Predictors of Early Acute Lung Injury at a Combat Support Hospital: A Prospective Observation Study

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The use of Army medical and/or other Army records in the preparation of this material is acknowledged, but is not to be construed as implying official Department of the Army approval of the conclusions presented.

Abstract

Background: The reported incidence of acute lung injury (ALI) in critically ill trauma patients is 12-25%. Damage control resuscitation consisting of blood component therapy with equal ratios of packed red blood cells (PRBC) and fresh frozen plasma (FFP) has altered transfusion practices in the treatment of combat casualties. While evidence exists for mortality benefit with this approach, the relationship between this practice and early ALI in survivors is unknown. We wondered if this approach, specifically transfusions with FFP, increases the incidence of ALI, as defined by a PaO2/FiO2 ratio less than 300, diffuse infiltrates, and absence of cardiogenic pulmonary edema.

Methods: We performed a prospective observational study of all injured patients admitted to an intensive care unit at a combat support hospital (CSH) who required greater than 6 units of blood transfusion within the first 24 hours of admission. Baseline demographic data along with Injury Severity Score (ISS), pulmonary injury, presence of long bone fracture, blood products transfused, mechanical ventilation data, and arterial blood gas analyses were collected. The primary endpoint of the study was the development of ALI at 48 hours after injury. Those who did not survive to admission to the ICU were not included in this analysis. Follow-up (including mortality) longer than 48 hours was unavailable secondary to rapid transfer out of our facility. A multivariate logistic regression was performed to determine independent effects of variables on the incidence of early ALI.

Results: During a twelve month period (January-December 2008), eighty-seven subjects were studied; of these, 66 patients met inclusion criteria. 22 patients developed ALI at 48 hours (33%). There was one death in the ALI group. Overall, the ratio of FFP:PRBC was 0.9+/-0.3. Those who developed ALI had a higher ISS (32+/-15 vs 26+/-11, p=0.04) and received more units of FFP (22+/-15 vs 12+/-7, p<0.001), PRBCs (22+/-16 vs 13+/-7, p=0.008), and platelets (5+/-11 vs 1+/-2, p=0.004) compared to those who did not develop ALI. Multivariate logistic regression analysis revealed that presence of pulmonary injury (OR 5.4, 95% CI 1.3-21.9), units of FFP transfused (OR 1.2, 95% CI 1.1-1.3) and initial tidal volume (OR 1.9, 95% CI 1.02-3.7) all had independent effects on ALI at 48 hours.

Conclusion: Based on this small prospective descriptive study of seriously injured patients admitted to the ICU, the presence of pulmonary injury and initial tidal volume appeared to have the greatest impact on the incidence of early ALI. There was also an independent relationship between the amount of FFP transfused and the incidence of early ALI. What are unknown from these limited data are the overall clinical implications of transfusing FFP. Is the initial hemorrhagic insult decreased and short term survival increased, at the expense of early ALI? What role does survival bias play in this cohort of patients? Does the potential benefit of a successful hemostatic resuscitation outweigh the risk of early ALI? These and other questions will only be answered by randomized clinical trials in civilian trauma patients.

Background

- Transfusion-related acute lung injury (TRALI) is the leading cause of transfusion mortality in the US[1,2]
- Higher ratios of FFP to PRBC have shown mortality benefits in severely injured trauma patients[3,4]
- FFP has been shown to be correlated with the development of ALI[5,6,7]

Objectives

- Determine the incidence of ALI in combat casualties requiring large transfusions with the use of FFP:PRBC ratios approaching 1:1
- Determine if different transfusion practices can predict the development of ALI

Methods

- Prospective observational study of traumatically injured patients admitted to the ICU at a CSH who require blood transfusion during their initial resuscitation .
- Baseline demographic data along with ISS, presence of pulmonary injury, presence of long bone fracture, blood products transfused, and mechanical ventilation data.
- Primary endpoint is the development of ALI at 48 hours. ALI defined as PaO2/FiO2 < 300, diffuse infiltrates, and absence of cardiogenic pulmonary edema.
- Statistical analysis including multivariate logistic regression to determine independent effects of variables on the incidence of ALI and death

Results

Variablea	ALI (n=22)	Non-ALI (n=44)	p value
Age (years)	28.3 ± 7.5	28.2 ± 8.6	0.812
ISS	32.2 ± 14.6	25.8 ± 11.4	0.044
Pulmonary Injury	11 (50%)	14 (32%)	0.151
Long Bone Fracture	7 (32%)	17 (39%)	0.587
PRBC (units)	22.3 ± 16.2	13.2 ± 6.9	0.008
FFP (units)	21.6 ± 14.6	11.7 ± 6.6	<0.001
FFP:PRBC (ratio)	1.0 ± 0.3	0.9 ± 0.3	0.059
Platelets (6-packs)	4.7 ± 11.2	1.1 ± 1.5	0.004
Crystalloid (liters)	6.4 ± 3.1	5.1 ± 2.3	0.089
Colloid (liters)	0.5 ± 0.6	0.3 ± 0.5	0.036
Initial Tidal Volume (ml/kg)	7.8 ± 1.1	7.4 ± 1.0	0.156

Table 1. Comparison of patients with and without ALI.
ISS, Injury Severity Score; PRBC, packed red blood cells; FFP, fresh frozen plasma

Variable	Adjusted OR (95% CI)	p value
FFP (units)	1.2 (1.08-1.33)	<0.01
Pulmonary Injury	5.36 (1.30-21.93)	0.02
Initial Tidal Volume ml/kg)	1.94 (1.02-3.70)	0.04
ISS	1.07 (1.00-1.15)	0.05
PRBC (units)	1.09 (0.74-1.58)	0.67
Platelets (6-packs)	0.96 (0.71-1.30)	0.81
Crystalloid (liters)	1.24 (0.86-1.78)	0.25
Colloid (liters)	3.19 (0.72-14.21)	0.13

Table 2. Logistic regression for predictors of ALI at 48 hours.
FFP, the presence of a pulmonary injury, and initial tidal volume all had independent effects on ALI at 48 hours.

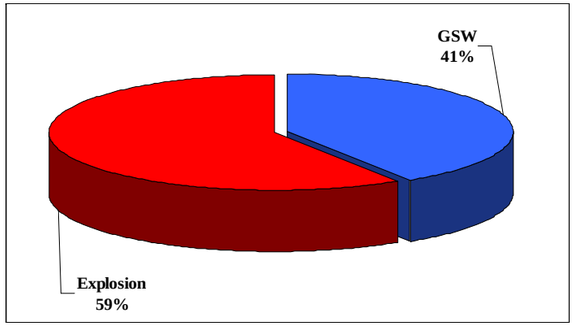

Figure 1. Distribution of the mechanisms of injury. GSW, gunshot wounds; Explosion injuries include improvised explosive devices (IED), mortar attacks, and explosively-formed projectiles (EFP).

Wounding Event	ALI (n=22)	Non-ALI (n=44)
Gunshot wounds	7 (32%)	20 (45%)
Explosions	15 (68%)	24 (55%)

Table 3. Comparison of mechanisms of injuries in patients with and without ALI. Explosion injuries include improvised explosive devices (IED), mortar attacks. and explosively-formed projectiles (EFP).

Conclusions

- The incidence of ALI was 33%.
- Patients who developed ALI tended to be more severely injured and required more blood products during their resuscitation.
- The presence of pulmonary injury and initial tidal volume appeared to have the greatest impact on the incidence of early ALI.
- There was an independent relationship between the amount of FFP transfused and the incidence of early ALI
- There was no difference in mechanism of injury on the development of ALI
- Randomized clinical trials are needed to verify these relationships in trauma patients

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