Treatment of combined traumatic brain injury and hemorrhagic shock with fractionated blood products vs. fresh whole blood

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INTRODUCTION

Treatment of combined traumatic brain injury and hemorrhagic shock poses a particular challenge due to the possible conflicting consequences. While restoring diminished volume is the treatment goal for hypovolemia, maintaining adequate cerebral perfusion pressure and avoidance of secondary damage remains a treatment goal for the injured brain. Various treatment modalities have been proposed, but the optimal resuscitation fluid and goals have not yet been clearly defined. A growing body of evidence suggests that in hypovolemic shock, resuscitation with fresh whole blood (FWB) may be superior to fractionated products without platelets (which are likely to be unavailable in the pre-hospital setting). Nevertheless, the effects of this approach have not been studied in the combined injury. Previously, in a rat model of combined injury we have found that mild resuscitation to MABP of 80 mmHg with FWB is superior to fluid resuscitation or aggressive resuscitation with FWB. In this study we investigate the physiological and neurological outcomes in a rat model of combined TBI and hypovolemic shock, submitted to treatment with varying amounts of FWB, compared to similar resuscitation goals with fractionated blood products - red blood cells (RBC’s) and Fresh Frozen Plasma (FFP) in a 1:1 ratio regimen.

METHODS

- 72 Male Lewis rats
- TBI: free falling rod on the exposed cranium.
- Treatment groups
  - Fresh Whole Blood
  - RBC+FFP in a 1:1 ratio
  - Resuscitation goals of a mean arterial blood pressure (MAP) of 80, 100, 120 mmHg at 15 minutes.
- MAP was assessed at 60 minutes, and neurological outcomes and mortality in the subsequent 24 hours.

RESULTS

- At 60 minutes MAP was highest for the group resuscitated most aggressively,
- Hemodynamic parameters were not significantly different between treatment groups resuscitated to similar MABP goals.
- Survival rates at 48 hours were best for the mildly resuscitated groups (MABP 80 mmHg with FWB and RBC+FFP 100%, vs. MABP 120 mmHg: FWB - 12.5%, RBC+FFP – 37.5%) 
- Neurological outcomes and mortality inversely correlated with the aggressiveness of resuscitation.
- The best neurological outcomes were found in the group mildly resuscitated with FWB and were better when compared to resuscitation with RBC+FFP to the same MABP goal (FWB: NSS 6 ± 2, RBC+FFP: NSS 10 ± 2, p<0.05).

CONCLUSIONS

- Mild resuscitation with goals of restoring MAP to 80 mmHg (which is lower than baseline) provided best results when considering hemodynamic stability, survival and neurological outcomes.
- Resuscitation with FWB (possessing all clotting factors) is a feasible modality in the combined TBI + hemorrhagic shock scenario, and may achieve better outcomes compared to a platelet free fractionated blood product regimen.
- Aggressive resuscitation may be detrimental, inducing processes which eventually cause a significant decrease in survival.