Damage Control Resuscitation

Tactics for the Exsanguinating Patient

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Objectives

- Define the concept of "damage control resuscitation"
- List evidence-based resuscitative approaches for hemorrhagic shock
- Describe relevant literature regarding:
  - Ratio-guided blood component therapy
  - Hypotensive resuscitation
  - Low titer whole blood

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Contributor Disclosures

CC PROJECT

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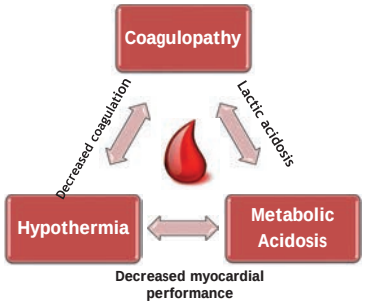
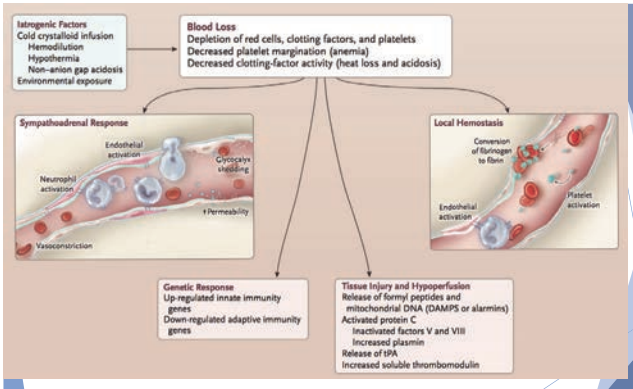
Mdanescrit.com

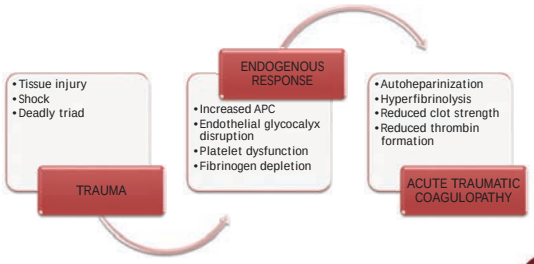
Deadly Triad in Trauma





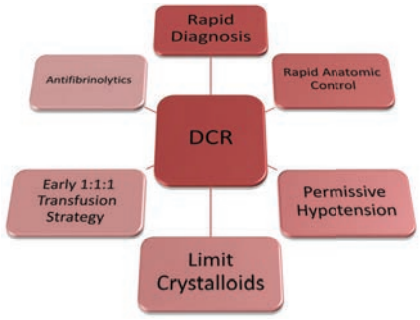
Cannon J. N Eng J Med 2018.

Acute Traumatic Coagulopathy



Simmons JW. Br J Anaesth 2016.
Sihler KC. Chest 2010.
Klages M. Curr Opin Anesthesiol 2016.

Tenets



Lammers DT & Holcomb J. J Trauma Acute Care Surg 2023.
Dutton RP. Br J Anaesth 2012.
Simmons JW. Br J Anaesth 2016.

Goal of DCR

- Early and aggressive correction of coagulopathy & metabolic derangement
  - Emphasis on correction of coagulopathy
  - Most **treatable** arm of "lethal triad"

Beekley AC. Crit Care Med 2008.

Benefits of DCR

- Improved mortality
- Earlier abdominal closure
- Decreased healthcare costs
- Decreased length of stay

Joseph B. J Trauma Acute Care Surg 2017.
Duchesne JC. J Trauma 2010.
Duchesne JC. J Trauma 2010.
Cotton BA. Ann Surg 2011.
Cotton BA. J Trauma 2008.
Holcomb JB. J Trauma 2007.
Gunter OL, J Trauma 2008.
Bradley M. Amer Surg 2014.
Dubose JJ. J Spec Oper Med 2017.

The majority of shock is occult or compensated

Parameter	Class I	Class II	Class III	Class IV
Blood loss	<15%	15-30%	31-40%	>40%
Heart rate	↔	↔/↑	↑	↑/↑↑
Blood pressure	↔	↔	↔/↓	↓
Pulse pressure	↔	↓	↓	↓
Urine output	↔	↔	↓	↓↓
GCS	↔	↔	↓	↓↓
Base excess	0 to -2	-2 to -6	-6 to -10	> -10
Need for blood	Monitor	Possible	Yes	Massive transfusion

American College of Surgeons. *ATLS* 10th Edition, 2018.

Validity of ATLS Classification

- TARN database
- N=107,649
- Inter-relationship between HR, SBP, RR relationships not as strong as ATLS suggests
  - Many confounding factors

Guly HR. Resuscitation 2010.

TABLE 1. Factors Found to Be Predictive of MT in Each Study

Study	Scoring System	Variables Used in MT Prediction Model	MT Definition	AUC for MT
Cuncio et al.[6]	RTS	SBP, DBP, GCS, HR, RR	≥10 U of PRBC/FWB in the first 24 h	0.64
	FTS	SBP, DBP, GCS		0.62
Yucel et al.[7]	TASH	SBP, HR, BE, Hg, male sex, FAST, unstable long bone/pelvic fracture	≥10 U of PRBC between ED and ICU admission	0.91*
Ruchholtz et al.[8]	ETS	SBP, age, scene admit, mechanism traffic/fall, FAST, unstable pelvic fracture	≥10 U of PRBC in the first 24 h**	0.78**
Schreiber et al.[9]		Hg, INR, penetrating injury	≥10 U of PRBC/FWB in the first 24 h	0.80
McLaughlin et al.[10]		SBP, HR, pH, Hct	≥10 U of PRBC/FWB in the first 24 h	0.75
Nunez et al.[11]	ABC	SBP, HR, FAST, penetrating injury	≥10 U of PRBC in the first 24 h	0.85
Larson et al.[12]		SBP, HR, pH, Hct	≥10 U of PRBC/FWB in the first 24 h	0.82
Rainer et al.[13]	PWH	SBP, HR, BD, Hg, unstable pelvic fracture, FAST	≥10 U of PRBC in the first 24 h, or ≥8 U of PRBC in the first 12 h, or patient's blood volume in the first 24 h	0.89
Vandromme et al.[14]		SBP, HR, Hg, INR, lactate	≥10 U of PRBC in the first 24 h	0.84
Stanworth et al.[15]		SBP, BD, PT, age, time to ED, penetrating injury	≥10 U of PRBC in the first 24 h	0.81
Dente[16]		SBP, BD, penetrating mechanism, high-risk trajectory	≥10 U of PRBC in the first 24 h	NR
Hsu[26]		BD, INR, hemoperitoneum	≥10 U of PRBC in the first 24 h	0.86
Leemann et al.[17]		ROTEM	≥10 U of PRBC in the first 24 h	0.83
Schöchl et al.[18]		FIBTEM	≥10 U of PRBC in the first 24 h	0.84
Vandromme et al.[19]		Lactate	≥6 U of PRBC in the first 24 h	0.74
Chen et al.[20]		PPG waveforms, SBP, DBP, HR, RR, SaO_2	≥5u PRBC in the first 24 h and hemorrhagic injury	0.81
Beekley et al.[21]		SO_2 ↑ INR, Hg	>10 U of PRBC/FWB in the first 24 h	0.91
Moore et al.[22]		SO_2 ↓ SBP, treatment at referring hospital, ISS, INR, pH	≥10 U of PRBC in the first 24 h	0.78
Vandromme et al.[23]	SI	HR, SBP	≥10 U of PRBC in the first 24 h	NR
Mutschler et al.[24]	SI	HR, SBP	≥10 U of PRBC between ED and ICU admission	NR

Shackelford S. J Trauma Acute Care Surg 2014.

Simple Indices to Detect Shock

- **Shock Index**
  - HR / SBP (>0.9)
  - Better indicator than hypotension alone
- **"ABC"**
  - 4 parameters:
    - **penetrating mechanism**
    - **positive FAST**
    - **SBP < 90**
    - **HR > 120**
  - 2 or more: AUROC=0.86 for predicting massive transfusion

Cocci MN. Emerg Med Clin North Am 2007.
Nunez TC. J Trauma 2009.
Pottecher J. J Trauma Acute Care Surg 2016.

When to start DCR

Anatomic Parameters	Physiologic Parameters	Lab Parameters
Estimated ISS >36	Weak or absent radial pulse	Lactate >2.5mmol/L
Penetrating abdominal injuries	Core body temperature <35°C	Platelet count < 90.000/ml
Penetrating chest injuries	Systolic BP <100 mmHg	Fibrinogen >1g/dl
Open pelvic fracture	Heart rate >100	PT> 16 secs
Long bone # with head injury	PaO2/FiO2 <250	INR >1.5
Long bone # with lung contusion	Urinary output <50ml/hour	Hb <11
Truncal haemorrhage & amputation		pH <7.2
		Base deficit <6

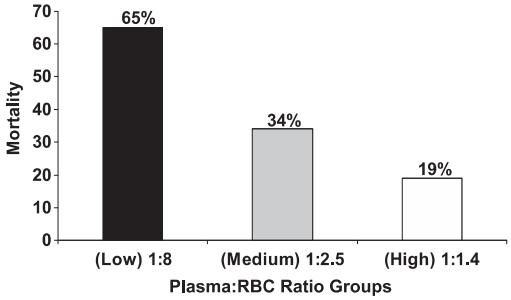
Giannoudi M. Eur J Trauma Emerg Surg 2016.
Stein P. Anaesthesia 2017.
Ghadimi K. Br J Anaesth 2016.

Ratio Guided Blood Component Therapy

Packed Red Cells

- Massive transfusion
  - >10 U / 24 hrs.
    - >20 / 48 hrs.
  - >4 units / 1 hr.
  - 1 blood volume in 24 hrs / 50% in 3 hrs.
- **1:1:1** ratio

Malone DL. J Trauma 2006.
Borgman MA. J Trauma 2007.
Kashuk JL. J Trauma 2008.

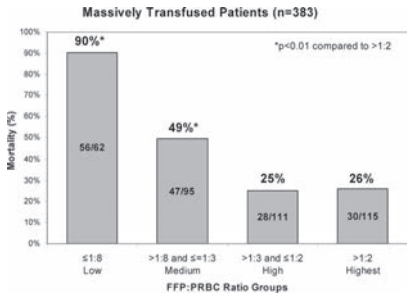


Borgman MA. J Trauma 2007.

Fresh Frozen Plasma

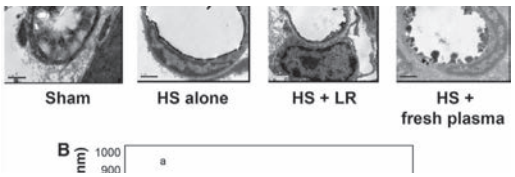
- 1 unit: 0.5 g fibrinogen + all clotting proteins
- Thawing takes 20 minutes
  - Factors V and VIII reduced to 65% activity
- Alternatives
  - Thawed plasma
  - Liquid plasma
  - Freeze-dried plasma
  - Lipophilized plasma
  - PCCs

FFP low ratio PRO



Texeira PGR. J Trauma 2009.

Defending the Glycocalyx



Kozar RA. Anesth Analg 2011.
Pati S. J Trauma 2010.

Platelets

- 1:1:1 → reduced mortality
- Lose functionality when stored
- Ideally, give *before* going to OR
- Augmentation of clotting pathway may increase production of thrombomodulin
  - May cause fibrinolysis

Gunter OL. J Trauma 2008.
Holcomb JB. Ann Surg 2009.

Cryoprecipitate

- **Fibrinogen, VWF, Factors VIII XIII, fibronectin**
- 2,400 mg fibrinogen
- When to give empirically?

Duchesne JC. J Trauma 2010.

PROPPR

- Pragmatic Randomized Optimum Platelet and Plasma Ratios study
  - Multicenter, prospective, randomized
  - Comparison of different blood product ratios
    - Target population: massive transfusion

"Extensive lab analysis will be done to examine the influence of fluid resuscitation on traumatic coagulopathy"

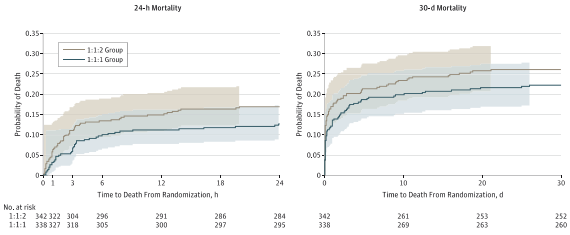
Holcomb J. JAMA 2015.

Original Investigation

Transfusion of Plasma, Platelets, and Red Blood Cells in a 1:1:1 vs a 1:1:2 Ratio and Mortality in Patients With Severe Trauma
The PROPPR Randomized Clinical Trial

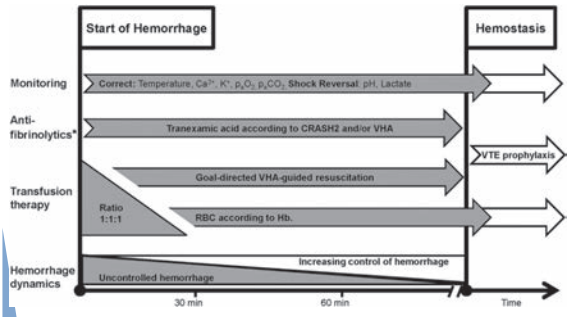
- 1:1:1 (plasma / platelets / PRBCs)
  - Vs. 1:1:2
- 12 Level 1 trauma centers
  - N=680
- Median ISS > 25
- 24-hr and 30-day all-cause mortality

Holcomb J. JAMA 2015.

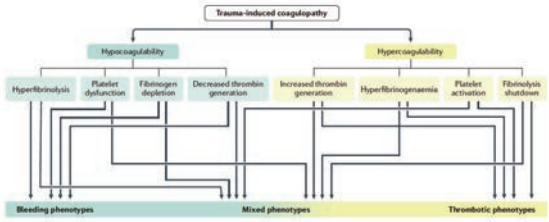


PROPPR: Conclusions

- More hemostasis achieved in 1:1:1 group
- Early survival advantage in 1:1:1 group
- No safety concerns
- Underpowered for mortality



Johanson PI. Blood. 2014.



Moore EE. Nature Reviews 2021.

What to do while waiting for blood?

- Hypertonic bolus
- Vasopressin bolus
  - 4 IU
  - No improved survival, but no harm
  - Shown to benefit animals in irreversible shock
- SBP < 80-90
- Steroids?

Rajani RR. Am Surgeon 2009.
Cohn SM. World J Surg 2011.
Stein DM. J Trauma Acute Care Surg 2013.
Tobin J. Anesth Analg 2012.

What about PCCs?

- Vitamin K dependent coagulation factors
  - Factors II, VII, IX, X
- PROCOAG trial
  - No significant reduction in 24-h total blood product consumption
  - More VTE (35% vs. 24%)

Bouzat P. Intensive Care Med 2023.
Bouzat P (PROCOAG). JAMA 2023.

References number/study ID	Design of study/study duration	Sample size	Intervention group	Control group	Conclusion
Bouzat et al. 2023 [11]	Randomised controlled trial	327	Four-factor PCC	Placebo	No decrease in total blood product consumption at 24 h in the PCC group. Increase in thrombotic risk in the PCC group
Zeeshan et al. 2019 [8]	Retrospective (propensity matched)	468	Four-factor PCC + FFP	FFP	Improved survival and reduction in total blood product consumption. No increase in the risk of thrombotic events
Jehan et al. 2018 [7]	Retrospective (propensity matched)	120	Four-factor PCC + FFP	FFP	PCC as a component therapy along with FFP is superior to FFP alone in treating coagulopathy
Joseph et al. 2016 [10]	Retrospective(propensity matched)	81	Three-factor PCC + FFP	FFP	PCC reduced the time to correct INR and time to intervention compared with patients who received FFP
Joseph et al. 2014 [9]	Retrospective (propensity matched)	252	Three-factor PCC + FFP	FFP	PCC as an adjunct to FFP is associated with reduction of blood product requirement and also lowers overall cost

Uncertainty regarding the use of viscoelastic monitoring for PCC in trauma

Bouzat P (PROCOAG). JAMA 2023.

HYPOTENSIVE RESUSCITATION

- Physiology
- Animal Studies
- Clinical Studies

Historical Perspective

Walter Cannon & John Fraser, 1918
"Blood that is sorely needed may be lost…"

Henry Beecher, 1945
"SBP 80-85 before surgery beneficial"

Bickell, 1994
"…delay of aggressive fluid resuscitation until operative intervention improves outcome"

Dutton, 2002
"…imprecision of SBP as a marker for tissue oxygen delivery"

Cannon W, Fraser J, Cowell, EM. The preventative treatment of wound shock. JAMA. 1918.
Beecher HK. Preparation of battle casualties for surgery. Ann Surg 1945;.

Physiological Principles

Pressure is easy to obtain

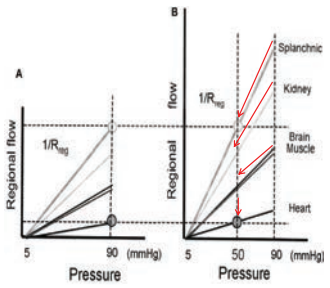
"Tangible" benefit

Blood Pressure ≠ Flow

Distribution of regional resistances more important

Alam H. International J Surg 2011.

Pressure ≠ Flow



Magder SA. Crit Care Med 2014.

"An emphasis on pressure can be misleading without an assessment of overall flow."

Magder SA. Crit Care Med 2014.

ANIMAL STUDIES

Study	Journal	Comment
Lin et al, 2013	Injury	Rat study; IL-6, TNF
Burris et al, 1999	J Trauma	Rat study
Bickel et al, 1991	Surgery	Swine model; aortotomy
Riddez et al, 1998	J Trauma	Swine model, more IVF bad
Lin et al, 2011	Anesthesiology	MAP 50-60; < 90 min. best
Zhang et al, 2013	PLoS ONE	Rabbit model, HTS
Stern, 1993	Ann Emerg Med	Swine model; more IVF bad
Kowalenko et al., 1992	J Trauma	Swine model
Smail, 1998	J Trauma	More IVF didn't improve flow

Organs at Risk

- **Brain & Heart**
  - 45-50 mm Hg sufficient in most acute situations
  - Individual constellations must be respected
- **Kidney**
  - > 50 mm Hg

Rowell LB. Human Circulation. 1st Ed. 1986.
Aizawa C. Jap Heart J 1969.
Dunser MW. Crit Care 2013.
Opie LH, Heusch G. Heart Physiology, 4th Ed. 2004.

The New England
Journal of Medicine

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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.

- Prospective RCT, N=598
- SBP<90, GSW/stab to torso
- Immediate vs. delayed IVF

Bickell, 1994

Variable	Immediate Resuscitation (N = 309)	Delayed Resuscitation (N = 289)	P Value
Systolic blood pressure (mm Hg)	79±46	72±43	0.02
Hemoglobin (g/dl)	11.2±2.6	12.9±2.2	<0.001
Platelet count ($\times 10^{-3}$/mm^3)	274±84	297±88	0.004
Prothrombin time (sec)	14.1±16	11.4±1.8	<0.001
Partial-thromboplastin time (sec)	31.8±19.3	27.5±12	0.007
Systemic arterial pH	7.29±0.17	7.28±0.15	0.46
Serum bicarbonate concentration (mmol/liter)	20±10	20±11	0.82

Bickell WH. N Eng J Med 1994.

BICKELL, 1994

Table 5. Outcome of Patients with Penetrating Torso Injuries, According to Treatment Group.

Variable	Immediate Resuscitation	Delayed Resuscitation	P Value
Survival to discharge — no. of patients/total patients (%)	193/309 (62)*	203/289 (70)†	0.04
Estimated intraoperative blood loss — ml‡	3127±4937	2555±3546	0.11
Length of hospital stay — days§	14±24	11±19	0.006
Length of ICU stay — days§	8±16	7±11	0.30

Withholding fluid resuscitation until hemorrhage control did not increase mortality

Bickell WH. N Eng J Med 1994.

Dutton, 2002

- SBP < 90 mm Hg w/in first hour of injury
- SBP > 100 vs. > 70 mm Hg
- Crystalloids or blood products to maintain

Dutton RP. J Trauma 2002.

Dutton, 2002

Table 1 Outcomes of Patients Enrolled in the Fluid Resuscitation in Trauma Study, by Target Blood Pressure Group (Means ± SD)

	SBP > 100 mm Hg	SBP = 70 mm Hg	*p* Value
Patients enrolled	55	55	
Average SBP during bleeding (mm Hg)	114 ± 12	100 ± 17	<0.001
Length of active hemorrhage (h)	2.97 ± 1.75	2.57 ± 1.46	0.20
Died	4	4	
Average ISS	19.55 ± 11.6	23.91 ± 13.8	0.08
Predicted survival rate (TRISS)	94.0 ± 12%	90.2 ± 17%	0.18
Actual survival rate (%)	92.7	92.7	

Dutton RP. J Trauma 2002.

SCHREIBER, 2015

- Out-of-hospital RCT
- Blunt or penetrating, SBP < 90
- Control: 2 L fluids for SBP > 110
- Experimental: 250 mL fluids for SBP > 70
- N=192
- 3.2 vs. 17.7% mortality in blunt trauma
  - Overall mortality 8.4 vs. 16.5% (N.S.)

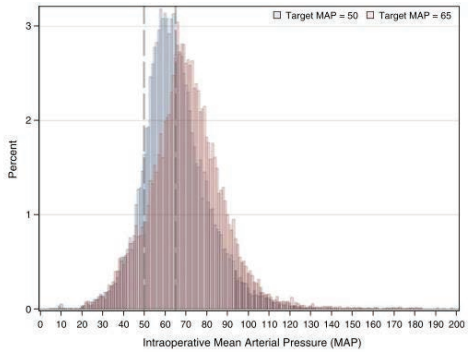
Schreiber MA. J Trauma Acute Care Surg 2015.

AAST 2015 Plenary Paper

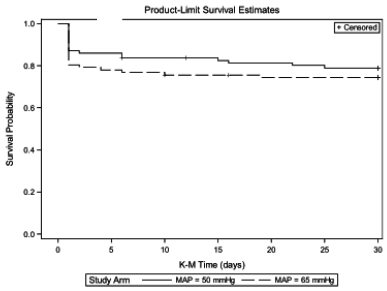
Intraoperative hypotensive resuscitation for patients undergoing laparotomy or thoracotomy for trauma: Early termination of a randomized prospective clinical trial

Matthew M. Carrick, MD, Catherine Anne Morrison, MD, MPH, Nicole M. Tapia, MD, Jan Leonard, MSPH, James W. Suliburk, MD, Michael A. Norman, MD, Francis J. Welsh, MD, Bradford G. Scott, MD, Kathy R. Liscum, MD, Sally R. Raty, MD, Matthew J. Wall, Jr., MD, *and* Kenneth L. Mattox, MD, *Plano, Texas*

- Prospective, 2-arm, intention-to-treat, RCT
- Penetrating trauma + SBP < 90
  - + Need for ex lap or thoracotomy
- Control: MAP > 65
- Experimental: MAP < 50
- Primary outcome: 30 day mortality



CARRICK, 2016



Traumatic Brain Injury / SCI

- **SBP ≥ 90 mm Hg**
  - **MAP > 80 ?**
- Impaired cerebral autoregulation
- Detrimental effect of hypotension on TBI outcomes
- Permissive hypotension studies have excluded TBI patients

Tobin JM. J of Critical Care 2014.
Brain Trauma Foundation. J Neurotrauma 2007.
Chestnut RM. J Trauma 1993.
Roissaint R. Crit Care 2016.
Galvagno SM. J Trauma Acute Care Surg 2017.

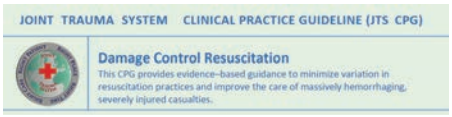
2016 TBI Guideline

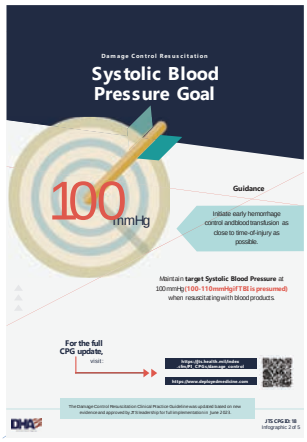
- SBP ≥ 100 for age 50-69
- SBP ≥ 110 for age 15-49 OR > 70

Level III recommendation

Carney N. Brain Trauma Foundation 2016.

Current Recommendations





JTS CPG. 12 Jul 2019..

THOR

- SBP < 100 mm Hg? → start blood products
- SBP 100-110? → slow down infusion rate
- SBP > 110? → stop / reduce infusion to TKO

Woolley T. J Trauma Acute Care Surg 2018.

Hypotensive Resuscitation Conclusion

- **Safe and feasible in many situations**
  - Severe hemorrhage from arterial source
- Advantageous in animal studies
- Avoid in SCI / TBI patients

Low Titer O Positive Whole Blood

THE LANCET

A Canadian, and American, and an Englishman…

Robertson LB. 1918.

Why LTOWB?

Composition	1:1:1 Blood Components	LTOWB
Hematocrit (%)	29%	33-43%
Platelets	~88,000	130,000-400,000
Coagulation activity (%)	~65%	86-100%
Fibrinogen (mg)	850	900
Volume (mL)	660	500-570

Powell & Galvagno, Crit Care Clin, 2024 (forthcoming).

Costs

Prehospital Costs

- 1 U LTOWB: ~$633
- 1 U PRBC: ~$217
- Median charge for RBC transfusion $2388
  - (IQR, $1798-$2492)

Costs vary widely by supplier

Jacobs JW, et al. Am J Hematol 2022.

Transfusion-related Cost Comparison of Trauma Patients Receiving Whole Blood Versus Component Therapy

Ciaraglia A, Myers JC, Braverman M, et al.
San Antonio, TX, USA

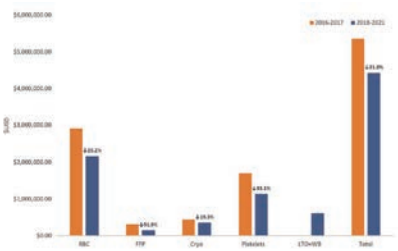
J Trauma Acute Care Surg 2023

- Retrospective review after introduction of LTOWB
- 17% decrease in mean annual costs
- Average net difference in cost: $978
- Lower cost/patient and cost/patient/mL

Transfusion-related Cost Comparison of Trauma Patients Receiving Whole Blood Versus Component Therapy

Ciaraglia A, Myers JC, Braverman M, et al.
San Antonio, TX, USA

J Trauma Acute Care Surg 2023



Outcomes

Impact of Incorporating Whole Blood Into Hemorrhagic Shock Resuscitation

Brill JB, Tang B, Hatton G, et al.
Houston, TX, USA

J Am Coll Surg 2022

- Prospective observational cohort
- N=840 (whole blood)
- 4-fold increased survival in adjusted analysis
- 60% reduction in overall transfusions

Not a prehospital study

Prehospital Whole Blood Reduces Early Mortality in Patients with Hemorrhagic Shock

Braverman MA, Smith A, Pokorny D, et al.
San Antonio, TX, USA

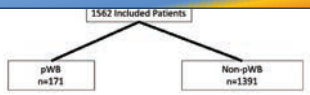
Transfusion 2020

- Registry study (2015-2019)
- N=58 LTOWB vs. N=156 no transfusion
- Fewer massive transfusions, lower SI
- Lower mortality in ED (0 vs. 8%)
  - 24h mortality similar

The Impact of Prehospital Whole Blood on Hemorrhaging Trauma Patients: A Multi-Center Retrospective Study

Braverman MA, Schauer SG, Ciaraglia A, et al.
San Antonio, TX, USA

Transfusion 2021



- LTOWB associated with improved SI
- Fewer massive transfusions with LTOWB
- Fewer median total units transfused/admission
- Adjusted analysis: similar mortality (P=0.14)

Prehospital Low Titer Group O Whole Blood is Feasible and Safe: Results of a Prospective Randomized Pilot Trial (PPOWER)

Guyette F, Zenati M, Triulzi DJ, et al.
Pittsburgh, USA

J Trauma Acute Care Surg 2022

- Cluster randomized pilot, 2018-2020, N=86
- 28% overall mortality at 28 d
  - No statistical mortality benefit (25 vs. 26.1%, P=0.85)
- LTOWB recipients → fewer PRBC transfusions at 24 h
- Lower incidence of thromboelastographic abnormalities in LTOWB group

Whole Blood Resuscitation and Association with Survival in Injured Patients with an Elevated Probability of Mortality

Sperry J, Cotton BA, et al. (SWAT Study Group)
Pittsburgh, USA

J Am Coll Surg 2023

- Prospective, multicenter observational cohort
- Primary outcome: 4-hour mortality
- N=1,051
- LTOWB vs. Component therapy
- 19% received prehospital LTOWB

S.W.A.T.

Whole Blood Resuscitation and Association with Survival in Injured Patients with an Elevated Probability of Mortality

Sperry J, Cotton BA, et al. (SWAT Study Group)
Pittsburgh, USA

S.W.A.T.

J Am Coll Surg 2023

Outcomes	LTOWB (n = 624)	COMPONENT (n = 427)	Unadjusted RR	Unadjusted 95% CI	Unadjusted p Value	Adjusted* RR	Adjusted* 95% CI	Adjusted* p Value
Primary								
4-h mortality†	50 (8.2)	32 (7.5)	1.09	(0.71–1.66)	0.70	0.90	(0.59–1.39)	0.64
TBI subgroup	6 (6.4)	2 (4.5)	1.40	(0.29–6.68)	0.67	0.61	(0.14–2.70)	0.51
Secondary								
24-h mortality	82 (13.4)	49 (11.5)	1.16	(0.83–1.62)	0.37	1.08	(0.77–1.52)	0.67
TBI subgroup	19 (20.2)	6 (13.6)	1.48	(0.64–3.45)	0.36	0.89	(0.41–1.96)	0.78
28-d mortality	110 (17.9)	66 (15.5)	1.16	(0.88–1.53)	0.30	1.10	(0.83–1.47)	0.51
TBI subgroup	25 (26.6)	11 (25.0)	1.06	(0.58–1.96)	0.84	0.84	(0.45–1.56)	0.57

No overall survival benefit

Whole Blood Resuscitation and Association with Survival in Injured Patients with an Elevated Probability of Mortality

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- No overall survival advantage…*BUT*
- Significant 4-hr survival advantage
  - For patients with prehospital predicted mortality of > 5%
  - RR 0.52 (95% CI, 0.32-0.87, P=0.01)
- No differences in VTE, MOFS, infections
  - No difference in hemolysis

Whole Blood Resuscitation and Association with Survival in Injured Patients with an Elevated Probability of Mortality

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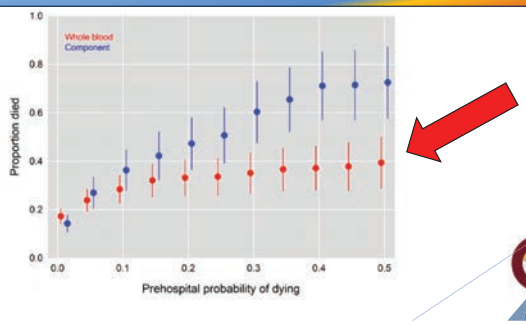

Low Titer Group O Whole Blood Resuscitation: Military Experience from the Point of Injury

Fisher AD, Miles EA, Broussard MA, et al.
JBSA Fort Sam Houston and University of New Mexico, USA

J Trauma Acute Care Surg 2020

- First 15 casualties
  - 13 survived
- 67% gunshot wounds
- Safe, feasible for combat units

Whole Blood at the Tip of the Spear: A Retrospective Cohort Analysis of Warm Fresh Whole Blood Resuscitation vs. Component Therapy

Staudt AM, del Junco DJ, et al.
US Army of Surgical Research, San Antonio, TX, USA

J Trauma Acute Care Surg 2020

- 1,105 (221 warm fresh whole blood; 884 non-warm fresh whole blood)
- Strong associations with decreased mortality
  - OR 0.27 (95% CI, 0.13-0.58)

Clinical Practice Guideline

- LTOWB is the preferred product for prehospital resuscitation
- Simplifies transfusion
- Facilitates more rapid resuscitation of casualties
  - Advantageous for MASCALs

Joint Trauma System Clinical Practice Guideline 12 Jul 2019.

Questions?

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