Published in final edited form as:

J Surg Res. 2018 September ; 229: 288–293. doi:10.1016/j.jss.2018.04.021.

Anemia and blood transfusion in elderly trauma patients

Tyler J. Loftus, MD^{a,b}, Scott C. Brakenridge, MD, MSCS^{a,b}, Travis W. Murphy, MD^a, Linda L. Nguyen, BS^c, Frederick A. Moore, MD, FACS, MCCM^{a,b}, Philip A. Efron, MD, FACS, FCCM^{a,b}, and Alicia M. Mohr, MD, FACS, FCCM^{a,b}

^aUniversity of Florida Department of Surgery, Gainesville, Florida

^bSepsis and Critical Illness Research Center, Gainesville, Florida

^cUniversity of Florida College of Medicine, Gainesville, Florida

Abstract

Background—The natural history of post-injury among elderly trauma patients has not been well described. We hypothesized that elderly trauma patients would have lower admission hemoglobin (Hb) levels, higher transfusion rates, and worse outcomes than young trauma patients.

Methods—We performed a propensity-matched retrospective cohort analysis comparing elderly (age ≥ 65 years) to young (age 18–64) trauma patients matched by sex, mechanism of injury, Injury Severity Score, base deficit, comorbidities, operative blood loss, and phlebotomy blood loss (n=41/group). Outcomes included Hb trends, packed red blood cell (PRBC) transfusion, length of stay, and mortality.

Results—Elderly patients had lower admission Hb (11.3 vs. 10.2 g/dL, $p=0.012$), received more PRBC transfusions within 24 hours (3.6 vs. 1.8 units, $p=0.046$) and during admission (6.9 vs. 4.3 units, $p=0.008$). Despite receiving more PRBC transfusions and having similar operative and phlebotomy blood loss, elderly subjects had lower discharge Hb (9.0 vs. 9.7 g/dL, $p=0.013$). Elderly subjects had fewer ICU-free days (2.0 vs. 6.0 days, $p<0.001$) and higher in-hospital mortality (15% vs. 0%, $p=0.026$).

Please address correspondence to: Alicia M. Mohr, MD, FACS, FCCM, University of Florida, Department of Surgery, 1600 SW Archer Road, Box 100108, Gainesville, FL 32610, Tel: (352) 273-5670, Fax: (352) 273-5683, Alicia.Mohr@surgery.ufl.edu.

TJL and AMM contributed to study design. TJL, SCB, TWM, and LLN contributed to data collection and analysis. All authors contributed to data interpretation. SCB, TWM, LLN, FAM, PAE, and AMM provided critical revisions.

Disclosure

This work was supported in part by grants R01 GM113945-01 (PAE), R01 GM105893-01A1 (AMM), and P50 GM111152-01 (SCB, FAM, PAE, AMM) awarded by the National Institute of General Medical Sciences (NIGMS). TJL was supported by a post-graduate training grant (T32 GM-008721) in burns, trauma and perioperative injury awarded by NIGMS. Research reported in this publication was supported by the National Center for Advancing Translational Sciences under Award Number UL1TR001427. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The authors have no relevant financial disclosures or conflicts of interest.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusions—Elderly trauma patients had lower admission Hb, received more transfusions, and had persistently lower Hb on discharge when controlling for injury severity, comorbid conditions, and blood loss. Aging may have a negative impact on post-injury anemia.

Keywords

trauma; injury; anemia; transfusion; aging; geriatric

Introduction

Anemia is both common and morbid among the elderly. About 10% of elderly subjects (age 65) are anemic (hemoglobin (Hb) < 12 g/dl in women and < 13 g/dL in men)¹. By age 85, the overall prevalence of anemia increases to 20%¹, and is associated with two-fold increased all-cause mortality². The prevalence and adverse effects of anemia among the elderly are magnified in the setting of traumatic injury, which is often accompanied by acute blood loss, and may inhibit erythropoiesis by compromising iron metabolism and bone marrow function due to high levels of inflammatory mediators and circulating catecholamines^{3–7}. Plasma norepinephrine levels rise with increasing age^{8,9}, and older mice are unable to replace lost red blood cells as quickly as younger controls following hemorrhage¹⁰. Elderly trauma patients may also be especially vulnerable to the adverse effects of packed red blood cell (PRBC) transfusion. Elderly intensive care unit (ICU) patients are more frequently transfused than younger counterparts¹¹, and may therefore be disproportionately subjected to immunosuppressive effects and increased mortality associated with blood transfusion^{11–14}.

Although multiple studies have investigated associations among age, anemia, blood transfusion, and outcomes^{15–17}, the essential differences in the natural history of anemia and incidence of transfusion between young and elderly trauma patients are not fully understood, in part due to inherent difficulties in controlling confounding variables. The purpose of this study was to characterize anemia and transfusion among elderly trauma patients in comparison to young trauma patients. We hypothesized that elderly trauma patients would have lower admission hemoglobin levels, higher transfusion rates, and worse outcomes than young trauma patients when controlling for injury severity, comorbid conditions, and blood loss.

Methods

We performed a propensity-score matched retrospective cohort analysis comparing elderly (age 65) and young (age 18–64) trauma patients presenting to our level one trauma center during a four year period ending September 1st, 2015. Patients were identified by searching our institutional database for all adult (age 18 years) trauma patients who received a PRBC transfusion. Burn patients, outside hospital transfers, and patients with unmeasured blood loss that was unrelated to their initial traumatic injury (e.g. gastrointestinal bleed, postoperative hemorrhage) were excluded. Institutional Review Board approval was obtained.

To isolate the effects of age on anemia and blood transfusion among trauma patients, propensity-score matching was performed to control for the following variables: sex, mechanism of injury, Injury Severity Score, admission base deficit, Charlson comorbidity index, history of chronic renal insufficiency, operative blood loss during admission, and phlebotomy blood loss during admission. To estimate phlebotomy blood loss, the amount of blood drawn for each commonly performed laboratory test was determined. At our institution during the study period, basic metabolic panels and complete blood counts contained 5–7 ml of blood, arterial blood gases contained 2 ml of blood, and blood cultures contained 8–10 ml of blood. The number of laboratory tests performed daily for ICU and floor patients was ascertained from previous reports^{18–21}. Based on these parameters, phlebotomy blood loss was calculated by multiplying the first 30 ICU days by 55 mL/day, multiplying all additional ICU days by 13 mL/day, multiplying the number of ICU-free days by 9 mL/day, and adding these three values. Assessment of anticoagulation and antiplatelet therapy prior to admission included vitamin K antagonists, direct thrombin inhibitors, factor Xa inhibitors, clopidogrel, and aspirin. At our institution, red blood cell transfusion is considered appropriate for trauma patients who have one or more of the following conditions: 1) Hb <7 g/dL, 2) Hb <10 g/dL and symptomatic cardiovascular disease, or 3) acute blood loss >30% of total blood volume. Data were collected by query of our institutional database and retrospective review of electronic medical records.

Statistical analysis and propensity-score matching were performed with SPSS version 23 (IBM, Armonk, NY). Propensity scores were generated by multiple logistic regression using elderly status as the dependent variable and entering the above matching parameters as independent variables. Young and elderly patients were matched according to their predicted probabilities by the nearest-neighbor method using caliper width 0.1 on the propensity score scale. From a cohort of 292 patients, this procedure matched 82 patients (28%), including 41 elderly and 41 young trauma patients in the final study population. A two-sample Kolmogorov-Smirnov was performed with the null hypothesis that the two samples were drawn from similar distributions. Outcomes included hemoglobin trends, blood transfusion, infection, and mortality. Groups were compared by one-way analysis of variance, Fisher's Exact test, and the Kruskal-Wallis test and reported as mean $\pm$ standard deviation, n (%), or median [interquartile range] as appropriate with $\alpha = 0.05$.

Results

Baseline characteristics of the study population are listed in Table 1. Younger (age < 65) and elderly (age $\geq$ 65) patients had similar characteristics across all matched variables and all other collected variables, including mechanism of injury, admission vital signs, coagulation parameters, and number of operations performed during admission (Table 1). The Kolmogorov-Smirnov test for each variable in Table 1 (not including age) was > 0.173, indicating that the distribution of these parameters were similar between groups. Elderly patients had lower admission hemoglobin levels (10.2 vs. 11.3 g/dL, $p=0.012$), were more likely to receive a PRBC transfusion within 24 hours, and received more early and total PRBC transfusions per patient (Table 2). The average storage duration for PRBC was similar between groups (Table 2). The early, late, and total of PRBC transfusions administered in each group are illustrated in Figure 1.

Hemoglobin levels decreased substantially during the first three days of admission in both groups (Figure 2). During the first three days of admission, daily intravenous fluid administration for young and elderly patients was 2.7L/day and 2.4L/day, respectively ($p = 0.564$). Over the next four days of admission, they received 1.2L/day and 1.3L/day, respectively ($p = 0.800$). After the first three days of admission, hemoglobin levels gradually increased over the course of 18 days in both groups, and appeared to make a stronger recovery among younger patients. At the time of discharge, hemoglobin levels were significantly lower among elderly patients (9.0 vs. 9.7 g/dL, $p = 0.013$) despite the fact that they lost roughly the same amount of blood (724 vs. 775 mL) and received more transfusions than younger counterparts.

Elderly trauma patients had significantly fewer ICU-free days than young trauma patients (2.0 vs. 6.0 days, $p < 0.001$, Table 3). Young patients were more likely to be discharged to a subacute rehabilitation facility for a brief course of physical therapy, whereas the elderly cohort was more likely to be discharged to a long-term acute care facility for prolonged rehabilitation and reconditioning (Table 3). The elderly cohort also had a significantly higher in-hospital mortality rate, with six total deaths that were attributed to sepsis ($n=4$), Acute Respiratory Distress Syndrome ($n=1$), and stroke ($n=1$).

Discussion

As expected, elderly trauma patients had lower hemoglobin levels on admission. Notably, the elderly cohort also had lower discharge hemoglobin levels than younger trauma patients, despite receiving more blood transfusions. These differences were not attributable to the nature of their injury, degree of shock on arrival, coagulation parameters, anticoagulation or antiplatelet medications, comorbid conditions including chronic renal insufficiency, blood loss in the operating room, phlebotomy blood loss, or unmeasured blood loss that was not related to their initial injury. Lower admission hemoglobin levels among elderly patients may reflect the impact of nutritional deficiencies, polypharmacy, and myelodysplasia in this population^{22–24}. Alternatively, elderly patients may have lost more blood in the course of their initial injury, though this seems unlikely given the similarities in injury severity, shock indicators, and integrity of the coagulation cascade. The fact that elderly patients had persistently lower hemoglobin levels at discharge despite receiving more transfusions is consistent with the hypothesis that elderly patients may be disproportionately affected by hypercatecholaminemia-mediated bone marrow suppression, though experimental studies are needed to address this hypothesis. Other possible contributors include erythropoietin resistance and overexpression of pro-inflammatory cytokines among the elderly^{25–27}.

Previous work in non-trauma populations has demonstrated similar trends. In a prospective study of 3534 critically ill medical and surgical patients, admission hemoglobin levels were significantly lower in patients age 90 or greater (9.9 mg/dL) compared to 80–90 year old patients (11.0 g/dL), and patients age 40 and below (11.7 g/dL)¹¹. Patients age > 80 were more frequently transfused than 18–30 year old counterparts (54% vs. 30%, $p < 0.001$), although the mean number of units transfused was not significantly different¹¹. Increased transfusion rates among elderly patients may be attributable to higher hemoglobin transfusion thresholds, adopted in deference to age-related alterations in cardiovascular

physiology. Elderly patients may not develop appropriate compensatory tachycardia and increased stroke volume in response to anemia, and therefore receive blood transfusions at higher Hb levels (9–10 mg/dl) than younger asymptomatic patients²⁸. In some situations, this practice may be warranted. Blood transfusion has been shown to decrease short term mortality for elderly patients with acute myocardial infarction and hematocrit > 30%²⁹. However, prospective data suggests that restrictive transfusion strategies are safe for patients' age > 50 with cardiovascular disease undergoing hip fracture repair with Hb < 8 g/dL or higher³⁰. Restrictive transfusion practices have the potential to reduce transfusion-related morbidity. In a retrospective review of elderly (age > 65) trauma patients, those receiving blood transfusion had increased infection rates and longer hospital and ICU length of stay compared to a random sample of elderly trauma patients who did not receive a transfusion³¹. In this study, elderly trauma patients who received PRBC were not compared to elderly trauma patients who did not receive transfusion. However, despite elderly patients receiving more transfusions, there was no difference in nosocomial infections between young and elderly trauma patients.

Elderly trauma patients had persistently lower hemoglobin levels at discharge despite receiving more transfusions. Factors contributing to this persistent anemia despite transfusion are not fully understood. Increased storage duration of transfusions has been shown to be an independent risk factor for organ failure, increased ICU length of stay and mortality³². In the current study, there was no difference in the storage duration of PRBC transfused to elderly trauma patients when compared to young. The transfusion of stored blood did not explain the persistence of anemia observed in the elderly trauma patients. Future studies should investigate the effects of hypercatecholaminemia on bone marrow suppression among elderly trauma patients, and determine whether higher basal catecholamine levels and qualitative bone marrow dysfunction exacerbate post-injury anemia. In addition, post-injury anemia is likely multifactorial, and future research should assess the relative contributions of malnutrition and occult blood loss, which may also disproportionately affect the elderly³³.

The major limitations of this study are its retrospective design, small sample size, a lack of specific indications for transfusions, and absence of data regarding iron metabolism and nutritional parameters. Specifically, iron metabolism and nutritional parameters likely impact post-injury erythropoiesis and may differ between young and elderly patients, but were not analyzed in this study. Finally, elderly patients may have been disproportionately affected by excessive phlebotomy, and this study may have been underpowered to detect a significant difference to this effect. The selection bias inherent to retrospective analyses is partially mitigated by propensity-score matching. A well-designed prospective study would further reduce selection bias and allow for assessment of iron metabolism parameters. These studies should also consider differences in iron metabolism, erythropoietin, and inflammatory mediators between young and elderly trauma patients.

Conclusions

Elderly trauma patients have lower hemoglobin levels on admission and persistently lower hemoglobin levels on discharge than younger trauma patients, despite receiving more blood

transfusions. These findings are observed when controlling for injury severity, comorbid conditions, and blood loss during admission, suggesting that aging may have a negative impact on maintenance of red blood cell mass following injury. Acute and subacute anemia was common among the elderly, and they appeared to respond less well to transfusion compared with young trauma patient, underscoring the importance of minimizing phlebotomy blood loss in this vulnerable population. Future research should assess the impact and value of nutritional interventions and should seek to identify patients for whom exogenous iron and erythropoietin administration may have therapeutic value.

Acknowledgments

This work was supported in part by grants R01 GM113945-01 (PAE), R01 GM105893-01A1 (AMM), and P50 GM111152-01 (SCB, FAM, PAE, AMM) awarded by the National Institute of General Medical Sciences (NIGMS). TJL was supported by a post-graduate training grant (T32 GM-008721) in burns, trauma and perioperative injury awarded by NIGMS. Research reported in this publication was supported by the National Center for Advancing Translational Sciences under Award Number UL1TR001427. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The authors have no relevant financial disclosures or conflicts of interest.

References

1. Patel KV. Epidemiology of anemia in older adults. *Semin Hematol*. 2008; 45:210–217. [PubMed: 18809090]
2. Izaks GJ, Westendorp RG, Knook DL. The definition of anemia in older persons. *JAMA*. 1999; 281:1714–1717. [PubMed: 10328071]
3. Livingston DH, Anjaria D, Wu J, et al. Bone marrow failure following severe injury in humans. *Ann Surg*. 2003; 238:748–753. [PubMed: 14578739]
4. Bible LE, Pasupuleti LV, Alzate WD, et al. Early propranolol administration to severely injured patients can improve bone marrow dysfunction. *J Trauma Acute Care Surg*. 2014; 77:54–60. discussion 59–60. [PubMed: 24977755]
5. Pirie K, Myles P, Wood E. Anemia and iron-restricted erythropoiesis in traumatic critical illness. *J Trauma Acute Care Surg*. 2016; 80:538–545. [PubMed: 26670117]
6. Robinson Y, Hostmann A, Matenov A, Ertel W, Oberholzer A. Erythropoiesis in multiply injured patients. *J Trauma*. 2006; 61:1285–1291. [PubMed: 17099548]
7. Rodriguez RM, Corwin HL, Gettinger A, et al. Nutritional deficiencies and blunted erythropoietin response as causes of the anemia of critical illness. *J Crit Care*. 2001; 16:36–41. [PubMed: 11230723]
8. Ziegler MG, Lake CR, Kopin IJ. Plasma noradrenaline increases with age. *Nature*. 1976; 261:333–335. [PubMed: 1272412]
9. Rowe JW, Troen BR. Sympathetic nervous system and aging in man. *Endocr Rev*. 1980; 1:167–179. [PubMed: 6263602]
10. Boggs DR, Patrene KD. Hematopoiesis and aging III: Anemia and a blunted erythropoietic response to hemorrhage in aged mice. *Am J Hematol*. 1985; 19:327–338. [PubMed: 4025313]
11. Vincent JL, Baron JF, Reinhart K, et al. Anemia and blood transfusion in critically ill patients. *JAMA*. 2002; 288:1499–1507. [PubMed: 12243637]
12. Charles A, Shaikh AA, Walters M, Huehl S, Pomerantz R. Blood transfusion is an independent predictor of mortality after blunt trauma. *Am Surg*. 2007; 73:1–5. [PubMed: 17249446]
13. Malone DL, Dunne J, Tracy JK, et al. Blood transfusion, independent of shock severity, is associated with worse outcome in trauma. *J Trauma*. 2003; 54:898–905. discussion 905–897. [PubMed: 12777902]
14. Corwin HL, Gettinger A, Pearl RG, et al. The CRIT Study: Anemia and blood transfusion in the critically ill—current clinical practice in the United States. *Crit Care Med*. 2004; 32:39–52. [PubMed: 14707558]

15. Fawcett VJ, Flynn-O'Brien KT, Shorter Z, et al. Risk factors for unplanned readmissions in older adult trauma patients in Washington State: a competing risk analysis. *J Am Coll Surg*. 2015; 220:330–338. [PubMed: 25542280]
16. Mitra B, Olaussen A, Cameron PA, O'Donohoe T, Fitzgerald M. Massive blood transfusions post trauma in the elderly compared to younger patients. *Injury*. 2014; 45:1296–1300. [PubMed: 24560872]
17. Mostafa G, Gunter OL, Norton HJ, et al. Age, blood transfusion, and survival after trauma. *Am Surg*. 2004; 70:357–363. [PubMed: 15098792]
18. Chant C, Wilson G, Friedrich JO. Anemia, transfusion, and phlebotomy practices in critically ill patients with prolonged ICU length of stay: a cohort study. *Crit Care*. 2006; 10:R140. [PubMed: 17002795]
19. Corwin HL, Parsonnet KC, Gettinger A. RBC transfusion in the ICU. Is there a reason? *Chest*. 1995; 108:767–771. [PubMed: 7656631]
20. Lyon AW, Chin AC, Slotsve GA, Lyon ME. Simulation of repetitive diagnostic blood loss and onset of iatrogenic anemia in critical care patients with a mathematical model. *Comput Biol Med*. 2013; 43:84–90. [PubMed: 23228481]
21. Dolman HS, Evans K, Zimmerman LH, et al. Impact of minimizing diagnostic blood loss in the critically ill. *Surgery*. 2015; 158:1083–1087. discussion 1087–1088. [PubMed: 26164619]
22. Guralnik JM, Eisenstaedt RS, Ferrucci L, Klein HG, Woodman RC. Prevalence of anemia in persons 65 years and older in the United States: evidence for a high rate of unexplained anemia. *Blood*. 2004; 104:2263–2268. [PubMed: 15238427]
23. Balducci L, Ershler WB, Krantz S. Anemia in the elderly-clinical findings and impact on health. *Crit Rev Oncol Hematol*. 2006; 58:156–165. [PubMed: 16387511]
24. Joosten E, Pelemans W, Hiele M, et al. Prevalence and causes of anaemia in a geriatric hospitalized population. *Gerontology*. 1992; 38:111–117. [PubMed: 1612458]
25. Berliner N. Anemia in the elderly. *Trans Am Clin Climatol Assoc*. 2013; 124:230–237. [PubMed: 23874029]
26. Kario K, Matsuo T, Nakao K. Serum erythropoietin levels in the elderly. *Gerontology*. 1991; 37:345–348. [PubMed: 1765284]
27. Ferrucci L, Corsi A, Lauretani F, et al. The origins of age-related proinflammatory state. *Blood*. 2005; 105:2294–2299. [PubMed: 15572589]
28. Goodnough LT, Schrier SL. Evaluation and management of anemia in the elderly. *Am J Hematol*. 2014; 89:88–96. [PubMed: 24122955]
29. Wu WC, Rathore SS, Wang Y, Radford MJ, Krumholz HM. Blood transfusion in elderly patients with acute myocardial infarction. *N Engl J Med*. 2001; 345:1230–1236. [PubMed: 11680442]
30. Carson JL, Terrin ML, Noveck H, et al. Liberal or restrictive transfusion in high-risk patients after hip surgery. *N Engl J Med*. 2011; 365:2453–2462. [PubMed: 22168590]
31. Keuter K, Ablah E, Vasquez D, Wetta-Hall R, Hawley SR. Blood transfusions in elderly trauma patients: is there a role for restrictive use? *J Am Geriatr Soc*. 2008; 56:168–170.
32. Ng MS, Ng AS, Chan J, Tung JP, Fraser JF. Effects of packed red blood cell storage duration on post-transfusion clinical outcomes: a meta-analysis and systematic review. *Intensive Care Med*. 2015; 41:2087–2097. [PubMed: 26438223]
33. Ramel A, Jonsson PV, Bjornsson S, Thorsdottir I. Anemia, nutritional status, and inflammation in hospitalized elderly. *Nutrition*. 2008; 24:1116–1122. [PubMed: 18692363]

Figure 1. Elderly trauma patients received more early and total packed red blood cell (PRBC) transfusions than younger trauma patients (* $p < 0.05$).

Figure 2.

Elderly trauma patients had lower hemoglobin levels on admission than younger trauma patients (* $p = 0.012$). Both groups experienced substantial decreases in hemoglobin levels over the first three days of hospitalization.

Table 1

Characteristics of the study population.

Patient characteristics	Age < 65 n = 41	Age ≥ 65 n = 41	p
Age (years)	47 ±14	75 ±7	<0.001
Male [†]	22 (54%)	22 (54%)	-
Penetrating trauma [†]	1 (2%)	3 (7%)	0.616
Motor vehicle/motorcycle/ATV crash	29 (71%)	31 (76%)	0.804
Pedestrian hit by motor vehicle	4 (10%)	2 (5%)	0.675
Fall	7 (17%)	5 (12%)	0.756
Ground level fall	4 (10%)	4 (10%)	>0.999
Injury Severity Score [†]	19 ±9	21 ±10	0.612
Glasgow Coma Scale score	12.5 ±4.2	12.7 ±4.1	0.853
On admission			
Heart rate	99 ±24	90 ±23	0.079
Systolic blood pressure (mmHg)	128 ±31	129 ±31	0.879
Mean arterial pressure (mmHg)	98 ±27	97 ±25	0.785
Temperature (°C)	36.4 ±0.8	36.2 ±1.0	0.194
Base deficit (mEq/L) [†]	3.6 ±4.2	3.8 ±4.7	0.892
Lactic acid (mmol/L)	2.5 ±1.3	2.4 ±1.7	0.581
International Normalized Ratio (INR)	1.2 ±0.2	1.3 ±0.3	0.114
Therapeutic anticoagulation or antiplatelet therapy	1 (2%)	2 (5%)	>0.999
Charlson comorbidity index [†]	0.8 ±1.2	1.0 ±1.2	0.481
History of chronic renal insufficiency [†]	0	1 (2%)	>0.999
Renal replacement therapy during admission	1 (2%)	3 (7%)	0.616
Trips to operating room during admission	2.9 ±2.1	2.3 ±1.5	0.096
Operative blood loss during admission (mL) [†]	400 [190–873]	275 [152–600]	0.449
Phlebotomy blood loss during admission (mL) [†]	375 [210–769]	449 [329–715]	0.368

[†]Propensity matched covariates. ATV: all-terrain vehicle. Data are presented as mean ±standard deviation, n (%), or median [interquartile range].

Table 2

Comparison of hematology parameters between young and elderly trauma patients.

Hematology parameters	Age < 65 n = 41	Age ≥ 65 n = 41	<i>p</i>
Hemoglobin on admission (g/dL)	11.3 ±2.0	10.2 ±1.9	0.012
Received ≥ 1 PRBC transfusion within 24h	17 (41%)	31 (76%)	0.003
PRBC transfusions within 24h	1.8 ±2.6	3.6 ±5.1	0.046
Massive transfusion (≥ 10U PRBC)	1 (2%)	3 (7%)	0.616
Received ≥ 1 PRBC transfusion after 24h	35 (85%)	34 (83%)	>0.999
PRBC transfusions after 24h	2.5 ±2.8	3.3 ±2.3	0.114
PRBC transfusions for entire length of stay	4.3 ±3.9	6.9 ±5.0	0.008
PRBC storage duration (days)	22.5 ±8.3	21.9 ±7.3	0.730

PRBC: packed red blood cell. Data are presented as mean ±standard deviation or n (%).

Table 3

Comparison of outcomes between young and elderly trauma patients.

Outcomes	Age < 65 n = 41	Age ≥ 65 n = 41	<i>p</i>
Nosocomial infection	5 (12%)	5 (12%)	-
Urinary tract infection	0	2 (5%)	0.494
Pneumonia	1 (2%)	2 (5%)	>0.999
Bloodstream infection	0	1 (2%)	>0.999
Surgical site infection	4 (10%)	1 (2%)	0.359
ICU length of stay (days)	5 [2–13]	7 [5–13]	0.170
ICU-free days	6 [4–10]	2 [0–7]	<0.001
Non-home discharge	27 (66%)	31 (76%)	0.467
Subacute rehabilitation	23 (56%)	11 (27%)	0.013
Long-term acute care	3 (7%)	12 (29%)	0.020
Another hospital	1 (2%)	1 (2%)	-
Hospice	0	1 (2%)	>0.999
In-hospital mortality	0	6 (15%)	0.026
Unplanned readmission [#]	5 (12%)	5 (12%)	>0.999
One-year mortality	3 (7%)	9 (22%)	0.116

ICU: intensive care unit,

[#] within 30 days. Data are presented as median [interquartile range] or n (%).