Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.JournalofSurgicalResearch.com

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,*]

[a] Department of Surgery, University of Florida, Gainesville, Florida
[b] Sepsis and Critical Illness Research Center, Gainesville, Florida
[c] University of Florida College of Medicine, Gainesville, Florida

ARTICLE INFO

Article history:
Received 2 October 2017
Received in revised form
6 March 2018
Accepted 12 April 2018

Keywords:
Trauma
Injury
Anemia
Transfusion
Aging
Geriatric

ABSTRACT

Background: The natural history of postinjury 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 y) 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 *versus* 10.2 g/dL, $P = 0.012$), received more PRBC transfusions within 24 h (3.6 *versus* 1.8 units, $P = 0.046$), and during admission (6.9 *versus* 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 *versus* 9.7 g/dL, $P = 0.013$). Elderly subjects had fewer ICU-free days (2.0 *versus* 6.0 d, $P < 0.001$) and higher in-hospital mortality (15% *versus* 0%, $P = 0.026$).

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 postinjury anemia.

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 mortality.[2] 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

* *Corresponding author*. Department of Surgery, University of Florida, 1600 SW Archer Road Box 100108, Gainesville, FL 32610. Tel.: +1 352 273 5670; fax: +1 352 273 5683.
E-mail address: alicia.mohr@surgery.ufl.edu (A.M. Mohr).
0022-4804/$ – see front matter © 2018 Elsevier Inc. All rights reserved.
https://doi.org/10.1016/j.jss.2018.04.021

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 hemorrhage.[10] 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 counterparts[11] 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 Hb 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 4 y period ending September 1, 2015. Patients were identified by searching our institutional database for all adult (age ≥18 y) 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/d, multiplying all additional ICU days by 13 mL/d, multiplying the number of ICU-free days by 9 mL/d, and adding these three values. Assessment of anticoagulation and antiplatelet therapy before 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 Hb 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 ± 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 ≥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 Hb levels (10.2 *versus* 11.3 g/dL, $P = 0.012$), were more likely to receive a PRBC transfusion within 24 h, 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.

Hb levels decreased substantially during the first 3 d of admission in both groups (Fig. 2). During the first 3 d of admission, daily intravenous fluid administration for young and elderly patients was 2.7 L/d and 2.4 L/d, respectively ($P = 0.564$). Over the next 4 d of admission, they received 1.2 L/d and 1.3 L/d, respectively ($P = 0.800$). After the first 3 d of admission, Hb levels gradually increased over the course of 18 d in both groups and appeared to make a stronger recovery among younger patients. At the time of discharge, Hb levels were significantly lower among elderly patients (9.0 *versus* 9.7 g/dL, $P = 0.013$) despite the fact that they lost roughly the same amount of blood (724 *versus* 775 mL) and received more transfusions than younger counterparts.

Elderly trauma patients had significantly fewer ICU-free days than young trauma patients (2.0 *versus* 6.0 d, $P < 0.001$,