

Damage Control Resuscitation with Aged Blood Worsens the Inflammatory Response Following Hemorrhage in Mice

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BACKGROUND

- Hemorrhagic shock is the leading cause of potentially preventable death after traumatic injury.
- Traumatic hemorrhage may result in a systemic inflammatory response, leading to organ failure and delayed mortality.
- Damage control resuscitation improves early survival in trauma patients.
- Surgical patients given aged blood products have higher rates of organ failure, infection, and mortality compared to those given fresh blood components.
- The effect of transfusing aged blood products in damage control resuscitation after hemorrhage is unknown.

METHODS

- Pressure clamp model of hemorrhagic shock in mice
- Systolic blood pressure of 25 mmHg for 60 minutes, followed by resuscitation with fresh plasma and pRBCs (Fresh 1:1) or FFP and pRBCs stored for 5, 10, or 20 days (5d old 1:1, 10d old 1:1, or 20d old 1:1)
- Sacrifice of mice with collection of serum for hematologic and biochemical analysis by I-stat and cytokine analysis by ELISA



RESULTS

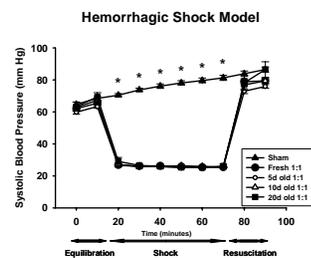


Figure 1. SBP of shams and mice resuscitated with fresh, 5d, 10d, and 20d old 1:1 plasma:pRBCs after hemorrhage. There are no significant differences between resuscitation groups. *p<0.05 vs. sham.

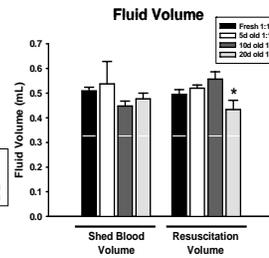


Figure 2. Total fluid volume withdrawn during hemorrhage and returned during resuscitation with fresh, 5d, 10d, and 20d old 1:1 plasma:pRBCs. *p<0.05 vs. 10d old 1:1.

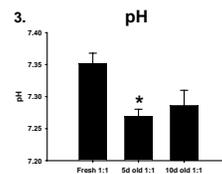


Figure 3. Serum pH level at 30 minutes in mice resuscitated as indicated. * p<0.05 vs. fresh 1:1.

Figure 4. Serum potassium at 30 minutes in mice resuscitated as indicated. * p<0.05 vs. all other groups.

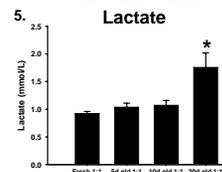


Figure 5. Serum lactate level at 30 minutes in mice resuscitated as indicated. * p<0.05 vs. all other groups.

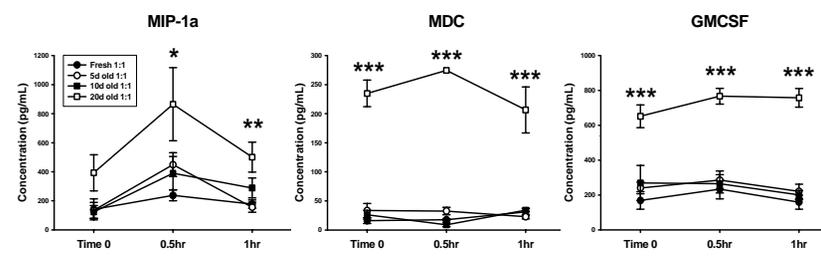


Figure 6. Serum levels of macrophage inflammatory protein-1a (MIP-1a), macrophage derived chemokine (MDC), and granulocyte monocyte colony stimulating factor (GMCSF) in mice hemorrhaged and resuscitated with fresh, 5d, 10d, or 20d old 1:1 plasma:pRBCs, sacrificed at 0, 30, and 60 minutes after resuscitation. * p<0.05 vs. fresh, ** p<0.05 vs. fresh and 5d old 1:1. Mice resuscitated with 20 d old 1:1 exhibited higher levels of MDC and GMCSF at all time points. *** p<0.05 vs. all groups.

CONCLUSIONS

- Damage control resuscitation with aged blood components increases systemic inflammation following hemorrhagic shock.
- Resuscitation with stored blood components, as compared to fresh components, alters biochemical parameters including pH, potassium, and lactate.
- The effects of the transfusion of aged blood products on physiologic parameters and inflammation may contribute to poorer clinical outcomes following hemorrhagic shock.