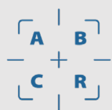

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Justification of the Use of Blood Products in Cardiac Surgery Patients

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ABSTRACT

Background: The aim of this study was to investigate whether patients on dual anticoagulant therapy undergoing cardiac surgery experience more significant bleeding and a greater need for blood products.

Methods: Data were collected from the medical documentation of the Transfusion Center at the University Clinical Hospital (UCH) Mostar and the Department of Cardiac Surgery at the Surgery Clinic, UCH Mostar. Medical histories, records retrieved from the hospital information system (HIS), and the Renovatio system were utilized. The recorded data included age, gender, blood group, Rh factor, type of surgical procedure, and primary and additional diagnoses, as well as hemoglobin levels, smoking habits, and the type and number of doses of blood products used.

Main findings: Age, Rh factor, primary diagnosis, type of surgery, and hemoglobin levels significantly influenced the number of blood product doses administered. On average, more blood product doses were used in male patients. No statistically significant differences were observed in other analyzed parameters.

Principal conclusion: The study demonstrated a justified increased use of blood products in cardiac surgery patients, emphasizing that every transfusion carries risks. When available, rational and justified usage of transfusion therapy provides benefits.

Key words: blood products, blood groups, hemoglobin levels, cardiac surgeries

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INTRODUCTION

Transfusion medicine involves collecting blood from voluntary blood donors, as well as testing, producing, and storing blood products. There are four known blood groups – A, B, AB, and O – which are distinguished by the Rh factor, which can be either positive or negative. Blood products are biologically derived medications produced through various physical processes. Unlike whole blood collected from donors, blood products undergo several processing steps. Commonly used blood products include whole blood, fresh frozen plasma, cryoprecipitate, and red blood cell and platelet concentrates.

The success of transfusion therapy depends on properly indicated transfusion treatment, appropriate selection of blood products, correct dosing, and the characteristics and effectiveness of the product itself. Transfusion therapy is based on the principle of targeted blood transfusion to enhance treatment efficacy and minimize the frequency and severity of adverse effects. Transfusions of blood products and plasma derivatives replenish cells or proteins that the patient lacks. Before initiating transfusion therapy, it is essential to verify the compatibility of the donor's and recipient's blood products. Pre-transfusion testing significantly enhances the safety of transfusion therapy (1).

Cardiac surgery is a branch of surgery dealing with diseases of the heart and large blood vessels. It is considered a relatively young surgical discipline, continually developing and advancing. The discovery of heparin and extracorporeal circulation devices marked significant milestones in the evolution of cardiac surgery. Common procedures include aortic and mitral valve replacement, myocardial revascularization, and heart transplantation (2). Various studies indicate that cardiovascular diseases are becoming increasingly prevalent and require diverse surgical treatment approaches (3).

Cardiac surgery is associated with a high percentage of bleeding during procedures (4). These operations require more blood products than any other medical specialty (5). Transfusion therapy plays a crucial role in cardiac surgical treatment, although every administered dose of blood products carries a risk of adverse effects (6). For patients on dual anticoagulant therapy, preoperative discontinuation of medication is necessary to reduce the incidence of postoperative bleeding and minimize the need for blood products (2). Cardiac surgery is one of the leading consumers of blood products, particularly red blood cell and platelet concentrates, in addition to fresh frozen plasma (7).

Demographic data indicate that populations in developed countries are aging, and older patients require more blood products (8). Protocols and guidelines specify when and to what extent blood replacement is necessary for patients, as well as recommendations for the preparation, use, and quality assurance of blood components.

The main aim of this study is to investigate whether patients on dual anticoagulant therapy undergoing cardiac surgery experience more significant bleeding and an increased need for blood products. By comparing blood product consumption based on age, gender, blood group, Rh factor, body mass index, and primary diagnosis, as well as smoking habits, hemoglobin levels, associated diagnoses, and type of surgery, we aim to assess the justification for the use of blood products in cardiac surgery patients.

PARTICIPANTS AND METHODS

Participants

This is a cross-sectional study conducted at the Transfusion Center and the Department of Cardiac Surgery, Surgery Clinic, University Clinical Hospital (UCH) Mostar. The research included patients over 18 years of age treated at the Department of Cardiac Surgery between

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January 2023 and December 31, 2023, who required blood products from the Transfusion Center. A total of 119 patients participated, including 95 males and 24 females. Patients on dual anticoagulant therapy with complete medical documentation and relevant treatment data were included. The exclusion criteria included incomplete medical documentation and patients not on dual anticoagulant therapy.

Methods

Data were collected from the medical documentation of the Transfusion Center and the Department of Cardiac Surgery. Patient histories and findings from the hospital information system (HIS) and the Renovatio system were used. The collected data included age, gender, blood group, Rh factor, body mass index, and primary and associated diagnoses, as well as hemoglobin levels and smoking habits, in addition to the type of surgery and type and dose of blood products utilized.

Statistical analysis

The statistical analysis employed Spearman's correlation test, the Mann-Whitney U test, and the Kruskal-Wallis test. Statistical data were presented in tables and graphs. Results were interpreted at a significance threshold of 0.05. P-values not expressible to three decimal places were reported as p<0.001. Data analysis was performed using IBM SPSS Statistics (version 25.0, SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel 2019 (Microsoft Corporation, Redmond, WA, USA).

RESULTS

Table 1 revealed a statistically significant positive correlation between the number of erythrocyte doses and a negative correlation between the number of platelet doses with patient age. No significant correlations were observed with other variables presented in the table.

Table 1. Comparison of blood product consumption by age

	Age	
	ρ	p
Erythrocyte concentrate	0.298	**0.002**
Platelet concentrate	-0.788	**0.020**
Fresh frozen plasma	-0.074	0.677
Cryoprecipitate	-0.258	0.742

Patients with a positive Rh factor consume more fresh frozen plasma, and the observed differences were statistically significant (Figure 1).

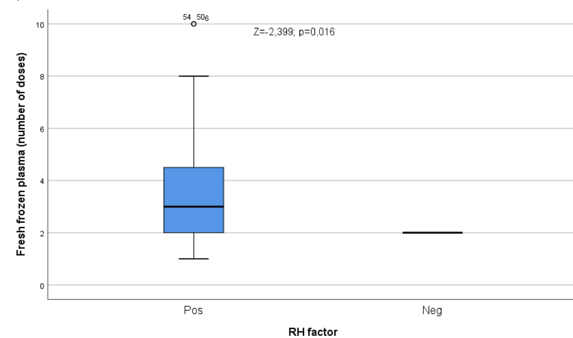

Figure 1. Comparison of fresh frozen plasma consumption by Rh factor

Table 2. Comparison of blood product consumption by hemoglobin levels

	Hemoglobin (g/L)	
	ρ	p
Erythrocyte Concentrate	-0.523	**<0.001**
Platelet concentrate	0.570	0.140
Fresh frozen plasma	0.087	0.624
Cryoprecipitate	0.544	0.456

A statistically significant negative correlation was observed in the consumption of erythrocyte concentrate and hemoglobin levels. No statistically significant differences were found in the consumption of other blood products (Table 2).

There were differences in the consumption and application of erythrocyte concentrate doses based on the primary diagnosis, with significantly higher consumption in mitral insufficiency; however, the difference was not statistically significant (Figure 2).

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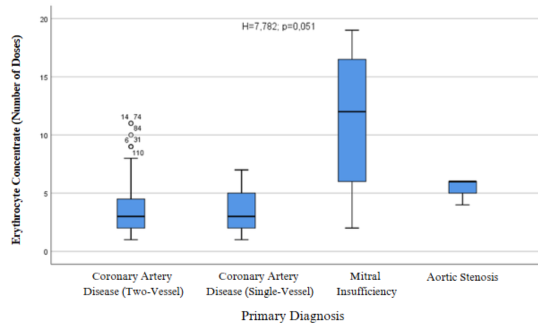

Figure 2. Comparison of erythrocyte concentrate consumption by primary diagnosis

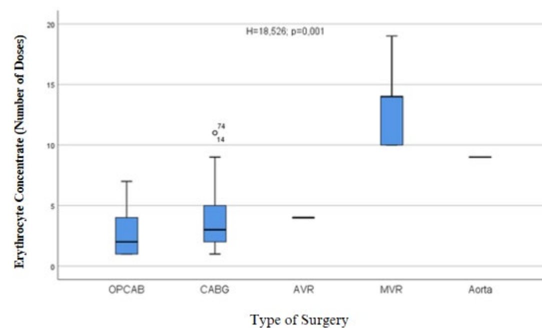

Figure 3. Comparison of erythrocyte concentrate consumption by type of surgery

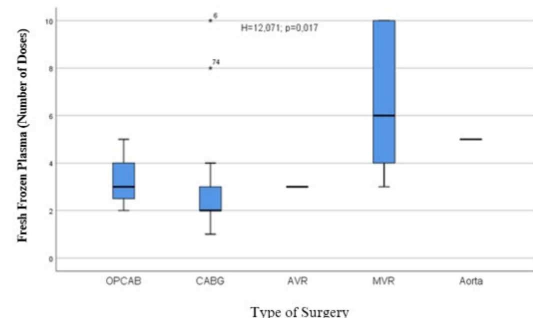

Figure 4. Comparison of fresh frozen plasma consumption by type of surgery

A statistically significant difference was found in the consumption of erythrocyte concentrate doses, with a significantly higher amount used in mitral valve replacement surgery (Figure 3). A statistically significant difference was observed in the consumption of fresh frozen plasma doses, with a significantly higher amount utilized in mitral valve replacement surgery (Figure 4).

DISCUSSION

The aim of this study was to determine the justification for the use of blood products in cardiac surgery patients who are on dual anticoagulant therapy and to examine whether there is a relationship between the consumption and usage of blood products and various observed parameters, with the goal of rationalizing blood product consumption in the Transfusion Center at UCH Mostar. The results of our research demonstrate a statistically significant positive correlation in the consumption and utilization of erythrocyte concentrates and a negative correlation between the number of platelet concentrate doses and the age of the patients. In patients with a negative Rh factor, a statistically significant difference in the consumption of fresh frozen plasma was identified. A statistically significant negative correlation was found between the number of erythrocyte concentrate doses and hemoglobin levels. In mitral valve replacement surgery, a statistically significant consumption of erythrocyte concentrates and fresh frozen plasma was noted.

Our results show both similarities and differences compared to previous works. Studies have revealed that the aging population requires a higher need for blood product replacement (8), which is consistent with our outcomes, where a positive correlation in erythrocyte concentrate consumption with age was identified. By analyzing the use of blood products based on Rh factor, it was confirmed that fresh frozen plasma had higher usage in individuals with a positive Rh factor, with a statistically significant difference; however, there is currently a lack of relevant works on how the Rh factor influences the number of blood product doses used.

In this study, the hemoglobin level was statistically negatively correlated with the number of erythrocyte concentrate doses used, which aligns with expectations, as lower hemoglobin levels require a greater need for transfusion therapy, and hemoglobin levels are utilized as a transfusion trigger. These results

were anticipated given the increased consumption of blood products during cardiac surgeries. The Society of Thoracic Surgeons and the Society of Cardiovascular Anesthesiologists published guidelines in 2007 for transfusion therapy in cardiac surgery patients. Transfusion of erythrocyte concentrates is indicated for patients undergoing coronary artery bypass grafting (CABG) surgery, with hemoglobin levels <70 g/L, and those over 65 years old with chronic cardiovascular or respiratory disease. For patients with hemoglobin levels between 70 and 100 g/L, the effectiveness of transfusion therapy is questionable. Transfusion is recommended for patients with acute blood loss greater than 1500 mL or more than 30% of blood volume (9).

The Transfusion Center at UCH Mostar has issued its own guidelines for transfusion therapy to reduce blood product consumption and the risk of post-transfusion reactions. A study by Kakuta et al. in Canada, which included several thousand patients over 17 years, also showed increased blood product consumption in patients undergoing mitral valve replacement. The research tracked blood product consumption, as well as the surgery outcomes, risk factors, prior heart surgeries, and factors such as body mass index (BMI), hemoglobin, and creatinine. The results demonstrated that complications were more common in mitral valve replacement surgeries and that there was a greater need for blood product replacement compared to other surgeries and diagnoses (10). This paper agrees with our results, which revealed increased consumption of erythrocyte concentrates and fresh frozen plasma in mitral valve replacement surgeries compared to other procedures.

Rasanen et al., in their research, analyzed the difference in erythrocyte concentrate consumption between men and women, and found that women have a greater need for transfusion replacement than men (11). Although women initially have a lower threshold for the usage of erythrocyte concentrates due to lower hemoglobin reference values, this increases transfusion needs and the associated risks. Interestingly, our study did not observe a statistically significant difference in blood product use between men and women, although a higher average number of doses was applied to men than to women. Kreuziger et al., in their research, investigated blood product consumption by blood type and showed that blood group O consumes significantly more than other blood types (12). However, in our results, no difference between blood types was identified, unlike in similar works.

An increased BMI, as one of the main risk factors for cardiovascular diseases (13), did not significantly impact blood product consumption, which seems paradoxical. However, other works have revealed that increased BMI is associated with less bleeding and a decreased need for blood product replacement in patients undergoing cardiac surgery (14). Smoking habits were not statistically significant, which is consistent with research by Roubinian et al., who in a study of over 90,000 patients found no association between smoking and increased transfusion needs (14). Diabetes, hypertension, and hyperlipidemia did not statistically significantly affect blood product consumption. This research included more men than women, which confirms the results of previous investigations indicating that men have a higher cardiovascular risk and are more often subjected to cardiac surgery (15).

This study has limitations, such as a small sample size and the retroactive collection of data from patients' medical records. The research did not track long-term outcomes of surgeries or late post-transfusion reactions, limiting the understanding of transfusion therapy needs. Although there are works on the usage of blood products during cardiac surgery, the influence of individual parameters

on the utilization of specific blood products has not been sufficiently researched. Future investigations should track additional parameters to reduce and improve the quality of blood product use.

CONCLUSION

The use of blood products has its advantages, but also significant risks. Therefore, the utilization of blood products in cardiac surgery patients is increasingly being restricted and rationalized. Clear criteria for the usage of blood products need to be defined. Transfusion therapy is increasingly considered a risk factor for adverse outcomes after cardiac surgery. By rationalizing transfusion therapy, the side effects of blood transfusion treatment could be reduced.

ACKNOWLEDGMENTS

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FUNDING

None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTIONS

We proved that consumption of blood products in cardiac surgery is justified. We proved that elderly persons (above 60 years) consume more blood products than younger persons.

ETHICAL BACKGROUND

Institutional review board statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the School of Medicine. University of Mostar (Reg. No. 01-1-259/24).

Informed consent statement: Informed consent was obtained from all subjects involved in the study.

Data availability statement: We deny any restrictions on the availability of data, materials, and associated protocols.

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