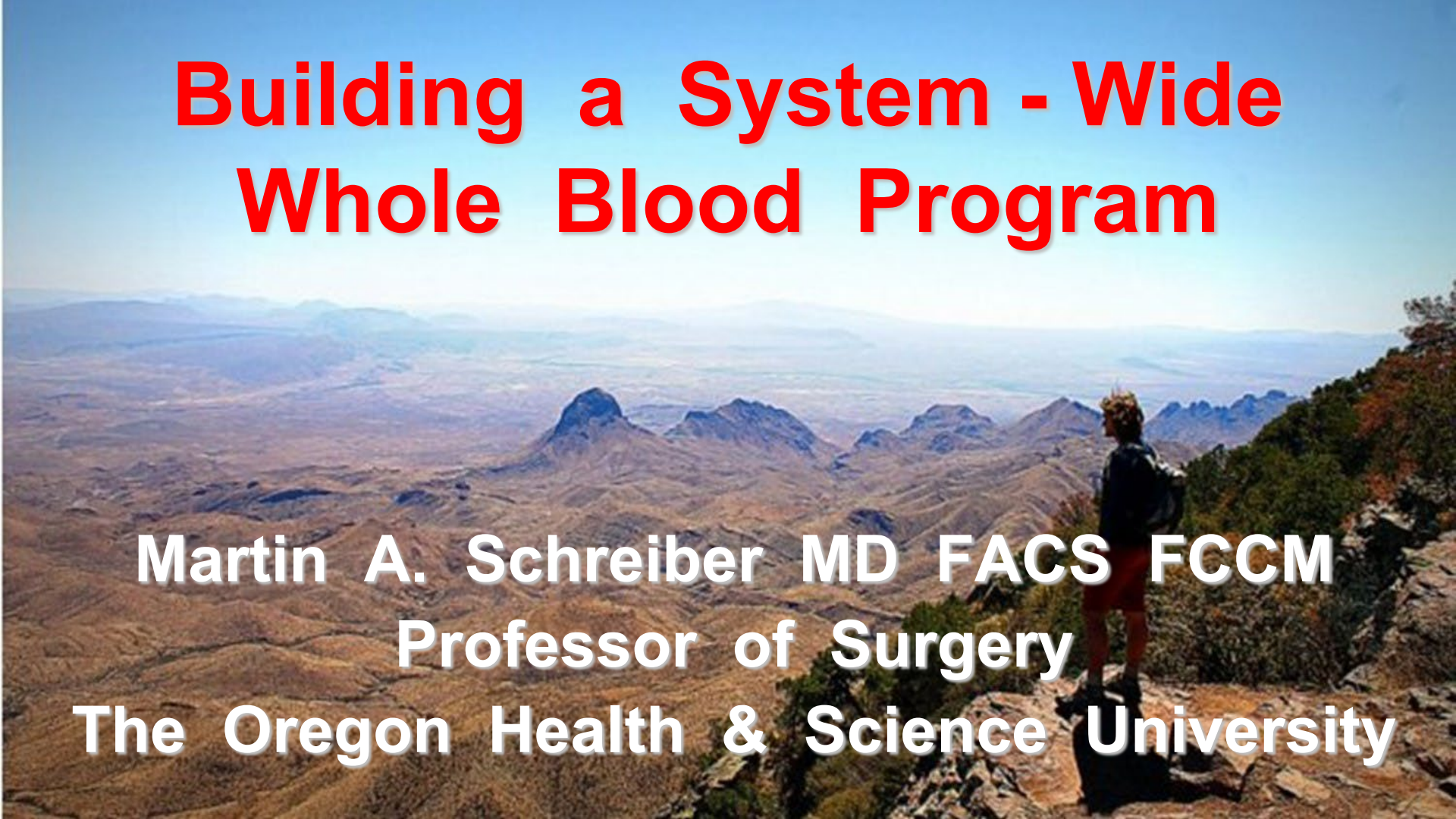
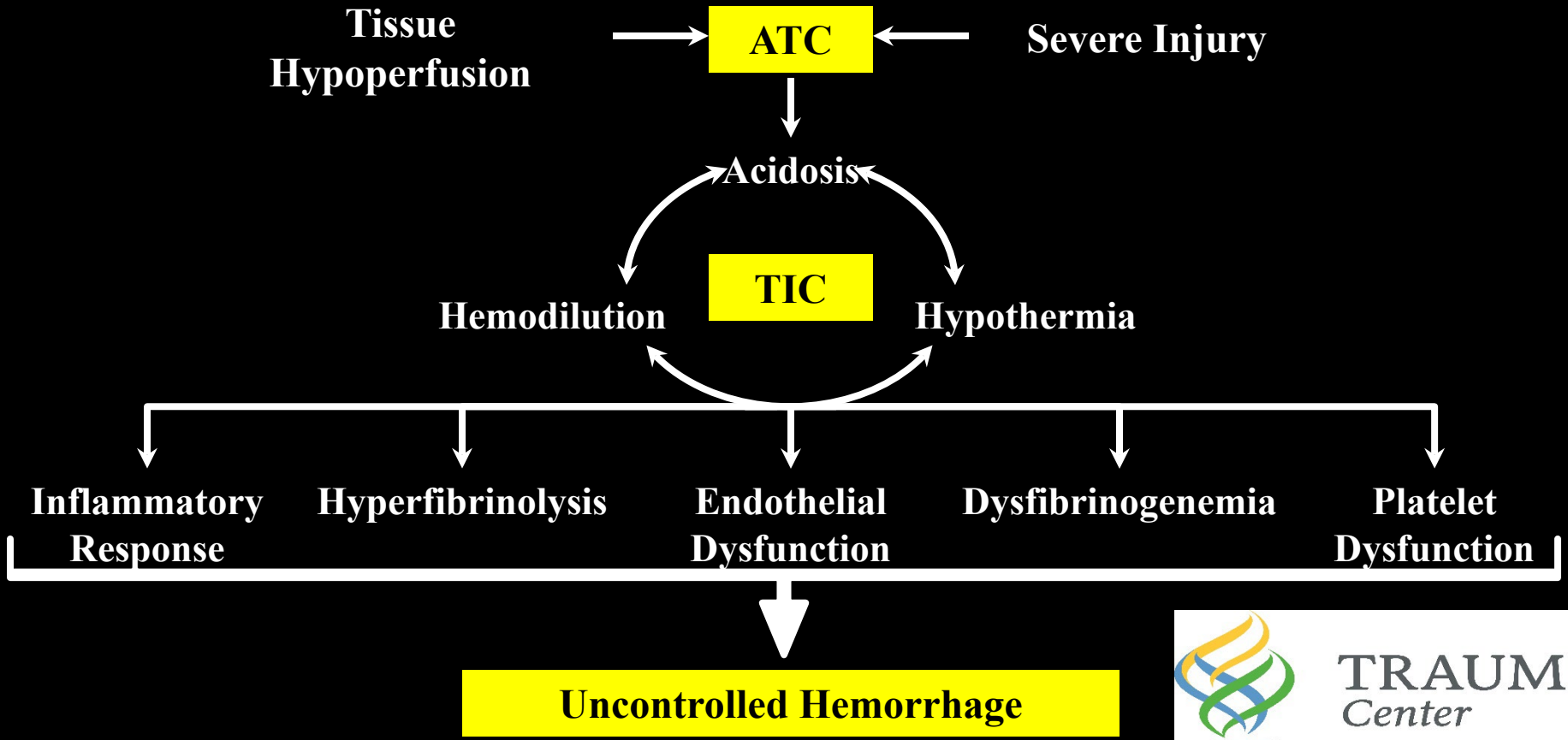
Building a System - Wide Whole Blood Program



Martin A. Schreiber MD FACS FCCM
Professor of Surgery
The Oregon Health & Science University

Acute Traumatic Coagulopathy (ATC)



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Whole Blood Systems

- Steady supply of safe donors
- Preparation of product
- Distribution based on incidence of use
- Cost effective
- Avoid waste especially with shortage

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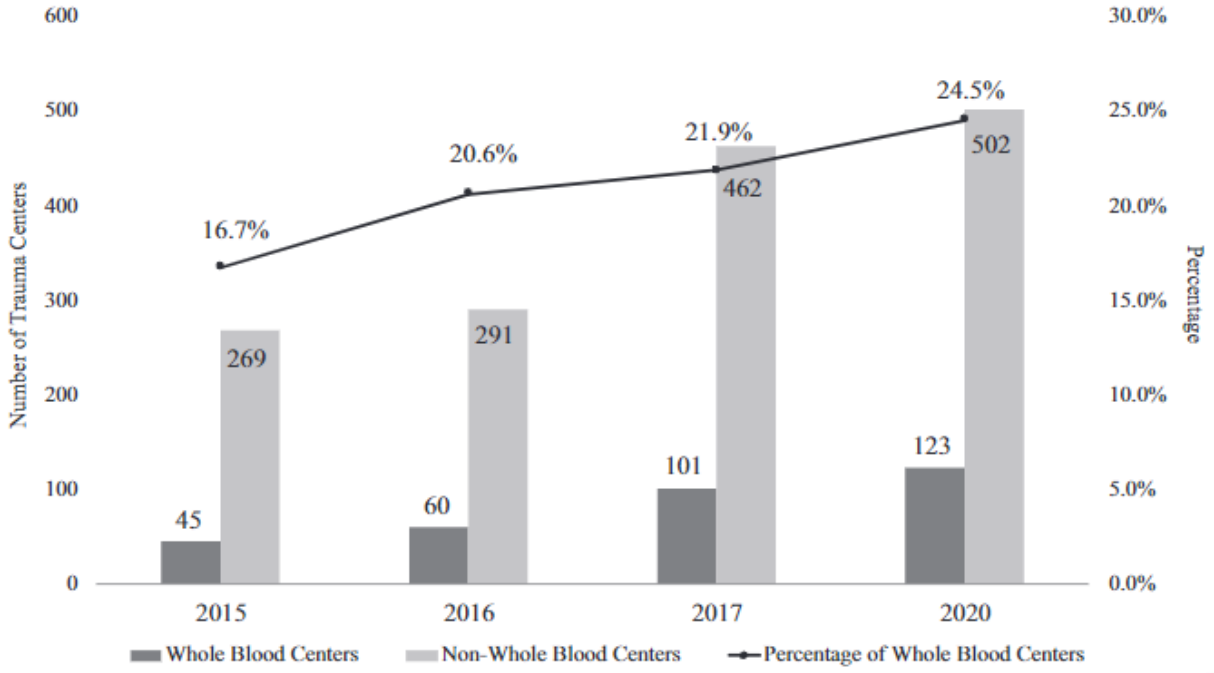
Whole Blood Use Increasing



Hashmi et al. *Transfusion* 2021;61:S348 – S353.

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Domaine Leroy
Musigny Grand
Cru – France
Cost - $75,000

Low Titer O
Fresh whole blood
Still warm!

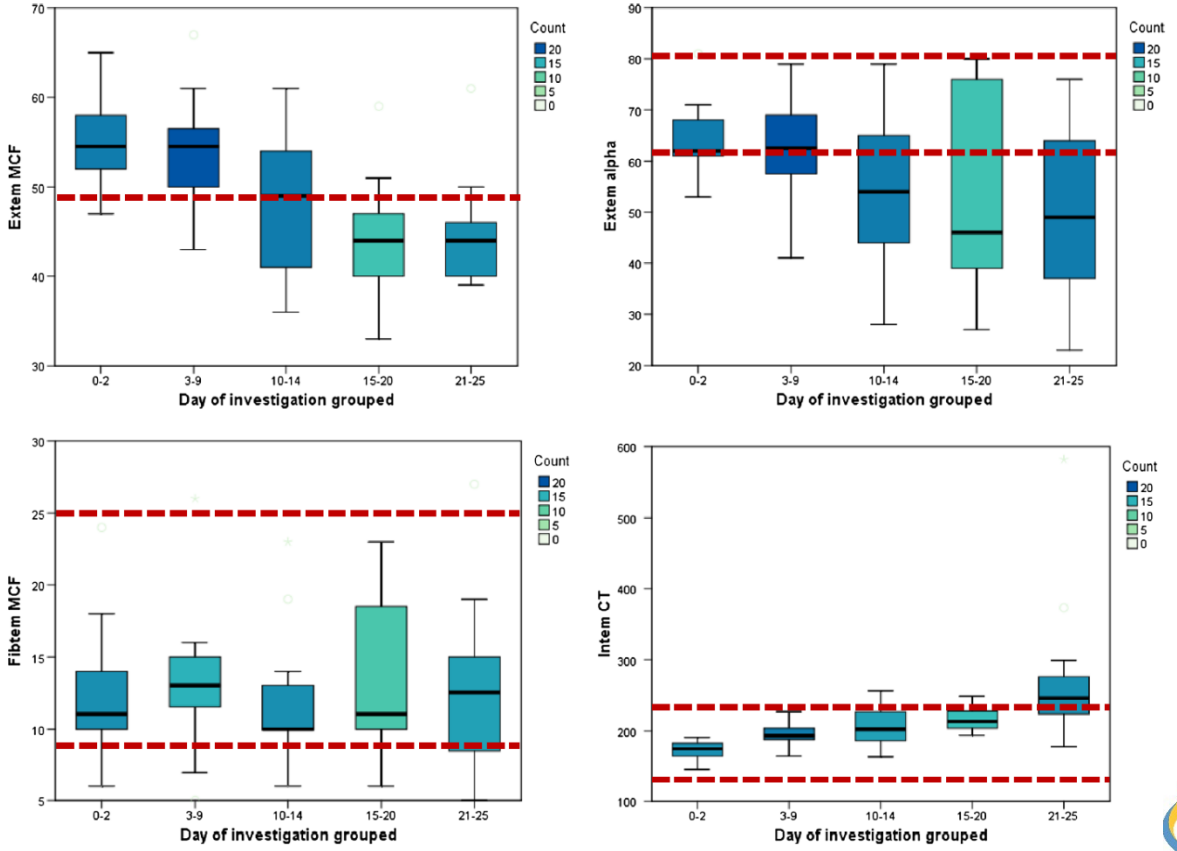
Cost - Priceless

Charles Shaw
Cabernet
California
Cost - $2.99

LTOWB – CPDA
Leukoreduced
35 Days old

Cost - $600

WB Coagulation Function Over Time



Strandness et al. *JTACS* 2015;78:S31 – S38.

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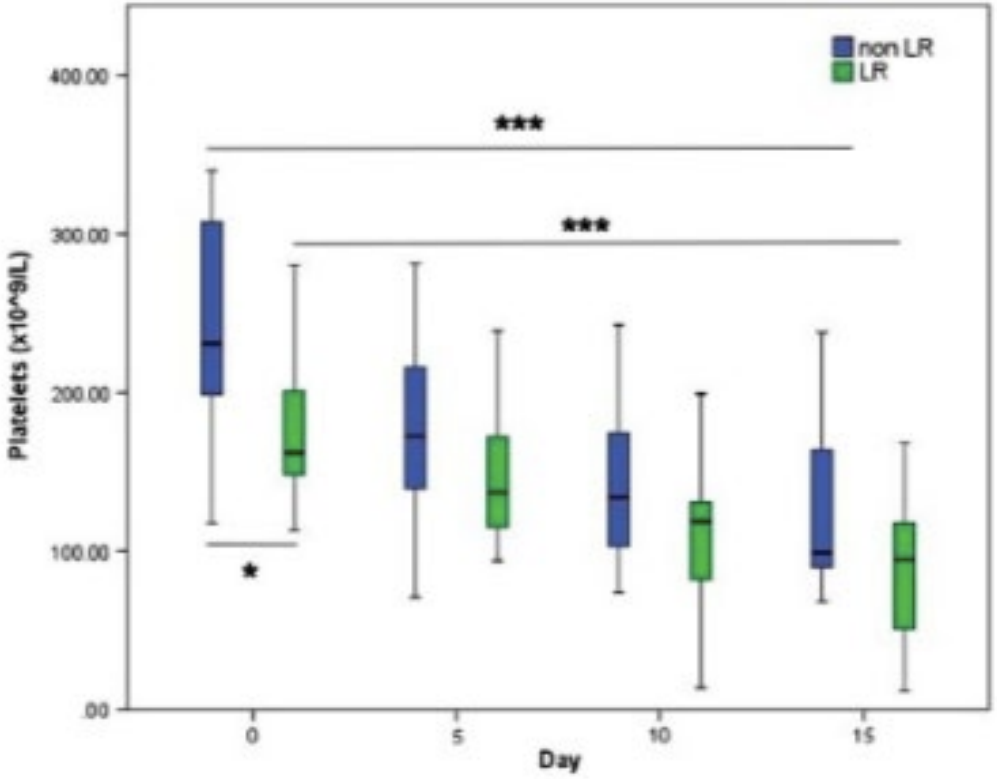
Effects of Leukoreduction



Remy et al. *JTACS* 2018;84:S104 – S114.

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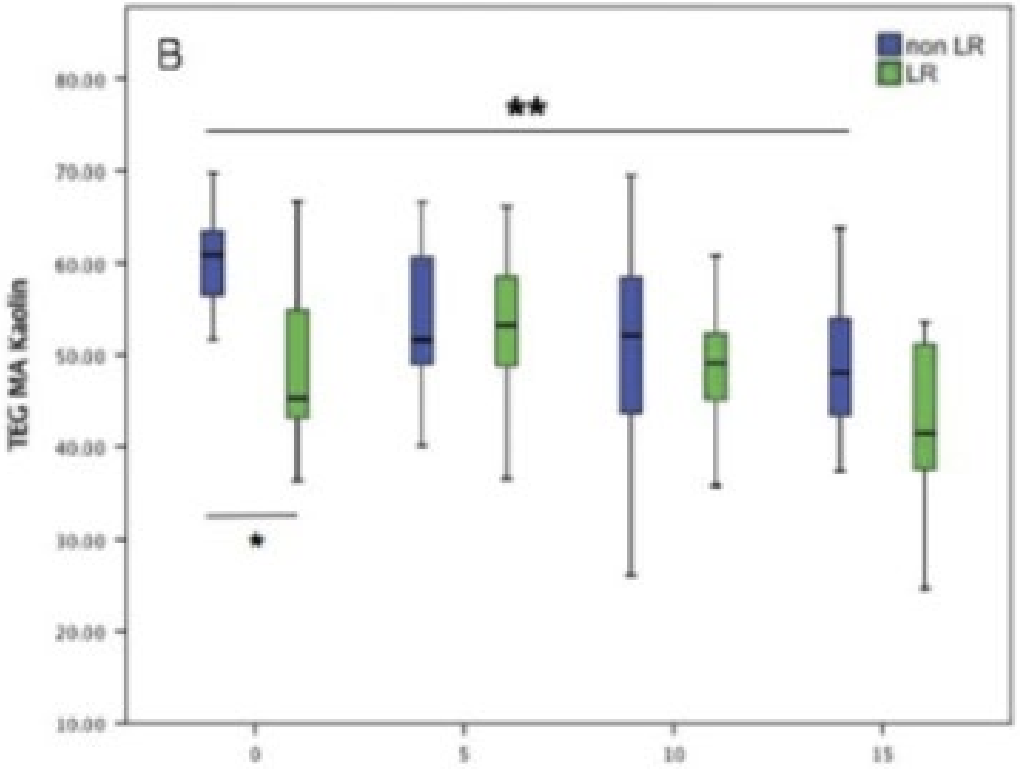
Effects of Leukoreduction



Remy et al. *JTACS* 2018;84:S104 – S114.

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Leukodepletion and Belmont

Blood Cell Count Components Pre and Post Cold Stored Leukoreduced Whole Blood infusion via Belmont RI (Rapid Infuser)

Component	Average Pre-Belmont (SD)	Average Post-Belmont (SD)	Mean Difference (SD)	95% Confidence Interval	*p* Value
Red Cell Count (thousand cells/μL)	3.90 (0.77)	4.12 (0.91)	−0.23 (1.09)	−1.01 ⟨−⟩ 0.55	0.552
Hemoglobin (mg/dL)	11.97 (2.80)	12.44 (2.72)	−0.47 (3.30)	1.89 ⟨−⟩ 2.83	0.663
Hematocrit (Liter of cell/ liter blood)	37.30 (7.82)	39.33 (9.03)	−2.03 (10.56)	−9.58 ⟨−⟩ 5.52	0.558
Mean Cell Volume (fL)	95.78 (5.21)	95.50 (5.96)	0.28 (1.38)	−0.71 ⟨−⟩ 1.27	0.538
Platelet Count (100,000 cells/μL)	75.50 (27.32)	59.60 (24.96)	15.9 (13.37)	6.35 ⟨−⟩ 25.44	0.004

Cell count components compared between the Pre and Post Belmont whole blood samples. *P* values represent one-sided Student-t-test.

Thromboelastography Component Comparison Pre and Post Cold Stored Leukoreduced Whole Blood infusion via Belmont RI (Rapid Infuser).

Component	Average Pre-Belmont (SD)	Average Post-Belmont (SD)	Mean Difference (SD)	95% Confidence Interval	p Value
R time (minutes)	10.03 (4.97)	8.12 (2.62)	1.91 (3.19)	−0.37 ⟨−⟩ 4.19	0.091
K time (minutes)	4.76 (3.37)	4.66 (0.91)	0.10 (3.47)	−2.39 ⟨−⟩ 2.59	0.929
α Angle (degrees)	57.49 (11.39)	57.22 (1.92)	0.27 (9.40)	−6.46 ⟨−⟩ 7.00	0.930
Maximum Amplitude (mm)	49.64 (6.06)	45.12 (1.44)	4.52 (5.75)	0.40 ⟨−⟩ 8.64	0.035
Clot Strength (Kdynes/cm^2)	5059.29 (1212.01)	4166.34 (769.70)	892.95 (1045.80)	144.82 ⟨−⟩ 1641.08	0.028

Thromboelastography components compared between the Pre and Post Belmont whole blood samples. P values represent one-sided Student-t-test.

14 Day old leukodepleted LTOWB before and after Belmont infusion

Hoyos Gomez T et al. *Injury* 2022 PMID 36180259.

LTOWB and Shortage

- Domaine Leroy Musigny
  - Effective hemostasis
  - Reduced blood requirement
  - Decreased need for donors
- 3 Buck Chuck
  - No improved hemostasis
  - Increased blood requirement
  - Exacerbate the shortage

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Armed Service Blood Program

- Worldwide responsibilities
  - Peacetime
  - War
- Servicemembers, family members, veterans in US or abroad
- Blood obtained from MTFs, shipped

ASBP
Armed Services Blood Program

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ASBP FWB

- Screened low risk population
- Formally tested for Hepatitis B and HIV at time of deployment
- Rapid testing after donation
- 80% sensitive
- Not FDA approved

ASBP
Armed Services Blood Program

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ASBP LTOWB

- Stored in CPDA – 1 solution, 35 days
- Not leukoreduced
- Better platelet number and function
- Supply chain
  - Level 1 trauma SAMMC
  - Deployed settings
    - Special Forces medic backpacks

ASBP
Armed Services Blood Program

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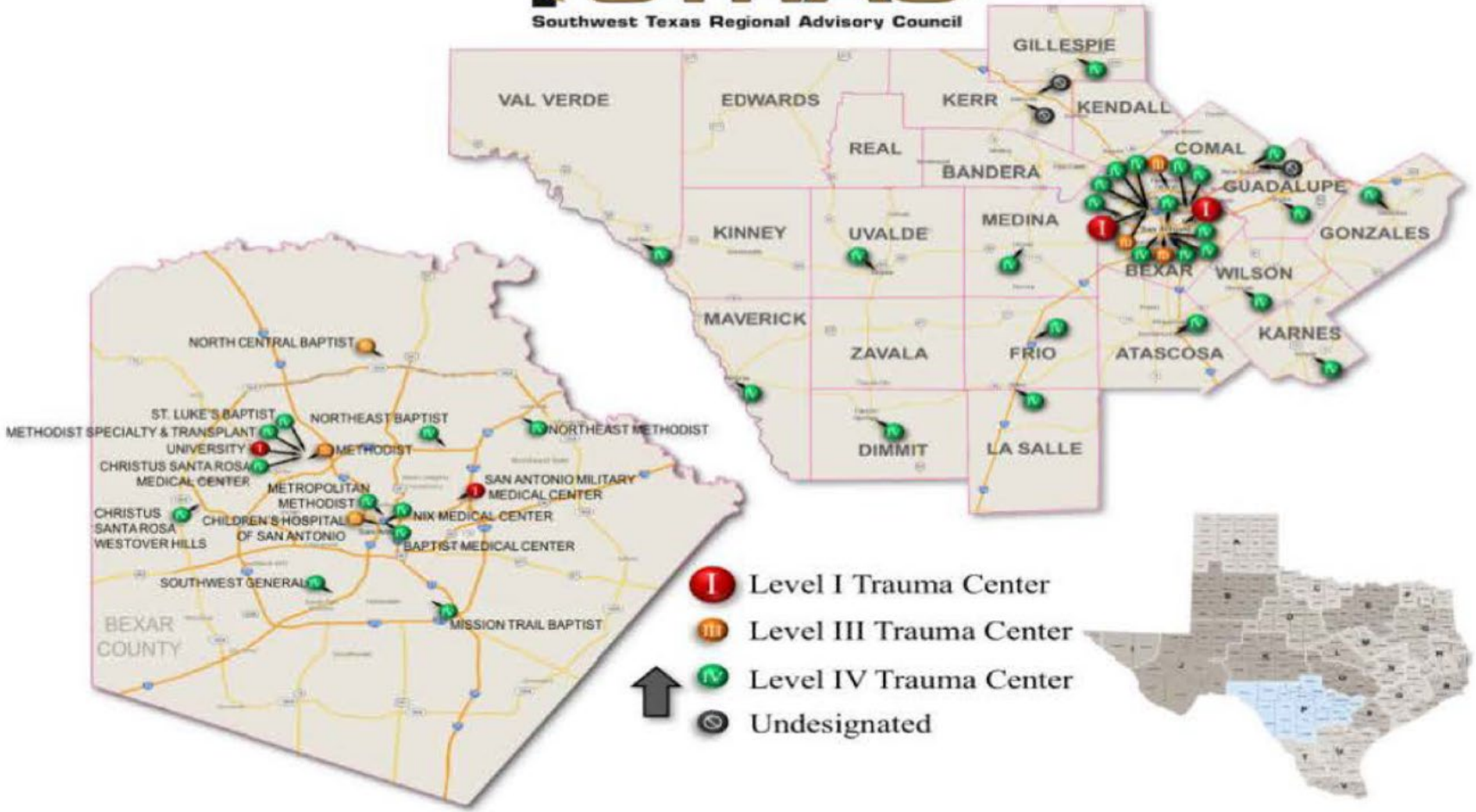
American Red Cross

- Largest supplier of blood products in US
- Donors - general population, stringent requirements, formal testing, FDA
- LTOWB
  - Leukoreduced (allows RBC salvage)
  - Stored in CPD solution, 21 days

REGIONAL TRAUMA & EMERGENCY HEALTHCARE SYSTEM

STRAC

Southwest Texas Regional Advisory Council



STRAC
Southwest Texas Regional Advisory Council

BROTHERS IN ARMS

South Texas Blood & Tissue Center

Regional Whole Blood* Program

*Whole Blood (WB) = Low Titer O+ Whole Blood

Donor → Blood Rotation Site: Day 1-14 → Blood Rotation Center Day 15-35

South Texas Blood & Tissue Center

0-Day Blood

14-Day Blood

15-Day Blood

For more information, visit: www.strac.org/blood

Rotation Site
Day 1-14 Blood (2 weeks)

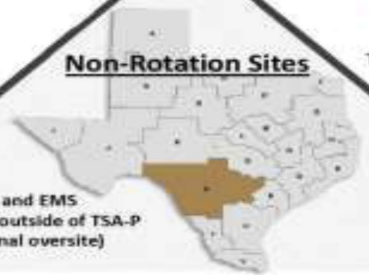
Has return privileges to STBTC (ensuring the LTOWB is rotated through to a higher usage rotation center)

Air Medical Providers

Level IV Trauma Centers

Ground EMS Providers

Non-Rotation Sites



Hospitals and EMS Agencies outside of TSA-P (operational oversite)

Rotation Center
Day 15-35 Blood (3 weeks)

Receives LTOWB that has already been cycled through the rotation sites.

Level I Trauma Centers

Future Sites

Level III Trauma Centers

Level IV Trauma Centers

Southwest Texas RAC

- Distributes WB across 26,000 sq miles
- Source – Brothers in Arms
- Anti – A, anti – B < 1:256
- O+
- No leukocyte reduction
- CPDA – 1, 35 days expiration

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Brothers in Arms

- Reliable and loyal donor source
- 75% of screened men were eligible
  - 1286 donating at last count
- Donation rate - Every 2 months
- Social media and special events
- Blood resupplied when used
- Wastage rate 1 – 2%

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Received: 31 December 2020 | Revised: 2 March 2021 | Accepted: 3 March 2021

DOI: 10.1111/trf.16528

SUPPLEMENT ARTICLE

TRANSFUSION

Prehospital whole blood reduces early mortality in patients with hemorrhagic shock

Maxwell A. Braverman[1] | Alison Smith[1] | Douglas Pokorny[1] | Benjamin Axtman[1] | Charles Patrick Shahan[1] | Lauran Barry[1] | Hannah Corral[1] | Rachelle Babbitt Jonas[1] | Michael Shiels[2] | Randall Schaefer[3] | Eric Epley[3] | Christopher Winckler[4] | Elizabeth Waltman[5] | Brian J. Eastridge[1] | Susannah E. Nicholson[1] | Ronald M. Stewart[1] | Donald H. Jenkins[1]

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	PHT ($n = 58$)	NT ($n = 156$)	p-value
Median prehospital nadir SBP (IQR)	75 (62–83)	74 (66–82)	.91
Median prehospital HR (IQR)	113 (90–128)	93 (79–125)	*.03*
Median prehospital SI (IQR)	1.5 (1.2–2.0)	1.4 (1.1–1.8)	.051
Median arrival SBP, mmHg (IQR)	92 (81–114)	86 (77–100)	.07
Median arrival HR, mmHg (IQR)	113 (92–130)	106 (83–128)	.87
Median arrival SI (IQR)	1.2 (0.87–1.48)	1.21 (0.9–1.5)	.66
Median Delta SI (IQR)	−0.38 (−0.08 to −0.72)	−0.18 (0.02 to −0.48)	.04
Death in ED, % (n)	0.0 (0)	7.1 (11)	*.04*
Death in 6 h, % (n)	5.3 (3)	14.1 (22)	.08
Death in 24 h, % (n)	17.2 (10)	23.1 (36)	.36
Hospital death, % (n)	13.8 (8)	25 (39)	.08
CAT3+ transfusion requirement, % (n)	53.4 (31)	60.3 (94)	.37
MT (>10 U in 24 h), % (n)	61.5 (16)	48.7 (75)	.23
Median arrival transfusion volume, ml (IQR)	1300 (0–2000)	1975 (1000–3175)	*<.01*
Median LOS transfusion volume, ml, (IQR)	2825 (1550–5500)	2000 (1300–4000)	.048

Braverman et al. *Transfusion* 2021;61:S15 – S21.

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Local Solutions

- Hospital systems
- Requires blood donation center
- Stable donor pool
- Hybrid possibilities
- Facilitates FWB but not FDA approved

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Blood Shortage - Pandemic

Category	Amount
US population	328.2 million persons
Pre–COVID-19 estimates	
Adjustment for exclusion factors (328.2 × 0.626)	205.4 million persons eligible to donate
Actual number of blood donors	8 million donors
Percentage of actual eligible blood donors (8 million/ 205.4 million)	3.9
COVID-19 estimates	
Impact estimate (18 × 3.34)	60 million persons
Adjustment for exclusion factors (328.2–60 = 268.2 × 0.626)	167 million persons eligible to donate
Actual number of blood donors (167 × 0.039)	6.5 million donors
Percentage change in actual eligible blood donors ([6.5–8]/8)	19

Riley et al. *AJPH* 2021;111:860 – 866.

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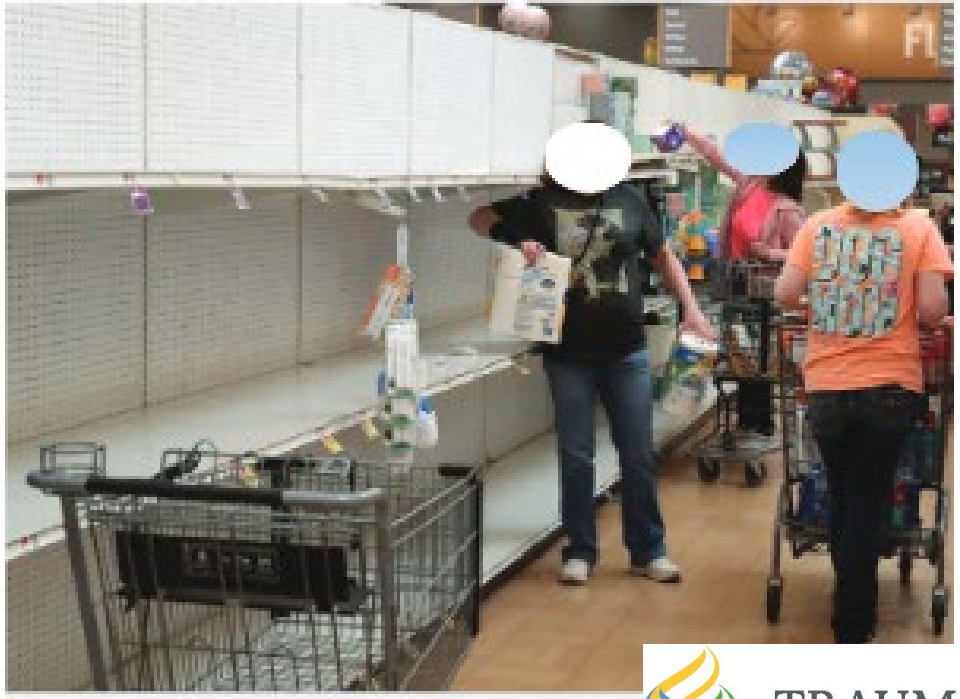
Why Have a Emergency Walking Blood Bank Plan Ready?
What is the plan when the shelves are empty?

January 2020

March 2020



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Received: 15 October 2020 | Revised: 12 January 2021 | Accepted: 14 January 2021

DOI: 10.1111/trf.16458

SUPPLEMENT ARTICLE

TRANSFUSION

Civilian walking blood bank emergency preparedness plan

John B. Holcomb[1] | Philip C. Spinella[2] | Torunn Oveland Apelseth[3,4] | Frank K. Butler[5] | Jeremy W. Cannon[6] | Andrew P. Cap[5,7,8] | Jason B. Corley[9] | Heidi Doughty[10] | Michael Fitzpatrick[11] | Sara F. Goldkind[12] | Jennifer M. Gurney[7] | Mary J. Homer[13] | Sarah J. Ilstrup[14] | Jan O. Jansen[15] | Donald H. Jenkins[16] | Marisa B. Marques[17] | Eugene E. Moore[18] | Paul M. Ness[19] | Kevin C. O'Connor[20] | Martin A. Schreiber[21] | Eilat Shinar[22] | Steve Sloan[23] | Geir Strandenes[3,24] | James R. Stubbs[25] | Audra L. Taylor[26] | Kevin R. Ward[27] | Elizabeth Waltman[28,29] | Mark Yazer[30,31,32]

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Execution

- Organize collection site prior
  - Collection, store and transfuse minimizing clerical errors
- Trained individuals
  - Adhere to safety practices
  - Rescreen donors
  - FDA screening, drawing, labeling

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EXIT

Pre – Screened Population

- Low risk population
- Blood type known
- Testing every 90 days
  - Full TTD panel
  - Low titer to anti – A and anti – B
  - anti – HLA antibodies in females

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When to Activate

- FDA approved products preferred
- Available blood supply overwhelmed
- May need FWB to get platelets
  - Rural
  - Urban

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CoTCCC Priority List

- Cold stored LTOWB
- FWB
- 1:1:1 plasma:platelets:RBCs
- 1:1 plasma:RBCs
- 1 Whatever you have

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Donor Testing

- Vital signs, Hgb
- Confirm blood type, Rh
- Rapid testing for HIV, Hep B, Hep C, RPR, malaria (85% sensitive)
- Aliquot to licensed lab for post hoc tests

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Collection

- Standard blood collection bags and tubing properly labeled
- 16 gauge needle
- Tourniquet or BP cuff 40 – 60 mmHg
- Bag filled to mark or 585g = 450cc
- Duration of collection documented

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POLYSEM
PVC SOFT
SANS POUDRE
POLYSEM
PVC SOFT
SANS POUDRE

SUPPLEMENT ARTICLE

How do I get an emergency civilian walking blood bank running?

Silje Helland Kaada,[1] Torunn Oveland Apelseth,[1,2] Kristin Gjerde Hagen,[1] Einar Klæboe Kristoffersen,[1,3] Stig Gjerde,[4] Kristian Sønstabø,[4] Henrik Halvorsen,[5] Tor Hervig,[1,3] Geir Arne Sunde,[4] Geir Olav Dahle,[4] Mari Christine Johnsen,[4] and Geir Strandenes[1,6]

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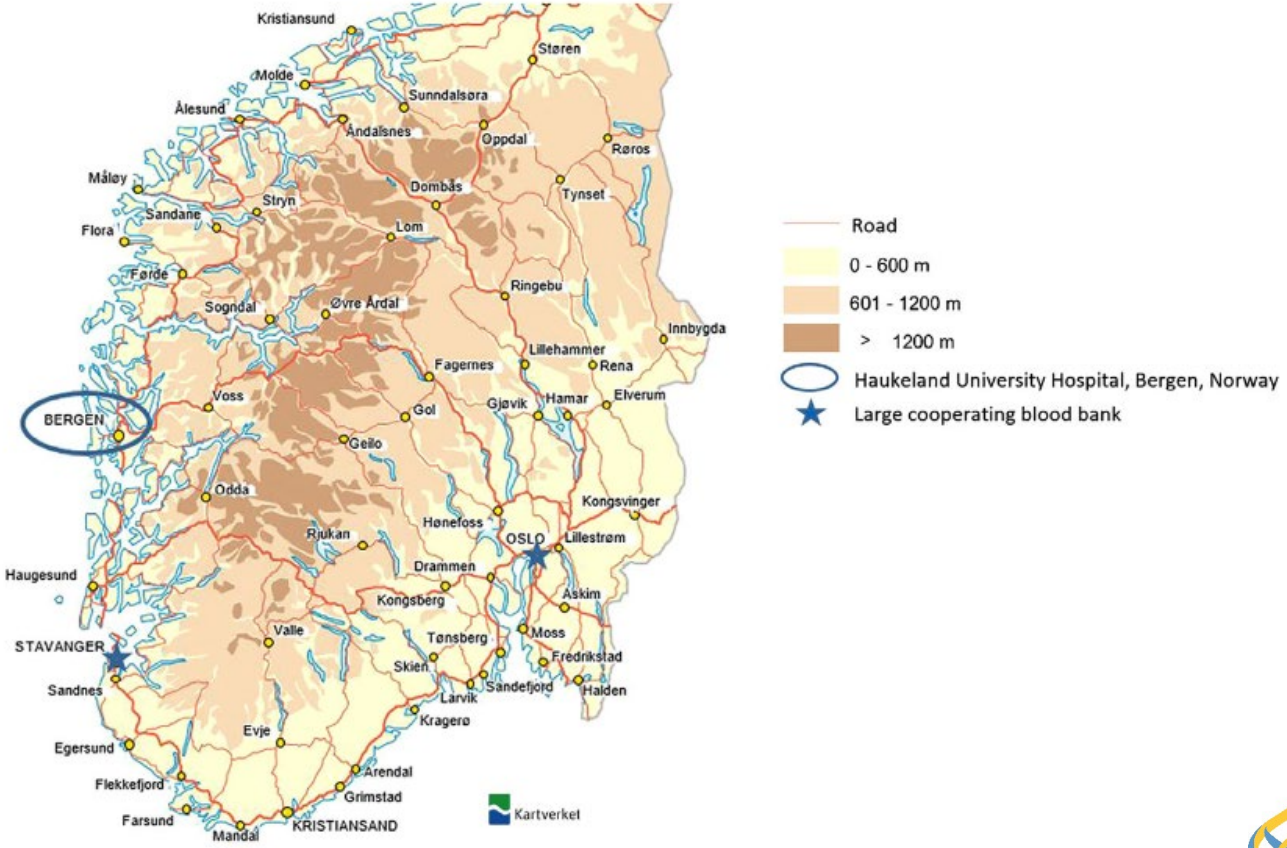

Fig. 2. Map illustrating geographical conditions around Bergen (pop. 300,000), the second largest city in Norway (pop 5.3 mil) and distance to the closest cooperating large blood banks.

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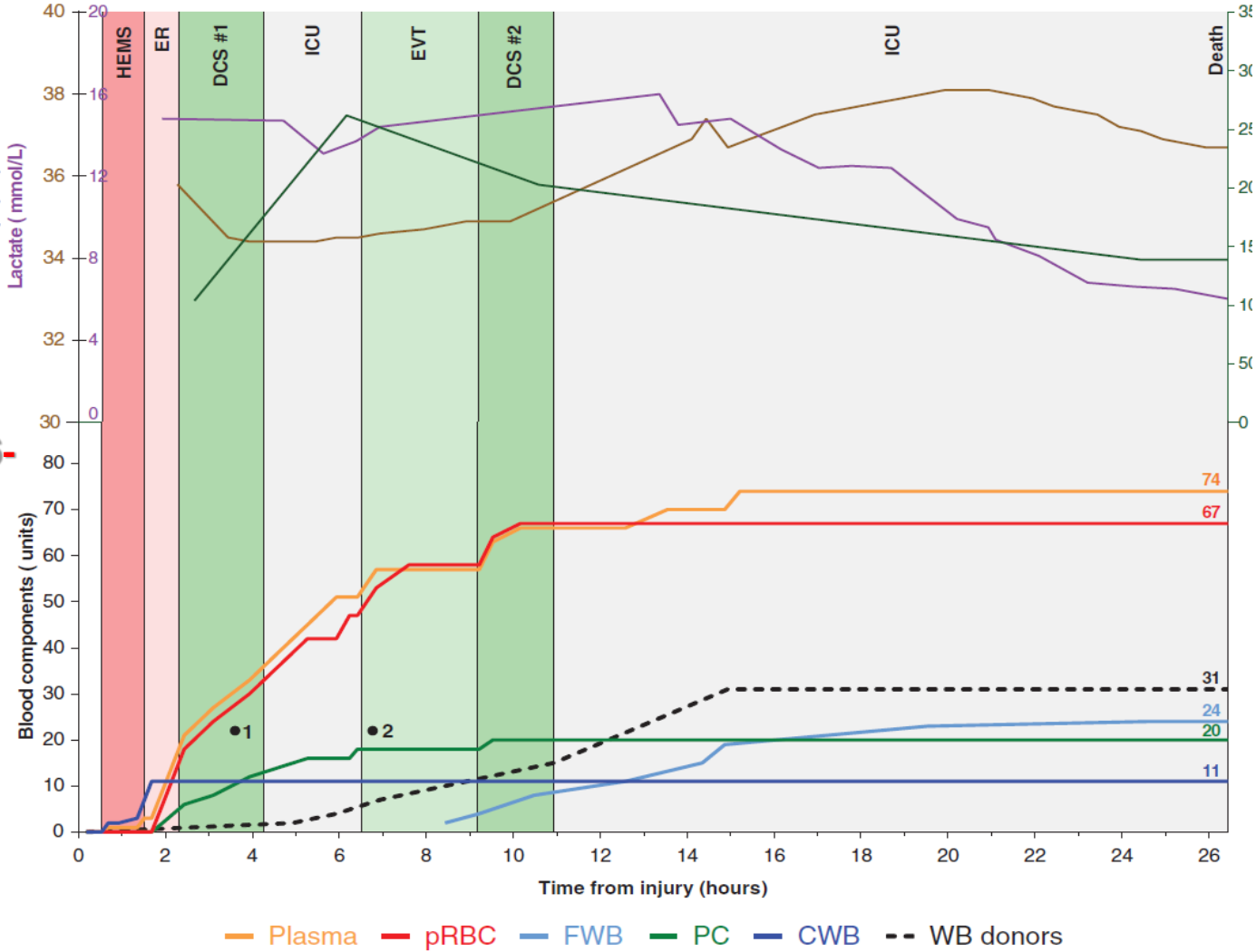
Kaada et al. Transfusion 2019;59:1446-1452.



Future Possibilities

- TTD biggest limitation
- Pathogen reduction riboflavin – UV light
  - Plasma
  - Platelets
- Whole blood being tested now

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Final System Considerations

- What is low titer?
- Will you give O+ to females?
- Can females donate?
- Will you leukoreduce?
- How long will you store the blood?
- Do you dare to consider WBB?
- How good is your wine?

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