Penn Medicine

Division of Traumatology, Surgical Critical Care & Emergency Surgery

Use of Whole Blood in Hospitals

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Disclosure

I have a financial relationship with the following companies/entities:

UpToDate	Author: Post-hemorrhage Resuscitation
CSL Behring	TAP Trial
NIH (NHLBI)	TROOP Trial
Patent Pending	Blood Navigator (Arcos, Inc.)

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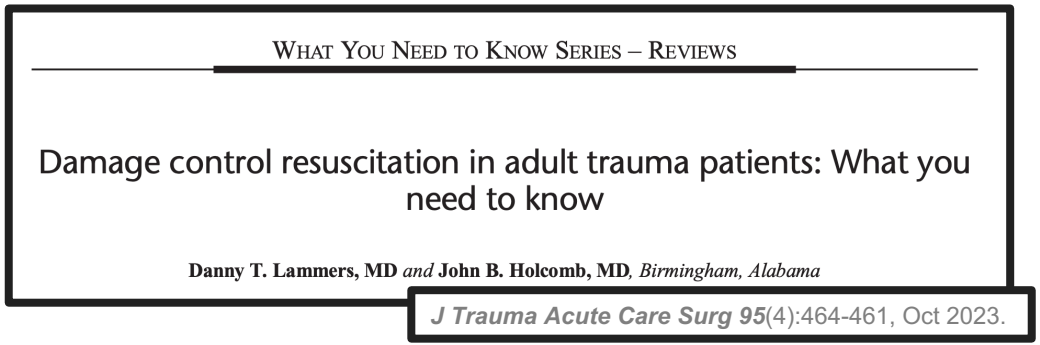
Further Reading



SCAN ME

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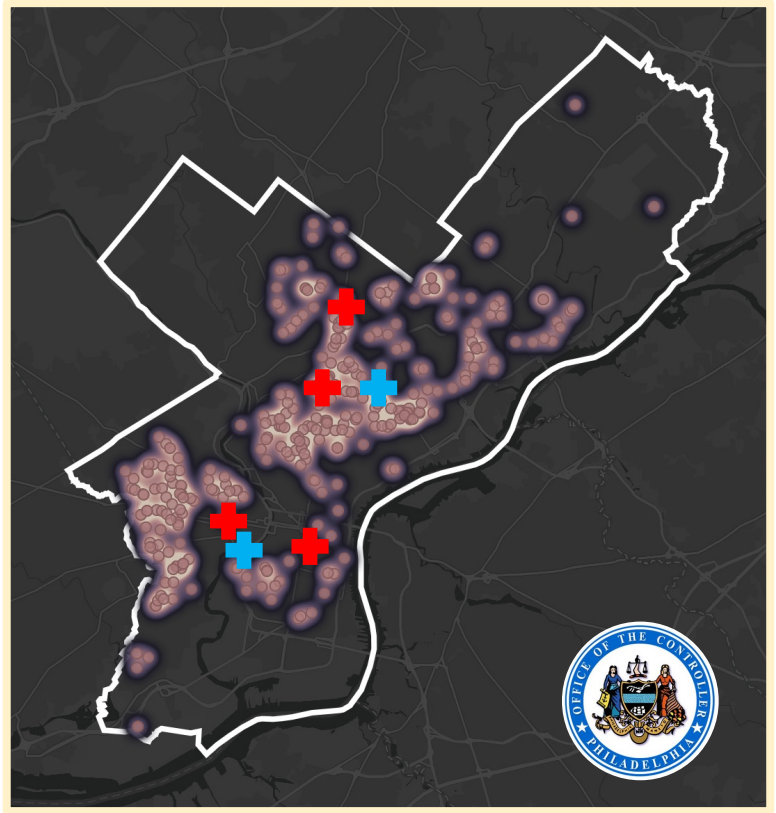
MAY 2016 JPP STAR Unit Dedication



Map of fatal shootings in Philadelphia in 2022
Adult Level 1 TC Pediatric Level 1 TC

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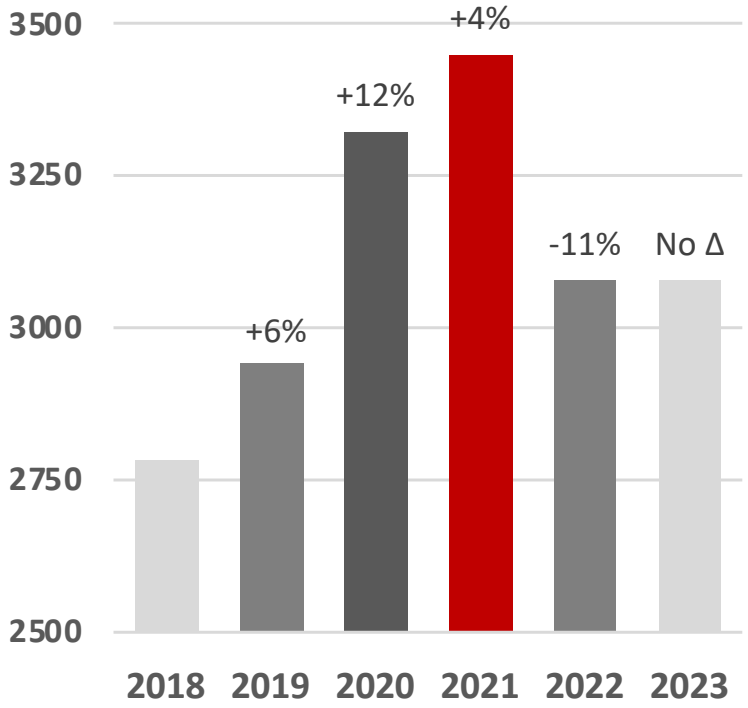
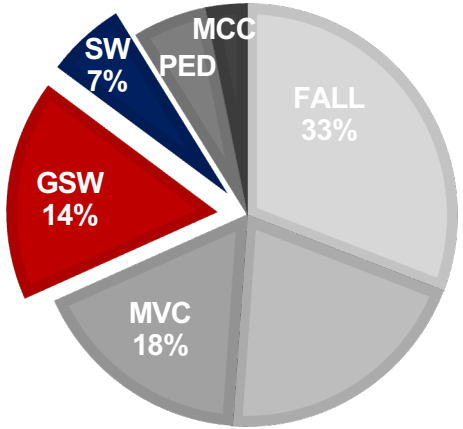
Trauma Volume and MOI 2018-2023





	2020	2021	2022	2023
Any Transfusion	254	276	267	**278**
MTP	69	71	77	**87**
Whole Blood	108	114	132	**160**
TEG Pts	314	389	474	**583**

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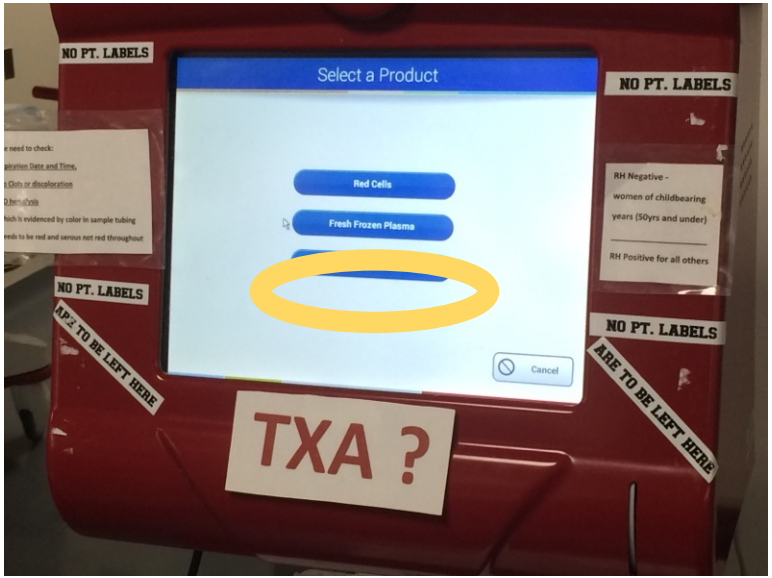
UPenn Whole Blood Protocol: Cold Stored **Type O**



Low-titer Type O WB from ARC
4 Units in TB
Stored up to 15 days

Males Any Age, Females Any Age
ABC>= 2, Need for Blood in TB
No EDT, No Severe TBI

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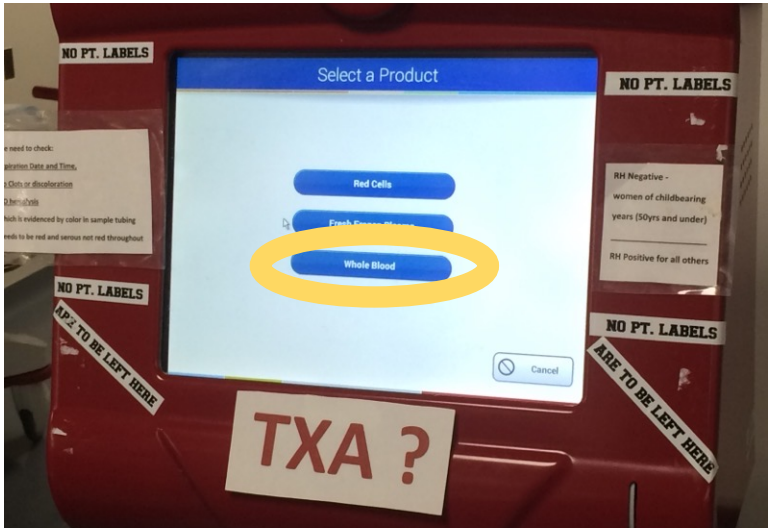
UPenn Whole Blood Protocol: Cold Stored **Type O**



Go-Live Oct 2017
>600 WB Patients
~50% Mismatch

n=160 in 2023!!

No Major Hemolytic Rxns
1 case of TACO
1 Female Recipient*
83% Survival (n=526/632)

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*Prior to practice change in JAN 2023

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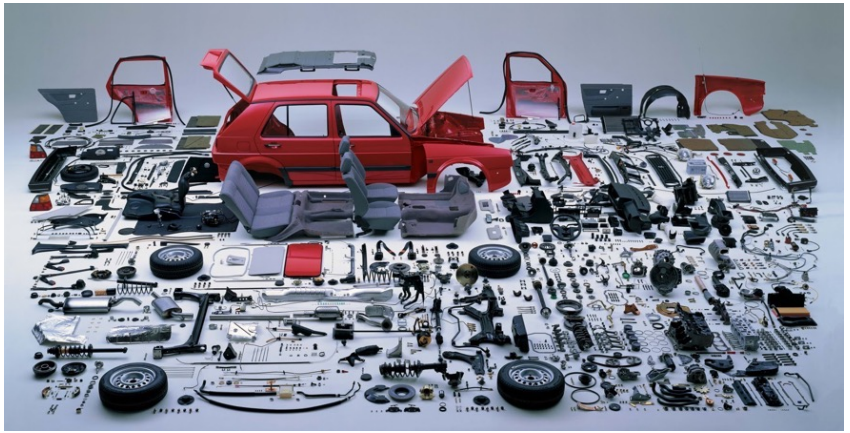
Hospital-Based Whole Blood For Trauma Patients

What I love about WB….

https://www.porsche.com/international/models/911/911-dakar/911-dakar/

www.bestrecipies.com



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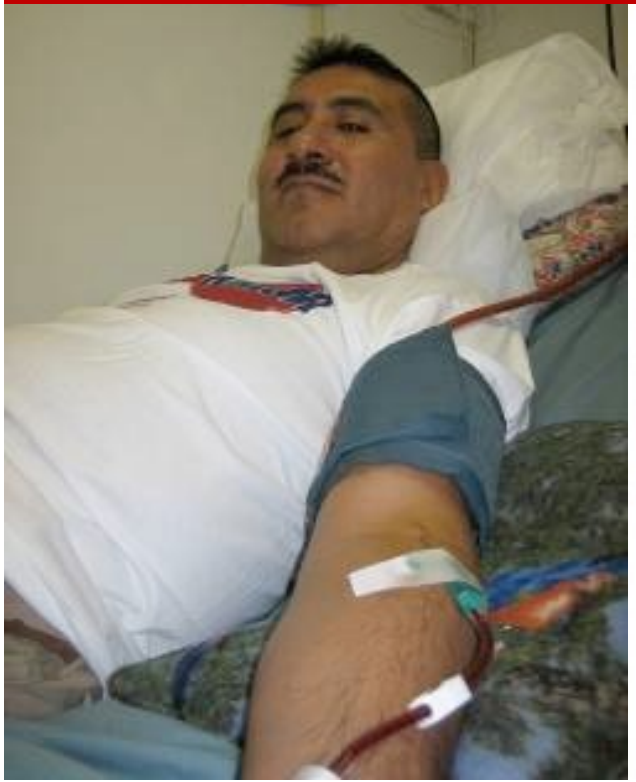
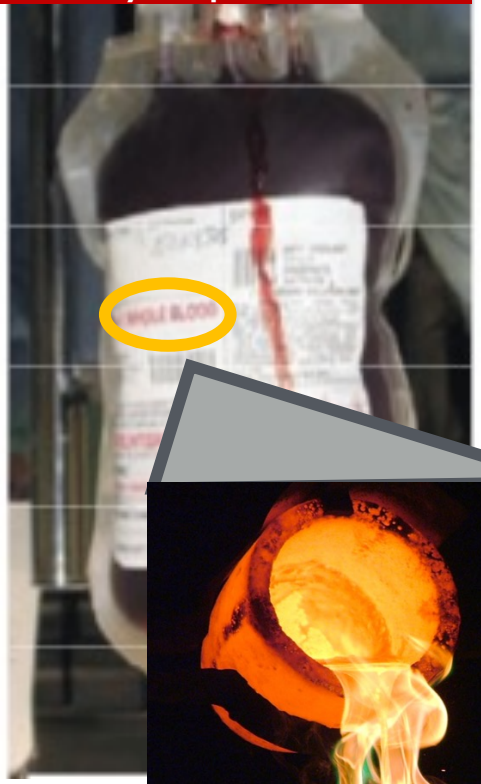
Warm Fresh Whole Blood: Military Experience



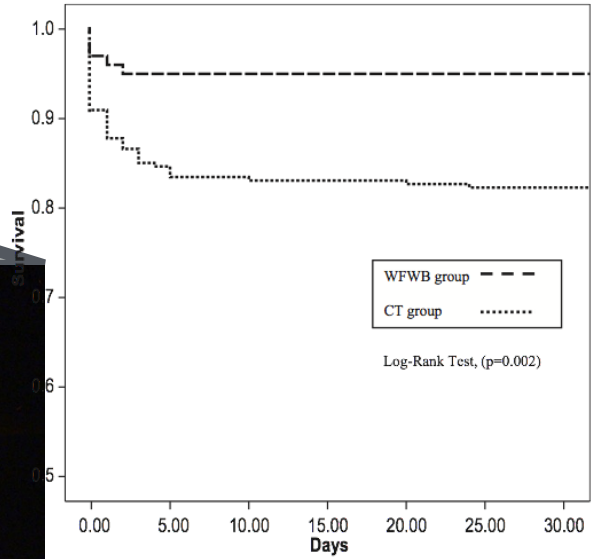


The Journal of TRAUMA® Injury, Infection, and Critical Care

Warm Fresh Whole Blood Is Independently Associated With Improved Survival for Patients With Combat-Related Traumatic Injuries

Philip C. Spinella, MD, Jeremy G. Perkins, MD, Kurt W. Grathwohl, MD, Alec C. Beekley, MD, and John B. Holcomb, MD

J Trauma. 2009;66:S69–S76.



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Courtesy, Dan Brown
https://www.flickr.com/photos/thepuzzler/5439493601

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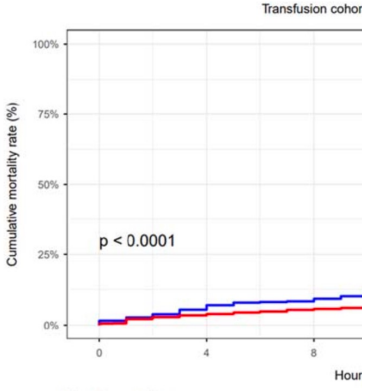
Whole Blood Results: EAST

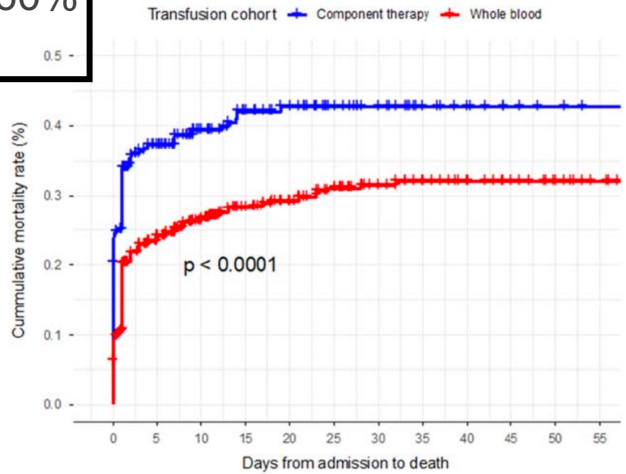
14 US Trauma Centers Using WB
2016-2021, prospective obs
1623 WB vs 443 Comp
Primary Outcome: Hosp Mortality

Hosp Mortality: ??
24-hr Mortality:
14% vs 32%, p<0.001

Shock Index 0.9 vs 0.8
Penetrating 51% vs 60%
ISS 22 vs 21

Major Limitation:
Convenience/Selection Bias





ASA Paper

Use of Cold-Stored Whole Blood is Associated With Improved Mortality in Hemostatic Resuscitation of Major Bleeding

A Multicenter Study

Joshua P. Hazelton, DO,✉ Anna E. Ssentongo, DrPh, MPH,¶¶¶ John S. Oh, MD,* Paddy Ssentongo, MD, PhD,* Mark J. Seamon, MD,§ James P. Byrne, MD, PhD,§ Isabella G. Armento, BS,‖ Donald H. Jenkins, MD,¶ Maxwell A. Braverman, DO,¶ Caleb Mentzer, DO,# Guy C. Leonard, BS,# Lindsey L. Perea, DO,** Courtney K. Docherty, DO,†† Julie A. Dunn, MD,‡‡ Brittany Smoot, BS,‡‡ Matthew J. Martin, MD,† Jayraan Badiee, MPH,† Alejandro J. Luis, MD,§§ Julie L. Murray, BSN, RN,‖‖ Matthew R. Noorbakhsh, MD,¶¶ James E. Babowice, DO,¶¶ Charles Mains, MD,## Robert M. Madayag, MD,## Haytham M.A. Kaafarani, MD, MPH,*** Ava K. Mokhtari, MD,*** Sarah A. Moore, MD,††† Kathleen Madden, MD,††† Allen Tanner, II, MD,‡‡‡ Diane Redmond, MSN,‡‡‡ David J. Millia, MD,§§§ Amber Brandolino, MS,§§§ Uyen Nguyen, BS,‖‖‖ Vernon Chinchilli, PhD,¶¶¶ Scott B. Armen, MD,### and John M. Porter, MD****

Ann Surg. 2022;276:579–588.

TABLE 3. Morbidity and Mortality Outcomes

Outcome	Adjusted OR (95% CI)	*P*
Mortality	0.52 (0.39–0.70)	< 0.0001
Bleeding complications	0.91 (0.91–0.91)	< 0.001
Acute kidney injury	1.51 (0.92–2.48)	0.10
Deep vein thrombosis/pulmonary embolism	1.33 (0.76–2.31)	0.38
Pulmonary complications	0.86 (0.36–2.05)	0.73

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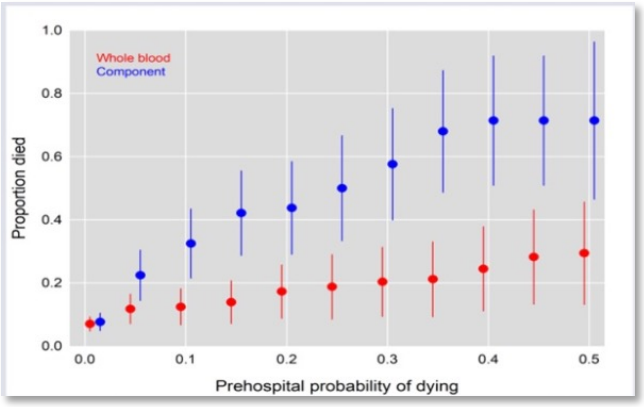
LITES
Linking Investigations in Trauma and Emergency Services

https://www.litesnetwork.org/

PARC PENNACUTE RESEARCH COLLABORATION

Shock, Whole Blood & Assessment of TBI (SWAT)



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

Jason L Sperry, MD, MPH, FACS, Bryan A Cotton, MD, FACS, James F Luther, MA, Jeremy W Cannon, MD, FACS, Martin A Schreiber, MD, FACS, Ernest E Moore, MD, FACS, Nicholas Namias, MD, MBA, FACS, Joseph P Minei, MD, FACS, Stephen R Wisniewski, PhD, Frank X Guyette, MD, MPH, the Shock, Whole Blood, and Assessment of Traumatic Brain Injury (SWAT) Study Group

JACS. 2023;237(2):206-219.

JACS JOURNAL OF THE AMERICAN COLLEGE OF SURGEONS

7 US Trauma Centers
2018-2021, prospective obs
624 WB vs 427 Comp
Primary Outcome: 4-Hr Mortality
TBI: 16% vs 10%

4-Hr Mortality: 8.2% vs 7.5%
24-Hr Mortality: 13.4% vs 11.5%
28-Day Mortality: 17.9% vs 15.5%

Post-Hoc Analysis
Unexpected Survivors
Dose-Response

TROOP TRIAL

Trauma **R**esuscitation with group **O** whole blood **O**r **P**roducts

https://www.youtube.com/watch?v=ZY0P93mBlNU&t=66s

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Whole Blood Results: Schreiber

Western Trauma Association

ORIGINAL ARTICLE SUBSCRIBED AHEAD OF PRINT

Whole blood versus balanced resuscitation in massive hemorrhage: six of one or half dozen of the other?

Barton, Cassie A. PharmD, BCCPS, FCCM[1]; Oetken, Heath J. PharmD, BCCCP[1]; Hall, Nicolas L. AG-ACNP[2]; Kolesnikov, Michael AG-ACNP, PhD(c)[2]; Levins, Elizabeth S. PharmD, MHA, BCCCP[1]; Sutton, Thomas MD, MCR[2]; Schreiber, Martin MD[2] Author Information

J Trauma Acute Care Surg. 2024 Apr 30.

Single US Trauma Center
2016-2021, prospective obs
CAT+ MTP Patients
180 WB vs 170 Comp
Primary Outcome: 24h, 30d mort

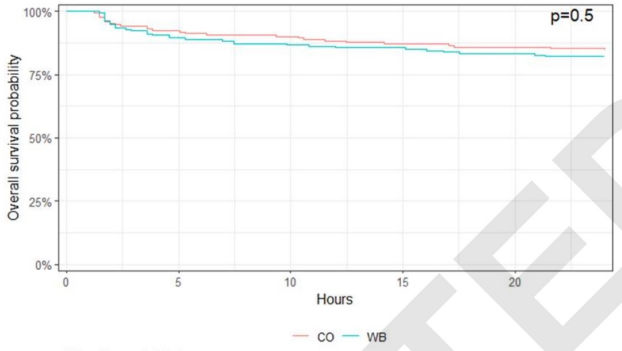
Groups Well Matched
Penetrating: 27% vs 29%

24-Hr: 18% vs 15%, p=0.5

30-Day: 32% vs 31%, p=0.5

Cox HR WB Mortality:
0.85, 95% CI 0.61-1.19, p=0.34

crystalloid fluid in their resuscitations. WB-based resuscitation resulted in a balanced resuscitation at all times, while CO resuscitation required adept attention to ratios of products administered and more frequently failed to meet balanced resuscitation goals when over twenty units were required within the first 24 hours of arrival.



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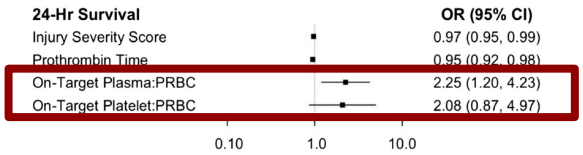
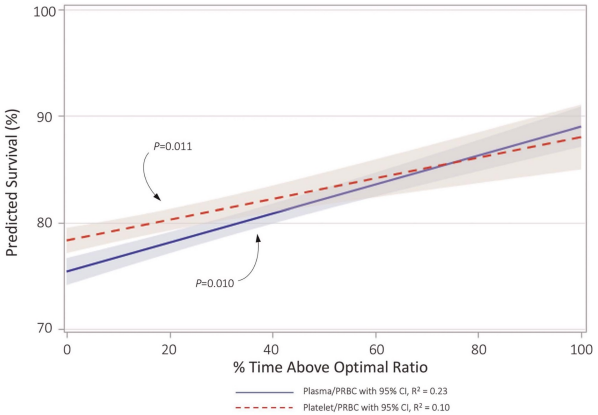
Discussion

- Warm Fresh Whole Blood == Gold Standard
- Benefits of cold stored type O WB for Trauma
  - Mortality benefit? (cold platelets, less anticoagulant/chelating agent)
  - Logistical benefit
  - Maintaining 1:1:1





2021 WTA Podium Paper

OPEN

Staying on target: Maintaining a balanced resuscitation during damage-control resuscitation improves survival

Allyson M. Hynes, MD, Zhi Geng, MD, MPH, Daniela Schmulevich, MCM, Erin E. Fox, PhD, Christopher L. Meador, MBA, Dane R. Scantling, DO, MPH, Daniel N. Holena, MD, MSCE, Benjamin S. Abella, MD, MPhil, Andrew J. Young, MD, Sara Holland, DNP, Pamela Z. Cacchione, PhD, Charles E. Wade, PhD, Jeremy W. Cannon, MD, SM, *and* PROMMTT Study Group, *Philadelphia, Pennsylvania*

J Trauma Acute Care Surg 2021;91(5):841-848

Physicians of all specialties committed to improving trauma care

Western Trauma Association

Zhi Geng, MD Ally Hynes, MD

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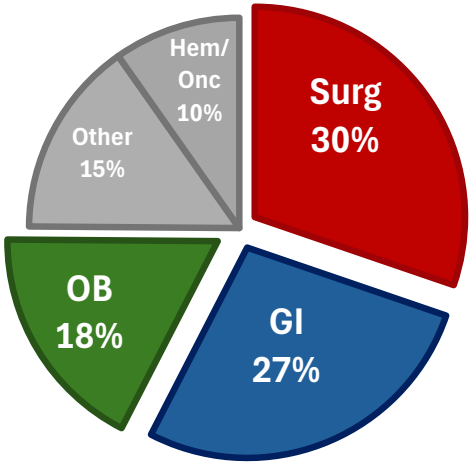
Whole Blood For Other Populations?

REVIEW

What's new in whole blood resuscitation? In the trauma bay and beyond

Stacy L. Coulthard[a,b], *Lewis J. Kaplan*[a,c] *and Jeremy W. Cannon*[a,b]

Current Opinion in Critical Care 30(3):209-216, June 2024.



- Surgical Patients
- Medical patients
  - Massive gastrointestinal bleeding
  - Heme-Onc
- Postpartum hemorrhage
- Outcomes
  - Poorly Reported
  - 3 allergic reactions
  - No major hemolytic reactions

Indication	Nowadly[1] BAMC, 1 yr	Smith[2] UTHSCSA, 2 yrs	Christian[3] OHSU, 1 yr	Total
Surgical	22	15	25	62
GI	11	27	18	56
OB/GYN	23	11	2	36
Other	28		3	31
Heme Onc	16	4		20
Total	**100**	**57**	**48**	**205**

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1. Nowadly et al. Mil Med 2022; 187(7 – 8):e821 – e825.
2. Smith et al. Am Surg 2023; 89:4934 – 4936.
3. Christian et al. Arch Path and Lab Med 2023; 147:710 – 715.

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Challenges

Hospital-Level Challenges

- Expense of WB
- Inventory Management
- WB Wastage

Whole Blood												
Bag broke / spiked		1										1
Out too long					1				1			2
Product expired	0	3	3	17		7	23	26	34	14	25	152
Visual Inspection not OK			2		2							4
Total	**0**	**4**	**5**	**17**	**3**	**7**	**23**	**26**	**35**	**14**	**25**	**159**

Creative Solutions to Minimize Waste

→Conversion to pRBC

→System-level Utilization

→ Broaden WB Indications

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Summary

Summary

- WB Benefits
  - Possible Mortality Benefit (TROOP underway in MTP pts)
  - Simplifies DCR
  - Staying ON TARGET
- Applications in other populations
  - Opportunity for more study
- Approaches to minimize waste

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June 20, 2024