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Washington University Emergency Medicine Journal Club
Blood Transfusion in Trauma: Timing and Product Ratio

Vignette

It's an active early spring afternoon in the city, and you're pretty sure that just about everyone and their sister have been shot at, with most of the poor souls ending up in your TCC. As these things tend to go, the GSWs thus far are to the extremities or benign grazes, but the excitement of getting the trauma team to come down as you prepare everyone for a potential resuscitation has your adrenaline going despite the lack of interesting pathology.

Then, the next EMS call-ahead page hits the comm center: "male GSW victim, shot in abdomen, HR 145, BP 110/60, ETA 2." You prep your team. Airway ready if needed, medics and nurses squared away on who is getting access and who is getting vitals. Then the charge nurse casually walks by and asks if you want to think about getting the Belmont ready. Before they can even get the question out, the patient arrives.

EMS is almost trotting into the trauma bay. Your patient is diaphoretic and significantly distressed. You gaze around, but your trauma team haven't had a chance to make it downstairs. The vitals begin appearing on the monitors: HR 150, looks sinus, SpO2 is having a difficult time picking up, the first BP cuff cycle doesn't seem to catch anything and it starts cycling again. You expose the patient and note a couple of ballistic wounds in the RLQ of the abdomen, nothing really on the back, lungs are clear. You ask a nurse to get a manual pressure after the second automatic cuff cycle fails to capture a BP measurement. You're pretty sure this guy is sick and is going to need a surgery. He will need some resuscitation to make it there. You ask the charge nurse to grab the blood. Then you pause; you think you remember something that Dr. Mudd was sounding off about regarding plasma resuscitation with PRBC resuscitation. Should you think about grabbing the uncrossed plasma at the same time? Can you just wait to give plasma until the first MTP box makes it downstairs? How much plasma do you give? When do you give it? Does any of this even benefit the patient sitting in front of you? He's bleeding right? Doesn't he just need the oxygen carrying capacity lost in the RBC with PRBC? Why do they send down platelets with the MTP box? And why doesn't EMS carry blood to give to patient such as this?

PICO Question
Population: Trauma patients requiring urgent blood transfusion or meeting massive transfusion protocol (MTP) criteria.
Intervention #1: Balanced blood transfusion (closer to a 1:1:1 ratio of plasma:platelets:RBCs)
Comparison #1: Higher blood to plasma/platelet ratio (i.e. closer to 1:1:2)

Intervention #2: Prehospital blood transfusion by EMS
Comparison #2: No prehospital blood transfusion
Outcome: Mortality, incidence of transfusion reaction, cost, hospital/ICU length of stay

Article 1: Holcomb JB, Tilley BC, Baraniuk S, et al; PROPPR Study Group. 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 Feb 3;313(5):471-82. Answer Key.

Article 2: Holcomb JB, del Junco DJ, Fox EE, et al; PROMMTT Study Group. The prospective, observational, multicenter, major trauma transfusion (PROMMTT) study: comparative effectiveness of a time-varying treatment with competing risks. JAMA Surg. 2013 Feb;148(2):127-36. Answer Key.

Article 3: Shackelford SA, Del Junco DJ, Powell-Dunford N, et al. Association of Prehospital Blood Product Transfusion During Medical Evacuation of Combat Casualties in Afghanistan With Acute and 30-Day Survival. JAMA. 2017 Oct 24;318(16):1581-1591. Answer Key.

Article 4: Perel P, Clayton T, Altman DG, et al; PROGRESS Partnership. Red blood cell transfusion and mortality in trauma patients: risk-stratified analysis of an observational study. PLoS Med. 2014 Jun 17;11(6):e1001664. Answer Key.

Brief Bottom Line

Rather than simply transfuse packed red blood cells (PRBCs) for acute traumatic hemorrhage, the concept of damage control resuscitation recommends a more balanced transfusion approach in order to prevent dilutional coagulopathy and treat the acute coagulopathy associated with trauma. While the most effective transfusion ratio was not initially known, early retrospective data suggested that plasma:RBC and platelet:RBC ratios closer to 1:1 during early resuscitation improved survival among US trauma patients receiving at least 3 units of blood product in the first 6 hours after ED admission (PROMMTT study).

A follow-up randomized controlled trial (the PROPPR study) attempted to compare 1:1:1 (plasma:platelets:RBC) ratio to a 1:1:2 ratio among patients requiring the highest level trauma activation at any of 12 North American level 1 trauma centers who were predicted to require a massive transfusion. While the authors found no statistically significant difference in survival at 24 hours or 30 days, there was a trend toward improved mortality in the 1:1:1 group (ARR -4.2% at 24 hours, 95% CI -9.6 to 1.1%; ARR -3.7% at 30 days, 95% CI -10.2 to 2.7%). Unfortunately, despite a fairly large cohort of patients, the study was insufficiently powered to detect a potentially clinically meaningful decrease in mortality of around 4% with a balanced resuscitation strategy. Given the lack of harm with this strategy, it seems reasonable to switch to a 1:1:1 transfusion policy in trauma patients requiring massive transfusion, which most centers have done.

A retrospective look at data from the CRASH-2 trial attempted to evaluate the association between RBC transfusion and mortality in trauma patients. As previously discussed, one limitation of the CRASH-2 study was that only half of the patients enrolled actually required any blood transfusion. A follow-up look at data from this study found higher mortality among patients who required a transfusion compared to those who did not (19.8% vs. 10.7%; OR 2.06, 95% CI 1.91-2.24). After stratifying patients by risk of death (using, unfortunately, a predictive model derived from this very patient population) the study found that in patients with a lower predicted risk of death (<20%), mortality was higher among patients who received a blood transfusion, while in patients with a higher predicted risk of death (>50%), mortality was lower among those who received blood. This data suggests that blood transfusions may be harmful to those trauma patients at low risk of mortality while it is beneficial in those at higher risk. While interesting, not only does this predictive model need to be prospectively validated, but its use in determining which patients would benefit from a blood transfusion and which may be harmed should also be prospectively evaluated.

Finally, the use of blood transfusions in the prehospital setting for trauma patients was also evaluated. Unfortunately, the only study evaluating this was conducted in a military setting among patients with a high rate of explosive injuries and a high rate of limb amputations. After use of frequency matching and logistic regression to balance for known confounders, the study found an association between prehospital transfusion and improved survival at both 24 hours (hazard ratio 0.26, 95% CI 0.08-0.82) and 30 days (hazard ratio 0.39, 95% CI 0.16-0.92). While interesting, this observational study was likely influenced heavily by selection bias and the presence of unknown confounders, and issues with external validity make its results nearly impossible to generalize to civilian trauma patients in the US.