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Duration of Red Cell Storage Influences Mortality After Trauma

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Abstract

Background—Although previous studies have identified an association between the transfusion of relatively older red blood cells (RBCs) (storage ≥14 days) and adverse outcomes, they are difficult to interpret because the majority of patients received a combination of old and fresh RBC units. To overcome this limitation, we compared in-hospital mortality among patients who received exclusively old versus fresh RBC units during the first 24 hours of hospitalization.

Methods—Patients admitted to a Level I trauma center between January 2000 and May 2009 who received ≥1 unit of exclusively old (≥14 days) vs. fresh (<14 days) RBCs during the first 24 hours of hospitalization were identified. Risk ratios (RRs) and 95% confidence intervals (CIs) were calculated for the association between mortality and RBC age, adjusted for patient age, Injury Severity Score, gender, receipt of fresh frozen plasma or platelets, RBC volume, brain injury, and injury mechanism (blunt or penetrating).

Results—One thousand six hundred forty-seven patients met the study inclusion criteria. Among patients who were transfused 1 or 2 RBC units, no difference in mortality with respect to RBC age was identified (adjusted RR, 0.97; 95% CI, 0.72–1.32). Among patients who were transfused 3 or more RBC units, receipt of old versus fresh RBCs was associated with a significantly increased risk of mortality, with an adjusted RR of 1.57 (95% CI, 1.14–2.15). No difference was observed concerning the mean number of old versus fresh units transfused to patients who received 3 or more units (6.05 vs. 5.47, respectively; $p = 0.11$).

Conclusion—In trauma patients undergoing transfusion of 3 or more RBC units within 24 hour of hospital arrival, receipt of relatively older blood was associated with a significantly increased mortality risk. Reservation of relatively fresh RBC units for the acutely injured may be advisable.

Keywords

Transfusion; Blood storage; Trauma

Although current techniques for allogenic red cell preservation allow for red blood cell (RBC) shelf life of up to 42 days, a number of morphologic and biochemical changes occur during storage before product expiry, and these changes may hinder erythrocyte viability and function after transfusion.[1–6] Despite a relatively large body of literature detailing the metabolic and structural deterioration that occurs during RBC storage, evidence for a

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significant detrimental clinical effect related to the transfusion of older blood remains less conclusive, limited primarily to observations in retrospective studies.[7,8]

The association between the transfusion of relatively older blood and morbidity and mortality has been demonstrated in multiple retrospective studies of trauma patients using various study designs.[9–15] It is notable, however, that a majority of patients in those studies received both relatively fresh and old units with respect to storage age, making evaluation of the independent role of storage age on outcomes quite complex. To overcome this limitation, we conducted a retrospective cohort study to evaluate the association between the age of transfused blood and in-hospital mortality among trauma patients who received exclusively old versus fresh RBC units during the first 24 hours of hospitalization.

METHODS

This study was approved by the Institutional Review Board of the University of Alabama at Birmingham (UAB). The study base consisted of those trauma patients admitted to the UAB University Hospital between January 2000 and May 2009. From the study base, patients who received at least one RBC transfusion during the first 24 hours after arrival to hospital were selected for inclusion. Each patient's transfusion history was obtained from blood bank records and the storage age (days) of each RBC unit transfused during the first 24 hours of hospitalization was determined. During the study period, all RBC units transfused had undergone prestorage leukoreduction, a practice implemented in our center in 1999. Red cells were leukoreduced within 24 hours of collection by high-efficiency filters.

As previous reports suggest that the deleterious effect of RBC transfusion becomes evident at a storage age beyond 2 weeks, each unit of RBC transfused was categorized as being less than 14 days old (i.e., "fresh" blood) or 14 or more days old (i.e., "old" blood).[11,15,16] Patients who received both fresh and old units during the first 24 hours of hospitalization were excluded from analysis.

Patients were grouped according to RBC storage age and number of units transfused (1–2 vs. ≥3 units). Demographic and injury characteristics were compared between patients in the old and fresh blood groups using *t*- and χ^2 tests for continuous and categorical variables, respectively. Poisson regression was used to calculate risk ratios (RRs) and 95% confidence intervals (CIs) for the association between mortality and blood age (old vs. fresh) with adjustment for etiologically relevant variables selected a priori: patient age, gender, Injury Severity Score (ISS), mechanism of injury, total number of RBC units transfused in the first 24 hours of hospitalization, receipt of fresh frozen plasma (FFP) or platelets, and presence of head injury. p values ≤0.05 (two sided) were considered statistically significant.

RESULTS

During the period of study, 25,920 patients were admitted to the trauma service of UAB University Hospital. Of these patients, 2,890 were transfused at least one RBC unit within the first 24 hours after hospital arrival. Exclusion of patients who received both fresh and old units left 1,647 patients for analysis.

For patients transfused 1 unit to 2 units, comparison of clinical variables is demonstrated in Table 1. No significant differences concerning demographic and injury characteristics were noted between the old blood and fresh blood groups. Similarly, no significant difference in the volume of RBC, FFP, or platelets was observed between groups.

For patients transfused 3 or more units, comparison of clinical variables is demonstrated in Table 2. It is notable that mean patient age was significantly higher in the fresh blood group

(44 years vs. 40 years, $p < 0.03$). The fresh blood group also had a higher prevalence of head injury (32% vs. 24%, $p < 0.03$). Both groups were transfused a similar volume of RBC and platelets. Patients in the old blood group, however, received a significantly higher volume of FFP (3.47 units vs. 2.76 units, $p < 0.03$).

Among patients transfused 1 unit to 2 units, crude in-hospital mortality was similar between the fresh blood and old blood groups (14.0% vs. 13.5%, $p = 0.80$). The adjusted RR for the receipt of old versus fresh blood was also not significant (adjusted RR, 0.97; 95% CI, 0.72–1.32; Table 3). Among patients transfused 3 or more units, crude in-hospital mortality was lower in the fresh blood group, but no statistically significant difference was observed (20.1% vs. 27.0%, $p = 0.08$). However, once adjusted for etiologically relevant variables, the adjusted RR for the receipt of old versus fresh blood was statistically significant (adjusted RR, 1.57; 95% CI, 1.14 –2.15; $p = 0.006$; Table 3).

DISCUSSION

In clinical practice, blood is often transfused with the goal of augmenting tissue oxygen delivery. Nonetheless, there has been increasing skepticism as to the effectiveness of transfusion in this regard, particularly as related to the duration of red cell storage.[3,6] In human studies concerning posttransfusion tissue oxygenation, observations have been somewhat contradictory. Marik and Sibbald[17] observed a decreased gastric pH, a measure of gastric mucosal oxygenation status, in patients receiving blood that had been stored beyond 15 days. Walsh et al.,[18] however, were unable to replicate these findings. In a prospective, double-blind trial of critically ill intensive care unit, patients randomized to receive leukodepleted red cells stored either ≤5 days or ≥20 days, Walsh et al. observed no significant differences in gastric pH measurements or other indices of global tissue oxygenation. Recently, Kiraly et al.[19] evaluated peripheral tissue oxygenation as measured by near infrared spectroscopy during the course of red cell transfusion. The authors observed that patients transfused with blood stored 21 days or longer had a statistically significant decline in tissue oxygen saturation compared with those transfused with blood <21 days old. Whether or not the magnitude of the observed decline is clinically meaningful in any way remains uncertain.

Concerning clinical outcomes among trauma patients, the association between the transfusion of relatively older blood and morbidity and mortality has been demonstrated in multiple retrospective studies using various study designs. Zallen et al.[15] examined the association between red cell storage age and multiple organ failure (MOF) in a matched case-control study concerning trauma patients that received between 6 and 20 RBC units in the first 12 hours after injury. The authors identified that the mean age of transfused blood was significantly greater in the MOF positive patients (30.5 days vs. 24 days). Multivariate analysis identified mean age of blood, number of units older than 14 days, and number of units older than 21 days as independent risk factors for MOF. Offner et al.[11] evaluated the association between transfusion of relatively older blood and postinjury infection in a similar patient cohort and observed that patients who developed infections had received 11.7 units and 9.9 units of red cells older than 14 days and 21 days, respectively, compared with 8.7 units and 6.7 units in patients who did not develop infections. Recently, Spinella et al.[12] evaluated the effect of storage age on mortality in a group of 202 trauma patients and found that increased storage age was independently associated with mortality (odds ratio, 4.00; 95% CI, 1.34 –11.61).

As evident in the studies described above, the evaluation of the independent role of storage age on outcomes in patient populations that received a heterogeneous distribution of relatively old and fresh blood is far from straightforward. Studies that report the mean or

median age of all units transfused to a given patient have been particularly problematic in this regard in that they assume that relatively fresh units offset the proposed deleterious effect of older blood. Moreover, this counterbalancing effect is not uniform and depends on the total volume of old and fresh units. Given the present understanding of the storage lesion, there is no evident rationale for this assumption. Alternatively, analyses that focus on the volume of old blood transfused, while avoiding this assumption of mechanism, are hindered by the fact that patients receiving more blood are likely to be more severely injured. Thus, the observed associations between the transfusion of relatively older blood and morbidity or mortality may be more reflective of the residual effect of total transfusion volume (i.e., injury severity) rather than blood storage age.

It is therefore important to consider not only the age of the blood transfused but also the volume and to not treat them in an independent manner. If the associations between older blood and outcomes as outlined above were actually secondary to the residual confounding of transfusion volume, the associations between outcome and the volume of fresh blood transfused would be expected to be similar. With this in mind, we recently evaluated the association between mortality and the transfusion of both relatively old and fresh blood, respectively.[13] Among 1,813 severely injured patients (mean ISS, 26) who received one or more units of blood within the initial 24 hours of hospitalization, it was observed that while larger volumes of blood, irrespective of storage age, were associated with an increased odds of mortality, the transfusion of blood stored beyond 14 days appeared to significantly potentiate this association, suggesting the existence of a veritable association between storage age and outcome. Subgroup analysis concerning only those patients who received exclusively fresh or old blood demonstrated that among those patients receiving a total of three or more red cell units, receipt of old blood was associated with an over threefold increased odds of death, consistent with the results reported herein.

In this study, we sought to simplify the evaluation of storage age's effect on mortality by limiting the study population to those who received exclusively old versus fresh blood in the first 24 hours in a relatively large cohort. In addition, as previous studies have been criticized for the lack of accounting for the confounding potential of the administration of blood products other than RBCs, we adjusted for the transfusion of fresh frozen plasma and platelets. Our results further support the notion that the transfusion of relatively older blood potentiates the risk of death after trauma.

Nonetheless, there are limitations to this study that deserve consideration. Multivariable analyses, unlike randomized trials, do not adjust for unknown confounders. Despite our best attempts to control for differences in baseline characteristics between groups, it is possible that a latent confounder could explain some or all the mortality difference observed if elucidated. Additionally, the incorporation of data concerning the rate of transfusion would certainly inform the study, given that differences in both baseline characteristics and outcomes would be anticipated in patients that received the same number of units of blood within 24 hours, but in temporally different patterns. Precise data regarding transfusion times, however, are not recorded in our trauma registry dataset.

It is notable that in this study, all patients were transfused with blood that had undergone prestorage leukoreduction. Although leukoreduction has well documented efficacy related to specific clinical circumstances, a generalized benefit remains unproven.[20] Indeed, Nathens et al.[21] performed a randomized trial comparing prestorage leukoreduced versus standard nonleukoreduced transfusions to evaluate whether or not leukoreduction might improve outcomes among trauma patients, and found no difference in mortality or infectious morbidity among the 268 patients eligible for analysis. This study demonstrates a mortality association with older blood despite universal leukoreduction, suggesting that

leukoreduction does not mitigate the deleterious clinical effects that have been associated with the storage lesion.

Although the growing body of literature demonstrating the deleterious effects of relatively old blood is compelling, as highlighted above, the difficulty in distinguishing the effect of storage age from the effect of transfusion volume in these studies is not insignificant. It remains quite possible that prospective evaluation of the effect of storage age on outcome might yield contradictory results. Certainly, confirmation of the effect of blood storage on morbidity and mortality by a prospective randomized trial is now warranted. Schulman et al.[22] attempted such a trial in the setting of a single-center Level I trauma center, randomizing patients to receive exclusively young (<11 days) versus old (>20 days) blood during the first 24 hours of hospitalization. Unfortunately, in 1 year, they were only able to enroll a small number of patients secondary to limitations of the blood bank. It is reasonable to expect that other institutions would face a similar challenge given the tight supply of blood. It is clear that only interinstitutional cooperation in the form of a multi-institutional trial will be successful in the recruitment of enough patients for a robust analysis. Hebert et al.[23] performed a multicenter feasibility study in Canada and reported that a large scale study would be feasible, but challenged by the maintenance of a sufficient blood supply to allow for randomization between old and fresh groups with a limited number of subsequent group crossovers. Until such studies have been completed and produce confirmative results, it would be premature to recommend any modification of current transfusion practice regarding storage age. Nonetheless, the implication that the transfusion of blood of relatively longer storage age may have negative consequences demands attention and, most importantly, further rigorous evaluation.

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REFERENCES

1. Almac E, Ince C. The impact of storage on red cell function in blood transfusion. Best Pract Res Clin Anaesthesiol. 2007; 21:195–208. [PubMed: 17650772]
2. Card RT. Red cell membrane changes during storage. Transfus Med Rev. 1988; 2:40–47. [PubMed: 2980078]
3. Fitzgerald RD, Martin CM, Dietz GE, Doig GS, Potter RF, Sibbald WJ. Transfusing red blood cells stored in citrate phosphate dextrose adenine-1 for 28 days fails to improve tissue oxygenation in rats. Crit Care Med. 1997; 25:726–732. [PubMed: 9187588]
4. Hess JR. An update on solutions for red cell storage. Vox Sang. 2006; 91:13–19. [PubMed: 16756596]
5. Raat NJ, Ince C. Oxygenating the microcirculation: the perspective from blood transfusion and blood storage. Vox Sang. 2007; 93:12–18. [PubMed: 17547560]
6. Raat NJ, Verhoeven AJ, Mik EG, et al. The effect of storage time of human red cells on intestinal microcirculatory oxygenation in a rat isovolemic exchange model. Crit Care Med. 2005; 33:39–45. discussion 238–239. [PubMed: 15644646]
7. Vandromme MJ, McGwin G Jr, Weinberg JA. Blood transfusion in the critically ill: does storage age matter? Scand J Trauma Resusc Emerg Med. 2009; 17:35. [PubMed: 19678943]
8. Zimrin AB, Hess JR. Current issues relating to the transfusion of stored red blood cells. Vox Sang. 2009; 96:93–103. [PubMed: 19152602]

9. Keller ME, Jean R, LaMorte WW, Millham F, Hirsch E. Effects of age of transfused blood on length of stay in trauma patients: a preliminary report. J Trauma. 2002; 53:1023–1025. [PubMed: 12435963]
10. Murrell Z, Haukoos JS, Putnam B, Klein SR. The effect of older blood on mortality, need for ICU care, and the length of ICU stay after major trauma. Am Surg. 2005; 71:781–785. [PubMed: 16468518]
11. Offner PJ, Moore EE, Biffl WL, Johnson JL, Silliman CC. Increased rate of infection associated with transfusion of old blood after severe injury. Arch Surg. 2002; 137:711–716. discussion 716–717. [PubMed: 12049543]
12. Spinella PC, Carroll CL, Staff I, et al. Duration of red blood cell storage is associated with increased incidence of deep vein thrombosis and in hospital mortality in patients with traumatic injuries. Crit Care. 2009; 13:R151. [PubMed: 19772604]
13. Weinberg JA, McGwin G Jr, Griffin RL, et al. Age of transfused blood: an independent predictor of mortality despite universal leukoreduction. J Trauma. 2008; 65:279–282. discussion 282–274. [PubMed: 18695462]
14. Weinberg JA, McGwin G Jr, Marques MB, et al. Transfusions in the less severely injured: does age of transfused blood affect outcomes? J Trauma. 2008; 65:794–798. [PubMed: 18849793]
15. Zallen G, Offner PJ, Moore EE, et al. Age of transfused blood is an independent risk factor for postinjury multiple organ failure. Am J Surg. 1999; 178:570–572. [PubMed: 10670874]
16. Biffl WL, Moore EE, Offner PJ, Ciesla DJ, Gonzalez RJ, Silliman CC. Plasma from aged stored red blood cells delays neutrophil apoptosis and primes for cytotoxicity: abrogation by poststorage washing but not prestorage leukoreduction. J Trauma. 2001; 50:426–431. discussion 432. [PubMed: 11265021]
17. Marik PE, Sibbald WJ. Effect of stored-blood transfusion on oxygen delivery in patients with sepsis. JAMA. 1993; 269:3024–3029. [PubMed: 8501845]
18. Walsh TS, McArdle F, McLellan SA, et al. Does the storage time of transfused red blood cells influence regional or global indexes of tissue oxygenation in anemic critically ill patients? Crit Care Med. 2004; 32:364–371. [PubMed: 14758149]
19. Kiraly LN, Underwood S, Differding JA, Schreiber MA. Transfusion of aged packed red blood cells results in decreased tissue oxygenation in critically injured trauma patients. J Trauma. 2009; 67:29–32. [PubMed: 19590304]
20. Blajchman MA. The clinical benefits of the leukoreduction of blood products. J Trauma. 2006; 60:S83–S90. [PubMed: 16763486]
21. Nathens AB, Nester TA, Rubenfeld GD, Nirula R, Gernsheimer TB. The effects of leukoreduced blood transfusion on infection risk following injury: a randomized controlled trial. Shock. 2006; 26:342–347. [PubMed: 16980879]
22. Schulman CI, Nathe K, Brown M, Cohn SM. Impact of age of transfused blood in the trauma patient. J Trauma. 2002; 52:1224–1225. [PubMed: 12045660]
23. Hebert PC, Chin-Yee I, Fergusson D, et al. A pilot trial evaluating the clinical effects of prolonged storage of red cells. Anesth Analg. 2005; 100:1433–1438. table of contents. [PubMed: 15845701]

EDITORIAL COMMENT

Changes occurring during the storage of blood have been long recognized and felt not to be of benefit to recipients of transfusions.[1] The term “storage lesion” has been in use since at least 1985,[2] and there is a tremendous body of literature characterizing such changes in vitro. The clinical consequences of the storage lesion have been more difficult to evaluate rigorously. The preponderance of retrospective data suggests that aged red blood cells (RBC) are associated with increased morbidity and mortality. Weinberg et al.[3] have contributed to this body of knowledge with their comparison of exclusively old versus exclusively fresh blood which has confounded previous publications.

The investigators report a retrospective analysis of trauma patients admitted to a single institution during a 9.5-year period from January 2000 through May 2009. Among patients

who received one or more units of RBCs during the first 24 hours of admission, two patient groups were defined: those who received blood that was exclusively fresh (<14 days) and those who received blood that was exclusively old (≥14 days)—patients receiving both fresh and old blood were excluded. The primary endpoint was overall mortality. Although no survival difference was noted for patients receiving 1 unit to 2 units of blood, an association with mortality was noted for patients receiving ≥3 units of old blood on multivariate regression analysis. This study is also notable in that all RBCs were prestorage leukoreduced. Although it has been shown that leukoreduction reduces the extent of changes during RBC storage,[4] this study highlights that it does not appear that leukoreduction completely abrogates the deleterious clinical effects that have been associated with the storage lesion.

What does one do with these data? As this is a retrospective analysis, these data can only show an association and cannot prove causality. Therefore, the status quo remains. Some institutions and blood banks have policies in place to provide “fresh blood” to patients requiring massive transfusion, a relatively uncommon event for civilian trauma centers.[5] The logistics of inventory supply are strained by a “last in, first out” policy for RBC units which increases wastage of units that are unused and become outdated. The findings from this study showing an association with increased mortality in patients receiving ≥3 units of blood (a much more common scenario than massive transfusion) certainly would have to be considered carefully.

Some institutions have not made changes to provide fresh blood for trauma patients, reasonably arguing that retrospective data are inconclusive and such policy changes must await the results from prospective clinical trials. The National Heart Lung and Blood Institute is sponsoring just such a clinical trial.[6] The Red Cell Storage Duration Study, or RECESS (NCT00991341), is a large, multicenter, randomized clinical trial intended to determine whether RBC storage time affects the postoperative outcomes of heart surgery patients. Although this is not a study specifically in trauma patients, one would hope that this effort would provide sufficient and clear insight into the clinical consequences of aged blood.

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REFERENCES

1. Valtis DJ. Defective gas-transport function of stored red blood-cells. *Lancet.* 1954;263:119 –125.

2. Wolfe LC. The red cell membrane and the storage lesion. *Clin Haematol.* 1985;14:259 –276.

3. Weinberg JA, McGwin G, Vandromme MJ, et al. Duration of Red Cell Storage Influences Mortality After Trauma. *J Trauma*. 2010;69:1427–1430.

4. McFaul SJ, Corley JB, Mester CW, Nath J. Packed blood cells stored in AS-5 become proinflammatory during storage. *Transfusion*. 2009;49: 1451–1460.

5. Malone DL, Dunne J, Tracy JK, Putnam AT, Scalea TM, Napolitano LM. Blood transfusion, independent of shock severity, is associated with worse outcome in trauma. *J Trauma*. 2003;54:898 –905.

6. Available at: http://clinicaltrials.gov/ct2/show/NCT00991341?term=00991341&rank=1. Accessed September 15, 2010.

EDITORIAL COMMENT

It is a standard practice to provide neonates aged up to 4 months with packed red blood cells (PRBCs) that are a maximum of 7 days old. Sickle cell and thalassemia patients require fresh blood, as do patients with end-stage renal disease. Cardiac surgery patients receive fresh blood, at least up to a prearranged limit. A few years ago, studies indicated that fresh blood might be advantageous for patients with HIV; hence, there was brief clamor for such blood utilization in the context of HIV. Evidence to support its use in trauma patients with severe hemorrhage is lacking.

PRBC and their storage media undergo characteristic morphologic and biochemical changes with ex vivo banking. These changes are collectively referred to as the “red cell storage lesion” and include lipid peroxidation of the red cell membranes, loss of deformability, loss of 2,3 diphosphoglycerate (and thus an increased oxygen affinity), and depletion of adenosine triphosphate that results in crenation, spicule formation, and cell swelling. Indeed, this age effect has been clinically shown to result in higher mortality rates, multiorgan failure rates, and infection rates in critically ill patients. So then, why do not we use only fresh blood in our patients *in extremis*? To justify providing fresh blood to trauma patients, a clinical trial would have to prove that fresh blood improves outcomes in trauma resuscitation and that the advantage is large enough to justify diverting fresh blood away from other patients. This would require determining the expected consumption of fresh PRBCs for traumas, the patient benefit per unit consumed, and the effect such consumption will have on the availability of fresh PRBCs for other patients. Because the blood supply network in this country is an astonishingly efficient producer and distributor of just-in-time blood products, it would be necessary to determine the extent to which consumption of fresh blood in traumas would lead to expiration of older, unused PRBC units. The marginal loss of such a scarce, life-saving resource at a cost of well >$200 per expired PRBC unit could be quite significant.

Before deciding to allocate fresh PRBCs to trauma patients, it would also be necessary to establish which subpopulations would derive the maximum benefit. If it were learned that only trauma patients *in extremis* would derive benefit from receiving fresh PRBCs, then we would need to treat patients accordingly. A catch-all approach of giving fresh PRBCs to all trauma patients would not be appropriate—if it were, we would need to ask whether everyone who required a transfusion for any reason might not benefit from fresh blood.

Weinberg et al.[1] notes that a large, multi-institutional study would be needed to enroll enough subjects to perform a prospective randomized trial. They acknowledge that the crucial limitation to performing such a trial is the tight blood supply. The burden of proof for starting such a trial is demanding: If a large, multi-institutional clinical trial will have a significant impact on blood allocation in participating hospitals, it is mandatory to use the best currently available evidence to justify performing the study. At minimum, the evidence must show a likelihood of success and demonstrate that a positive outcome will change clinical practice. So far, the evidence in favor of fresh red cells for trauma patients falls far short of that mark.

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REFERENCE

1. Weinberg JA, McGwin G, Vandromme MJ, et al. Duration of Red Cell Storage Influences Mortality After Trauma. *J Trauma*. 2010;69: 1427–1430.

TABLE 1

Comparison of Demographic and Clinical Characteristics by Storage Age Among Patients Transfused 1 to 2 RBC Units

	RBC Storage Age		
	Fresh	**Old**	***p***
No. patients	393	654	
Mean age (SD; yr)	42 (18)	41 (19)	0.40
Male (%)	66	63	0.40
Mean ISS (SD)	25 (14)	24 (14)	0.69
Mechanism (% blunt)	76	76	0.82
Brain injury (%)	27	26	0.55
Mean RBC units (SD)	1.67 (0.47)	1.68 (0.47)	0.79
Mean FFP (SD)	0.61 (1.42)	0.79 (1.51)	0.06
Mean platelets (SD)	0.06 (0.26)	0.06 (0.28)	0.84

TABLE 2

Comparison of Demographic and Clinical Characteristics by Storage Age Among Patients Transfused 3 or More RBC Units

	RBC Storage Age		
	Fresh	**Old**	***p***
No. patients	189	411	
Mean age (SD; yr)	44 (21)	40 (19)	0.03
Male (%)	72	71	0.63
Mean ISS (SD)	29 (16)	30 (16)	0.52
Mechanism (% blunt)	71	72	0.83
Brain injury (%)	32	24	0.03
Mean RBC units (SD)	5.47 (3.38)	6.05 (4.39)	0.11
Mean FFP (SD)	2.76 (3.08)	3.47 (3.75)	0.02
Mean platelets (SD)	0.39 (0.67)	0.51 (0.93)	0.11

TABLE 3

Results of Poisson Regression Evaluating Association Between RBC Storage Age and Mortality

	RR (95% CI)	*p*
1–2 RBC units		
Old blood	0.97 (0.72–1.32)	0.85
Age	1.01 (1.00–1.02)	0.01
ISS	1.04 (1.03–1.05)	<0.0001
Male gender	1.09 (0.79–1.51)	0.60
Units FFP	0.99 (0.91–1.08)	0.88
Head injury	1.75 (1.24–2.47)	0.002
Units RBC	1.29 (0.9–1.84)	0.17
Blunt mechanism of injury	0.55 (0.38–0.78)	0.001
≥3 RBC units		
Old blood	1.57 (1.14–2.15)	0.01
Age	1.01 (1.01–1.02)	<0.0001
ISS	1.03 (1.02–1.03)	<0.0001
Male gender	1.33 (0.98–1.80)	0.07
Units FFP	0.96 (0.91–1.01)	0.16
Units platelets	0.87 (0.71–1.05)	0.15
Head injury	1.74 (1.26–2.40)	0.001
Units RBC	1.10 (1.06–1.13)	<0.0001
Blunt mechanism of injury	0.70 (0.50–0.99)	0.05