Table 3. REVIEW of the MASSIVE TRANSFUSION in TRAUMA LITERATURE
(All studies are retrospective):

Civilian

1. Mitra et al. Australia. Fresh frozen plasma (FFP) use during massive blood transfusion in trauma resuscitation. Injury. 2010 Jan;41(1):35-9. Studied 331 patients who were given ≥ 5 units RBCs in the first 4h. Median Injury Severity Score (ISS) was 36 (25-50). Mortality was 29.9%. A low plasma: RBC ratio in the first 4h of resuscitation, older age, low initial GCS and coagulopathy on presentation were significant independent factors associated with mortality. When deaths in the first 24h were excluded, the plasma: RBC ratio had no association with mortality.

2. Shaz et al. Atlanta. Increased number of coagulation products in relationship to red blood cell products transfused improves mortality in trauma patients. Transfusion. 2010 Feb;50(2):493-500. Studied 214 patients who received ≥ 10 RBC units. High versus low transfusion ratios (plasma: RBC, platelet: RBC, and cryoprecipitate: RBC) were associated with improved 30-day survival. By multivariable stepwise logistic regression analysis, increased plasma: RBC and platelet: RBC, and decreased age, injury severity score, and total RBCs were associated with improved 30-day survival.

3. Inaba et al. California. The impact of platelet transfusion in massively transfused trauma patients. J Am Coll Surg. 2010 Nov;211(5):573-9. Studied 657 patients who received ≥10 units RBCs within 24 hours of admission. Mortality was evaluated according to 4 apheresis platelet:RBC ratios: Low ratio (<1:18), medium ratio (≥1:18 and <1:12), high ratio (≥1:12 and <1:6), and highest ratio (≥1:6). Mortality at 24 hours increased in a stepwise fashion with decreasing apheresis platelet: RBC ratio. A similar stepwise increase in mortality with decreasing platelet ratio was observed at 12 hours after admission and for overall survival to discharge. After stepwise logistic regression, a high apheresis platelet: RBC ratio was independently associated with improved survival at 24 hours.


5. Dente et al. USA. Improvements in early mortality and coagulopathy are sustained better in patients with blunt trauma after institution of a massive transfusion protocol in a civilian level I trauma center. J Trauma 2009; 66:1616-24. Studied 157 patients receiving...
≥10 units RBC in the first 24 hours of hospitalization before and after instituting a MTP. Early deaths from coagulopathic bleeding occurred in 4 of 13 patients in the MTP group vs. 21 of 31 patients in the pre-MTP group. Concluded that aggressive use of FFP and platelets reduced 24-hour mortality and early coagulopathy. Reduction in 30 day mortality was seen after blunt trauma.

6. Teixeira et al. Los Angeles. Impact of plasma transfusion in massively transfused trauma patients. J Trauma. 2009 Mar;66(3):693-7. Studied 383 patients receiving ≥ 10 units RBCs during 24 hours. Excluded patients with severe head trauma. Classified patients into four groups according to the plasma: RBC ratio received: low ratio (≤ 1:8), medium ratio (> 1:8 and ≤ 1:3), high ratio (> 1:3 and ≤ 1:2), and highest ratio (> 1:2). Higher plasma: RBC ratio was an independent predictor of survival. There was no survival advantage after a 1:3 plasma: RBC ratio had been reached.

7. Cotton et al. Nashville. Predefined massive transfusion protocols are associated with a reduction in organ failure and postinjury complications. J Trauma. 2009 Jan;66(1):41-8. Studied 264 patients that required surgery and received ≥ units RBCs in the first 24 hours. Compared patients before and after institution of a MTP which consisted of immediate delivery of products in a 3:2 ratio of RBC:FFP and 5:1 for RBC:platelets. Pneumonia, pulmonary failure, open abdomens, and abdominal compartment syndrome were lower after institution of the MTP. As well, severe sepsis or septic shock and multiorgan failure were both lower in the MTP cohort. There was no difference in renal failure or systemic inflammatory response syndrome between cohorts.

8. Holcomb et al. USA. 2008. Increased plasma and platelet to red blood cell ratios improves outcome in 466 massively transfused civilian trauma patients. Ann Surg. 2008 Sep;248(3):447-58. Studied 466 patients receiving ≥10 units of RBC in 24 hours in 16 trauma centers. Survival varied by center from 41% to 74%. The plasma: RBC ratio ranged from 0 to 2.89 and the platelets: RBC ratio ranged from 0 to 2.5. Plasma and platelet to RBC ratios and injury severity score were predictors of death at 6 hours, 24 hours, and 30 days. Thirty-day survival was increased in patients with high plasma: RBC ratio ≥1:2) relative to those with low plasma: RBC ratio (<1:2). 30-day survival was increased in patients with high platelet: RBC ratio ≥1:2) relative to those with low platelet: RBC ratio.

Unfallchirurgie. Vox Sang. 2008 Aug;95(2):112-9. Studied 713 patients with Injury Severity Score > 16 and massive transfusion (> 10 RBCs). Patients were divided into three groups according to the plasma: RBC ratio transfused: (i) RBC : plasma > 1.1; (ii) RBC : plasma 0.9-1.1 (1 : 1); and (iii) RBC : plasma < 0.9. Acute mortality (< 6 h) rates for RBC : FFP > 1.1, RBC : FFP 0.9-1.1 (1 : 1), and RBC : FFP < 0.9 ratios were 24.6, 9.6 and 3.5%; 24-h mortality rates were 32.6, 16.7 and 11.3%; 30-day mortality rates were 45.5, 35.1 and 24.3%. The frequency of septic complications and organ failure was higher in the RBC : plasma 0.9-1.1 (1 : 1) group; Ventilator days and length of stay were highest in the RBC : plasma < 0.9 ratio group.

10. Sperry et al. USA 2008. An FFP:PRBC transfusion ratio >=1:1.5 is associated with a lower risk of mortality after massive transfusion. J Trauma. 2008 Nov;65(5):986-93. Studied 415 patients who required ≥8 units RBCs within the first 12 hours. Patients who received transfusion products in ≥1:1.5 plasma : RBC vs <1:1.5 plasma : RBC ratio required less blood transfusion at 24 hours (16 ± 9 units vs. 22 ± 17 units). Receiving a high plasma: RBC ratio was associated with a lower risk of mortality and a higher risk of ARDS.

11. Gunter et al. USA 2008. Optimizing outcomes in damage control resuscitation: identifying blood product ratios associated with improved survival. J Trauma 2008;65: 527-34. Studied 259 patients that (1) underwent immediate surgery and (2) received ≥ 10 units PRBC in the first 24 hours. Patients receiving plasma: RBC at a ratio of ≥ 2:3 had a significant reduction in 30-day mortality compared with those who received < 2:3 ratio. Controlling for age and trauma injury severity, the ratio of plasma: RBC was an independent predictor of 30-day mortality. (OR 1.78, 95% CI 1.01-3.14).

12. Kashuk et al. USA 2008. Postinjury life threatening coagulopathy: is 1:1 fresh frozen plasma: packed red blood cells the answer? J Trauma 2008; 65:261-71. Studied 133 patients who received >10 units RBC in 6 hours. Data suggested that 1:1 plasma: RBC reduced coagulopathy. However, there was no survival benefit. Overall mortality was 56%; 50% died from acute blood loss in the operating room.

13. Duchesne et al. USA 2008. Review of current blood transfusions strategies in a mature level i trauma center: were we wrong for the last 60 years? J Trauma 2008; 65:272-78. Studied 135 patients who received >10 units RBC during and after initial surgical intervention. Improved survival when plasma: RBC ratio was 1:1 versus 1:4. A plasma: RBC ratio of 1:4 was associated with increased risk of mortality (relative risk, 18.88; 95% CI, 6.32-56.36) when compared with a ratio of 1:1. Concluded that a plasma: RBC ratio close to 1:1 confers a survival advantage.

Military

1. Perkins el al. Iraq. 2009. An evaluation of the impact of apheresis platelets used in the setting of massively transfused trauma patients. J Trauma. 2009 Apr;66(4 Suppl):S77-84. Studied 694 patients who received ≥10 units RBCs during the first 24 hours. At 24 hours, patients receiving a high ratio of platelets had higher survival (95%) as compared with patients receiving a medium ratio (87%) and patients receiving the lowest ratio of
platelets. The survival benefit for the high and medium ratio groups remained at 30 days as compared with those receiving the lowest ratio of platelets (75% and 60% vs. 43%). Plasma: RBC ratios and platelet: RBC were both independently associated with improved survival at 24 hours and at 30 days.

2. Stinger et al. 2008. The ratio of fibrinogen to red cells transfused affects survival in casualties receiving massive transfusions at an army combat support hospital. J Trauma. 2008 Feb;64(2 Suppl):S79-85. Studied 252 patients who received ≥10 units of RBCs in 24 hours. Transfusion of an increased fibrinogen: RBC ratio was independently associated with improved survival to hospital discharge, primarily by decreasing death from hemorrhage. Mortality was 27 of 52 (52%) and 48 of 200 (24%) in the low and high fibrinogen: RBC ratio groups, respectively. Additional variables associated with survival were admission temperature, systolic blood pressure, hemoglobin, International Normalized Ratio (INR), base deficit, platelet concentration and Combined Injury Severity Score (ISS).

3. Borgman et al. Iraq. 2007. The ratio of blood products transfused affects mortality in patients receiving massive transfusions at a combat support hospital. J Trauma. 2007 Oct;63(4):805-13. Studied 246 patients who received ≥10 units of RBCs in 24 hours. For the low ratio group the plasma: RBC ratio was 1:8; for the medium ratio group, 1:2.5; and for the high ratio group, 1:1.4. Median Injury Severity Score (ISS) was 18 for all groups. For low, medium, and high plasma: RBC ratios, overall mortality rates were 65%, 34%, and 19%. Plasma: RBC ratio was independently associated with survival (odds ratio 8.6, 95% confidence interval 2.1-35.2).