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The relationship between total red blood cells and plasma transfusion and acute lung injury risk after cardiac surgery: A retrospective study

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ABSTRACT

The aim of our study was to determine whether red blood cells (RBCs) and fresh frozen plasma (FFP) transfusion is independently associated with the development of acute lung injury (ALI) in patients after cardiac surgery. In retrospective study, 165 patients were included. The results showed total fresh RBCs transfusion were not significantly increased in patients who developed ALI compared with patients who did not develop ALI (4.7 ± 2.4, 4 [0–12] units VS 4.0 ± 1.9, 3 [0–9] units, $P = 0.119$). FFP transfusion were also not significantly increased (704.1 ± 832.5, 600 [150–6500] ml VS 533.9 ± 323.6, 400 [125–3100] ml, $P = 0.053$). Multivariable logistic regression analysis showed that only age and CPB time were independent factors for ALI, but not for total RBCs and FFP transfused, with the adjusted OR 0.952 (95% CI 0.762–1.189, $P = 0.664$), and 1.000 (95% CI 0.999–1.001, $P = 0.480$), respectively. In subgroup analysis, female patients showed a lower ALI incidence in low RBCs transfused group (23.9% VS 45.0%, OR 0.38, 95% CI 0.15–0.98) and in low FFP transfused group (22.0% VS 44.4%, OR 0.35, 95% CI 0.14–0.90). Our study demonstrates that red blood cells and fresh-frozen plasma transfusion are not related with ALI after cardiac surgery in our institution.

1. Introduction

Cardiac surgery with cardiopulmonary bypass (CPB) has been associated with a frequent complication of acute lung injury (ALI). The estimated ALI incidence was as many as 20% after cardiac surgery, and the related mortality was as high as 80% [1]. Care for patients with acute respiratory distress syndrome is supportive, with low tidal volume ventilation being the mainstay of therapy. Careful fluid management, minimization of blood product transfusion, appropriate nutrition, and early physical rehabilitation may improve outcomes [1]. Patients developing ALI were longer ventilated and had a greater length of ICU and hospital stay ($P < .05$ for all, respectively) [2]. ALI will also increase the cost of the treatment. Studies have shown that the etiology of lung injury is multifactorial, including pulmonary hypoperfusion, the induction of inflammatory mediators, hypothermia, and blood contact with the foreign surfaces of the CPB system [3].

Transfusion of multiple units has long been considered a risk factor for ALI [4,5]. The incidence of transfusion-related ALI in the critically ill patients ranged from 5.4% to 8% [6,7]. Leukocyte antibodies, present in fresh frozen plasma and platelet concentrates from multiparous donors, and neutrophil priming agents released in stored cellular

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blood components have been considered to be causative [8]. In the perioperative period of cardiac surgery, patients often require transfusions of blood products. Studies have confirmed platelet transfusion was associated with ALI after cardiac surgery [9]. However, the relationship between red blood cells (RBCs) and fresh-frozen plasma (FFP) transfusion and the development of ALI after cardiac surgery has not been confirmed.

The specific aim of our study was to determine whether RBCs and FFP transfusion is independently associated with the development of ALI in patients after cardiac surgery.

2. Methods

2.1. Patients

The study was performed in a university hospital in China. There are about 150–250 cases of cardiac surgery carried out each year. We performed a retrospective analysis among consecutive patients with cardiac surgery between January 2012 and December 2012. The study was approved by the medical ethics committee of the hospital. Pediatric and adult patients of any age undergoing cardiac surgery with cardiopulmonary bypass met the inclusion criteria. Exclusion criteria included the following: ① cardiac surgery without cardiopulmonary bypass (such as off-pump coronary artery bypass grafting, transpleural and extrapleural ligation of patent ductus arteriosus); ② percutaneous transluminal coronary angioplasty.

2.2. ALI definition

ALI was defined according to the standard American–European Consensus Conference on acute respiratory distress syndrome (ARDS) definition [10] as follows: ① oxygenation: $PaO_2/FiO_2 < 300$ mm Hg (regardless of positive end-expiratory pressure); ② chest radiograph: bilateral infiltrates seen on frontal chest radiograph; ③ pulmonary artery occlusion pressure: $\leqslant$18 mm Hg when measured or no clinical evidence of left atrial hypertension.

2.3. Data collection

All data were obtained by reviewing patients' medical records. Data were retrieved by trained medical personnel using specifically tailored data forms. We collected data on patient demographics and admission diagnosis. Transfusion data collection included the total amount of transfused leuko-reduced fresh RBCs and FFP. All the blood products were centrifuged, separated, and frozen solid at −30 °C within 6 h of collection, and the storage age of RBCs was no more than 5 days. The blood products form multiparous female donors were avoid. We also collected potential risk factors for onset of ALI, including smoking ($\geqslant$100 cigarettes for lifetime), chronic obstructive pulmonary disease, diabetes mellitus, hypertension, alcohol abuse (more than 40 g of alcohol per day), and cardiopulmonary bypass time.

2.4. Statistical analysis

Demographics and baseline characteristics were compared between patients in whom ALI developed and those in whom it did not develop. Continuous data were firstly checked for distribution. Normal distributed data were analyzed using analysis of unpaired student's t test. Non-normal distribution data were analyzed using Mann–Whitney U test. Categorical data were analyzed with the χ^2 test. In order to exclude potential confounding factors of ALI, we (1) conducted multivariable logistic regression analysis after univariate analysis; (2) used Mantel–Haenszel tests stratified by the each subgroup. A two-sided p value of <0.05 was considered to be statistically significant. Analyses were performed using SPSS 17.0 software (SPSS Inc., Chicago, IL, USA) and Stata 12.0 (Stata Corp., College Station, TX, USA).

3. Results

3.1. Patient characteristics

During the screening period, a total of 165 cardiac surgery patients were included in our study. Among theses, 56 patients (33.9%) developed ALI after surgery. Of these 165 patients, 79 (47.9%) were male and 86 (52.1%) were female, the age of which ranged from 8 months to 81 years. The overall distribution of type of surgery included congenital heart disease surgery at 17.0%, valve heart disease surgery at 67.3%, and other cardiac surgery at 15.8%. The cardiopulmonary bypass time ranged from 38 to 330 min. All patients received RBCs and FFP transfusion, but none of patients received platelet concentrates and cryoprecipitates. The transfused products consisted of 702 units RBCs, and 97,630 ml FFP. Demographic and baseline characteristics for these patients are shown in Table 1.

3.2. Transfusion of RBCs and FFPs is not the main cause of ALI in our institution

Total RBCs transfused amount were not significantly increased in patients with ALI (4.7 ± 2.4 units, 4 [0–12] units) compared with patients who did not develop ALI (4.0 ± 1.9 units, 3 [0–9] units), with P value 0.119 (Fig. 1a). Total FFP transfused amount were also not significantly increased in patients with ALI (704.1 ± 832.5 ml, 600 [150–6500] ml) compared with patients who did not develop ALI (533.9 ± 323.6 ml, 400 [125–3100] ml), with P value 0.053 (Fig. 1b). However, patients' age were significantly increased in patients with ALI (56.9 ± 13.3 years, 58 [5–81] years) compared with patients who did not develop ALI (47.8 ± 18.9 years, 53 [1–80] years), with P value 0.002 (Fig. 1c). CPB time was also significantly increased in patients with ALI (142.1 ± 55.9 min, 126.5 [60–330] min), compared with patients who did not develop ALI (115.2 ± 48.5 min, 107 [38–268] min), with P value 0.002 (Fig. 1d). Other characteristics, such as type of surgery, alcohol abuse, smoking, diabetes mellitus, hypertension and chronic obstructive pulmonary diseases, were not

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