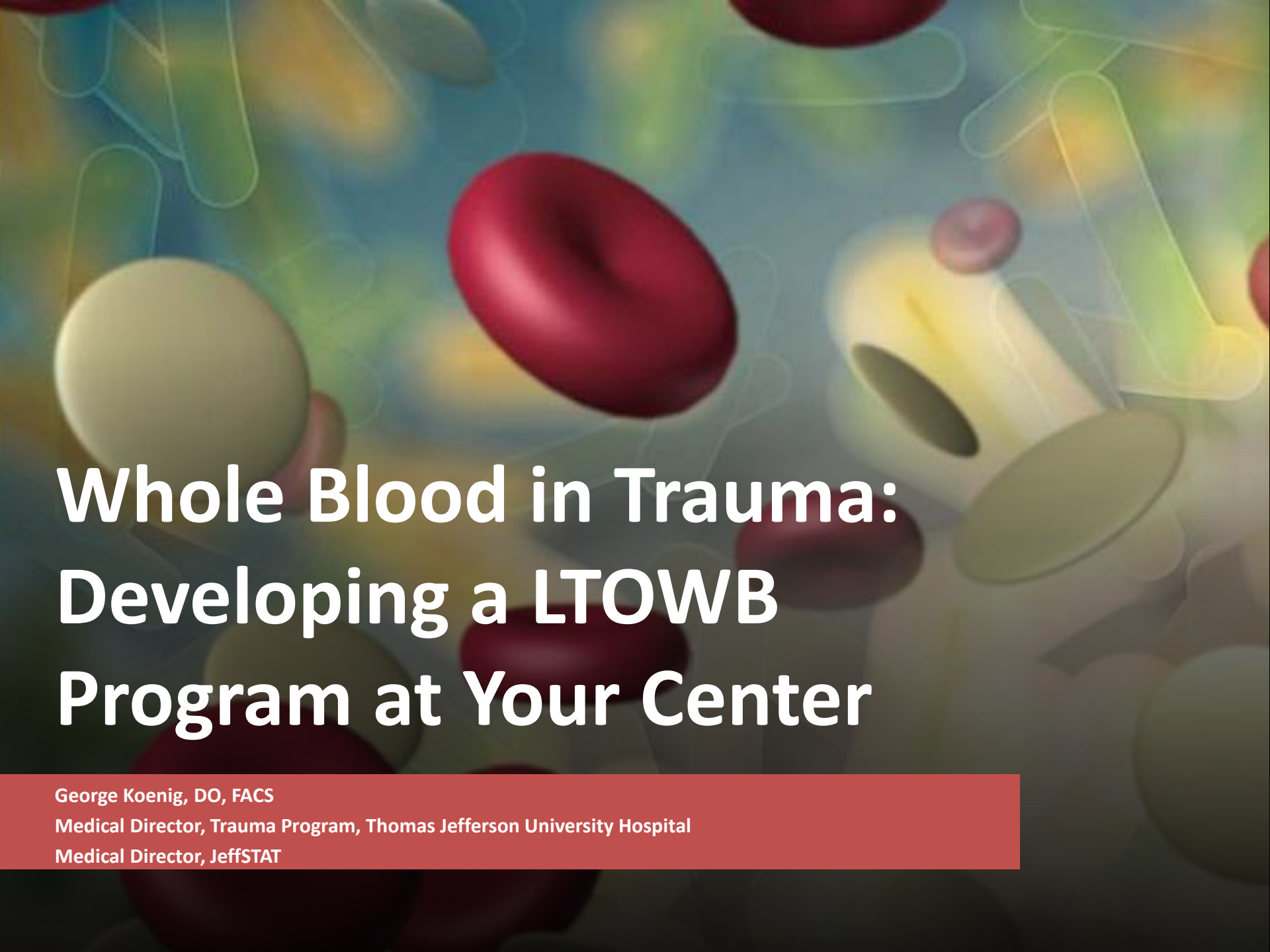


Whole Blood in Trauma: Developing a LTOWB Program at Your Center

George Koenig, DO, FACS
Medical Director, Trauma Program, Thomas Jefferson University Hospital
Medical Director, JeffSTAT

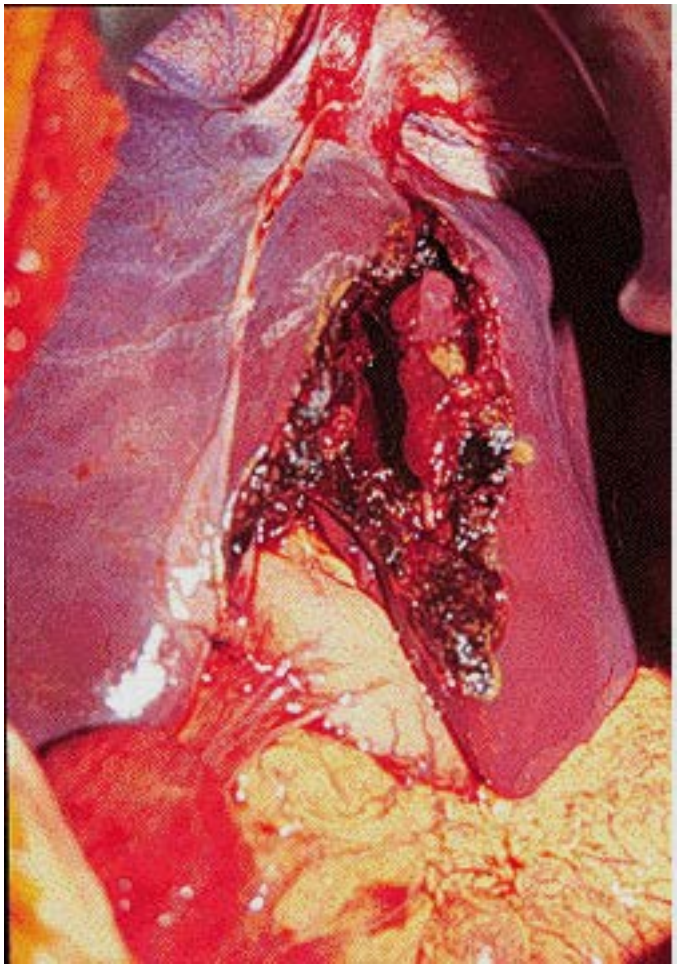
Death in Trauma

- Injury is the leading cause of death worldwide between the ages of 5 to 44.
- In the U.S., it is the leading cause of death in the 1 to 44 year age group and the 3rd leading cause of death overall.
- Exsanguination is the second cause (37%) after CNS trauma.

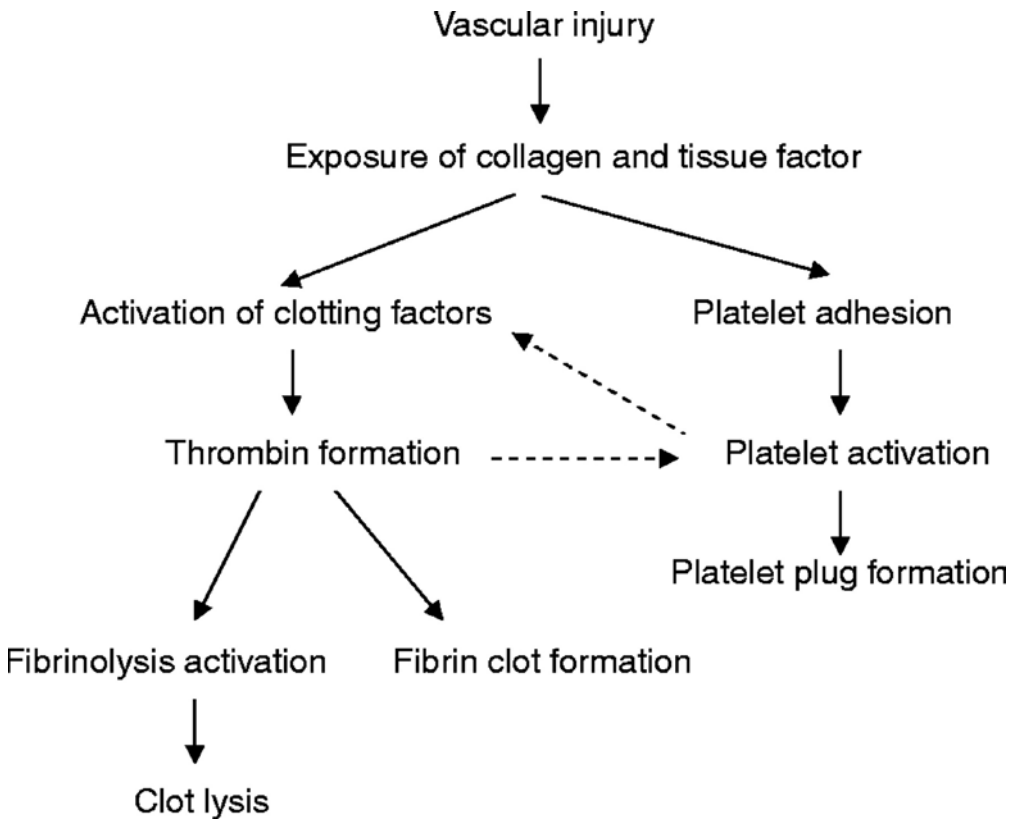
- Deaths due to injury:
  - 50% in the field
  - 30% occur in the first 24 hrs
    - 30-50% exsanguination
  - 20% occur late
    - Multiple organ failure

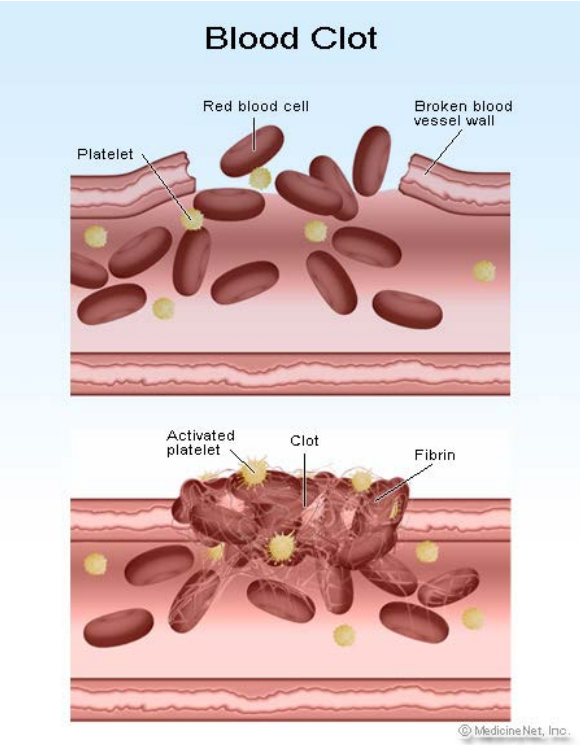
Why Trauma Patient Bleed

- Complex visceral injuries
  - Liver lacerations
- Major vascular injury
- Pelvic fractures



Key Steps of Hemostasis

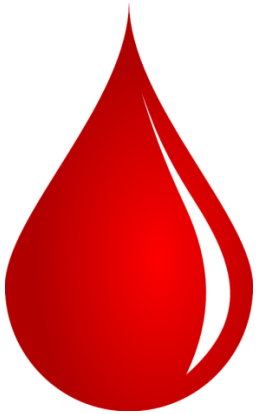




Spahn, D. R. et al. Br. J. Anaesth. 2005 95:130-139

BJA British Journal of Anaesthesia

Resuscitation



Vigorous Fluid Resuscitation

Hemodilution Increased

Recurrent Hypotension

Traditional Guidelines

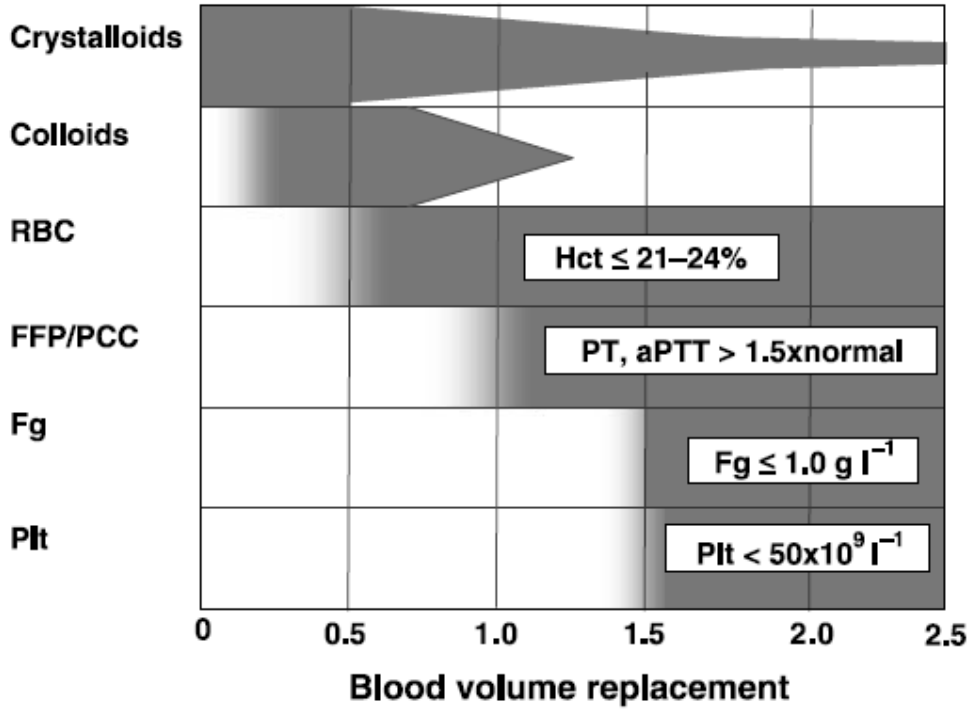
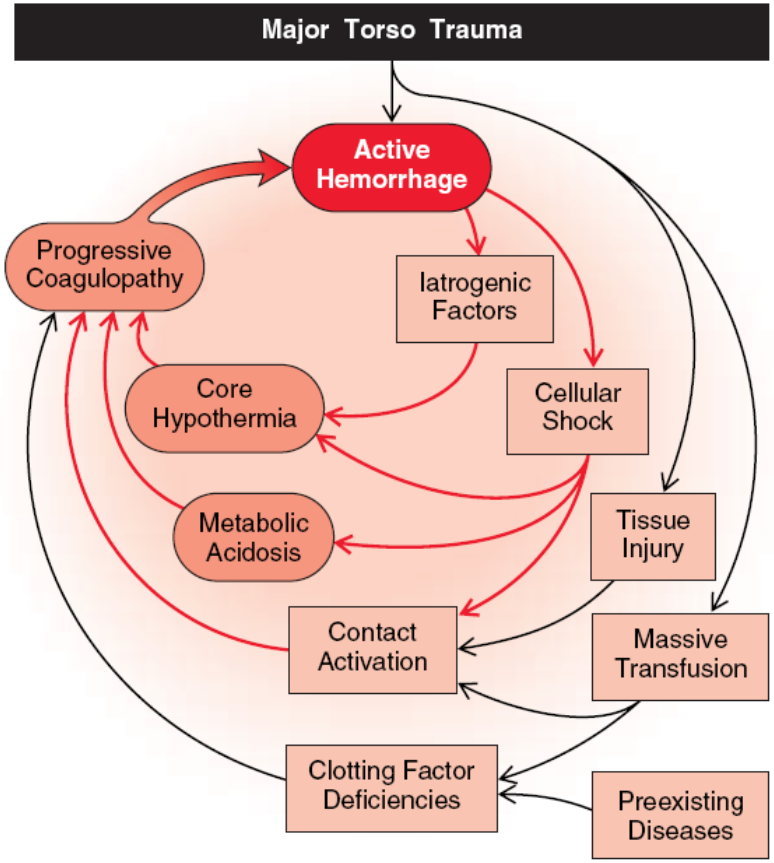


FIG. 2. **Blood volume replacement during first 12 to 24 h after trauma.** Values of various parameters represent trigger points at which relevant blood components should be transfused. aPTT = activated partial thromboplastin time; Fg = fibrinogen; Hct = hematocrit; PCC = prothrombin complex concentrate; Plt = platelets; PT = prothrombin time; RBCs = red blood cells. Reprinted with permission from Oxford University Press/*Br J Anaesth* 2005;95:130. Copyright 2005, Board of Management and Trustees.

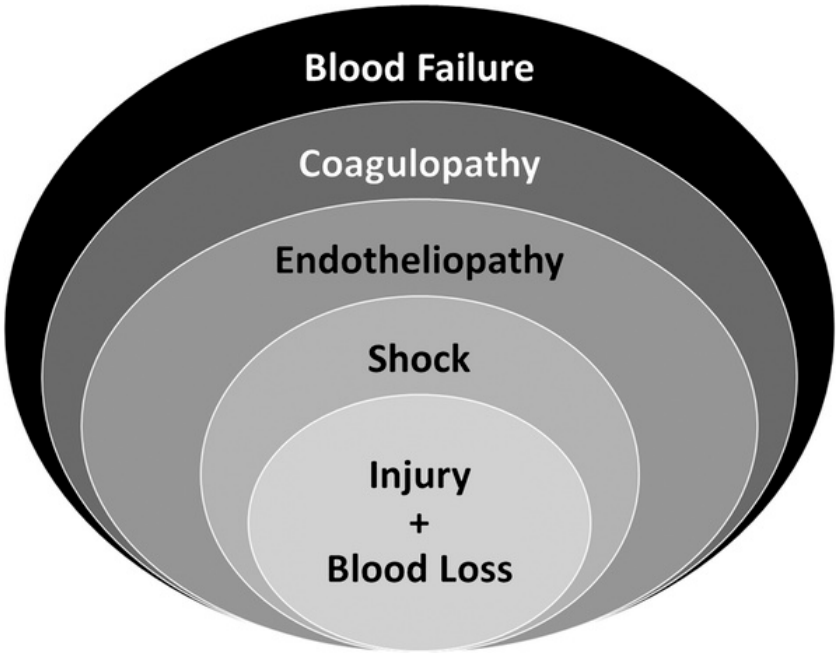
Shock. 2006; 26:322-331.

Hemorrhage

Bloody Vicious Cycle



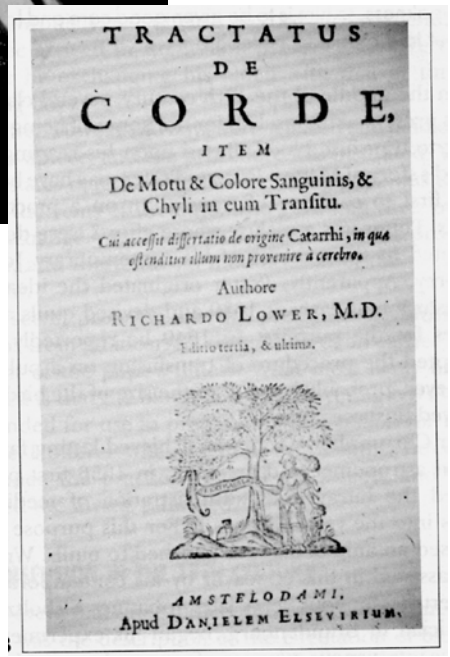
Hemorrhagic Blood Failure



Hemorrhagic blood failure: Oxygen debt, coagulopathy, and endothelial damage.
White, Nathan; MD, MS; Ward, Kevin; Pati, Shibani; MD, PhD; Strandenes, Geir; Cap, Andrew; MD, PhD

Journal of Trauma and Acute Care Surgery. 82(6S) Supplement 1:S41-S49, June 2017.

Richard Lower



- The first Blood transfusions of record take place (1665).
- Animal experiments conducted by Richard Lower, an Oxford physician started as dog-to-dog experiments and proceeded to animal-to-human over the next two years.
- Dogs were kept alive by the transfusion of Blood from other dogs.

Lower R. The method observed in transfusing blood out of one live animal into another. Phil Trans R Soc Lond 1666; 1: 353–8.

Sketch of Blundell's gravitator. Blood from the donor dripped into a cup fixed several feet above the arm of the recipient and was directed through tubing into the recipient's vein. Adapted from Blundell J, Observations on transfusion (Lancet. 1828;2:321)

History of Blood Transfusion

1795 — In Philadelphia an American physician, Philip Syng Physick, performed the first known human Blood transfusion, although he did not publish the particulars.

1901 — Karl Lansteiner, an Austrian physician, and the most important individual in the field of Blood transfusion, documented the first three human Blood groups (based on substances present on the red Blood cells), A, B and O.

1907 — Reuben Ottenberg performed the first Blood transfusion using Blood typing and cross-matching. Ottenberg also observed the 'Mendelian inheritance' of Blood groups and recognized the “universal” utility of group O donors.

1914 — Long-term anticoagulants, among them sodium citrate, were developed, allowing longer preservation of blood.

History of Blood Transfusion

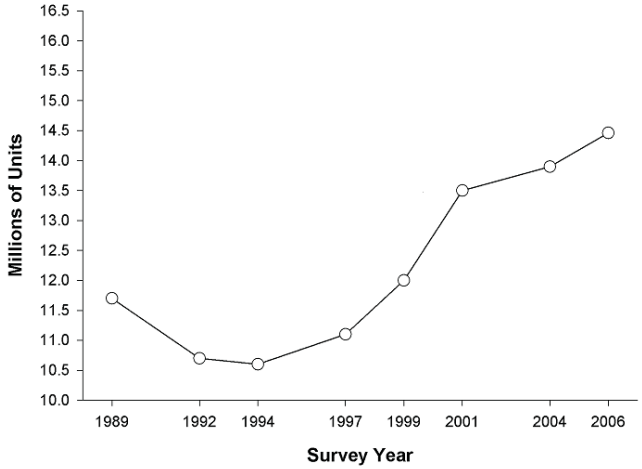
1916 — Francis Rous and J. R. Turner introduced a citrate-glucose solution that permitted storage of Blood for several days after collection. This discovery also directly led to the establishment of the first Blood 'depot' by the British during World War I.

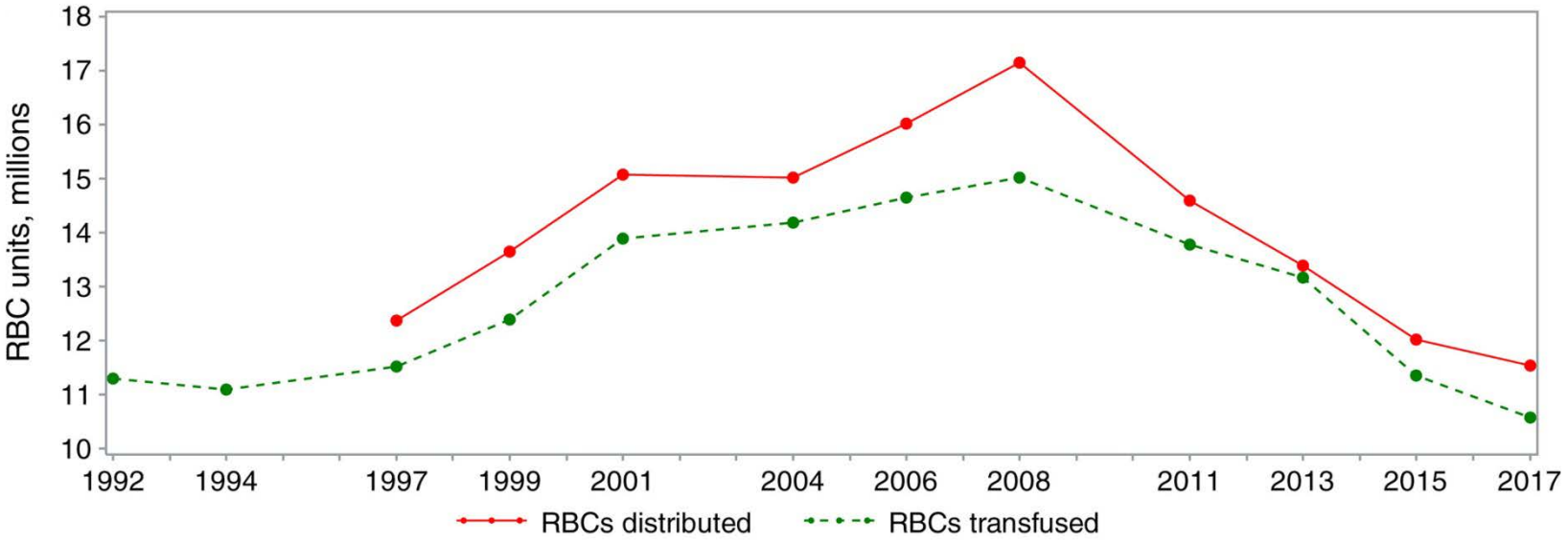
1932 — The first facility functioning as a Blood bank was established in a Leningrad Russia hospital.

1937 — Bernard Fantus, director of therapeutics at the Cook County Hospital in Chicago, Illinois (U. S.), established the first hospital Blood bank in the United States.

1953 — Development of the refrigerated centrifuge began to further expedite Blood component therapy.

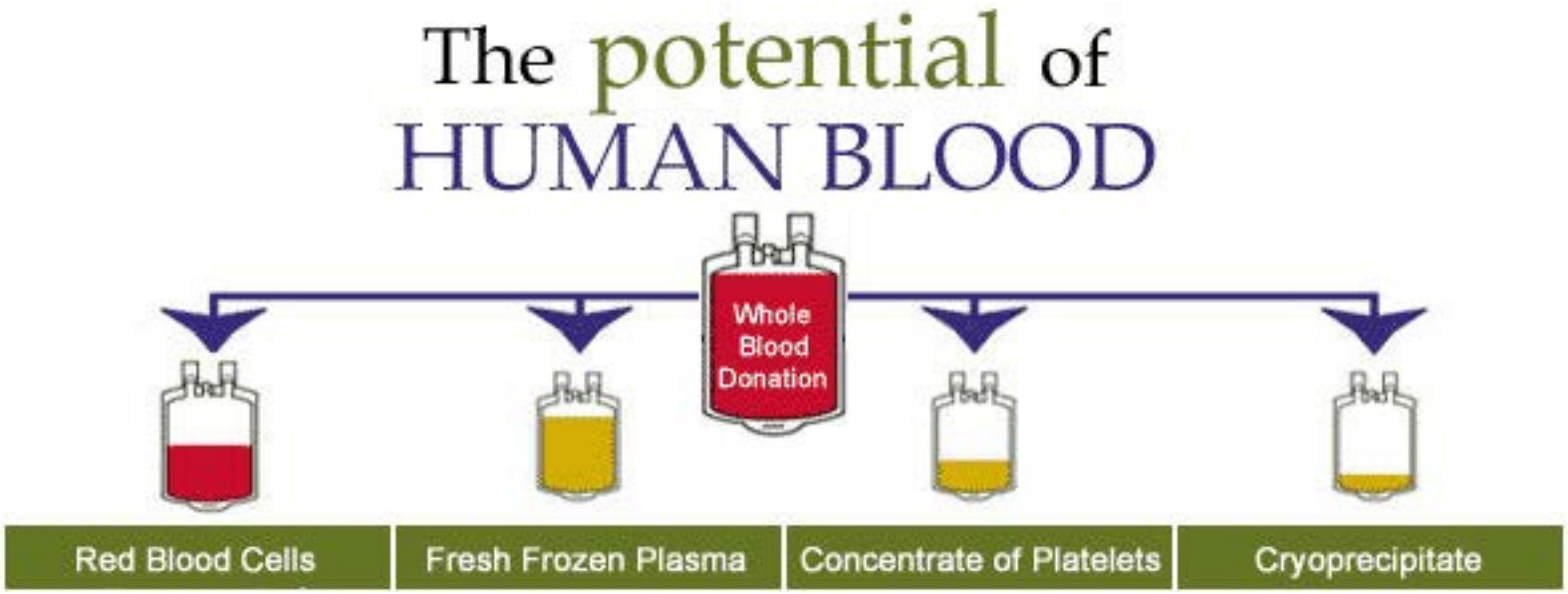
Transfusion in the United States

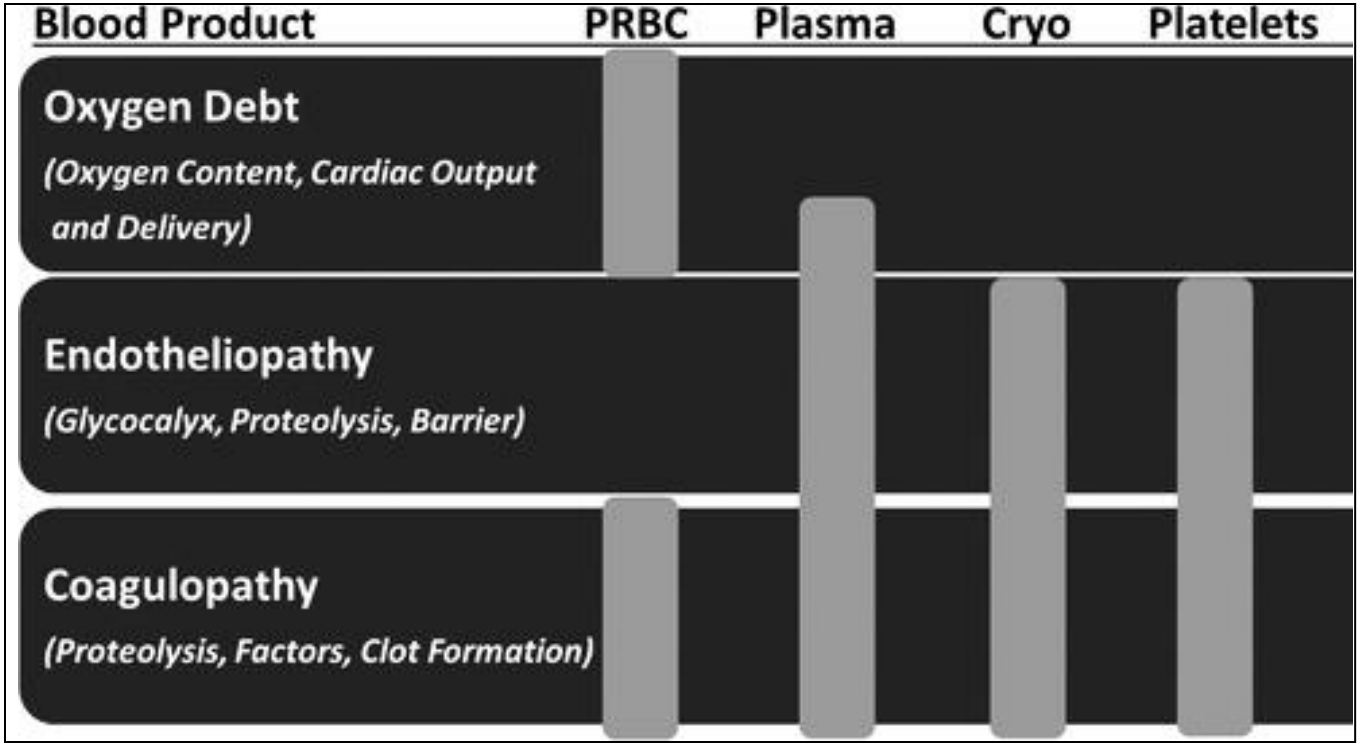




Transfusion, Volume: 60, Issue: S2, Pages: S1-S9, First published: 21 February 2020

Component Therapy





Hemorrhagic blood failure: Oxygen debt, coagulopathy, and endothelial damage.

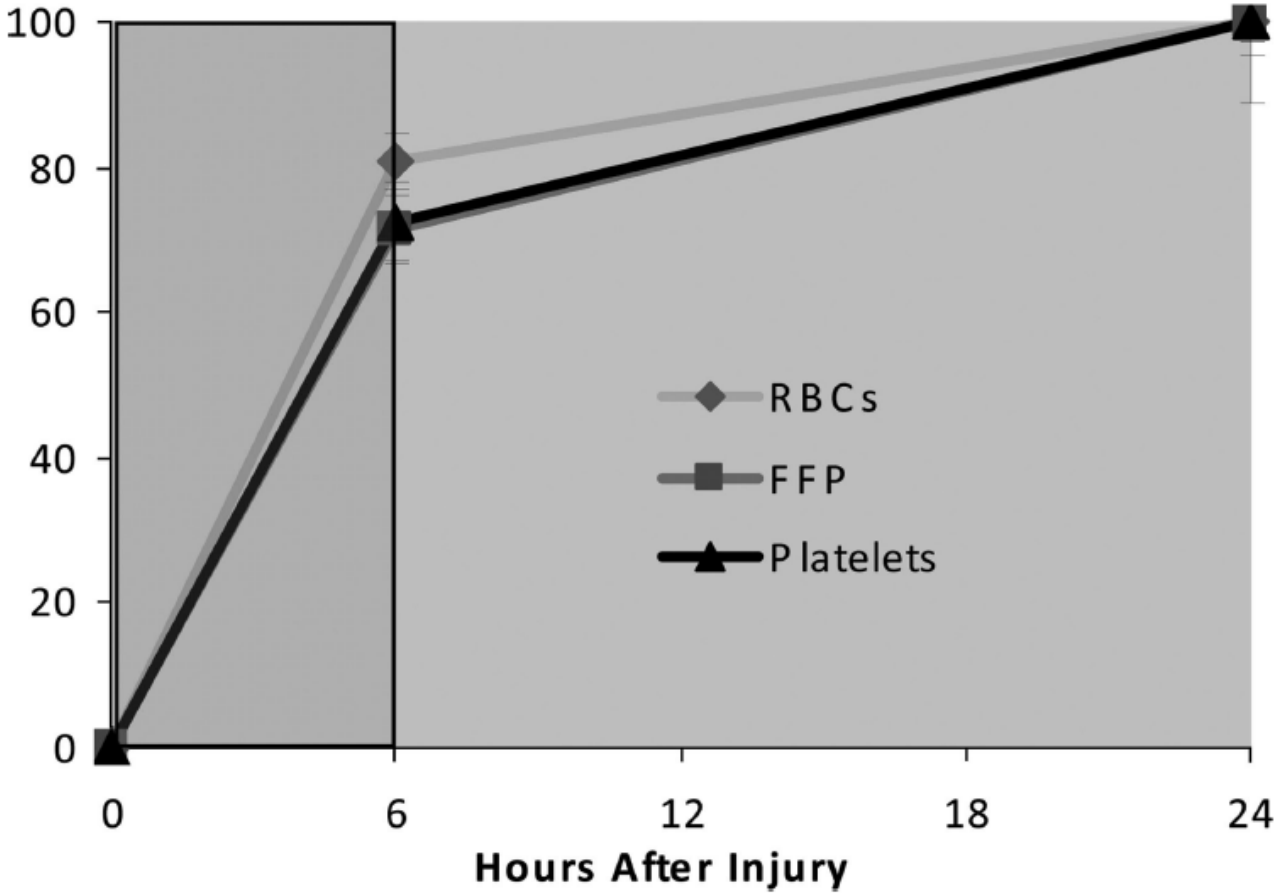
White, Nathan; MD, MS; Ward, Kevin; Pati, Shibani; MD, PhD; Strandenes, Geir; Cap, Andrew; MD, PhD

Journal of Trauma and Acute Care Surgery. 82(6S) Supplement 1:S41-S49, June 2017.
DOI: 10.1097/TA.0000000000001436

Massive Transfusion

- Definition of massive transfusion not universally agreed upon and has changed over time with the improvement of blood bank processing and resources.
- Historically defined as 10 units of RBC per 24 hours.
- Alternative definitions such as three units of red blood cells over one hour or any four blood components in 30 minutes.

Percentage of Blood Products Over Time

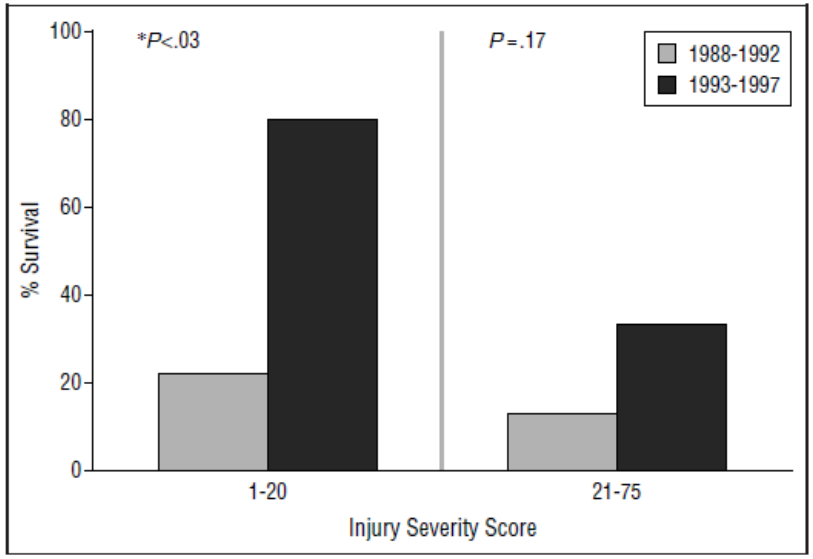


Within first 6 hours after injury, a median of 80% of RBC's, FFP, and platelets were transfused.

J Trauma. 2008;65:261-271

Massive Transfusion Outcome

- 1971 – 6.6% survival rate following > 25 unit blood transfusion
- 1980's – Several reports of survival > 50% following transfusion of > 20 units of blood



Greater than 50 units of pRBC in the 48 hrs following admission.

Arch Surg. 1999; 134:964-970

Is There a Limit to Massive Blood Transfusion After Severe Trauma?

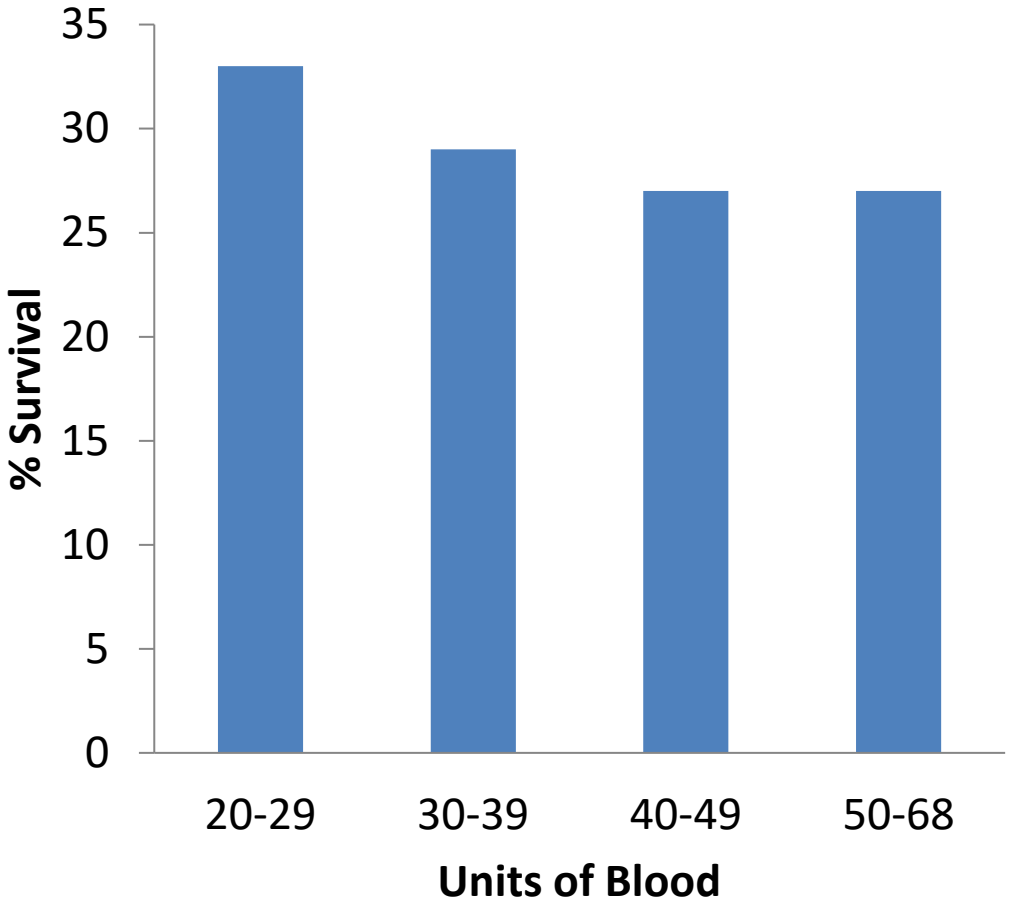
George C. Velmahos, MD, PhD; Linda Chan, PhD; Michael Chan; Raymond Tatevossian, BS; Edward E. Cornwell III, MD; Juan A. Asensio, MD; Thomas V. Berne, MD; Demetrios Demetriades, MD, PhD

141 Patients over 4 years at LA County who received ≥ 20 units of blood

Mean transfusion rate 31 units for survivors, 32 units for non-survivors

74% had penetrating trauma

Overall survival rate 30.5%



Arch Surg. 1998; 133:947-952

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

Massive Transfusion Exceeding 50 Units of Blood Products in Trauma Patients

Steven N. Vaslef, MD, PhD, Nancy W. Knudsen, MD, Patrick J. Neligan, FCARSI, and Mark W. Sebastian, MD

Background: Massive transfusion of blood products in trauma patients can acutely deplete the blood bank. It was hypothesized that, despite a large allocation of resources to trauma patients receiving more than 50 units of blood products in the first 24 hours, outcome data would support the continued practice of massive transfusion.

Methods: A retrospective review of charts and registry data of trauma patients who received over 50 units of blood products in the first day was conducted for a 5-year period at a Level I trauma center. Patients were stratified into groups on the basis of the number of transfusions received. Results are expressed as mean ± SD. Univariate analysis and multivariate logistic regression were used to identify those risk factors determined in the first 24 hours after admission that were predictive of mortality. Physiologic differences between survivors and nonsurvivors were also examined.

Results: Of 7,734 trauma patients admitted between July 1, 1995, and June 30, 2000, 44 (0.6%) received > 50 units of blood products in the first day. Overall mortality in these patients was 57%. There was no significant difference ($p = 0.565$, χ^2) in mortality rate between patients who received > 75 units of blood products in the first day versus those who received 51 to 75 units. Multiple logistic regression analysis identified only one independent risk factor, base deficit > 12 mmol/L, associated with mortality. Base deficit > 12 mmol/L increases the risk of death by 5.5 times ($p = 0.013$; 95% confidence interval, 1.44–20.95). Neither the total blood product transfusion requirement in the first day nor the packed red blood cell transfusion amount in the first day were significant independent risk factors. Causes of the 25 deaths in this series included exsanguination in the operating room (n = 1) or in the surgical intensive care unit (n = 12), multiple organ failure/sepsis (n = 3), head injury (n = 3), respiratory failure (n = 2), cerebrovascular accident (n = 1), and other (n = 3). Of the survivors, 63% were discharged to home, 21% to rehabilitation, 11% to nursing home, and 5% to another acute care facility. Of the nonsurvivors, the mean Injury Severity Score was 43, 88% had a base deficit > 12 mmol/L, 68% had a Glasgow Coma Scale score < 8, and 64% had a Sequential Organ Failure Assessment score > 10.

Conclusion: The 43% survival rate in trauma patients receiving > 50 units of blood products warrants continued aggressive transfusion therapy in the first 24 hours after admission.

Key Words: Massive transfusion, Trauma, Multiple organ failure, Coagulopathy.

J Trauma. 2002;53:291–296.

7734 trauma patients admitted between July 1, 1995 and June 30, 2000

44 (0.6) received > 50 units of blood products in the first day (pRBC, FFP, cryp, plts)

Overall survival rate 43%

No difference in survival between >75 versus 51-75 units of product

Table 2 Total Blood and Component Transfusion Requirements in the First Day after Injury in Massive Transfusion Survivors and Nonsurvivors

	Survivors (n = 19)	Nonsurvivors (n = 25)	Total (n = 44)	*p* Value
Total blood products (units)	71 ± 17	79 ± 26	75 ± 22	0.263
% transfused > 75 units	31.6	40.0	36.4	0.565
PRBCs (units)	26 ± 9	38 ± 16	33 ± 14	0.005
% transfused > 25 units PRBCs	47.4	76.0	63.6	0.051
FFP (units)	10 ± 6	9 ± 5	9 ± 5	0.469
Cryoprecipitate (units)	26 ± 10	24 ± 14	25 ± 12	0.615
Platelets (units)	8 ± 5	7 ± 6	8 ± 6	0.554

The Ratio of Blood Products Transfused Affects Mortality in Patients Receiving Massive Transfusions at a Combat Support Hospital

Matthew A. Borgman, MD, Philip C. Spinella, MD, Jeremy G. Perkins, MD, Kurt W. Grathwohl, MD, Thomas Repine, MD, Alec C. Beekley, MD, James Sebesta, MD, Donald Jenkins, MD, Charles E. Wade, PhD, and John B. Holcomb, MD

Background: Patients with severe traumatic injuries often present with coagulopathy and require massive transfusion. The risk of death from hemorrhagic shock increases in this population. To treat the coagulopathy of trauma, some have suggested early, aggressive correction using a 1:1 ratio of plasma to red blood cell (RBC) units.

Methods: We performed a retrospective chart review of 246 patients at a US Army combat support hospital, each of who received a massive transfusion (≥10 units of RBCs in 24 hours). Three groups of patients were constructed according to the plasma to RBC ratio transfused during massive transfusion. Mortality rates and the cause of death were compared among groups.

Results: For the low ratio group the plasma to RBC median ratio was 1:8 (interquartile range, 0:12–1:5), for the medium ratio group, 1:2.5 (interquartile range, 1:3.0–1:2.3), and for the high ratio group, 1:1.4 (interquartile range, 1:1.7–1:1.2) ($p < 0.001$). Median Injury Severity Score (ISS) was 18 for all groups (interquartile range, 14–25). For low, medium, and high plasma to RBC ratios, overall mortality rates were 65%, 34%, and 19%, ($p < 0.001$); and hemorrhage mortality rates were 92.5%, 78%, and 37%, respectively, ($p < 0.001$). Upon logistic regression, plasma to RBC ratio was independently associated with survival (odds ratio 8.6, 95% confidence interval 2.1–35.2).

Conclusions: In patients with combat-related trauma requiring massive transfusion, a high 1:1.4 plasma to RBC ratio is independently associated with improved survival to hospital discharge, primarily by decreasing death from hemorrhage. For practical purposes, massive transfusion protocols should utilize a 1:1 ratio of plasma to RBCs for all patients who are hypocoagulable with traumatic injuries.

Key Words: Blood components, Fresh frozen plasma, Trauma, Coagulopathy.

J Trauma. 2007;63:805–813.

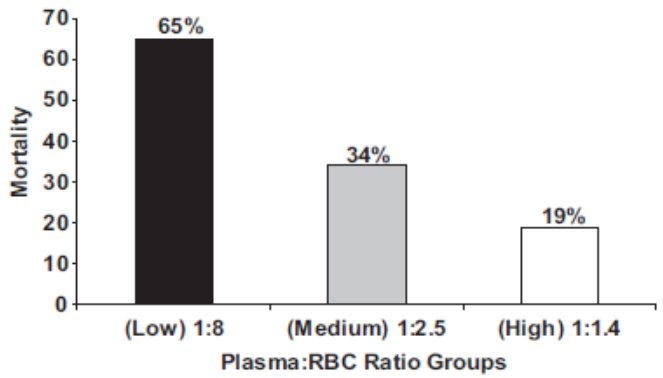
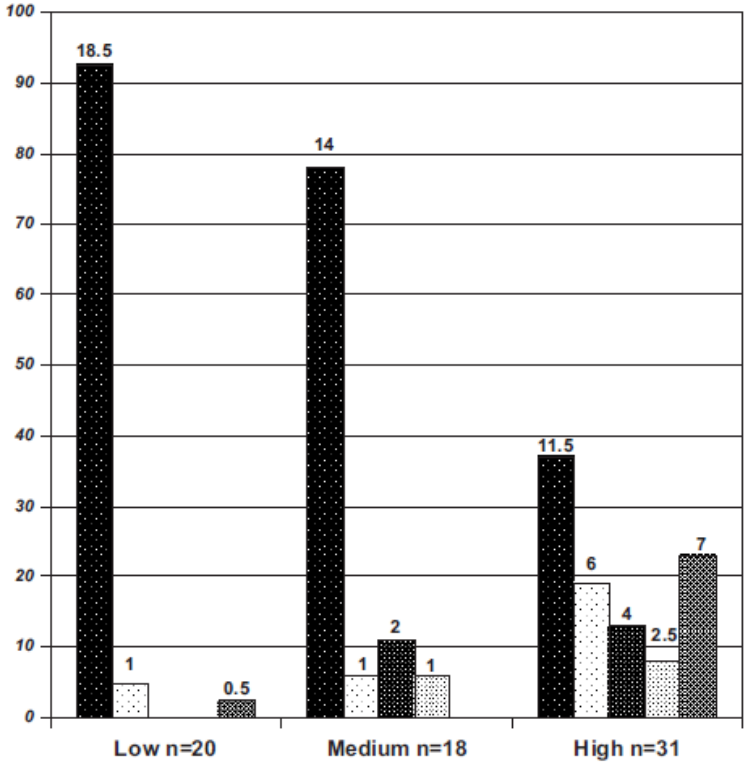


Fig. 1. *Percentage mortality associated with low, medium, and high plasma to RBC ratios transfused at admission. Ratios are median ratios per group and include units of fresh whole blood counted both as plasma and RBCs.*

Retrospective review of 246 patients that received greater than 10 units of pRBC



Hemorrhage %†	**92.5 [a]**	**78 [a]**	**37 [b]**
Sepsis %	5	6	19
MOF %	0	11	13
Airway/Breathing %	0	6	8
CNS %	2.5	0	23
Time to death (hrs)[2*]	**2 (1 – 4) [a]**	**4 (2-16) [b]**	**38 (4 – 155) [c]**

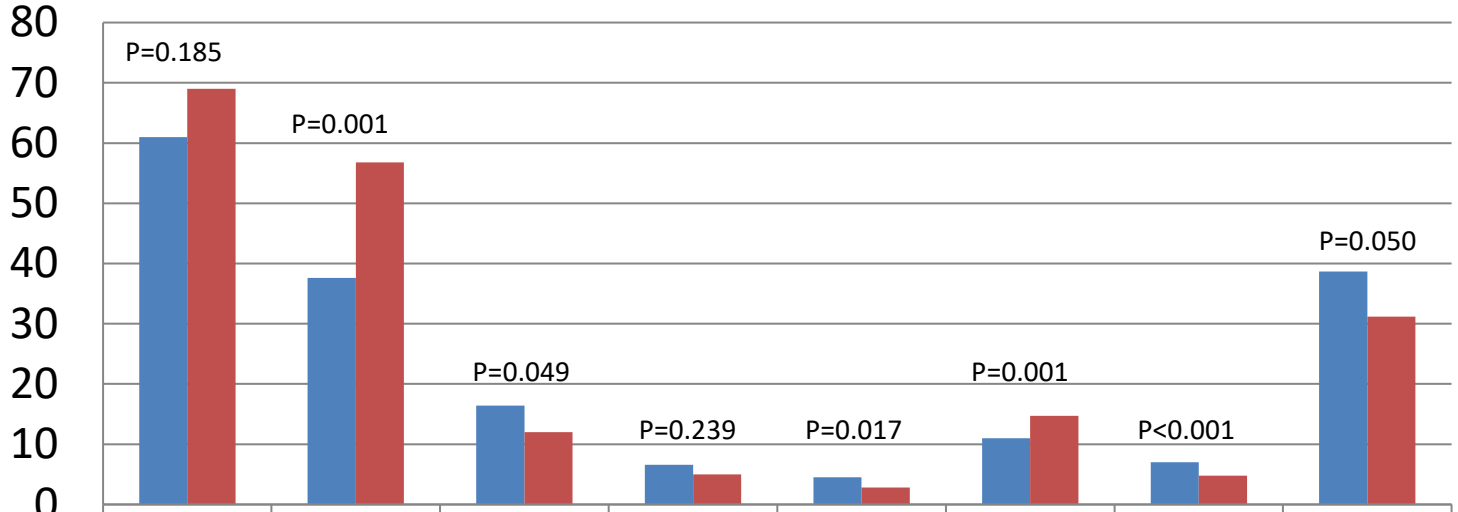
The Journal of TRAUMA® Injury, Infection, and Critical Care

Predefined Massive Transfusion Protocols are Associated With a Reduction in Organ Failure and Postinjury Complications

Bryan A. Cotton, MD, Brigham K. Au, BS, Timothy C. Nunez, MD, Oliver L. Gunter, MD, Amy M. Robertson, MD, and Pampee P. Young, MD, PhD

- Historical control study comparing patients over a 23 month period before and after the implementation of a trauma exsanguination protocol.
- Protocol involves the immediate delivery of products in a 3:2 ration of RBC:FFP and 5:1 for RBC:PLTS

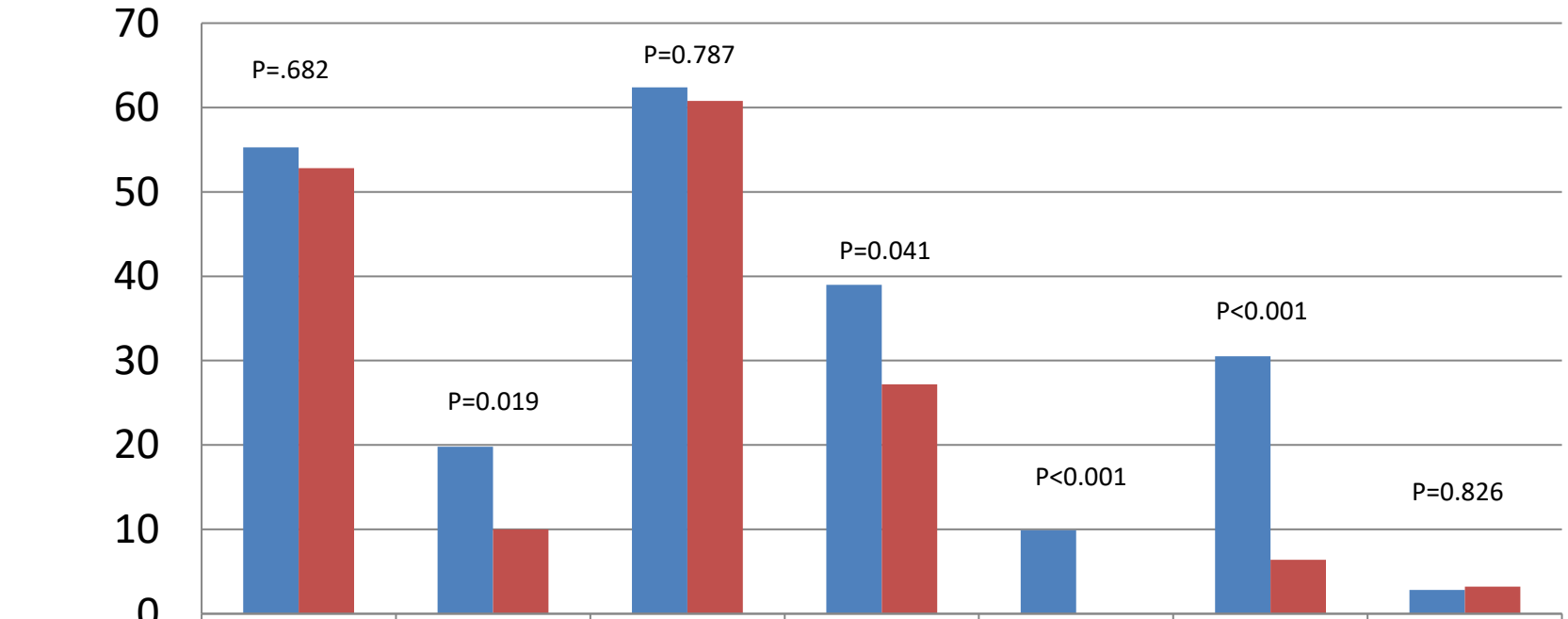
Outcome and Resuscitation Comparison Between Groups



	24-h Surv.	30-d Surv.	Hosp. LOS	ICU LOS	Vent. Days	IO Blood Prod.	IO Cryst.	24-h Blood Prod.
Pre TEP	61	37.6	16.4	6.6	4.5	11	7	38.7
TEP	69	56.8	12	5	2.8	14.7	4.8	31.2

J Trauma. 2009;66:41– 49.

Complications Rates Between Groups



	SIRS	Severe sepsis	VDRF	VAP	ACS	Open Abd	CVVH/HD
Pre TEP	55.3	19.8	62.4	39	9.9	30.5	2.8
TEP	52.8	10	60.8	27.2	0	6.4	3.2

J Trauma. 2009;66:41– 49.

Hemostatic Resuscitation During Surgery Improves Survival in Patients With Traumatic-Induced Coagulopathy

Juan C. Duchesne, MD, Tareq M. Islam, MD, MPH, Lance Stuke, MD, MPH, Jeremy R. Timmer, MD, James M. Barbeau, MD, JD, Alan B. Marr, MD, John P. Hunt, MD, MPH, Jeffrey D. Dellavolpe, MD, Georgia Wahl, MD, NREMT-P, Patrick Greiffenstein, MD, Glen E. Steeb, MD, Clifton McGinness, MD, Christopher C. Baker, MD, and Norman E. McSwain, Jr., MD

Background: Although hemostatic resuscitation with a 1:1 ratio of fresh-frozen plasma (FFP) to packed red blood cells (PRBC) after severe hemorrhage has been shown to improve survival, its benefit in patients with traumatic-induced coagulopathy (TIC) after >10 units of PRBC during operation has not been elucidated. We hypothesized that a survival benefit would occur when early hemostatic resuscitation was used intraoperatively after injury in patients with TIC.

Methods: A 7-year retrospective study of patients with emergency department diagnosis of TIC after transfusion of >10 units of PRBC in the operating room. TIC was defined as initial emergency department international normalized ratio > 1.2, prothrombin time > 16 seconds, and partial thromboplastin time > 50 seconds. Patients were divided into FFP:PRBC ratios of 1:1, 1:2, 1:3, and 1:4. Patients with diagnosis of TIC who received transfusion of both FFP and PRBC during surgery were included. Other variables evaluated included age, gender, mechanism of injury, initial base deficit, mean operative time, trauma intensive care unit length of stay (TICU LOS) and Injury Severity Score. The primary outcome measure evaluated was the impact of the early FFP:PRBC ratio on mortality.

Results: Four hundred thirty-five patients underwent emergency operations postinjury and received FFP with >10 units of PRBC in the operating room; 135 (31.0%) of these patients had TIC and 53 died (39.5% mortality). Mean operative time was 137 minutes (SD ± 49). There were no differences with regard to age, gender, mechanism of injury, initial base deficit, or Injury Severity Score among all groups. A significant difference in mortality was found in patients who received >10 units of PRBC when FFP:PRBC ratio was 1:1 versus 1:4 (28.2% vs. 51.1%, $p = 0.03$). Intermediate mortality rates were noted in patients with 1:2 and 1:3 ratios (38% and 40%, respectively). From a linear regression model, 13 days of increased TICU LOS was observed among 1:4 group compared with 1:1 group ($p < 0.01$).

Conclusion: TIC is common after severe injury and is associated with a high mortality in patients transfused with >10 units of PRBC during surgery. Early hemostatic resuscitation during first hours after injury improves survival with shorter TICU LOS in patients with TIC.

Key Words: Damage control resuscitation, Trauma-induced coagulopathy, Early hemostatic resuscitation, Ratio's, Outcomes.

(*J Trauma.* 2009;67: 33–39)

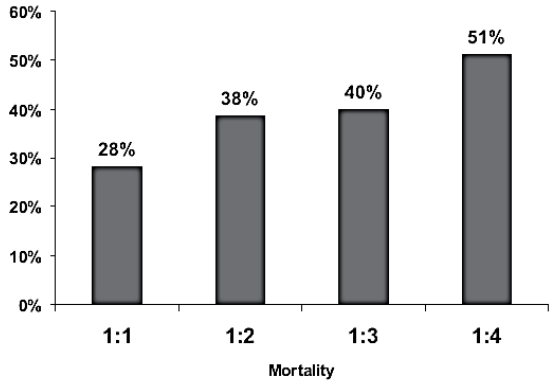


Figure 2. Overall mortality among the study groups.

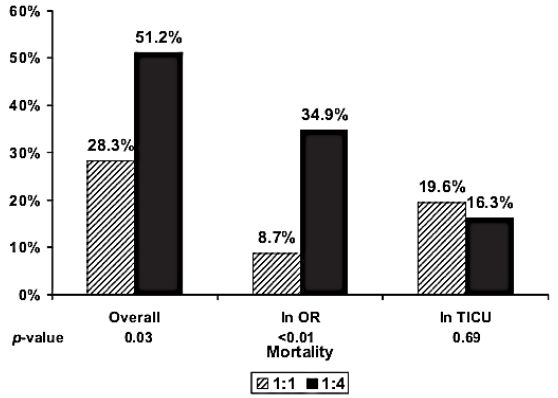


Figure 3. Mortality between 1:1 and 1:4 study groups.

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

Postinjury Life Threatening Coagulopathy: Is 1:1 Fresh Frozen Plasma: Packed Red Blood Cells the Answer?

Jeffry L. Kashuk, MD, Ernest E. Moore, MD, Jeffrey L. Johnson, MD, James Haenel, RRT, Michael Wilson, MD, John B. Moore, MD, C. Clay Cothren, MD, Walter L. Biffl, MD, Anirban Banerjee, PhD, and Angela Sauaia, MD, PhD

Background: Recent military experience suggests that immediate 1:1 fresh frozen plasma (FFP); red blood cells (RBC) for casualties requiring >10 units packed red blood cells (RBC) per 24 hours reduces mortality, but no clinical trials exist to address this issue. Consequently, we reviewed our massive transfusion practices during a 5-year period to test the hypothesis that 1:1 FFP:RBC within the first 6 hours reduces life threatening coagulopathy.

Methods: We queried our level I trauma center's prospective registry from 2001 to 2006 for patients undergoing massive transfusion. Logistic regression was used to evaluate the independent effect of FFP:RBC in 133 patients who received >10 units RBC in 6 hours on (1) Coagulopathy (international normalized ratio [INR] >1.5 at 6 hours), controlling for our previously described risk factors predictive of coagulopathy, as well as RBC, FFP, and platelet administration (2) Death (controlling for all variables plus age, crystalloids per 24 hours, INR >1.5 at 6 hours).

Results: Overall mortality was 56%; 50% died from acute blood loss in the operating room. Over 80% of the RBC transfusions were completed in the first 6 hours: (Median RBC: 18 units) Median FFP:RBC survivors, 1:2, nonsurvivors: 1:4. ($p < 0.001$) INR >1.5 at 6 hours occurred in 30 (23%); 81% died. Regarding mortality, logistic regression showed significant variables ($p < 0.05$) included: RBC per 6 hours (OR = 1.248, 95%CI: 1.957–53.255), INR at 6 hours >1.5 (OR = 10.208, 95% CI: 1.957–53.255), ED temperature <34°C (OR = 15.491, 95% CI 1.376–174.396), and age >55 years (OR = 40.531, CI 5.315–309.077). The adjusted OR for FFP:RBC ratio including the quadratic term was found to follow a U-shaped association (quadratic term estimate 0.6737 ± 0.0345, $p = 0.0189$).

Conclusion: Although our data suggest that 1:1 FFP:RBC reduced coagulopathy, this did not translate into a survival benefit. Our findings indicate that the relationship between coagulopathy and mortality is more complex, and further clinical investigation is necessary before recommending routine 1:1 in the exsanguinating trauma patient.

Key Words: Postinjury, Coagulopathy, Plasma, Transfusion.

J Trauma. 2008;65:261–271.

Retrospective trial from 2001 to 2006 identified 133 patients that received >10 units pRBC in 6 hours

Overall mortality was 56%

50% died from acute blood loss in the operating room

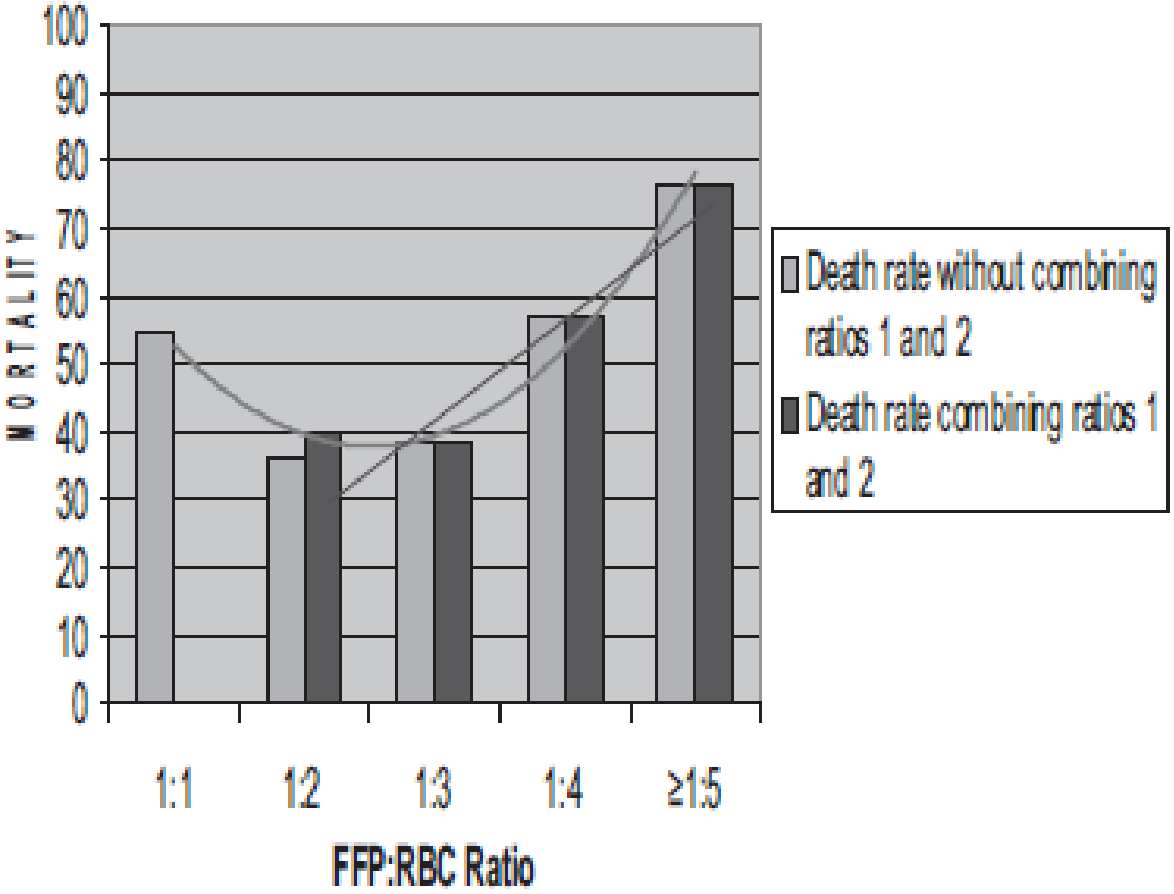


Fig. 9. *The significance of the U-shaped curve is emphasized by the importance of separating transfusion ratios. When 1:1 and 1:2 ratios were combined, the U-shaped curve is lost, resulting in a linear relationship of FFP:RBC ratio to mortality.*

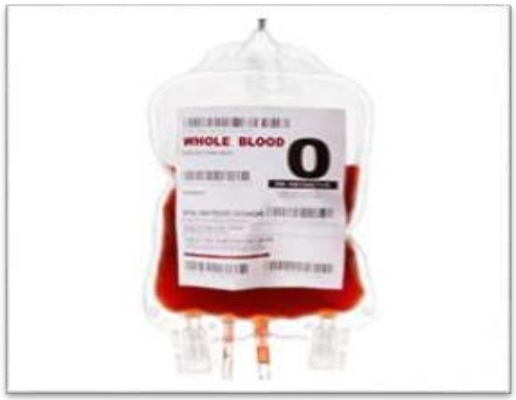
Component Therapy versus LTOWB

Low Titer Type O Whole Blood (LTOWB)

- Who is eligible to make LTOWB donations?
  - Type O male donors
  - Type O female donors who have never been pregnant
  - Type O female donors who test negative for HLA antibodies and have not been pregnant since testing
- Anti-A and Anti-B antibodies are tested for each donation to determine if the individual blood product contains a low titer of ABO antibodies.
- The titer cutoff used by various centers ranges from less than 50 to 256 as measured by direct agglutination at room temperature in an immediate spin saline tube

Volume and Concentrations Between Component Therapy vs. Warm Whole Blood

VS



Component Therapy: 680 mL

RBC unit + PLT unit + FFP unit + Cryo unit

- Red blood cell concentration: 29%
- Platelets: 80,000
- Coagulation factors: 65%

Whole Blood: 500 mL

A single WB unit

- Red blood cell concentration: 38-50%
- Platelets: 150,000-400,000
- Coagulation factor concentration: 100%

Standard Amounts of Anti-coagulants and Additives in Reconstituted Whole Blood vs Whole Blood

Component Therapy per Unit:

- 6 x RBC (AS-5) — 6 x 120ml = 720ml
- 6 x FFP — 6 x 50ml = 300ml
- 1 x aPLT — 1 x 35ml = 35ml

Total = 1055mL

Whole Blood per Unit:

- 1 x WB — 6 x 63ml = 378ml

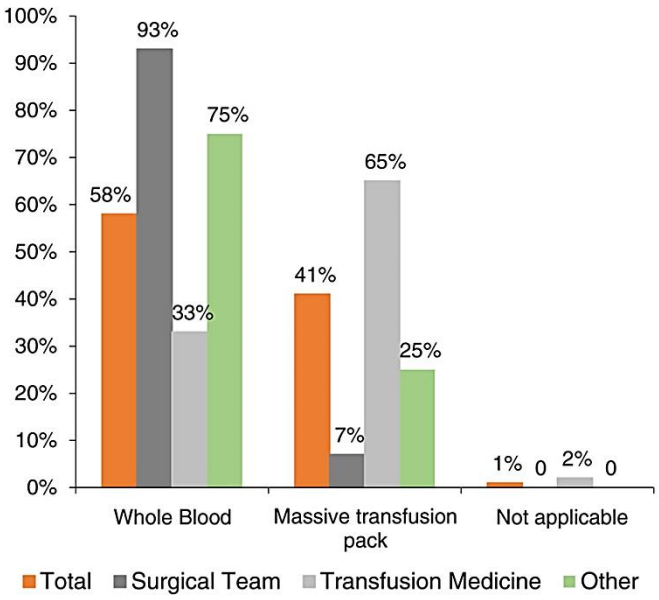
Total = 378ml

There is 3 times the volume of anticoagulant and additives with reconstituted whole blood from components compared to whole blood

Spinella PC, J Trauma. 2009;66:S69-76

Making Whole Blood for Trauma Available (again): The American Red Cross Experience

A



B

➢ **Prefer Massive Transfusion**

- Lack of evidence/research in support of using Whole Blood
- Allows for optimal flexibility (Whole Blood must be ABO identical)
- Ratios may be altered to meet needs of patient
- Lack of confidence in cold storage platelets
- Concern for potential mistransfusion
- Whole Blood requires maintaining dual inventory
- Availability/expiration of Whole Blood
- Infrequency of mass transfusions

➢ **Prefer Whole Blood**

- Provides more effective oxygen carrying capacity, coagulation factors, and volume in the same package
- Improved efficiency (i.e., single product, no thawing of plasma)
- Easy administration / no need for multiple components
- Ensures correct component ratio
- Limits recipient exposure to donors
- Hemostasis and hemodynamic stability are achieved faster
- Closer to physiology
- Supported in US military practice

Transfusion, Volume: 59, Issue: S2, Pages: 1439-1445, First published: 13 April 2019.

Clinical outcomes among low-titer group O whole blood recipients compared to recipients of conventional components in civilian trauma resuscitation

Jansen N. Seheult,[1] Vincent Anto,[2] Louis H. Alarcon,[3,4] Jason L. Sperry,[3,4] Darrell J. Triulzi,[1,5] and Mark H. Yazer[1,5]

- Retrospective analysis (received ≤ 4 units of LTOWB)
- A total of 135 patients who received LTOWB (median 2 units) were matched to 135 patients who received conventional components.
- There were no significant differences in outcomes: median in-hospital mortality or 24-hour mortality.
- The hospital and intensive care unit LOS were not significantly different between groups.
- The median number of RBC units transfused, including the contribution from the LTOWB, was not significantly different between the groups.

Transfusion. 2018;58;1838–1845

Safety profile and impact of low-titer group O whole blood for emergency use in trauma

James Williams, BS, Nicholas Merutka, BS, David Meyer, MD, MS, Yu Bai, MD, PhD, Samuel Prater, MD, Rodolfo Cabrera, BSN, EMT-P, John B. Holcomb, MD, Charles E. Wade, PhD, Joseph D. Love, DO, *and* Bryan A. Cotton, MD, MPH, *Houston, Texas*

- Retrospective, 198 patients receiving LTOWB versus 152 receiving component therapy
- Low-titer group O whole blood had similar evidence of laboratory hemolysis (up to 6 units), similar transfusion reaction rates, no change in mortality.
- When adjusted for severity of shock associated with a 50% reduction in post-ED transfusions and two fold increase in survival.

J Trauma Acute Care Surg. 2020;88: 87–93

SUPPLEMENT ARTICLE

The use of low-titer group O whole blood is independently associated with improved survival compared to component therapy in adults with severe traumatic hemorrhage

Susan M. Shea,[1] Amanda M. Staudt,[2] Kimberly A. Thomas,[1] Douglas Schuerer,[3] James E. Mielke,[1] Danielle Folkerts,[1] Ethan Lowder,[1] Callista Martin,[1] Grant V. Bochicchio,[3] and Philip C. Spinella[1]

- The use of LTOWB is independently associated with improved 24-hour and 28-day survival, and does not increase organ dysfunction at 72 hours.
- Use of LTOWB most impacted survival of patients with reduced clot firmness (MCF ≤60 mm).

Will the Platelets Work?

- Current standard is room temperature storage with constant agitation with a shelf life of 5 days
- Rationale has been based off of hypoproliferative thrombocytopenia patients that require prophylactic platelet transfusion
- Refrigerated platelets are cleared more rapidly from circulation

SHOCK, Vol. 41, Supplement 1, pp. 51-53, 2014

Prevention versus Clotting

- Focus on circulating time rather than adhesion aggregation nor contribution to clot strength
- Maximized recovery and survival following transfusion
- Refrigerated PLTS are cleared more rapidly from circulation
- RCTs have shown cold platelets are more hemostatic

Key Considerations

- How will it be dispensed?
- How much LTOWB should be immediately available?
- When should you switch to standard MTP component resuscitation?
- Do you need to stock both O+ and O- LTOWB?
- Cost?

BloodTrack Emerge

Every minute counts: Time to delivery of initial massive transfusion cooler and its impact on mortality

David E. Meyer, MD, Laura E. Vincent, RN, Erin E. Fox, PhD, Terence O'Keeffe, MBChB, Kenji Inaba, MD, Eileen Bulger, MD, John B. Holcomb, MD, *and* Bryan A. Cotton, MD, *Houston, Texas*

- Among 680 patients, the median time from patient arrival to MT protocol activation was 9 minutes with a median time from MT activation call to delivery of first cooler of 8 minutes.
- Delays in MT protocol activation and delays in initial cooler arrival were associated with prolonged time to achieve hemostasis and an increase in mortality. Independent of products ratios, every minute from time of MT protocol activation to time of initial cooler arrival increases odds of mortality by 5%.

J Trauma Acute Care Surg. 2017; Vol 83, No 1

Improving Efficiency and Reducing Time to Transfusions

- Thirty-one patients were transfused LTOWB between 4/1/19-4/1/20 versus 21 patients in the preceding 12 months.
- During this period, 91 units of LTOWB were transfused in the trauma bay.
- The median time to first blood product administered was 10 minutes in the LTOWB group versus 14 minutes ($p<0.05$) in the pre-intervention group.
- The utilization of LTOWB not only simplified the steps needed in issuing and restocking blood products at the point-of-need, but also reduced the time to first blood product transfusion.

A case for stocking O D+ red blood cells in emergency room trauma bays

Erin Meyer and Lynne Uhl

- 10 year retrospective study
- A total of 498 ED O− RBC units were transfused to 268 patients (168 male, 100 female).
- A total of 322 units were transfused to males and 114 to females at least 50 years of age. Thirty-nine (14%) were D− with 18 receiving O+ RBCs.
- A total of 109 had follow-up antibody screens; one D− patient developed alloanti-D.
- The majority of ED O− RBCs (88%) went to patients who qualified for O+ RBCs; a minority (1.5%) of patients were D− females less than 50 years of age.
- The rate of alloimmunization was low.

Emergency Transfusion of Patients with Unknown Blood Type with Blood Group O Positive Red Blood Cell Concentrates

- Prospective single-center observational study done between Jan 1, 2001, and Dec 31, 2015
- 437 recipients were screened at 2,3,6 and 12 months
- The overall risk of inducing anti-D antibodies was 4% (95% CI 2·44–6·14)

In non-emergent transfusion 26% (95% CI 19·0–35.3) developed anti-D alloimmunization.

The Lancet Haematology. Vol 4 ,Issue 5, E218-E224, 2017.

Transfusion Medicine and Hemotherapy

Research Article

Transfus Med Hemother 2018;45:158–161
DOI: 10.1159/000485388

Received: September 21, 2107
Accepted: November 13, 2017
Published online: March 7, 2018

Unmatched Type O RhD+ Red Blood Cells in Multiple Injured Patients

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Steffen Ruchholtz[b] Ulrich J. Sachs[a,d]

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[b] Department of Trauma, Hand and Reconstructive Surgery, University Hospital Gießen and Marburg, Campus Marburg, Marburg, Germany;
[c] Asklepios Klinik Wandsbek, Hamburg, Germany;
[d] Institute for Clinical Immunology and Transfusion Medicine, Justus Liebig University, Gießen, Germany

- Out of 823 patients, 62 were immediately transfused 259 units, RhD+ RBCs
- 18 of these patients were RhD- and RhD-incompatible RBCs
- Seroconversion rate was 50%
- 3 were female of child bearing age (2 MTP seroconverted)

Cost?

- Prices do vary depending supplier
- Benefits of a blood donor / processing center

- Unit of Whole Blood – $633.17
- Unit of PRBC – $216.90

- Shelf life 21 days
- Prior to expiration can be spun down to its components

Low-Titer O Whole Blood: Our Process

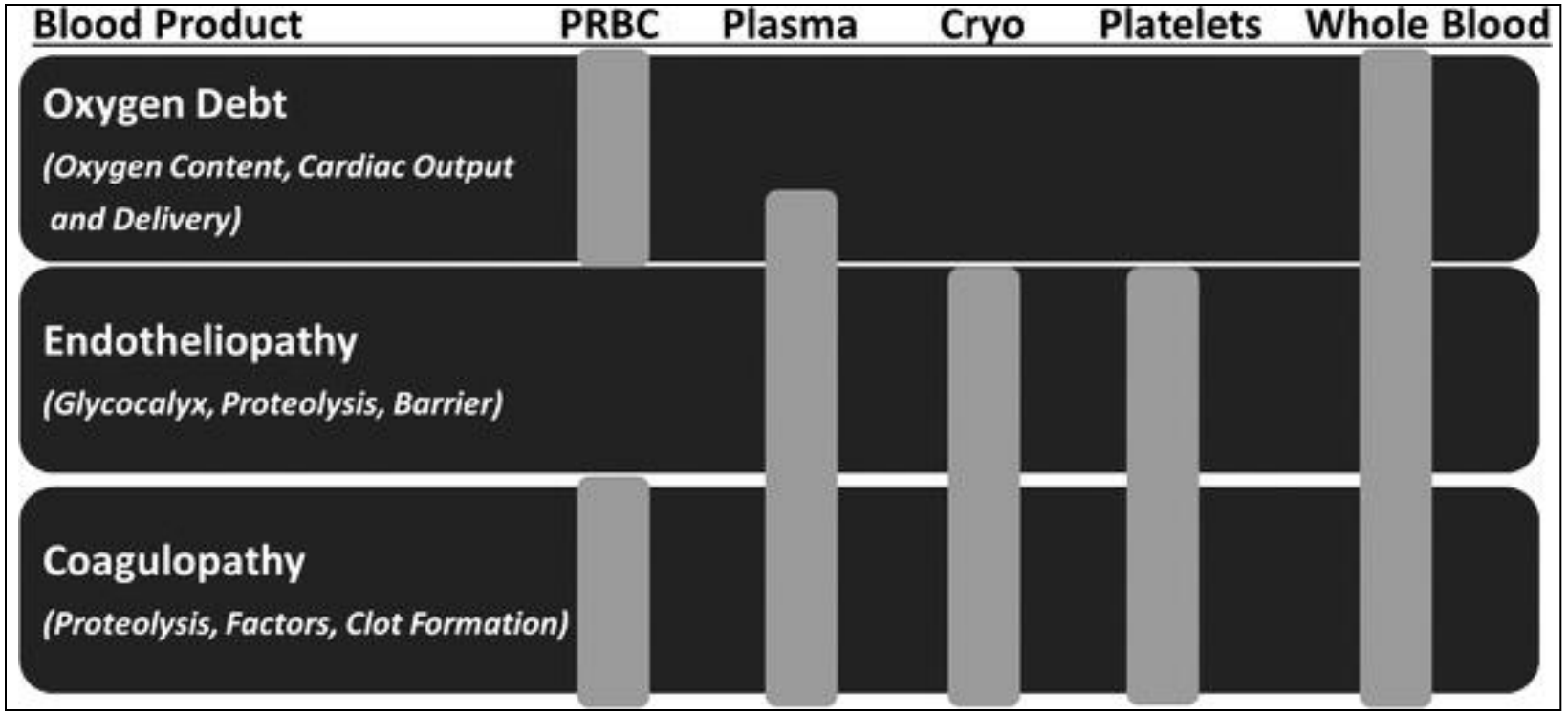
- LTOWB units were collected in our hospital-based blood center in CPD preservative and then manufactured and processed in our blood bank laboratory as per AABB and FDA regulations.
- The blood center identified type O male and never-pregnant female donors as LTOWB donors.
- Titers <1:200 were deemed ‘low-titer’ and acceptable for manufacturing LTOWB.
- For donors with titers >1:200, units were manufactured into RBC and plasma units.
- Leukoreduction (LR) with a platelet sparing filter was performed on each LTOWB unit.
- LR quality control was performed on 100% of LTOWB units.

LTOWB: Our Process

- Four units of O-positive LTOWB and two units of O-negative LTOWB were stocked in a secure, software- and temperature-controlled refrigerator in the trauma bay.
- LTOWB was issued by the trauma team only to trauma patients for whom massive transfusion protocol was initiated.
- The trauma team was responsible for reporting transfusion-related adverse events.
- Blood bank laboratory personnel was responsible for managing the inventory of the refrigerator in the trauma bay.
- At 14 days of storage, LTOWB units were returned to the blood bank laboratory for manufacture into red blood cell (RBC) units; the associated plasma was discarded.

LTOWB: Our Experience

- From 4/16/19-4/28/20, 113 LTOWB units were transfused to 43 patients.
- There were no reported transfusion-related adverse events.
- Due to the minimal use of O-negative LTOWB units, the production of O-negative LTOWB units is in the process of being discontinued.
- Instead, O-negative RBC units will be exclusively used for female trauma patients of child-bearing age.


Blood Product
PRBC
Plasma
Cryo
Platelets
Whole Blood
Oxygen Debt
(Oxygen Content, Cardiac Output and Delivery)
Endotheliopathy
(Glycocalyx, Proteolysis, Barrier)
Coagulopathy
(Proteolysis, Factors, Clot Formation)

Questions ?

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