Doi: 10.5152/TJAR.2019.02058

Original Article

Thoracic and Cardiovascular Surgery Anaesthesia

Turkish Journal of Anaesthesiology & Reanimation

The Results of Cardiac Surgery in Terms of Patient Blood Management in Our Hospital

Gökçe Selçuk Sert[1], Mine Çavuş[3], Perihan Kemerci[1], Şerife Bektaş[3], Zeliha Aslı Demir[1], Ayşegül Özgök[1], Doğan Sert[2], Ümit Karadeniz[1]

[1]Clinic of Anaesthesiology and Reanimation, Türkiye Yüksek İhtisas Training and Research Hospital, Ankara, Turkey

[2]Clinic of Cardiovascular Surgery, Türkiye Yüksek İhtisas Training and Research Hospital, Ankara, Turkey

[3]Clinic of Intensive Care, Türkiye Yüksek İhtisas Training and Research Hospital, Ankara, Turkey

ORCID IDs of the authors: G.S.S. 0000-0002-8603-0379; M.Ç. 0000-0003-2584-0463; P.K. 0000-0002-7999-5113; Ş.B. 0000-0001-6057-723X; Z.A.D. 0000-0003-3053-0443; A.Ö. 0000-0002-0105-3388; D.S. 0000-0003-1053-114X; Ü.K. 0000-0002-0067-6938.

Cite this article as: Sert, GS, Çavuş M, Kemerci P, Bektaş Ş, Demir ZA, Özgök A, et al. The Results of Cardiac Surgery in Terms of Patient Blood Management in Our Hospital. Turk J Anaesthesiol Reanim 2019; DOI: 10.5152/TJAR.2019.02058

Abstract

Objective: Clinic of Anaesthesiology and Reanimation, Türkiye Yüksek İhtisas Training and Research Hospital, beginning in 2014, the patient blood management (PBM) protocol is individualised based on patients' comorbidities, and the threshold for transfusion is 7 g dL^{-1} of haemoglobin for patients without comorbidities and 8-9 g dL^{-1} for patients with comorbidities. In this study, our aim was to compare patient outcomes, requirement for transfusion and the cost of transfusion between two different periods with and without PBM protocol.

Methods: 229 and 283 patients who underwent open-heart surgery using cardiopulmonary bypass during the first 4 months of 2012 and the first 4 months of 2017, respectively, were included in this retrospective, cross-sectional study.

Results: There were no differences between the groups in preoperative data. Blood and blood product usage was observed to be significantly lower at the time of the PBM protocol. The use of packed red blood cells decreased from 2 units to 0and that of fresh frozen plasma decreased from 2 units to 0. In terms of postoperative mortality, there were no differences between the groups.

Conclusion: According to the results of this study, the transfusion of unnecessary blood and blood products was reduced and the cost decreased with PBM protocol. Blood product usage did not affect 30-day mortality. It will be possible to achieve more valuable results if more patients are assessed, PBM protocol is implemented and postoperative results are evaluated in detail.

Keywords: Cardiac anaesthesia, cardiopulmonary bypass, haemoglobin threshold value, packed red blood cells, patient blood management, perioperative bleeding

Introduction

Patient blood management (PBM) is a multidisciplinary, evidence-based approach for the care of patients who may require transfusions during surgery. It is individualized according to the needs of each patient and involves evaluating the patient hematologically, developing a perioperative management plan to improve preoperative blood parameters, and assessing the general condition of the patient being prepared for the operation. The basic steps of PBM include pre-treating problems that may result in transfusion, minimizing blood loss, and idealizing anaemia tolerance (1).

As a prevalent problem, preoperative anaemia is encountered in 16-54% of all cardiac surgeries (2-4), which are major procedures that may result in significant blood loss. The introduction of a PBM program in cardiac surgery is expected to detect and treat preoperative anaemia, reduce perioperative blood loss and increase anaemia tolerance.

This study was previously presented at the 24th Meeting of the Society of National Thoracic- Cardiovascular Surgery Anaesthesia and Intensive Care which was held on between 3-6 May, 2018 in İzmir, Turkey

Corresponding Author: Gökçe Selçuk Sert E-mail: gokcesert83@gmail.com

Received: 17.09.2018 Accepted: 30.10.2018
Available Online Date: 22.05.2019

When we partially implemented a PBM program in the anaesthesia clinic of our hospital in 2014, the haemoglobin value for intraoperative transfusion was determined as 7 g dL^{-1} in patients without comorbidity and 8-9 g dL^{-1} in patients with comorbidity. In this study, we aimed to compare two groups of patients who underwent cardiac surgery at two different time periods with and without PCM protocol, and determine the transfusion requirements, transfusion costs and survival rate.

Methods

Following approval from our local ethics committee at Turkey Yuksek Ihtisas Hospital (date: 16.08.2018, number: 29620911), patients who underwent elective open heart surgery using cardiopulmonary bypass in January, February, March and April 2012 and in January, February, March and April 2017 were included in our retrospective cross-sectional study. The exclusion criteria were: patients who had undergone revisions or reoperations, surgeries performed of pumping hearts, paediatric patients, placement of devices for left and right ventricular support, patients undergoing vascular congenital surgeries, and patients under emergency conditions. Demographic data of both time periods, use of intraoperative blood and blood products, haemorrhage, cross clamp, cardiopulmonary bypass durations, and 30-day mortality data were obtained from files and electronic data systems. The cost of blood and blood products per patient were calculated.

In the 2014 PBM program, patients with deep anaemia were referred to the haematology clinic. No patient was treated with erythropoietin but some cases have taken intravenous iron supplement in our clinic. For patients with a high risk of bleeding (thoracoabdominal aortic and ascending aortic aneurysms, dissections) who were scheduled for surgical procedures, cell saver was used for intraoperative blood loss reduction, where 1 mg kg^{-1} dose of tranexamic acid was administered to them. At the beginning of the cardiopulmonary bypass, the patient's blood was removed for autologous donation and was re-transfused at the end of the operation. The cardiopulmonary bypass pump was primed with less volume and the excess prime solution was taken out of the lines at the time of entry into the pump after venous cannulation (retrograde autologous prime). In the intraoperative period, the threshold haemoglobin values were accepted as 7 g dL^{-1} and 8-9 g dL^{-1} for patients without and with comorbidity respectively, although the values could change with respect to patients and conditions. Patients (especially high-risk cases) were monitored to measure cardiac output, systemic vascular resistance, stroke volume variability, pulse pressure variability, pulse rate variability index, near infrared spectroscopy, and transesophageal echocardiography. With the help of the data obtained from devices, heart rates and fluid responsiveness of the patients were evaluated and anaemia tolerance was tackled with targeted treatment.

Statistical analysis

In statistical analysis, continuous variables were evaluated as average ± standard deviation, differences between groups were evaluated using the Kolmogorov-Smirnov test, data showing normal distribution were evaluated with the Independent variables t-test, and Mann-Whitney-U test was used for data not showing normal distribution.

Results

A total of 229 patients who underwent elective open heart surgery using cardiopulmonary bypass in the first four months of 2012 and 283 patients who underwent the same operation in the first four months of 2017 were included in our retrospective cross-sectional study. Characteristic variables, diseases present during the preoperative period, preoperative haemoglobin, haematocrit values, platelet levels, and INR values are given in Table 1. In our hospital, all patients were operated upon after achieving normal INR values preoperatively (medication was discontinued in case of the use of warfarin). The patient demographics were similar in both groups. Data on intraoperative cross-clamp duration, cardiopulmonary bypass duration, intraoperative

Table 1. Demographic and preoperative laboratory data for both periods

	Year 2012 n=229	Year 2017 n=283	p
Age (mean±SD)	60±11	56±14	0.09
F/M	54/175	75/ 208	0.12
BMI (mean±SD)	31±17	29±11	0.85
Hypertension, n and %	40 (17)	38 (13)	0.56
Diabetes mellitus, n and %	11 (5)	19 (7)	0.31
COPD, n and %	25 (11)	32 (11)	0.39
Renal disease, n and %	7 (3)	11 (4)	0.39
Neurological disease, n and %	21 (9)	27 (10)	0.41
Haemoglobin (mean±SD)	13±1.6	14±1.8	0.44
Haematocrit (mean±SD)	39±5	41±5	0.33
Platelets (mean±SD)	220±46	228±54	0.65
INR (mean±SD)	1.4±0.5	1.5±1	0.53

COPD: Chronic obstructive pulmonary disease; SD: standard deviation

Table 2. Intraoperative data

	Year 2012 n=229	Year 2017 n=283	p
CPB duration (mean±SD)	99±36	105±53	0.12
Cross-clamp time (mean±SD)	68±28	75±38	0.08
Erythrocyte suspension (U) (mean±SD) (median, min-max)	2.3±1.2 2 (0-6)	0.7±1.2 0 (0-5)	0.001*
Fresh frozen plasma (U) (mean±SD) (median, min-max)	1.9±0.6 2 (0-4)	0.5±1.1 0 (0-5)	0.001*
Intraoperative bleeding (mL)	780	750	0.32
Coronary surgery, n and %	150 (65)	162 (57)	0.41
Valve surgery, n and %	50 (21)	63 (22)	0.58
Others, n and %	29 (14)	58 (21)	0.31

*statistically significant. CPB: cardiopulmonary bypass; SD: standard deviation

bleeding amounts, types of surgery and the use of blood and blood products are provided in Table 2. The use of blood and blood products was significantly lower during the application of PBM program. It was observed that the use of erythrocyte suspension and fresh frozen plasma decreased to 0 from 2 units, each., . While 5 U and 6 U red blood cell suspensions were used in 2 isolated cases out of 229 patients in 2012, 5 U erythrocyte suspension was used in 1 case out of 287 patients in 2017. After the commencement of PBM program, approximately 140 of the total patients we investigated in 2017 did not use any blood or blood products. There were no differences between the groups in the durations of use of intraoperative cross clamp, cardiopulmonary bypass, bleeding amounts, and surgical types. In terms of the cost of application of PBM, the cost of erythrocyte suspension per patient decreased from 627 TL (Turkish lira) to 140 TL, while the cost for the fresh frozen plasma decreased from 184 TL to 36 TL.

Discussion

In the current study, we observed that the rate of intraoperative blood and blood product usage per patient decreased significantly since we implemented the PBM program in our hospital. Before the use of PBM, 5 U erythrocyte suspension and 2 U fresh frozen plasma were routinely transfused regardless of the indication (median values 2 U and 2 U respectively), as soon as the patient went under anaesthesia. After the initiation of PBM program, all routine transfusions were stopped, patients were monitored more carefully and a transfusion decision was taken only where necessary (median values 0 U and 0 U respectively).

The previous demands for blood and blood product use have decreased over time as the surgeons' current knowledge of blood and its products has been enhanced. Although unnecessary transfusion has decreased and the use of antifibrinolytic agents and cell saver has increased, no decreasein intraoperative bleeding was observed. This may be due to the fact that the use of tranexamic acid is still not routine and the use of cell saver is preferred in special cases due to its high cost. When the economic data related to PBM is analysed, the cost of erythrocyte suspension per patient decreased from 627 TL to 140 TL, whereas the cost of fresh frozen plasma decreased from 184 TL to 36 TL.

Besides positive developments such as the limitation of unnecessary transfusions and cost reduction, some problems exist in terms of preoperative patient preparation. After the start of the PBM program in our hospital in 2014, the patients who had deep anaemia in the preoperative period were referred to the haematology clinic. These patients were treated under the supervision of haematology department. On the contrary, patients with moderate and mild early-stage anaemia were not be able to be treated in the early stage, but as time passed by, more patients were evaluated in terms of preoperative anaemia. Those with iron deficiency were treated preoperatively with iron therapy under the guidance of the clinicians, but in spite of this, the adequate sensitivity of this procedure has not been reached yet. Although this issue has been addressed with the haematology clinic under the guidance of some clinicians, patients still continue to undergo surgery without treatment in the preoperative period for iron deficiency anaemia, possibly also because administering iron and other nutritional therapies is time-consuming, even if preoperative anaemia is present and the aetiology is differentiated.

The adverse medical effects of long-term waiting on the patient in cardiac surgery as well as the fact that surgeons do not want to postpone these surgeries are the reasons for restriction of the treatment of preoperative anaemia. Therefore, we can conclude that PBM is not fully performed in the preoperative period.

As seen in this study, preoperative haemoglobin levels in patients in both periods were found to be 13 g dL^{-1} and above. In general, although this value is above the criteria for anaemia, it could be more accurate to classify patients according to their preoperative haemoglobin levels and analyse the blood and blood product usage accordingly, although transfusion ultimately aims to increase the oxygen delivery to tissues, replace the factor deficiencies, and repair the coagulation mechanism, transfusion has many immunological and non-immunological side effects in the acute and chronic phase. In cardiac surgery, transfusion has been proposed as an independent risk factor for poor clinical outcomes (5-7), however, in recent years, it has been claimed that approaches that limit transfusion do not make any difference in the results of the surgery (8, 9).

In our study, no difference was found between the groups in terms of postoperative 30-day mortality. Since the correct information on patients' postoperative complications could not be reached in our study, morbidity data could not be obtained and the evaluations were performed depending only on the 30-day mortality. A close look at the patients who underwent high transfusion revealed that 5 U was applied to 1 case, 6 U was applied to 1 of the 229 patients in the pre-PBM period, and 5 U erythrocyte suspension was applied to one out of the 283 patients in the post-PBM period. In our hospital, after the initiation of PBM program, it was seen that no blood and blood product were used in the case 140 patients.

Patients who had preoperative anaemia were not investigated separately in the current study, and the investigation of anaemic patients with further comprehensive prospective studies may give good results. In 2012, we observed that the patient had transfusions without considering haemoglobin values. However, after the patient's blood management program was put on the agenda, blood and blood product transfusion were not performed unless the haemoglobin value did not fall below the values determined according to comorbidities.

Conclusion

According to the results of our cross-sectional retrospective study, we found that unnecessary blood and blood product transfusions were reduced and the cost per patient decreased with the application of PBM program. With these findings, postoperative 30-day mortality was not affected by blood and blood product usage rates. Consequently, the use of a rigorous surgical technique, a targeted coagulation algorithm and the use of a more restrictive transfusion threshold resulted in a significant reduction in blood and blood product transfusions at a lower cost. This shows that the PBM principles are effective, even though the PBM program is not fully implemented. It will be possible to reach more valuable results by further studies that include more patients, which can be fully implemented where the postoperative results are evaluated in detail.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Türkiye Yüksek İhtisas Hospital (Date: 16.08.2018, No: 29620911).

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept G.S.S, Z.A.D.; Design G.S.S., M.Ç., Z.A.D.; Supervision Ü.K., Z.A.D., A.Ö.; Resources G.S.S.; Data Collection and/or Processing G.S.S., P.K., D.S., M.Ç.; Analysis and/or Interpretation G.S.S., D.S., Z.A.D., Ş.B., A.Ö.; Literature Search G.S.S., M.Ç., P.K.; Writing Manuscript G.S.S., Z.A.D.; Critical Review G.S.S., Z.A.D., D.S., P.K., A.Ö., Ü.K.; Other Ş.B.

Conflict of Interest: The authors ha ve no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Shander A, Hofmann A, Isbister J. Patient blood management-the new frontier. Best Pract Res Clin Anaesthesiol 2013; 27: 5-10. **[CrossRef]**
2. Kulier A, Levin J, Moser R, Rumpold-Seitlinger G, Tudor IC, Snyder-Ramos SA, et al. Impact of preoperative anemia on outcome in patients undergoing coronary artery bypass graft surgery. Circulation 2007; 116: 471-9. **[CrossRef]**
3. Van straten AH, Hamad MA, Van Zundert AJ, Martens EJ, Schönberger JP, de Wolf AM. Preoperative hemoglobin level as a predictor of survival after coronary artery bypass grafting: a comparison with the matched general population. Circulation 2009; 120: 118-25. **[CrossRef]**
4. Hung M, Besser M, Sharples LD, Nair SK, Klein AA. The prevalence and association with transfusion, intensive care unit stay and mortality of pre-operative anaemia in a cohort of cardiac surgery patients. Anaesthesia 2011; 66: 812-8. **[CrossRef]**
5. Lapar DJ, Crosby IK, Ailawadi G, Ad N, Choi E, Spiess BD, et al. Blood product conservation is associated with improved outcomes and reduced costs after cardiac surgery. J Thorac Cardiovasc Surg 2013; 145: 796-804. **[CrossRef]**
6. Karkouti K, Wijeysundera DN, Yau TM, McCluskey SA, Chan CT, Wong PY, et al. Influence of erythrocyte transfusion on the risk of acute kidney injury after cardiac surgery differs in anemic and nonanemic patients. Anesthesiology 2011; 115: 523-30. **[CrossRef]**
7. Vermeulen Windsant IC, de Wit NC, Sertorio JT, Beckers EA, Tanus-Santos JE, Jacobs MJ, et al. Blood transfusions increase circulating plasma free hemoglobin levels and plasma nitric oxide consumption: a prospective observational pilot study. Crit Care 2012; 16: R95. **[CrossRef]**

8. Hajjar LA, Vincent JL, Galas FR, Nakamura RE, Silva CM, Santos MH, et al. Transfusion requirements after cardiac surgery: the TRACS randomized controlled trial. JAMA 2010; 304: 1559-67. **[CrossRef]**

9. Weltert L, Nardella S, Rondinelli MB, Pierelli L, De Paulis R. Reduction of allogeneic red blood cell usage during cardiac surgery by an integrated intra- and postoperative blood salvage strategy: results of a randomized comparison. Transfusion 2013; 53: 790-7. **[CrossRef]**