

## Whole Blood: The Whole Story

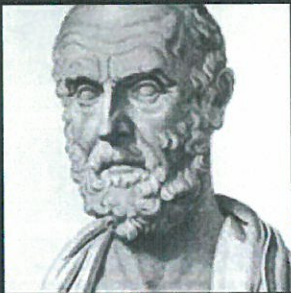
Joseph Restivo, DO  
Medical Director, Transfusion Services  
Forward Pathology Solutions, HCA MidAmerica – Kansas City

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## Disclosures

- ◆ No relevant disclosures
- ◆ The following reflect my own opinions and not those of any entities with whom I am affiliated.
- ◆ Not a substitute for clinical judgment

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Where there is love of medicine,  
there is love of humankind.

~ Hippocrates

AZ QUOTES

"Hippocrates." AZQuotes.com. Wind and Fly LTD, 2020. 25 September 2020. <https://www.azquotes.com/quote/1426748>

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## Objectives

- ◆ Discuss the proposed clinical benefits of whole blood for trauma resuscitation
- ◆ Describe the logistical advantages/concerns to using whole blood for trauma resuscitation
- ◆ Discuss theoretical risks of whole blood for trauma resuscitation
- ◆ Summarize current literature supportive or dismissive of whole blood use for trauma resuscitation

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## Component Therapy Review

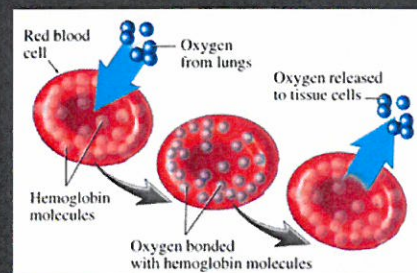
- Red Blood Cells
- Platelets
- Fresh Frozen Plasma



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## Rationale for RBC Transfusion

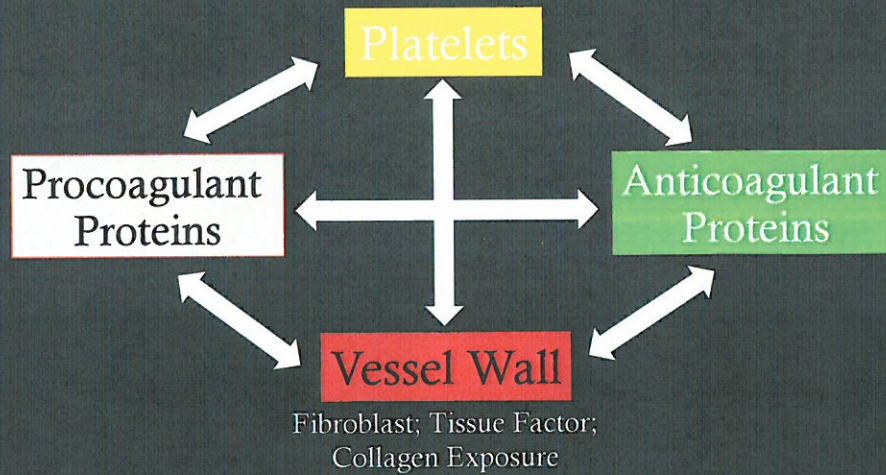
- ◇ Increase oxygen delivery
  - ◇ O<sub>2</sub> bound to Hgb in RBCs
  - ◇ Anemia can lead to ↓ delivery
- ◇ Most patients can compensate
  - ◇ ↑ cardiac output by ↑ heart rate and/or stroke volume increases O<sub>2</sub> delivery
  - ◇ At rest large reserve
    - ◇ O<sub>2</sub> delivery is 4x greater than consumption
    - ◇ If volume maintained, ↑ in CO, R shift in O<sub>2</sub> dissociation curve, ↑ extraction at tissue level all compensates for ↓ in Hgb
- ◇ When Hgb at 5-6 g/dL or lower.....healthy patients unable to compensate (blood failure)
- ◇ RBCs push platelets to vessel walls



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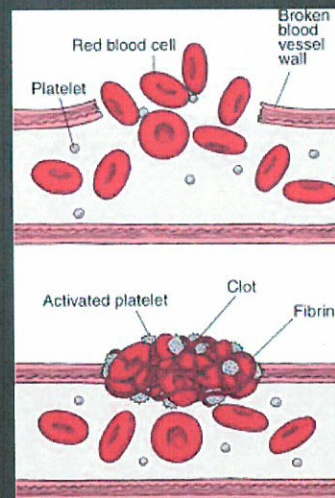
## Normal Hemostasis – Intricate Balance & Interaction of Multiple Elements



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## Formation of a Clot

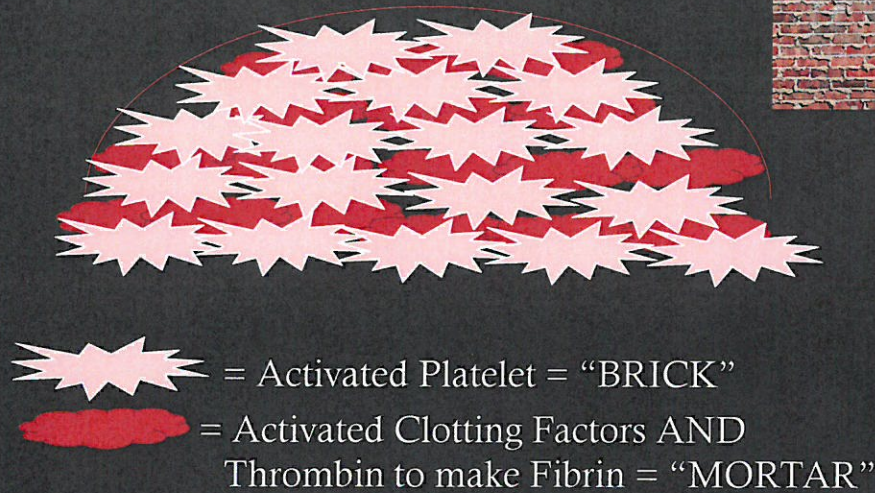
- ◊ Injured blood vessel contracts or becomes smaller so less blood escapes
- ◊ Platelets attracted to site → become activated → adhere to vessel → secrete molecules to attract more platelets → platelet plug
- ◊ Clotting factors also recruited. By a series of activation of clotting proteins → thrombin generated → fibrinogen converted to fibrin



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## Building a Clot = Building a Wall at the Injury Site



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## What is Whole Blood?

- ◇ Not all WB is created equal
  - ◇ Warm Fresh Whole Blood - Walking Donors – Mil only – 24 hr shelf life
  - ◇ Stored Whole Blood/Cold Whole Blood – Refrigerated Whole blood – usually CPD (21 day shelf life)
  - ◇ Low Titer O Whole Blood – Blood type O donor, tested for amount of anti-A and B antibodies (can be WFWB (ROLO) or SWB) \*Different titer methods and cutoffs.
  - ◇ Platelet sparing leukoreduced vs. non-leukoreduced

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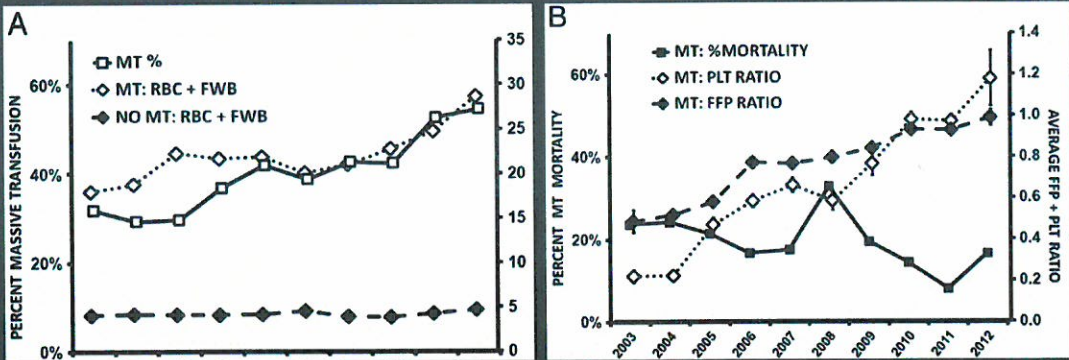


# Why Whole Blood?

- ◇ Better understanding of trauma related coagulopathy. Back to the future for the solution. Military use since 1917. (WWI, WWII, Korea, etc.) Largely LTOWB.
- ◇ Recent military experience with Warm Fresh Whole Blood and retrospective analysis suggesting improved survival with 1:1:1 ratio component therapy.

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# OIF/OEF Experience 2002-2012



Pidcoke, Heather F. MD; Aden, James K. PhD; Mora, Alejandra G.; Borgman, Matthew A. MD; Spinella, Philip C. MD; Dubick, Michael A. PhD; Blackburne, Lorne H. MD; Cap, Andrew P. MD, PhD Ten-year analysis of transfusion in Operation Iraqi Freedom and Operation Enduring Freedom: Increased plasma and platelet use correlates with improved survival. *Journal of Trauma and Acute Care Surgery*: December 2012 - Volume 73 - Issue 6 - p S445-S452 doi: 10.1097/TA.0b013e3182754796

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## OIF/OEF Experience 2002-2012

Transfusion Ratio	Low FFP, Low PLT	High FFP, Low PLT	Low FFP, High PLT	High FFP, High PLT
Odds ratio (95% confidence interval)	1.000	0.759	0.343	0.220
n	1,369	1,197	82	980
Nonsurvivors, %	17	17	16	12*
ISS	16	21†	22†	26†
IQR	10-22	14-29	14-29	18-34

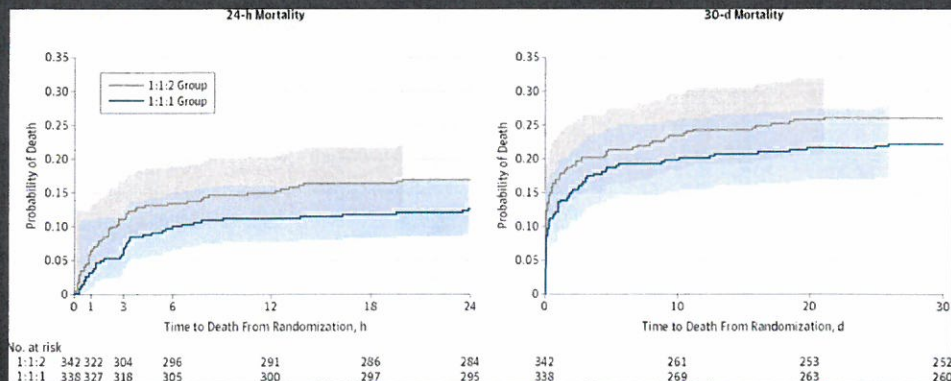
\* $p = 0.015$ , † $p \leq 0.001$  compared with the low-FFP/low-PLT group.

Factors Associated with Survival Outcomes: Effect of Transfusion Ratio on Survival Status

Pidcoke, Heather F. MD; Aden, James K. PhD; Mora, Alejandra G.; Borgman, Matthew A. MD; Spinella, Philip C. MD; Dubick, Michael A. PhD; Blackbourne, Lorne H. MD; Cap, Andrew P. MD, PhD Ten-year analysis of transfusion in Operation Iraqi Freedom and Operation Enduring Freedom: Increased plasma and platelet use correlates with improved survival, *Journal of Trauma and Acute Care Surgery*: December 2012 - Volume 73 - Issue 6 - p S445-S452 doi: 10.1097/TA.0b013e3182754796

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## Civilian Experience - PROPPR



Holcomb JB, Tilley BC, Baraniuk S, et al. 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. *JAMA*. 2015;313(5):471-482. doi:10.1001/jama.2015.12

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# Warm Fresh Whole Blood (WFWB) (<48 hours)

Published in final edited form as:  
*J Trauma*. 2009 April ; 66(4 Suppl): S69-S76. doi:10.1097/TA.0b013e31819d851b.

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

**Philip C. Spinella, MD.**  
 United States Army Institute of Surgical Research, Fort Sam Houston, Texas, Connecticut  
 Children's Medical Center, Hartford, Connecticut

**Jeremy G. Perkins, MD.**  
 United States Army Institute of Surgical Research, Fort Sam Houston, Texas; Walter Reed Army Medical Center, Bethesda, Maryland

**Kurt W. Grathwohl, MD.**  
 Brooke Army Medical Center, Fort Sam Houston, Texas

**Alec C. Beekley, MD, and**  
 Madigan Army Medical Center, Tacoma, Washington

**John B. Holcomb, MD**

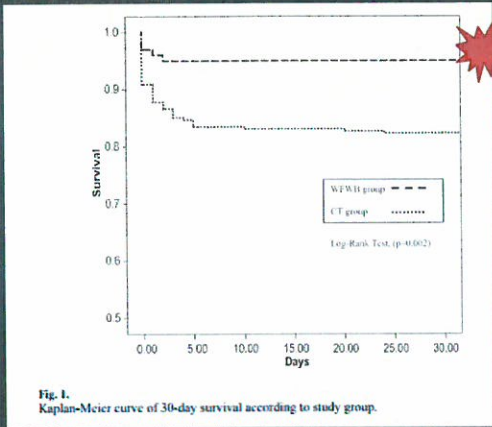


Fig. 1. Kaplan-Meier curve of 30-day survival according to study group.

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# WFWB

Comparison of Individual Blood Products, Volumes and Ratios Between WFWB and CT Groups

Variable	WFWB (n = 100)	CT (n = 254)	p Value
Stored RBC (L)	9 (7-14)	16 (10-22)	<0.001
Plasma (L)	4 (3-8)	10 (6-16)	<0.001
Apheresis platelets (L)	0	2 (1-4)	<0.001
WFWB (L)	5 (3-9)	0 (0-0)	<0.001
Cryoprecipitate (L)	0 (0-0)	0 (0-1)	0.07
Total RBC (L)	16 (11-22)	16 (10-22)	0.44
Total blood volume (L)	7.4 (5.8-10.4)	9.3 (6.2-13.3)	0.006
Anticoagulant/adhesives (L)	1.7 (1.3-2.5)	2.5 (1.6-3.6)	<0.001
Actual blood volume (L)	5.7 (4.1-8.1)	6.8 (4.5-10)	0.03
PLT/RBC ratio	0.33 (0.2-0.5)	0.86 (0.6-1.3)	0.001
Plasma/RBC ratio	0.74 (0.55-0.9)	0.73 (0.53-1)	0.73
Massive transfusion (%)	89/100 (89%)	196/254 (77%)	0.017
rFVIIa use (%)	42/100 (42%)	101/253 (40%)	0.72

Data presented as Median (IQR) or as percentages.  
 rFVIIa, recombinant factor VIIa.

Table 5  
 Comparison of Survival Outcomes and Adverse Events Between Study Groups

Variable	WFWB (n = 100)	CT (n = 254)	p Value
24 h survival	96/100 (96%)	223/254 (88%)	0.018
30 d survival	95/100 (95%)	209/254 (82%)	0.002
Deep vein thrombosis	15/100 (15%)	21/254 (8%)	0.06
Pulmonary embolism	7/100 (7%)	11/254 (4%)	0.3
Myocardial infarction	1/100 (1%)	0 (0%)	0.28
Cerebral stroke	0 (0%)	5/254 (2%)	0.33
ARDS	7/100 (7%)	7/254 (3%)	0.08
Renal failure	8/100 (8%)	7/254 (3%)	0.04

ARDS, Acute Respiratory Distress Syndrome.

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❖ Great but WFWB is not FDA approved. Is SWB as good?

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## LTOWB/SWB

Variables	Component Therapy Only n = 83		Received WB n = 42			p Value
	n	Stat (95% CI or IQR)	n	Stat	95% CI or IQR	
Age at admit	83	44.0** (39.7-48.3)	42	45.9** (40.1-51.7)		0.60
Sex (% male)	64	77%	27	64%		0.13
Race (% white)	49	59%	30	71%		0.29
Hispanic	6	7%	3	7%		0.11
Hypertension	10	12%	7	17%		0.48
Obesity	14	17%	11	26%		0.23
Smoking	21	25%	4	10%		0.03
Alcoholism/substance abuse	16	19%	5	12%		0.29
Blunt injuries	55	66%	33	79%		0.15
ISS	83	29.2** (26.2-32.2)	41	28.1** (22.9-33.3)		0.72
HR	83	101.7** (94-109.4)	41	102.3** (91.3-113.4)		0.92
RR	76	23.7** (21-26.4)	36	21.8** (19.4-24.2)		0.30
SBP	83	114.8** (106-123.6)	42	122.3** (108.7-135.8)		0.36
ICU LOS, d	83	2.8* (0.5-7.1)	34	2.8* (1.5-7.3)		0.30
Hospital LOS, d	83	7.7* (0.6-17.3)	40	5.7* (0.3-13.3)		0.56
Ventilator days	83	2*(1-4)	40	2* (1-3.8)		0.97

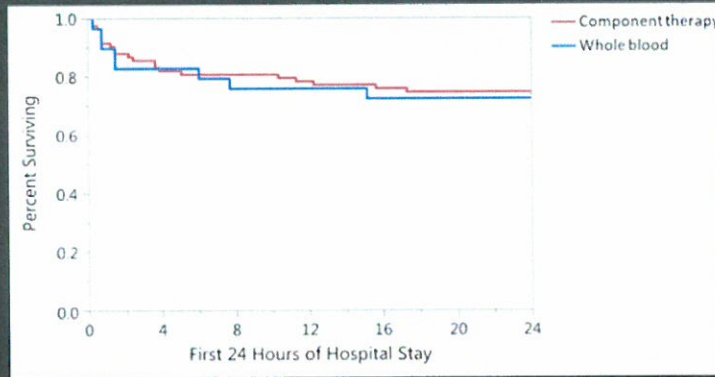
IQRs are reported with medians (\*) and 95% CIs are reported with means (\*\*)  
 ISS, Injury Severity Score; HR, heart rate; RR, respiratory rate; SBP, systolic blood pressure; LOS, length of stay; 95% CI, 95% confidence interval.  
 Demographics and Clinical Characteristics on Presentation

Gallagher, Jared Robert MD, MPH; Dixon, Alexandra MD, MPH; Cockcroft, April DO; Grey, Maverick BA; Dewey, Elizabeth MS; Goodman, Andrew BS; Schreiber, Martin MD Large volume transfusion with whole blood is safe compared with component therapy, Journal of Trauma and Acute Care Surgery: July 2020 - Volume 89 - Issue 1 - p 238-245 doi: 10.1097/TA.0000000000002687

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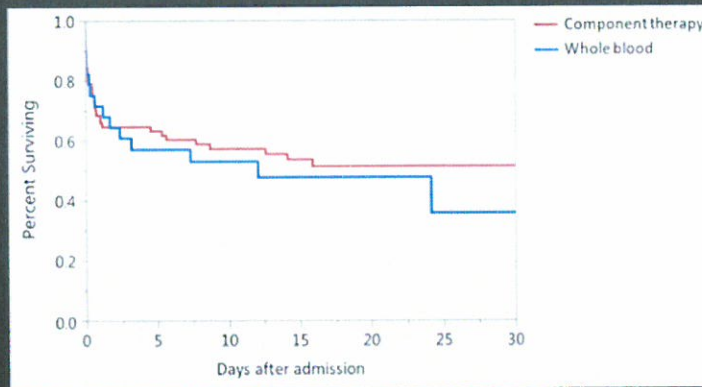
# LTOWB/SWB



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# LTOWB/SWB



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◊ If no improvement, why switch?

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## LTOWB/SWB + Prehospital

	LTO-WB Patients (n = 198)	COMP Patients (n = 152)	p
Median age, y	41 (26, 56)	38 (24, 51)	0.121
Male sex	72%	69%	0.493
Median BMI	27 (24, 29)	26 (23, 30)	0.424
Blunt mechanism	71%	65%	0.231
White race	45%	35%	0.059
Median head AIS score	3 (0, 4)	2 (0, 4)	0.367
Median chest AIS score	3 (0, 4)	2 (0, 3)	0.027
Median abdomen AIS score	2 (0, 3)	0 (0, 3)	0.201
Median extremity AIS score	2 (0, 3)	2 (0, 3)	0.280
Median ISS	25 (16, 36)	22 (16, 34)	0.203
ABO blood type			
O	52%	44%	0.137
A	32%	37%	
B	13%	18%	
AB	3%	1%	
Rh status			
Rh+	91%	91%	0.997
Rh-	9%	9%	

Comparison of Baseline and Demographic Between Patients Receiving WB and COMP Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma. *Journal of Trauma and Acute Care Surgery*; January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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## LTOWB/SWB + Prehospital

	LTO-WB Patients (n = 198)	COMP Patients (n = 152)	p
Scene transport	90%	81%	0.013
Helicopter transport	45%	30%	0.027
Median scene HR	114 (86, 130)	101 (80, 126)	0.063
Median scene SBP	106 (85, 132)	129 (98, 141)	0.085
Median scene DBP	65 (52, 82)	70 (54, 93)	0.237
Median scene GCS	13 (3, 15)	12 (3, 15)	0.387
Median scene GCS-motor	6 (1, 6)	5 (1, 6)	0.664
Prehospital (+) FAST	31%	26%	0.306
Prehospital intubation	45%	32%	0.073

Comparison of Prearrival Physiology Between Patients Receiving WB and COMP Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma. *Journal of Trauma and Acute Care Surgery*. January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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## LTOWB/SWB + Prehospital

	LTO-WB Patients (n = 198)	COMP Patients (n = 152)	p
Median arrival HR	110 (83, 128)	97 (84, 122)	0.269
Median arrival SBP	94 (75, 123)	105 (88, 132)	0.005
Median arrival DBP	59 (40, 75)	65 (52, 81)	0.023
Median arrival GCS	3 (3, 15)	8 (3, 15)	0.241
Median arrival GCS-motor	4 (1, 6)	6 (1, 6)	0.302
ED (+) FAST	29%	25%	0.532
MTP activation	80%	71%	0.127
Median arrival hemoglobin	12.8 (11.2, 14.1)	11.9 (10.3, 13.8)	0.032
Median arrival platelet ct	221 (176, 275)	212 (173, 251)	0.465
Median arrival pH	7.22 (7.11, 7.29)	7.26 (7.18, 7.33)	0.011
Median arrival base excess	-7 (-11, -4)	-5 (-9, -3)	0.014
Median arrival lactate	5.1 (3.1, 7.5)	3.5 (2.3, 5.1)	<0.001

Comparison of Arrival Physiology and Shock Parameters Between Patients Receiving WB and COMP Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma. *Journal of Trauma and Acute Care Surgery*. January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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## LTOWB/SWB + Prehospital

	LTO-WB Patients (n = 198)	COMP Patients (n = 152)	p
Median ED RBC, U	1 (0, 3)	2 (0, 6)	0.040
Median ED plasma, U	1 (0, 3)	2 (0, 5)	0.065
Median ED platelets, U	0 (0, 1)	0 (0, 1)*	0.216
Median ED WB, U	1 (0, 1)	0 (0, 0)	<0.001
Median post-ED RBC, U	0 (0, 3)	2 (0, 6)	<0.001
Median post-ED plasma, U	0 (0, 1)	1 (0, 3)	0.018
Median post-ED platelets, U	0 (0, 0)	0 (0, 1)	0.231
Median post-ED products, U	0 (0, 4)	3 (0, 10)	0.001

Comparison of ED and Post-ED Transfusions Between Patients Receiving WB and COMP Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma. Journal of Trauma and Acute Care Surgery: January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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## LTOWB/SWB + Prehospital

30-d Survival	Odds Ratio	95% CI	p-Value
LTO-WB	2.19	1.010-4.767	0.047
Age	0.97	0.958-0.998	0.032
Chest AIS score	0.98	0.790-1.229	0.898
Prehospital SBP	0.99	0.985-1.010	0.723
Arrival base value	1.13	1.049-1.221	0.001
Blunt mechanism	1.09	0.470-2.572	0.827
Post-ED blood transfusions			
	Odds ratio	95% CI	p-value
LTO-WB	0.47	0.239-0.941	0.033
Age	0.99	0.974-1.008	0.302
ISS	1.06	1.029-1.096	<0.001
Prehospital SBP	0.99	0.986-1.008	0.623
Arrival base value	1.01	0.949-1.083	0.670
Blunt mechanism	1.72	0.823-3.608	0.148

95% CI, 95% confidence interval.  
 Multivariate Logistic Regression Model Evaluating the Impact of LTO-WB on 30-Day Survival and Post-ED Blood Product Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma. Journal of Trauma and Acute Care Surgery: January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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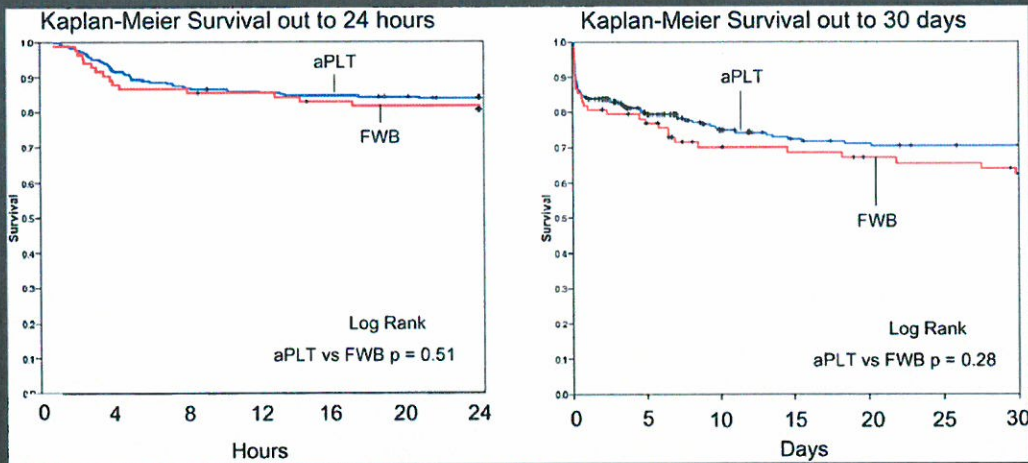


# LTOWB Logistics

- ◊ LTOWB has only refrigerated storage requirement vs. multiple shelf lives and storage conditions. This facilitates forward deployment for EMS and ED based storage.
- ◊ Do the cold stored platelets and clotting factors in SWB work as well? For how long?
  - ◊ Platelets and clotting factors as good if not better (platelets are pre-activated) for 14 days shelf life, after which WB can be spun down into a pRBC. 14 day cold stored apheresis platelets available now (very limited).
- ◊ LTOWB is more concentrated. 2 fewer liters transfused on average. Significantly less citrate. Probably less K+. 13 products vs. 4-5.

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## Component vs FWB as only source of plts



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## Potential Risks/Questions to LTOWB Transfusion

- ◇ This WILL create patient ABO typing issues
  - ◇ True, hospitals MUST get a pretransfusion sample if possible. May need to transfuse with O's for a long time
- ◇ What about Rh alloimmunization?
  - ◇ The odds are low (1-1.5%) that a trauma victim needing LTOWB will be an Rh neg female of child bearing potential. Only 20% of these patients will develop anti-D alloantibodies to Rh pos pRBCs, and of these only 20% will develop severe HDFN. At RMC up to 2 of the 5 units will be O neg, and preferentially transfused to child bearing age females, if available from the supplier to further mitigate this risk.
- ◇ What about minor ABO incompatibility with out of group transfusion (Anti-A, Anti-B and Anti-A,B in type O donor plasma given to non-O patients)

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### Transfusion of Platelets Containing ABO-Incompatible Plasma: A Survey of 3156 North American Laboratories

Mark K. Fung, MD, PhD, FCAP, Katharine A. Downes, MD, FCAP, and Ira A. Shulman, MD, FCAP

Severe hemolytic transfusion reaction, including death have been associated with ABO minor mismatch platelet transfusion

Source, y	Recipient Group	Donor Group	Component Transfused	Reaction	Anti-A or Anti-B Titer	Age of Recipient
SHOT Steering Group, <sup>41</sup> 2002	A	O	Pooled platelets	3 cases that led to either a hemolytic transfusion reaction or subsequent cross-matching problems.	High-titer antibody excluded in 1 case and not tested in the other 2 cases.	Not stated
	A	O	Pooled platelets			
	A	O	Apheresis platelets			
SHOT Steering Group, <sup>42</sup> 2004	A	O	Apheresis platelets	Significant hemolysis (elevated bilirubin, falling Hgb, decreased renal function)	>1024 (saline) >8192 (iAT)	11 y
Josephson et al., <sup>11</sup> 2004	A	O	Apheresis platelets	Both patients had hemoglobinemia and hemoglobinuria, rigors and back pain	256 (IgM) 8192 (IgG)	Not stated
Fauzie et al., <sup>12</sup> 2004	A	O	Apheresis platelets	Severe back pain and fall in Hgb	1024 (IgG) 32 (saline) 32 (iAT)	Not stated
	A	O	Apheresis platelets			
	A	O	Apheresis platelets			
Sapatnekar et al., <sup>13</sup> 2005	A	O	Apheresis platelets; received 145 mL	Shock and marked intravascular hemolysis with drop in Hgb of at least 4 g/dL	2048 (saline) 16 384 (iAT)	2 y
	A	O				
	A	O				
Reinhardt et al., <sup>14</sup> 2005	A	O	Apheresis platelets	Severe hemolysis	512 (saline)	Not stated
Novotny and Brand, <sup>15</sup> 2005	AB	O	Apheresis platelets	Severe hemolytic reaction	Not reported	Child
MacLennan, <sup>16</sup> 2005	A	O	7 aliquots of platelets	Free plasma Hgb of 316 g/L within 24 h of platelet transfusion	<20	3 mo

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**Some Immunohematologic Results of Large Transfusions of Group O Blood in Recipients of Other Blood Groups**

A Study of Battle Casualties in Korea  
 WILLIAM H. CROSBY LT.COL. and JOSEPH H. AKEROYD LT.COL.

Blood 1954 9:103-116;

◊ “Clinically the hemolytic disease on the basis of such transfused isoantibodies while causing destruction of native red cells did not threaten the lives or impede the recovery of these patients. No reactions were encountered and none were heard of in Korea that might have been ascribed to a dangerous universal donor. The partition of group O blood into high titer and low titer on the basis of dilution of 1:200 to 1:256 has proved in practice to be safe.”

**TABLE 2—Response to Large Transfusions of Group O Blood**

Patient	ABO blood group	Date	Cumulative total blood received (pints)	Total RBC (10 <sup>6</sup> )	Inagglutinable RBC (10 <sup>6</sup> )	Proportion of donor RBC (%)	Plasma hemoglobin (mg/100 ml)	Foreign isoagglutinin (5 C.)	Reticulocytes (%)
D CSW: lacerations of bowel	AB	21 Nov	14	6.55	5.40	84	35	1:128	←
		22 Nov		7.41	5.26	87	19		
		23 Nov		6.64	5.42	81	21	1:128	
		24 Nov		6.65	5.32	83	18	1:64	
		25 Nov					14		
		26 Nov		6.64	5.71	85	5.2	1:64	
		27 Nov		6.94	6.13	87	3.9	1:16	
		29 Nov		6.91	5.74	84	2.5	1:8	
		1 Dec		6.68	5.40	81	0	0	
		4 Dec		7.10	5.41	76	0	0	

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**LTOWB/SWB + Prehospital**

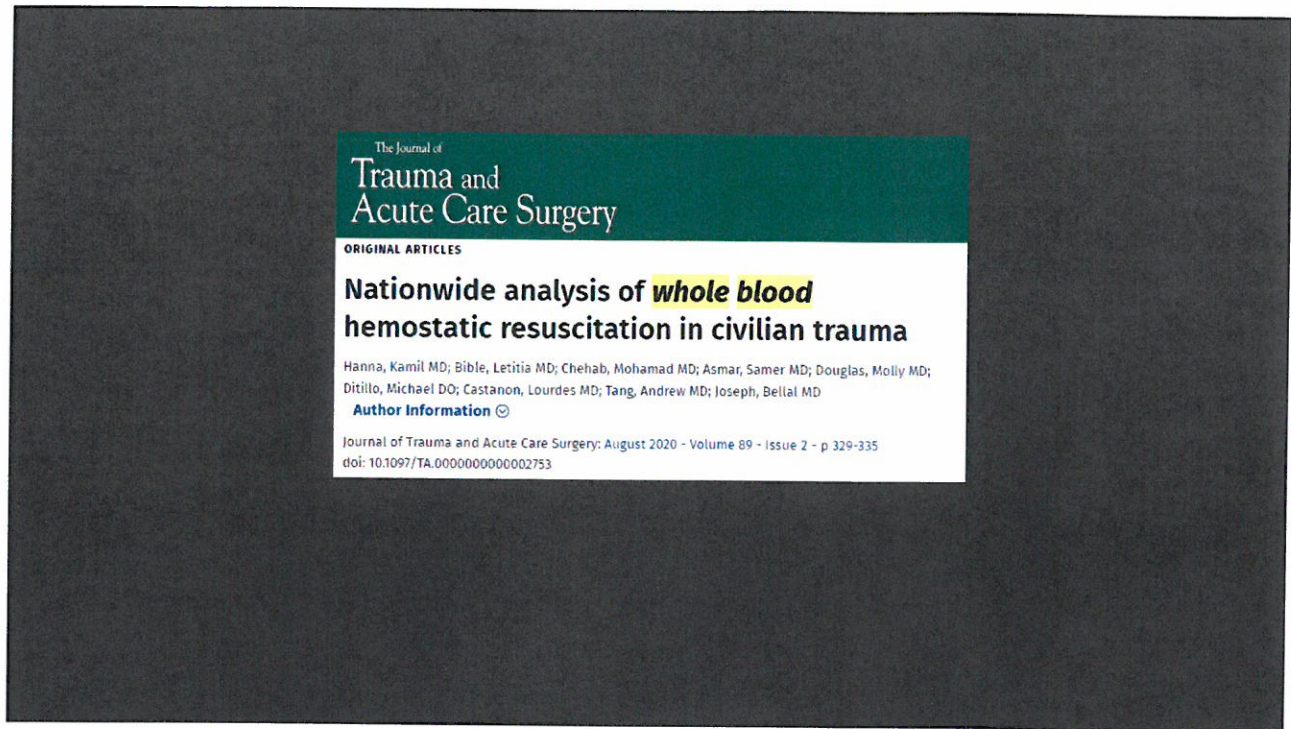
	LTOWB Patients (n = 198)	COMP Patients (n = 152)	p
Median arrival creatinine	1.2 (1.1, 1.5)	1.2 (0.9, 1.6)	0.699
Median ICU creatinine	1.1 (0.8, 1.4)	1.0 (0.7, 1.3)	0.102
Median 24-h creatinine	1.0 (0.7, 1.4)	0.9 (0.7, 1.4)	0.352
Median 48-h creatinine	0.8 (0.6, 1.2)	0.9 (0.7, 1.1)	0.398
Median arrival K+	3.8 (3.3, 4.3)	3.7 (3.4, 4.2)	0.921
Median ICU K+	4.1 (3.7, 4.5)	4.2 (3.8, 4.5)	0.713
Median 24-h K+	4.2 (3.8, 4.4)	4.1 (3.8, 4.4)	0.323
Median 48-h K+	4.0 (3.6, 4.3)	4.1 (3.8, 4.4)	0.198
Median arrival bilirubin	N/A	N/A	
Median ICU bilirubin	1.0 (0.7, 1.5)	1.1 (0.7, 2.0)	0.811
Median 24-h bilirubin	0.7 (0.5, 1.1)	1.1 (0.7, 2.5)	0.014
Median 48-h bilirubin	0.6 (0.4, 0.8)	1.1 (0.4, 2.1)	0.068
Median arrival LDH	N/A	N/A	
Median ICU LDH	461 (293, 695)	379 (66, 496)	0.252
Median 24-h LDH	408 (279, 593)	492 (301, 593)	0.898
Median 48-h LDH	361 (227, 536)	456 (201, 533)	0.932
Median arrival haptoglobin	N/A	N/A	
Median ICU haptoglobin	60 (35, 103)	68 (42, 94)	0.871
Median 24-h haptoglobin	67 (30, 112)	81 (29, 134)	0.985
Median 48-h haptoglobin	118 (63, 171)	167 (72, 211)	0.478
Median arrival P/F ratio	344 (230, 480)	391 (239, 532)	0.247
Median ICU P/F ratio	351 (227, 481)	385 (233, 485)	0.245
Median 24-h P/F ratio	377 (275, 482)	333 (198, 476)	0.118
Median 48-h P/F ratio	325 (247, 405)	292 (232, 379)	0.161

ICU, intensive care unit.  
 Comparison of Mann-Whitney U-test and P/F Ratio: Trends in the First 48 Hours After Arrival in Patients Receiving SWB and COMP Transfusions

Williams, James BS; Merutka, Nicholas BS; Meyer, David MD, MS; Bai, Yu MD, PhD; Prater, Samuel MD; Cabrera, Rodolfo BSN, EMT-P; Holcomb, John B. MD; Wade, Charles E. PhD; Love, Joseph D. DO; Cotton, Bryan A. MD, MPH Safety profile and impact of low-titer group O whole blood for emergency use in trauma, Journal of Trauma and Acute Care Surgery: January 2020 - Volume 88 - Issue 1 - p 87-93 doi: 10.1097/TA.0000000000002498

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## Safety

- ◆ Analysis of TQIP data from 2015-2016
- ◆ 8,494 patients of which 280 received WB
- ◆ On regression analysis, WB was independently associated with:
  - ◆ Reduced 24-hour mortality (odds ratio [OR], 0.78 [0.59–0.89];  $p = 0.006$ )
  - ◆ Reduced in-hospital mortality (OR, 0.88 [0.81–0.90];  $p = 0.011$ )
  - ◆ Reduced major complications (OR, 0.92 [0.87–0.96];  $p = 0.013$ ).

Hanna, Kamil MD; Bible, Letitia MD; Chehab, Mohamad MD; Asmar, Samer MD; Douglas, Molly MD; Ditillo, Michael DO; Castanon, Lourdes MD; Tang, Andrew MD; Joseph, Bellal MD Nationwide analysis of whole blood hemostatic resuscitation in civilian trauma, Journal of Trauma and Acute Care Surgery: August 2020 - Volume 89 - Issue 2 - p 329-335 doi: 10.1097/TA.0000000000002753

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