

Appropriate blood component therapy can reduce postcardiac surgery acute kidney injury through packed cell transfusion reduction

Kianoush Saberi, Mehrdad Salehi, Mehrzad Rahmanian, Ali Reza Bakhshandeh, Gholam Reza Massoumi¹

Imam Khomeini Medical and Research Center, Tehran University of Medical Sciences, Tehran, ¹Department of Anesthesiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

Background: Acute kidney injury (AKI) can happen due to different factors such as anemia. Packed cell (PC) transfusion is an important cause of AKI occurrence. The aim of the study is to investigate whether appropriate blood component (BC) therapy can reduce blood transfusion and it would result in AKI decreasing. **Materials and Methods:** We conducted a cohort study of 1388 patients who underwent cardiac surgery in one university hospital. A serum creatinine higher than 2 mg/dl, renal disease history, renal replacement therapy (chronic dialysis) were our exclusion criteria. **Results:** from our 1088 samples, 701 (64.43%) patients had normal kidney function, 277 (25.45%) were in the AKI-1 group, 84 (7.72%) had an AKI-2 function, and the rest of patients were classified as end stage. A mean of more than three PC units were transfused for the second and third stage of AKI, which was significantly higher than other AKI groups ($P = 0.009$); this higher demand of blood product was also true about the fresh frozen plasma, platelet, and fibrinogen. However, there were no needs of fibrinogen in the patients with normal kidney function. The cardiopulmonary bypass time had an average of 142 ± 24.12 , which obviously was higher than other groups ($P = 0.032$). Total mortality rate was 14 out of 1088 (1.28%), and expiration among the AKI stages 2 and 3 was meaningfully ($P = 0.001$) more than the other groups. **Conclusion:** A more occurrence of AKI reported for the patients who have taken more units of blood. However, BC indicated to be safer for compensating blood loss because of low AKI occurrence among our patients.

Key words: Acute kidney Injury(AKI), blood transfusion, cardiac surgery

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INTRODUCTION

One of the most important complications which patients face after cardiac surgeries is acute kidney injury (AKI).^[1] Until now, different factors, such as anemia, have been reported as independent factors for AKI occurrence. Anemia and red blood packed cells (PCs) transfusion can cause different morbidity like AKI.^[2,3] Further, it was indicated that restricted criteria for blood and blood product transfusion will result in better outcome in patients.^[4] In our center, we use a precise and restricted protocol for blood and blood component (BC) transfusion. Of note, using BCs in a good manner can result in a PC transfusion reduction.^[5] The aim of the study is to

investigate whether appropriate BC therapy can reduce blood transfusion and it would result in AKI decreasing.

MATERIALS AND METHODS

A cohort study was conducted on individuals who were referred for cardiac surgery to Imam Hospital in Tehran, Iran, from November 2014 to June 2015 (Registered number is 8811215125). Out of 1338 potential participants, 1088 were eligible for the present study. They were categorized into five different groups: Coronary artery bypass graft (CABG), CABG-valve, valve, Bentall, and congenital defect surgery.

The participants were assigned into two groups: Patients have hemoglobin (Hb) under 7.3 mg/dl and patients

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Address for correspondence: Dr. Gholam Reza Massoumi, Department of Anesthesiology, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran. E-mail: massoumireza@yahoo.com

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had an Hb above 7.3 mg/dl. Our standard for transfusion therapy was Hb under 7.3 mg/dl. For patients who had a platelet level of $<50,000/\mu\text{l}$, we transfused a unit platelet as a prophylaxis. Fresh frozen plasma (FFP) used when blood loss estimated to be more than 1 volume (when prothrombin time and active thromboplastin time) could not be obtained (these values cannot be obtained in emergency situations because it may put the patient at risk) (or it was >1.5 times control). Moreover, last but not least, we used fibrinogen whenever the activated coagulation time was suitable and FFP was administered and patient's bleeding needs more support. Both the study patients and the investigators were blinded during the study.

Base creatinine (Cr) was determined at the day before the surgery. After the surgery, Cr record continued for 7 days. In our research, we calculated the ratio of base Cr and the highest Cr after surgery. AKI was defined according to the AKI Network (AKIN). Of note, the patients who took a renal replacement therapy after the operation were grouped directly in stage 3 AKI (our classification is based on the AKIN as mentioned in the method part and it just has three groups. This is newer than RIFLE (Risk, Injury, Failure, Loss of kidney function, and End-stage kidney disease) and it is known as standard for AKI classification).^[3]

Briefly, anesthesia process was almost performed with this constant protocol: 1 mg lorazepam as a premedication, 0.1 mg/kg morphine was administered. Anesthesia induction was executed using 0.1 mg/kg midazolam, 0.5 $\mu\text{g}/\text{kg}$ sufentanil (Sufenta Abureyhan), 1–2 mg/kg propofol (Propofol Dongkook Pharm), 0.2 mg/kg cisatracurium (Cisatra Abureyhan) along with 500 ml of Ringer serum. Anesthesia was maintained using 20–100 $\mu\text{g}/\text{kg}/\text{min}$ propofol, 0.25–0.5 $\mu\text{g}/\text{kg}/\text{min}$ midazolam (Mida Tehran Shimi), 0.5 $\mu\text{g}/\text{kg}/\text{h}$ fentanyl (Fenta Caspian Tamin), and 2–4 $\mu\text{g}/\text{kg}/\text{min}$ atracurium (Atra Abureyhan).

For the patients which the surgery was not off-pump, a nonpulsatile cardiopulmonary bypass (CPB) with a roller pump was utilized. Using Ringer's lactate, Voluven[®] together with a membrane oxygenator, the extracorporeal system was prepared. We avoided using the solutions which contained glucose before and during CPB. Data were analyzed using version of SPSS 18.0 (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc.). A $P < 0.05$ is considered statistically significant. ANOVA, two-way *t*-test, and Chi-square test were utilized to analyze the continuous and discrete data properly.

RESULTS

From our 1088 samples, 701 (64.43%) patients had normal kidney function, 277 (25.45%) were in the AKI-1 group,

84 (7.72%) had an AKI-2 function, and the rest of patients were classified as end stage. A mean of more than 3 PC units were transfused for the second and third stage of AKI, which was significantly higher than other AKI groups ($P = 0.009$); this higher demand of blood product was also true about the FFP, platelet, and fibrinogen. However, there were no needs of fibrinogen in the patients with normal kidney function. The CPB time had an average of 142 ± 24.12 , which obviously was higher than other groups ($P = 0.032$). Most of the patients who had a CABG surgery were grouped into AKI-1 308 (28.30%); the combined valve-CABG 195 (17.92%) and valve repaired 158 (14.52%) candidates were the next majorities in this group. Bentall consisted of the minority of our samples (3.67%). There was no relationship between diabetes (whether insulin dependent or not) and AKI occurrence in our data; however, there was a significant relationship ($P = 0.009$) between PC and AKI stage, and a lack of such relation exists in BCs. A mean number of transfused units \pm SD is also present in Table 1. Total mortality rate was 14 out of 1088 (1.28%), and expiration among the AKI stages 2 and 3 was meaningfully ($P = 0.001$) more than the other groups. Other characteristics of the participants are shown in Table 1.

DISCUSSION

Renal dysfunction is one of the most important reasons of mortality and morbidity, whether exactly after the operation or in a long term period.^[6] So, identification of factors that affect renal function can be beneficial in a better patient's outcome evaluation. Fluid management and hemodynamic monitoring are among the most important factors in stability of renal functions.

This study presents a new exploration on the patients of a single cardiac operation center during 2014–2015, in which some of them had a PC or BC transfusion. Hb about 6–7 mg/dl was shown to be suitable for tissue's oxygen demand; every person who had an Hb under 7.3 mg/dl was a candidate for blood transfusion in our study. One unit of PCs can increase a 70 kg man's hematocrit for about 3%. Due to lack of coagulation factors in these units, we have to administer FFP in the cases of large amount transfusion (more than 5 units). Basically, we administer a platelet unit when the platelet count was under $50,000/\mu\text{l}$; however, in a patient who does not have an active bleeding, we do not administer platelet unless platelet count was under 20–30,000. One unit of platelet can increase a 70 kg adult platelet count for 7000–10,000. In addition, FFP is used regularly in 2–4 units' amount.^[6]

The main finding of our study was the blood pressure transfusion effect on renal status after the surgery. Most of

Table 1: Patient characteristics and details of transfusion and procedures

	No AKI (n=701)	AKI-1 (n=277)	AKI-2 (n=84)	AKI-3 (n=26)	P
Age	53.10±11.98	57.03±15.04	51.00±15.87	53.03±12.42	NS
Weight (kg)	76.00±13.36	73.09±14.83	67.91±16.95	74.26±16.32	NS
Base Hb	12.32±2.16	12.20±1.97	12.18±1.97	11.14±2.25	NS
GFR base	102.3±29.8	80.3±22.1	75.9±22.7	75.9±22.7	<0.0001
GFR maximum	105.8±34.7	64.6±25.3	52.2±27.3	47±25	0.013
EF	42.50±10.60	39.97±11.08	42.25±11.38	40.78±12.20	NS
Female (%)	319 (29.31)	98 (9.00)	41 (3.76)	17 (1.56)	NS
Addiction (%)	48 (4.41)	420 (38.60)	87 (7.99)	23 (2.11)	NS
Convulsion history (%)	8 (0.73)	34 (3.12)	11 (1.01)	4 (0.36)	NS
IDDM (%)	8 (0.73)	22 (2.02)	13 (1.19)	9 (0.82)	NS
NIDDM (%)	2 (0.18)	10 (0.91)	3 (0.27)	1 (0.09)	NS
HTN (%)	16 (1.47)	57 (5.23)	13 (1.19)	12 (1.10)	NS
HLP (%)	4 (0.36)	87 (7.99)	14 (1.28)	15 (1.37)	0.046
Redo (%)	4 (0.36)	44 (4.04)	5 (0.45)	3 (0.27)	NS
Surgery type (%)					
CABG	308 (28.30)	113 (10.38)	33 (3.03)	10 (0.91)	NS
CABG-valve	195 (17.92)	90 (8.27)	25 (2.29)	8 (0.73)	
Valve	158 (14.52)	48 (4.41)	15 (1.37)	5 (0.45)	
Bentall	19 (1.74)	14 (1.28)	5 (0.45)	2 (0.18)	
Congenital	21 (1.93)	12 (1.10)	6 (0.55)	1 (0.09)	
CPB time (min)	91.00±41.53	115.60±38.13	135.73±27.46	142±24.12	0.032
Cross-clamp time (min)	45.02±24.17	62.46±28.42	71.78±21.91	68.19±23.02	0.021
Transfusion					
PLT	3.00±2.82	4.38±1.85	4.50±1.73	5.01±2.10	NS
Fibrinogen	-	1.40±0.51	1.00±0.00	1.83±0.07	NS
PC	1.00±0.57	2.04±1.09	3.40±2.27	3.79±2.03	0.009
FFP	3.50±3.53	4.83±2.03	6.00±1.00	6.30±1.20	NS
Postoperative (%)					
Reexplore	8 (0.73)	22 (2.02)	5 (0.45)	1 (0.09)	NS
Expired in ICU	1 (0.14)	3 (1.08)	5 (5.95)	5 (19.23)	0.001

Hb = Hemoglobin; GFR = Glomerular filtration rate; EF = Ejection fraction; IDDM = Insulin-dependent diabetes mellitus; NIDDM = Noninsulin-dependent diabetes mellitus; HTN = Hypertension; HLP = Hyperlipidemia; CABG = Coronary artery bypass graft; PLT = Platelet; PC = Packed cell; FFP = Fresh frozen plasma; ICU = Intensive Care Unit; NS = Not significant; AKI = Acute kidney injury; CPB = Cardiopulmonary bypass

our patients had a normal renal function (64.43%). It was proved recently that a transfusion of more than 2 units of PC is associated with AKI incidence.

The result of that study indicated a better kidney outcome for the groups, in which the transfusion was circumscribed.^[5] It is well known among the practitioners that blood transfusion is most of the time depending on clinical manifestation; however, using such protocols and algorithm would lead to a more accurate evaluation of patient's status and a better-individualized plan for each person.

The same limitation was faced by our study; though due to a large utilization of such product, the result of our study can be beneficial to assess transfusion criteria. Karkouti in 2015 showed that there is an interrelationship between RBC transfusion and AKI and suggested a reduction in transfusion when it is possible.^[7] In line with other researches,^[3] PC transfusion was significantly associated with AKI occurrence, but the same condition did not apply to BCs.

Furthermore, for the patients who had undergone an on-pump surgery, using Ringer's lactate for priming the extracorporeal system along with ultra-filtration has indicated to be effective for reduction of bleeding and transfusion.^[8] Our study limitation consists of using the AKIN definition in which different confounding variable is not considered.

CONCLUSION

We found a large incidence of AKI among the patients who undergone different cardiac surgeries regardless of operation characteristic. However, BC indicated to be safer for compensating blood loss because of low AKI occurrence among our patients.

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Conflicts of interest

There are no conflicts of interest.

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