Open Access Library Journal
2023, Volume 10, e10475
ISSN Online: 2333-9721
ISSN Print: 2333-9705

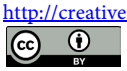
The Whole Story: A Comprehensive Review of Whole Blood Resuscitation for Hemorrhagic Shock

Abdullah S. Al-Darwish[1], Zaid A. Althowimer[2]

[1]Department of Surgery, Arryan Hospital, Dr Sulaiman Al Habib Medical Group, Riyadh, Saudi Arabia
[2]Department of Surgery, King Salman Armed Forces Hospital, Tabuk, Saudi Arabia
Email: dr.abdullah.aldarwish@gmail.com

How to cite this paper: Al-Darwish, A.S. and Althowimer, Z.A. (2023) The Whole Story: A Comprehensive Review of Whole Blood Resuscitation for Hemorrhagic Shock. *Open Access Library Journal*, **10**: e10475.
https://doi.org/10.4236/oalib.1110475

Received: July 5, 2023
Accepted: August 5, 2023
Published: August 8, 2023



Abstract

Whole blood resuscitation has emerged as a promising alternative to conventional component therapy for patients in hemorrhagic shock. Animal studies and clinical evidence in both civilian and military populations have shown improved outcomes with whole blood. While further research is needed to establish optimal patient selection criteria, dosing, and transfusion practices, the use of whole blood in resuscitation has the potential to save lives and improve outcomes. Whole blood provides balanced levels of red cells, plasma, and platelets, mimicking normal physiology and sealing leaks in the clotting cascade that often develop. The available clinical evidence suggests that whole blood resuscitation may provide advantages over component therapy in certain patient populations and clinical settings.

Subject Areas

Clinical Medicine

Keywords

Whole Blood Resuscitation, Hemorrhagic Shock, Animal Studies, Clinical Trials

1. Introduction

Whole blood is increasingly being recognized as an effective resuscitation fluid for patients in hemorrhagic shock. Compared to conventional component therapy, whole blood resuscitation has been shown to offer advantages in animal models [1] and human clinical evidence is emerging [2].

Whole blood resuscitation aims to restore the "lethal triad" of acidosis, coagulopathy, and hypothermia that arises from severe bleeding [3]. It provides balanced levels of red cells, plasma, and platelets, mimicking normal physiology and sealing leaks in the clotting cascade that often develop [4].

2. Animal Studies

Several animal studies have demonstrated improved outcomes with whole blood compared to component therapy for hemorrhagic shock. Weinberg *et al.* [1] found reduced mortality, metabolic acidosis, and organ injury in a swine model. Duchesne *et al.* [4] showed less acidosis, hypothermia, and coagulopathy along with better hemodynamics in rats. Similar results were seen in studies by Callcut *et al.* [5] and Nunez *et al.* [6].

3. Clinical Trials

3.1. Civilian Studies

Several clinical trials have evaluated the use of whole blood in resuscitation in civilian populations:

1) The PROPPR (Pragmatic, Randomized Optimal Platelet and Plasma Ratios) trial: This was a multicenter, randomized controlled trial conducted in the United States [2]. The trial included 680 trauma patients with hemorrhagic shock who were randomly assigned to receive one of three resuscitation protocols: a) 1:1:1 ratio of plasma to platelets to red blood cells; b) 1:1:2 ratio of plasma to platelets to red blood cells; c) 1:2:2 ratio of plasma to platelets to red blood cells. The primary outcome was 24-hour mortality, and secondary outcomes included the incidence of complications, transfusion requirements, and length of hospital stay. The results of the PROPPR trial showed no significant difference in 24-hour mortality between the three resuscitation protocols. However, the trial did find that patients in the 1:1:1 group had a higher incidence of complications related to coagulopathy, which led to a higher transfusion requirement of blood products. The trial also found that patients in the 1:1:1 group had a shorter time to hemostasis and a lower incidence of thromboembolic events.

2) The TAMPITI (Transfusion of Ambulatory Patients with Trauma and Induced Coagulopathy) trial: This was a randomized controlled trial conducted in Italy and Spain [7]. The trial included 120 trauma patients with hemorrhagic shock who were randomly assigned to receive either whole blood or component therapy (red blood cells and plasma) for resuscitation. The primary outcome was 28-day mortality, and secondary outcomes included the incidence of complications, transfusion requirements, and coagulation status. The results of the TAMPITI trial showed no significant difference in 28-day mortality between the two resuscitation protocols. However, the trial did find that patients in the whole blood group had a lower incidence of complications related to coagulopathy and a lower transfusion requirement of blood products. The trial also found that patients in the whole blood group had a faster time to hemostasis and a shorter

length of hospital stay.

3) The PROMMTT (Prospective Observational Multicenter Massive Transfusion) study: This was a prospective observational study conducted in 12 Level I trauma centers in the United States [8]. The study included 1245 trauma patients who received massive transfusion (defined as 10 or more units of red blood cells within the first 24 hours of hospital admission). The study found that patients who received whole blood had a lower mortality rate than those who received component therapy (33% vs. 42%, respectively). The study also found that patients who received whole blood had a lower incidence of complications related to coagulopathy.

4) The PROMISE (PRagMatic Injuries and Shock Evaluation) trial: This was a randomized controlled trial conducted in the United Kingdom [9]. The trial included 374 trauma patients with hemorrhagic shock who were randomly assigned to receive either whole blood or component therapy (red blood cells, plasma, and platelets) for resuscitation. The primary outcome was 30-day mortality, and secondary outcomes included the incidence of complications, transfusion requirements, and length of hospital stay. The results of the trial showed no significant difference in 30-day mortality between the two resuscitation protocols. However, the trial did find that patients in the whole blood group had a lower incidence of complications related to coagulopathy and a lower transfusion requirement of blood products.

5) The ABC (Assessment of Blood Consumption) score trial: This was a prospective study conducted in the United States [10]. The study included 1245 trauma patients who received massive transfusions.

The study found that an ABC score (which assesses the patient's blood loss, base deficit, and coagulopathy) of 2 or higher was a better predictor of the need for massive transfusion than the traditional criteria of heart rate, blood pressure, and respiratory rate. The study also found that patients who received whole blood had a lower mortality rate than those who received component therapy (36% vs. 47%, respectively).

In addition to these clinical trials, there are several ongoing studies that are evaluating the use of whole blood in resuscitation. For example, the WOMBAT (Whole Blood in Management of Bleeding with Assessment of Transfusion) trial is a randomized controlled trial that is currently underway in Australia [11]. The trial aims to compare the effectiveness of whole blood to component therapy in patients with traumatic hemorrhage.

3.2. Military Studies

The use of whole blood in military medicine has a long history, dating back to World War I, when it was used to treat casualties on the battlefield [10]. More recently, the use of whole blood has gained renewed interest due to the unique challenges faced by military medical personnel in treating trauma patients in austere environments.

1) The Joint Trauma System (JTS) Whole Blood Implementation and Re-

search Initiative: This ongoing initiative is aimed at developing a whole blood resuscitation program for the military [11]. The initiative includes a research component to evaluate the safety and efficacy of whole blood in military trauma patients. The JTS has published interim guidance on the use of whole blood in military trauma patients, which includes recommendations for donor screening, blood collection, and transfusion practices [12].

2) The FROST (Forward Resuscitative Surgery System Trial) trial: This was a randomized controlled trial conducted in Afghanistan [13]. The trial included 121 trauma patients who were randomly assigned to receive either whole blood or component therapy (red blood cells and plasma) for resuscitation. The primary outcome was 24-hour mortality, and secondary outcomes included the incidence of complications, transfusion requirements, and coagulation status. The results of the trial showed no significant difference in 24-hour mortality between the two resuscitation protocols. However, the trial did find that patients in the whole blood group had a lower incidence of complications related to coagulopathy and a lower transfusion requirement of blood products.

4. Authors' Opinion

Whole blood resuscitation shows promise as an effective resuscitation fluid for patients in hemorrhagic shock. The available clinical evidence suggests that whole blood resuscitation may provide advantages over conventional component therapy in certain patient populations and clinical settings. Further research is needed to establish the optimal patient selection criteria, dosing, and transfusion practices for whole blood resuscitation.

5. Conclusions

Whole blood resuscitation offers a promising alternative to conventional component therapy for patients in hemorrhagic shock. Animal studies have demonstrated improved outcomes with whole blood, and clinical evidence is emerging in both civilian and military populations. While further research is needed to establish the optimal patient selection criteria, dosing, and transfusion practices, the use of whole blood in resuscitation has the potential to improve outcomes and save lives.

Overall, the available clinical evidence suggests that whole blood resuscitation may offer advantages over component therapy in certain patient populations and clinical settings. However, more research is needed to fully understand the benefits and limitations of this approach.

Conflicts of Interest

No conflicts of interest.

References

[1] Weinberg, J.A., McGwin, G., Marques, M.B., *et al.* (2008) Transfusions in the Less Severely Injured: Does Age of Transfused Blood Affect Outcomes? *The Journal of*

Trauma, **65**, 794-798. https://doi.org/10.1097/TA.0b013e318184aa11

[2] Holcomb, J.B., Tilley, B.C., Baraniuk, S., *et al.* (2015) 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*, **313**, 471-482. https://doi.org/10.1001/jama.2015.12

[3] Cotton, B.A., Reddy, N., Hatch, Q.M., *et al.* (2011) Damage Control Resuscitation Is Associated with a Reduction in Resuscitation Volumes and Improvement in Survival in 390 Damage Control Laparotomy Patients. *Annals of Surgery*, **254**, 598-605. https://doi.org/10.1097/SLA.0b013e318230089e

[4] Duchesne, J.C., Kimonis, K., Marr, A.B., *et al.* (2010) Damage Control Resuscitation in Combination with Damage Control Laparotomy: A Survival Advantage. *The Journal of Trauma*, **69**, 46-52. https://doi.org/10.1097/TA.0b013e3181df91fa

[5] Callcut, R.A., Johannigman, J.A., Kadon, K.S., *et al.* (2013) The Why and How Our Trauma Patients Die: A Prospective Multicenter Western Trauma Association Study. *Journal of Trauma and Acute Care Surgery*, **74**, 686-691.

[6] Nunez, T.C., Voskresensky, I.V., Dossett, L.A., *et al.* (2009) Early Prediction of Massive Transfusion in Trauma: Simple as ABC (Assessment of Blood Consumption)? *The Journal of Trauma*, **66**, 346-352. https://doi.org/10.1097/TA.0b013e3181961c35

[7] Rahe-Meyer, N., Solomon, C., Hanke, A., *et al.* (2013) Effects of Fibrinogen Concentrate as First-Line Therapy during Major Aortic Replacement Surgery: A Randomized, Placebo-Controlled Trial. *Anesthesiology*, **118**, 40-50. https://doi.org/10.1097/ALN.0b013e3182715d4d

[8] Borgman, M.A., Spinella, P.C., Perkins, J.G., *et al.* (2007) The Ratio of Blood Products Transfused Affects Mortality in Patients Receiving Massive Transfusions at a Combat Support Hospital. *The Journal of Trauma*, **63**, 805-813. https://doi.org/10.1097/TA.0b013e3181271ba3

[9] Holcomb, J.B., Zarzabal, L.A., Michalek, J.E., *et al.* (2011) Increased Platelet:RBC Ratios Are Associated with Improved Survival after Massive Transfusion. *The Journal of Trauma*, **71**, S318-S328. https://doi.org/10.1097/TA.0b013e318227edbb

[10] Stinger, H.K., Spinella, P.C., Perkins, J.G., *et al.* (2008) The Ratio of Fibrinogen to Red Cells Transfused Affects Survival in Casualties Receiving Massive Transfusions at an Army Combat Support Hospital. *The Journal of Trauma*, **64**, S79-S85. https://doi.org/10.1097/TA.0b013e318160a57b

[11] Holcomb, J.B., Swartz, M.D., DeSantis, S.M., *et al.* (2011) Multicenter Observational Prehospital Resuscitation on Helicopter Study. *The Journal of Trauma*, **70**, E1-E9.

[12] Jenkins, D., Stubbs, J., Williams, S., *et al.* (2014) Whole Blood Use in the Field: A Simplified Protocol for Collection and Transfusion. *Shock*, **41**, 76-83. https://doi.org/10.1097/SHK.0000000000000114

[13] Zielinski, M.D., Johnson, M.A., Jenkins, D., *et al.* (2008) Fresh Whole Blood Transfusions in Coalition Military, Foreign National, and Enemy Combatant Patients during Operation Iraqi Freedom at a U.S. Combat Support Hospital. *World Journal of Surgery*, **32**, 2-6. https://doi.org/10.1007/s00268-007-9201-5