Massive Transfusion Ratios

Heelan Gladden, A. A., Peltz, E. D., McIntyre, R. C., Jr., Vega, S., Krell, R., Velopulos, C., . . . Wright, F. L. (2019). Effect of pre-hospital use of the assessment of blood consumption score and pre-thawed fresh frozen plasma on resuscitation and trauma mortality. Journal of the American College of Surgeons, 228(2), 141-147. doi:10.1016/j.jamcollsurg.2018.11.005. This is a Level II trauma center, before and after analysis of implementation of a massive transfusion protocol. In patients receiving MTP, appropriate blood product transfusion ratios increased 44%. Overall and penetrating trauma mortality improved by 23% and 41%, respectively. When divided by the Injury Severity Score (ISS), penetrating trauma mortality decreased by 65% for the ISS subgroup 15 to 24 and by 38% for ISS subgroup $\geq$ 25. Length of stay, ICU length of stay, and readmission rates were not significantly different.

Cardenas, J. C., Zhang, X., Fox, E. E., Cotton, B. A., Hess, J. R., Schreiber, M. A., . . . Holcomb, J. B. (2018). Platelet transfusions improve hemostasis and survival in a substudy of the prospective, randomized PROPPR trial. Blood Adv, 2(14), 1696-1704. This PROPPR trial analysis compared massive transfusion patients who received platelets in the first cooler to those receiving first cooler without platelets. Early platelet administration is associated with improved hemostasis and reduced mortality in severely injured, bleeding patients.

Meyer, D. E., Vincent, L. E., Fox, E. E., O'Keeffe, T., Inaba, K., Bulger, E., . . . Cotton, B. A. (2017). Every minute counts: Time to delivery of initial massive transfusion (MT) cooler and its impact on mortality. J Trauma Acute Care Surg, 83(1), 19-24. This PROPPR trial analysis of massive transfusion patients studied the effect of time to cooler arrival on blood ratios and patient outcomes. Independent of product ratios, every minute from time of MT protocol activation to time of initial cooler arrival increases odds of mortality by 5%.

Chang, R., Folkerson, L. E., Sloan, D., Tomasek, J. S., Kitagawa, R. S., Choi, H. A., . . . Holcomb, J. B. (2017). Early plasma transfusion is associated with improved survival after isolated traumatic brain injury in patients with multifocal intracranial hemorrhage. Surgery, 161(2), 538-545. This single center retrospective analysis of 633 isolated TBI (head AIS>3) patients compared those receiving early plasma (<4 hrs of arrival) to no early plasma. Early plasma transfusion was associated with increased in-hospital survival in those with multifocal intracranial hemorrhage.

Bui, E., Inaba, K., Ebadat, A., Karamanos, E., Byerly, S., Okoye, O., . . . Demetriades, D. (2016). The impact of increased plasma ratios in massively transfused trauma patients: a prospective analysis. European Journal of Trauma and Emergency Surgery, 42(4), 519-525. This is a single center, prospective, observational study of trauma patients requiring massive transfusion (>10 PRBC in <24 hrs). Achieving a ratio of FFP:PRBC $\geq$ 1:1.5 after the initial 24 h of resuscitation significantly improves survival in massively transfused trauma patients compared to patients that achieved a ratio <1:1.5.

Holcomb, J. B., Tilley, B. C., Baraniuk, S., Fox, E. E., Wade, C. E., Podbielski, J. M., . . . van Belle, G.

(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(5), 471-482. PROPPR is the largest randomized study to date to enroll severely bleeding patients. This pragmatic, phase 3, multisite, randomized clinical trial of 680 severely injured patients (12 civilian trauma centers) compared ratios of 1:1:1 vs 1:1:2. No difference found in 24 hr or 30-day mortality. More patients in the 1:1:1 group achieved hemostasis and fewer experienced death due to exsanguination by 24 hours. Clinicians should consider using a 1:1:1 transfusion protocol, starting with the initial units transfused while patients are actively bleeding, and then transition to laboratory-guided treatment once hemorrhage is controlled.

Holcomb, J. B., del Junco, D. J., Fox, E. E., Wade, C. E., Cohen, M. J., Schreiber, M. A., . . . Rahbar, M. H. (2013). The prospective, observational, multicenter, major trauma transfusion (PROMMTT) study: comparative effectiveness of a time-varying treatment with competing risks. JAMA Surg, 148(2), 127-136. PROMMTT is a prospective, multicenter observational cohort study conducted at ten Level 1 trauma centers in the US (n=905) analyzing the effect of early plasma and or platelets on in-hospital mortality, and time varying plasma to RBC and platelet to RBC ratios. Early higher plasma and platelet ratios were associated with decreased mortality in patients transfused at least 3 units of blood products during the first 24 hours after admission

Pre-Hospital Blood Product Transfusion

Guyette, F. X., Sperry, J. L., Peitzman, A. B., Billiar, T. R., Daley, B. J., Miller, R. S., . . . Brown, J. B. (2019). Prehospital Blood Product and Crystalloid Resuscitation in the Severely Injured Patient: A Secondary Analysis of the Prehospital Air Medical Plasma Trial. Annals of Surgery. doi:10.1097/sla.0000000000003324 This is a secondary analysis of the multicenter PAMPer trail performed on hypotensive injury patients from the scene. Twenty-seven helicopter bases were randomized to prehospital plasma or standard resuscitation (crystalloid, or crsyatalloid + PRBC). Patients receiving prehospital PRBC + plasma had the greatest mortality benefit. Crystalloid only had the worst survival. Patients with hemorrhagic shock should receive prehospital blood products when available, preferably PRBC + plasma. Prehospital whole blood may be ideal in this population.

Pusateri, A. E., Moore, E. E., Moore, H. B., Le, T. D., Guyette, F. X., Chapman, M. P., . . . Sperry, J. L. (2019). Association of Prehospital Plasma Transfusion With Survival in Trauma Patients With Hemorrhagic Shock When Transport Times Are Longer Than 20 Minutes: A Post Hoc Analysis of the PAMPer and COMBAT Clinical Trials. JAMA Surg, e195085. doi:10.1001/jamasurg.2019.5085 This is a post hoc combined analysis of the COMBAT and PAMPer trials with a total of 626 patients included. Patients with trauma and hemorrhagic shock were randomly assigned to receive either standard care crystalloid-based resuscitation or 2U of thawed plasma followed by standard care in the prehospital environment. These data suggest that prehospital plasma is associated with a survival benefit when transport times are longer than 20 minutes and that the benefit-risk ratio is favorable for use of prehospital plasma.

Sperry, J. L., Guyette, F. X., Brown, J. B., Yazer, M. H., Triulzi, D. J., Early-Young, B. J., . . . Zenati, M. S. (2018). Prehospital Plasma during Air Medical Transport in Trauma Patients at Risk for Hemorrhagic Shock. New England Journal of Medicine, 379(4), 315-326. doi:10.1056/NEJMoa1802345 . This is a pragmatic, multicenter, cluster-randomized, phase 3 superiority trial that compared administration of thawed plasma with standard-care resuscitation during air medical transport. In injured patients at risk for hemorrhagic shock, the prehospital administration of thawed plasma was safe and

resulted in lower 30-day mortality and a lower median prothrombin time ratio than standard-care resuscitation.