E. van Oostendorp. Scand J of Trauma, Res and Em Med, 2016; 24:110,

- **R**eplace the volume loss

- **S**urgery

*Guerado E, et al. Open Orthop 2015; 9: 283,




*Leo M.G, et al. Injury, Int. J. Care Injured, 2015;46: 4–9*

*Hampton DA, et al. J Trauma Acute Care Surg, 2013; 75(1): 9-15.*

# TOO MUCH FLUID IS TOO BAD

***Hypotension always is not the goal***


*Leo M.G, et al. Injury, Int. J. Care Injured, 2015;46: 4–9*

*Hampton DA, et al. J Trauma Acute Care Surg, 2013; 75(1): 9-15.*

# *High-volume regimens*

- There are no animal or human studies of uncontrolled hemorrhage that show high-volume resuscitation regimens lead to improved outcomes.

*Holcomb JB,et al. JAMA Surg. 2013;148(2):127-136*

# *Liberal Versus Restricted Fluids?*

## Liberal Versus Restricted Fluid Resuscitation Strategies in Trauma Patients: A Systematic Review and Meta-Analysis of Randomized Controlled Trials and Observational Studies*

Chih-Hung Wang, MD[1]; Wen-Han Hsieh, MS[2]; Hao-Chang Chou, MD[1]; Yu-Sheng Huang, MD[1]; Jen-Hsiang Shen, MS[3]; Yee Hui Yeo, MS[4]; Huai-En Chang, MS[5]; Shyr-Chyr Chen, MD, MBA[1]; Chien-Chang Lee, MD, MSc[6,7]

Critical Care Medicine. 2014; 42(4):954–961

**Conclusions:** Current evidence indicates that initial liberal fluid resuscitation strategies may be associated with higher mortal-

**No overall mortality difference between liberal and restrictive fluid strategies (relative risk, 1.18; 95% CI, 0.98–1.42).**

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

**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*

**BACKGROUND:** The scope of prehospital (PH) interventions has expanded recently—not always with clear benefit. PH crystalloid resuscitation has been challenged, particularly in penetrating trauma. Optimal PH crystalloid resuscitation strategies remain unclear in blunt trauma as does the influence of PH hypotension. The objective was to characterize outcomes for PH crystalloid volume in patients with and without PH hypotension.

**METHODS:** Data were obtained from a multicenter prospective study of blunt injured adults transported from the scene with ISS > 15. Subjects were divided into HIGH (>500 mL) and LOW (≤500 mL) PH crystalloid groups. Propensity-adjusted regression determined the association of PH crystalloid group with mortality and acute coagulopathy (admission International Normalized Ratio, >1.5) in subjects with and without PH hypotension (systolic blood pressure [SBP], <90 mm Hg) after controlling for confounders.

**RESULTS:** Of 1,216 subjects, 822 (68%) received HIGH PH crystalloid and 616 (51%) had PH hypotension. Initial base deficit and ISS were similar between HIGH and LOW crystalloid groups in subjects with and without PH hypotension. In subjects without PH hypotension, HIGH crystalloid was associated with an increase in the risk of mortality (hazard ratio, 2.5; 95% confidence interval [95% CI], 1.3–4.9; $p < 0.01$) and acute coagulopathy (odds ratio [OR], 2.2; 95% CI, 1.01–4.9; $p = 0.04$) but not in subjects with PH hypotension. HIGH crystalloid was associated with correction of PH hypotension on emergency department (ED) arrival (OR, 2.02; 95% CI, 1.06–3.88; $p = 0.03$). The mean corrected SBP in the ED was 104 mm Hg. Each 1 mm Hg increase in ED SBP was associated with a 2% increase in survival in subjects with PH hypotension (OR, 1.02; 95% CI, 1.01–1.03; $p < 0.01$).

**CONCLUSION:** In severely injured blunt trauma patients, PH crystalloid more than 500 mL was associated with worse outcome in patients without PH hypotension but not with PH hypotension. HIGH crystalloid was associated with corrected PH hypotension. This suggests that PH resuscitation should be goal directed based on the presence or absence of PH hypotension. (*J Trauma Acute Care Surg*. 2013;74: 1207–1214. Copyright © 2013 by Lippincott Williams & Wilkins)

# Guidelines for Prehospital Fluid Resuscitation in the Injured Patient

*Bryan A. Cotton, MD, MPH, Rebecca Jerome, MLIS, MPH, Bryan R. Collier, DO, Suneel Khetarpal, MD, Michelle Holevar, MD, Brian Tucker, DO, Stan Kurek, DO, Nathan T. Mowery, MD, Kamalesh Shah, MD, William Bromberg, MD, Oliver L. Gunter, MD, and William P. Riordan, Jr., MD; EAST Practice Parameter Workgroup for Prehospital Fluid Resuscitation*

*J Trauma. 2009;67: 389–402)*

- Debate over the best approach to fluid resuscitation in traumatic shock is likely to continue.
- Insufficient evidence for the superiority of any particular fluid type

# Crystalloid to packed red blood cell transfusion ratio in the massively transfused patient: When a little goes a long way

**Matthew D. Neal, MD, Marcus K. Hoffman, MD, Joseph Cuschieri, MD, Joseph P. Minei, MD, Ronald V. Maier, MD, Brian G. Harbrecht, MD, Timothy R. Billiar, MD, Andrew B. Peitzman, MD, Ernest E. Moore, MD, Mitchell J. Cohen, MD,** *and* **Jason L. Sperry, MD, MPH,** *Pittsburgh, Pennsylvania*

**BACKGROUND:** Massive transfusion (MT) protocols have emphasized the importance of ratio-based transfusion of plasma and platelets relative to packed red blood cells (PRBCs); however, the risks attributable to crystalloid resuscitation in patients requiring MT remain largely unexplored. We hypothesized that an increased crystalloid:PRBC (C:PRBC) ratio would be associated with increased morbidity and poor outcome after MT.

**METHODS:** Data were obtained from a multicenter prospective cohort study evaluating outcomes in blunt injured adults with hemorrhagic shock. Patients requiring MT (≥10 units PRBCs in first 24 hours) were analyzed. The C:PRBC ratio was computed by the ratio of crystalloid infused in liters (L) to the units of PRBCs transfused in the first 24 hours postinjury. Logistic regression modeling was used to characterize the independent risks associated with the 24-hour C:PRBC ratio, after controlling for important confounders and other blood component transfusion requirements.

**RESULTS:** Logistic regression revealed that the 24-hour C:PRBC ratio was significantly associated with a greater independent risk of multiple organ failure (MOF), acute respiratory distress syndrome (ARDS), and abdominal compartment syndrome (ACS). No association with mortality or nosocomial infection was found. A dose-response analysis revealed that patients with a C:PRBC ratio >1.5:1 had over a 70% higher independent risk of MOF and over a twofold higher risk of ARDS and ACS.

**CONCLUSION:** In patients requiring MT, crystalloid resuscitation in a ratio greater than 1.5:1 per unit of PRBCs transfused was independently associated with a higher risk of MOF, ARDS, and ACS. These results suggest overly aggressive crystalloid resuscitation should be minimized in these severely injured patients. Further research is required to determine whether incorporation of the C:PRBC ratio into MT protocols improves outcome. (*J Trauma.* 2012;72: 892–898. 

# Resuscitation With Normal Saline (NS) vs. Lactated Ringers (LR) Modulates Hypercoagulability and Leads to Increased Blood Loss in an Uncontrolled Hemorrhagic Shock Swine Model

*Laszlo N. Kiraly, MD, Jerome A. Differding, MS, T. Miko Enomoto, MD, Rebecca S. Sawai, MD, Patrick J. Muller, MS, Brian Diggs, PhD, Brandon H. Tieu, MD, Michael S. Englehart, MD,*

**The two have no superiority**

and normal saline (NS) are used interchangeably in many trauma centers. The purpose of this study was to compare the effects of LR and NS on coagulation in an uncontrolled hemorrhagic swine model. We hypothesized resuscitation with LR would produce hypercoagulability.

***Methods:*** There were 20 anesthetized swine (35 ± 3 kg) that underwent central venous and arterial catheterization, celiotomy, and splenectomy. After splenectomy blinded study fluid equal to 3 mL per gram of splenic weight was administered. A grade V liver injury was made and animals bled without resuscitated with the respective study fluid to, and maintained, at the preinjury MAP until study end. Prothrombin Time (PT), Partial Thromboplastin Time (PTT), and fibrinogen were collected at baseline (0′) and study end (120′). Thrombelastography was performed at 0′and postinjury at 30′, 60′, 90′, and 120′.

***Results:*** There were no significant baseline group differences in R value, PT, PTT, and fibrinogen. There was no significant difference between baseline and 30 minutes R value with NS ($p = 0.17$). There was a significant R value reduction from baseline to 30 minutes with LR ($p = 0.02$). At 60 minutes, R angle, maximum amplitude, and clotting index were higher ($p < 0.05$) in the LR versus the NS group. R value, PT, and PTT were significantly decreased at study end in the LR group compared with the NS group ($p < 0.05$). Overall blood loss was significantly higher in the NS versus LR group ($p = 0.009$).

***Conclusions:*** This data indicates that resuscitation with LR leads to greater hypercoagulability and less blood loss than resuscitation with NS in uncontrolled hemorrhagic shock.

***Key Words:*** Coagulation, Trauma, Thrombelastogram, Saline, Ringers.

*J Trauma.* 2006;61:57–65.

**Two RCT:**

Hypertonic saline is not superior to normal saline for TBI both with hypovolemic shock and non shock

Eileen M, et al. JAMA. 2010;304(13):1455-1464

# WHICH FLUIDS, IF ANY, SHOULD WE USE FOR TRAUMA PATIENTS WHO DO NOT REQUIRE DAMAGE CONTROL RESUSCITATION?

## Hypertonic saline in the traumatic hypovolemic shock: meta-analysis

**Metaanalysis of 6 randomized trials involving patients with hemorrhagic shock reported no benefit (95% CI, 0.82–1.14).**

ARTICLE INFO

*Article history:*
Received 13 December 2013
Received in revised form
16 March 2014
Accepted 15 April 2014
Available online 21 April 2014

**Keywords:**
Hypertonic saline
Traumatic hypovolemic shock
Meta-analysis
Randomized controlled trial

ABSTRACT

*Background:* A wealth of evidence from animal experiments has indicated that hypertonic saline (HS) maybe a better choice for fluid resuscitation in traumatic hypovolemic shock in comparison with conventional isotonic saline. However, the results of several clinical trials raised controversies on the superiority of fluid resuscitation with HS. This meta-analysis was performed to better understand the efficacy of HS in patients with traumatic hypovolemic shock comparing with isotonic saline.

*Materials and methods:* According to the search strategy, we searched the PubMed, EMBASE, and the Cochrane Central Register of Controlled Trials, which was completed on October 2013. After literature searching, two investigators independently performed the literature screening, assessment of quality of the included trials, and data extraction. Disagreements were resolved by consensus or by a third investigator if needed. The outcomes included mortality, blood pressure, fluid requirement, and serum sodium.

*Results:* Six randomized controlled trials were included in the meta-analysis. The pooled risk ratio for mortality at discharge was 0.96 (95% confidence interval [CI], 0.82—1.14), whereas the pooled mean difference for the change in systolic blood pressure from baseline and the level of serum sodium after infusion was 6.47 (95% CI, 1.31—11.63) and 7.94 (95% CI, 7.38—8.51), respectively. Current data were insufficient to evaluate the effect of HS on the fluid requirement for the resuscitation.

*Conclusions:* The present meta-analysis was unable to demonstrate a clinically important improvement in mortality after the HS administration. Moreover, we observed HS administration maybe accompanied with significant increase in blood pressure and serum sodium.

# The value of colloids (albumin solution, dextran) for resuscitation of traumatic shock is unproven

A metaanalysis of 59 RCT (including 16,889 trauma and surgical patients) found no difference in mortality

Annals of Surgery. 2011, 253(3):470–483

BMJ Open

# Haemodynamic response to crystalloids or colloids in shock: an exploratory subgroup analysis of a randomised controlled trial

Nicholas Heming,[1,2] Souheil Elatrous,[3] Samir Jaber,[4] Anne Sylvie Dumenil,[5] Joël Cousson,[6] Xavier Forceville,[7] Antoine Kimmoun,[8] Jean Louis Trouillet,[9] Jérôme Fichet,[10] Nadia Anguel,[11] Michael Darmon,[12] Claude Martin,[13] Sylvie Chevret,[14] Djillali Annane,[1,2] for the CRISTAL Investigators

Conclusion CRISTAL participants monitored by a PAC reached broadly similar haemodynamic outcomes whether treated by crystalloids or by colloids. Colloids were associated with lower heart rates and lower volume of administered fluids than crystalloids.

Heming N, et al. BMJ Open 2017;7:e016736.

Cochrane Database Syst Rev. 2018 Aug 3;8:CD000567. doi: 10.1002/14651858.CD000567.pub7.

# Colloids versus crystalloids for fluid resuscitation in critically ill people.

Lewis SR[1], Pritchard MW, Evans DJ, Butler AR, Alderson P, Smith AF, Roberts I.

There is no evidence from RCTs that resuscitation with colloids reduces the risk of death, compared to resuscitation with crystalloids, in patients with trauma, burns or following surgery.

As colloids are not associated with an improvement in survival, and as they are more expensive than crystalloids, it is hard to see how their continued use in these patients can be justified outside the context of RCTs.

# Role of albumin, starches and gelatins versus crystalloids in volume resuscitation of critically ill patients

*Luca Zazzeron*[a], *Luciano Gattinoni*[b], *and Pietro Caironi*[a,c]

Curr Opin Crit Care 2016, 22:428–436

**Summary**

- Fluid administration should be tailored to patient characteristics.
- Synthetic colloids should be avoided when possible, especially in patients at risk for kidney injury.
- In critically patients colloids are not be superior to crystalloids in expanding plasma volume.
- Albumin appears to be less harmful than synthetic colloids, although its beneficial effects need to be further investigated.
- The endothelial glycocalyx layer is the key structure finely regulating intravascular fluid distribution.

# Clear end-points for fluid therapy remain undefined

Further resuscitation is based on the patient's response to initial IV fluids

**Penetrating trauma**

- MAP around 65 mmHg or
- SBP around 90 mmHg

**In blunt trauma patients, particularly those with possible TBI,**

- MAP above 85 mmHg or
- SBP above 120 mmHg

**The ideal MAP or SBP for the severely injured trauma patient remains unclear.**

# Resuscitation in Patients with Traumatic Brain Injury

- The permissive hypotension approach is most conflicted in patients who are bleeding and have a major TBI
- The data for worse outcomes are from patients with isolated TBI
- Preserve cerebral perfusion (SBP > 100/110 mm Hg).

**Guidelines for the Management of SevereTraumatic Brain Injury, Fourth Edition.** ***Neurosurgery, 2017; 80:6–15,***

# Experimental evidence

High-dose crystalloid resuscitation to target higher blood pressures is associated with

- Increased cerebral edema,
- Increased intracranial pressure,
- Decreased cerebral perfusion pressure, and
- Reduced cerebral oxygen delivery with the cerebral circulation protected in trauma shock.

**Zhi W, et al. Critical Care Medicine. 2010; 38(3):928-932.**

If hemorrhagic shock seems to be the dominant pathophysiology

A DCR approach with permissive hypotension

Where brain injury seems to be the dominant pathology,

Target a high/normal SBP to maintenance of cerebral perfusion pressure.

- We still do not have human study, and studies on permissive hypotension have excluded patients with TBI.

## This strategy has been referred to as

- Delayed fluid resuscitation,
- Controlled hypotension,
- Permissive hypotension,
- Hypotensive resuscitation, or
- Controlled resuscitation,

**Delayed fluid resuscitation/controlled hypotension**

# Hypotensive Resuscitation Strategy Reduces Transfusion Requirements and Severe Postoperative Coagulopathy in Trauma Patients With Hemorrhagic Shock: Preliminary Results of a Randomized Controlled Trial

*C. Anne Morrison, MD, MPH, Matthew M. Carrick, MD, Michael A. Norman, MD, Bradford G. Scott, MD, Francis J. Welsh, MD, Peter Tsai, MD, Kathleen R. Liscum, MD, Matthew J. Wall, Jr., MD, and Kenneth L. Mattox, MD*

**Conclusions:**

- **Hypotensive resuscitation is a safe strategy for use**
- Less blood product transfusions.
- Minimum MAP of 50 mm Hg, rather than 65 mm Hg,
- *Lower risk of early postoperative death and*
- *Less coagulopathy.*

J Trauma. 2011;70(3):652.

# 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*

**BACKGROUND:**

**METHODS:**

CR(defined as SBP >70 mmHg) is achievable in out-of-hospital and hospital settings and may offer an early survival advantage in blunt trauma.

**RESULTS:** A total of 192 patients were randomized (97 CR and 95 SR). The CR and SR groups were similar at baseline. The mean (SD) crystalloid volume administered during the study period was 1.0 L (1.5) in the CR group and 2.0 L (1.4) in the SR group, a difference of 1.0 L (95% confidence interval [CI], 0.6–1.4). Intensive care unit–free days, ventilator-free days, renal injury, and renal failure did not differ between the groups. At 24 hours after admission, there were 5 deaths (5%) in the CR group and 14 (15%) in the SR group (adjusted odds ratio, 0.39; 95% CI, 0.12–1.26). Among patients with blunt trauma, 24-hour mortality was 3% (CR) and 18% (SR) with an adjusted odds ratio of 0.17 (0.03–0.92). There was no difference among patients with penetrating trauma (9% vs. 9%; adjusted odds ratio, 1.93; 95% CI, 0.19–19.17).

**CONCLUSION:** CR is achievable in out-of-hospital and hospital settings and may offer an early survival advantage in blunt trauma. A large-scale, Phase III trial to examine its effects on survival and other clinical outcomes is warranted. (*J Trauma Acute Care Surg.* 2015;78: 687–697. 

# Hemostatic Resuscitation

- The main purpose of blood transfusion is to restore the oxygen-carrying capacity of the intravascular volume.

## 1: Give Blood Early

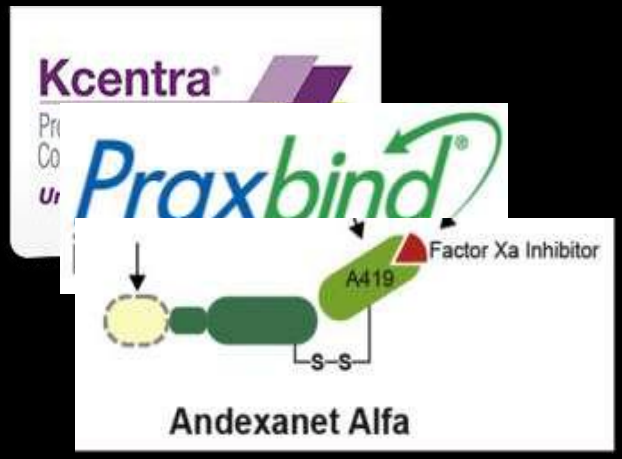
## 2: Resemble Whole Blood



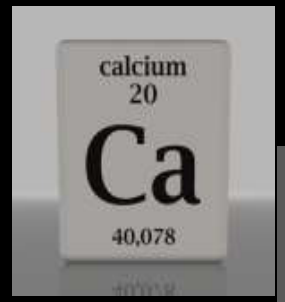
## 3: Anticipate & Prevent Coagulopathy




## 4: Reverse Known Coagulopathy




## 5: Treat Complications




**TRALI & TACO**

# Protocolized transfusion avoids dilutional coagulopathy

# Why 1:1:1?

PROMMTT

PROspective Observational Multicenter Massive Transfusion sTudy

Observational, Multicenter → Higher Plasma & Platelet ratios improved mortality

PROPPR

Pragmatic, Randomized Optimal Platelet and Plasma Ratios

RCT, Multicenter → RBC:FFP:Platelets 1:1:1 vs 1:1:2

Holcomb JB, et al, JAMA; 2015; 313(5): 471-82.

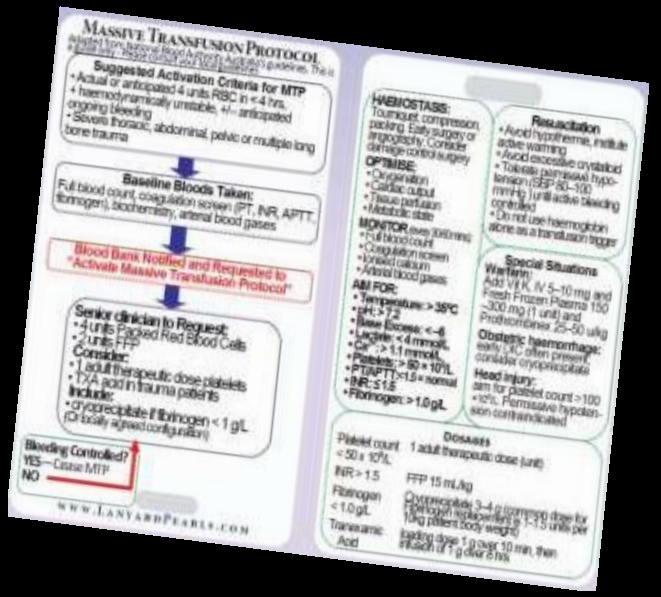

MASSIVE TRANSFUSION
ABC
SI

# ABC >2

- Penetrating Mechanism
- ED SBP < 90 mmHg
- ED HR > 120
- Positive FAST


# Do you have an MTP?

# What is it?



MASSIVE TRANSFUSION PROTOCOL

Suggested Activation Criteria for MTP
- Actual or anticipated 4 units RBC in < 4 hrs.
- + haemodynamically unstable, +/- anticipated ongoing bleeding
- Severe thoracic, abdominal, pelvic or multiple long bone trauma

Baseline Bloods Taken:
Full blood count, coagulation screen (PT, INR, APTT, fibrinogen), biochemistry, arterial blood gases

Blood Bank Notified and Requested to "Activate Massive Transfusion Protocol"

Senior clinician to Request:
- 4 units Packed Red Blood Cells
- 2 units FFP

Consider:
- 1 adult therapeutic dose platelets
- TXA acid in trauma patients

Include:
- cryoprecipitate if fibrinogen < 1 g/L
(Clinically aligned contiguration)

Bleeding Controlled?
YES—Cease MTP
NO

HAEMOSTASIS:
Tourniquet, compression, packing. Early surgery or angiography. Consider damage control surgery

OPTIMISE:
- Oxygenation
- Cardiac output
- Tissue perfusion
- Metabolic state

MONITOR every 30-60 mins:
- Full blood count
- Coagulation screen
- Ionised calcium
- Arterial blood gases

AIM FOR:
- Temperature: > 35°C
- pH: > 7.2
- Base Excess: < –6
- Lactate: < 4 mmol/L
- $Ca^{2+}$: > 1.1 mmol/L
- Platelets: > 50 × $10^9$/L
- PT/APTT: < 1.5 × normal
- INR: ≤ 1.5
- Fibrinogen: > 1.0 g/L

Resuscitation
- Avoid hypothermia, institute active warming
- Avoid excessive crystaloid
- Tolerate permissive hypotension (SBP 80–100 mmHg) until active bleeding controlled
- Do not use haemoglobin alone as a transfusion trigger

Special Situations
Warfarin:
Add Vit K IV 5–10 mg and Fresh Frozen Plasma 150–300 mg (1 unit) and Prothrombinex 25–50 u/kg

Obstetric haemorrhage:
early LSC often present, consider cryoprecipitate

Head injury:
aim for platelet count >100 ×$10^9$/L. Permissive hypotension contraindicated

DOSAGES

| | 1 adult therapeutic dose (unit) |
|---|---|
| Platelet count < 50 × $10^9$/L | |
| INR > 1.5 | FFP 15 mL/kg |
| Fibrinogen < 1.0 g/L | Cryoprecipitate 3–4 g (commercial dose for fibrinogen replacement is 1–1.5 units per 10kg patient body weight) |
| Tranexamic Acid | Loading dose 1 g over 10 min, then infusion of 1 g over 8 hrs. |

www.LanyardPearls.com

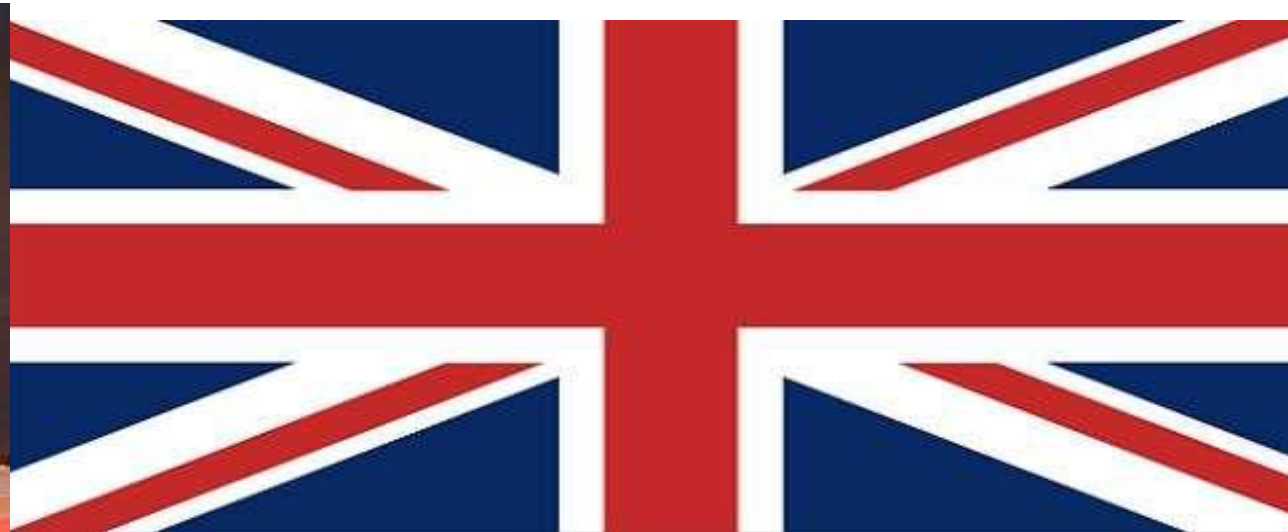
# Prehospital Transfusion of Plasma and Red Blood Cells in Trauma Patients

John B. Holcomb, MD, Daryn P. Donathan, BS, Bryan A. Cotton, MD, Deborah J. del Junco, PhD, Georgian Brown, RN, Toni von Wenckstern, RN, Jeanette M. Podbielski, RN, Elizabeth A. Camp, PhD, Rhonda Hobbs, Yu Bai, MD, PhD, Michelle Brito, BS, Elizabeth Hartwell, MD, James Red Duke, MD, Charles E. Wade, PhD

## Prehospital plasma – some benefit

# Prehospital blood transfusion in the en route management of severe combat trauma: A matched cohort study

**David J. O'Reilly, FRCS, Jonathan J. Morrison, MRCS, Jan O. Jansen, FRCS, FFICM, Amy N. Apodaca, PhD, Todd E. Rasmussen, MD,**
*and* **Mark J. Midwinter, MD, FRCS,** *Birmingham, United Kingdom*

# Ideal Raplacements

- Would transport oxygen effectively,
- Expand intravascular volüme,
- Exhibit few or no side effects
- Demonstrate great durability

# In Summary

## DCR→less fluids, more factors,

1. **Permissive Hypotension**
2. **Hemostatic Resuscitation**
   - Early blood (1:1:1)
3. **Damage Control Surgery**

# In Summary

- The optimal type and volume remains debate,
- < 500-1000 mL boluses of NS ASAP, till blood products are available or a SBP of 90 mmHg is achieved
- LR and NS do not have superior to eachother,
- The value of colloids is unproven
- The ideal MAP or SBP remains unclear,
- Further study to clarify the role of hypertonic saline
- **Permussive Hypotensive resuscitation is a safe strategy**
- Shorthen the transition time from fluid to blood,
- Goal is to minimize crystalloid administration while avoiding significant hypotension,

## Based on current data, the best strategy appears to be

.

- Limiting fluid resuscitation to 1 L or less and
- Moving directly to blood products