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Benefit from using recycling red blood cells in cardiovascular surgery

Benefício do uso de recuperadores de hemácias em cirurgias cardiovasculares

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Abstract

Objective: **To show if blood salvage is indicated in all patients submitted to cardiovascular surgery with cardiopulmonary bypass.**

Methods: **We studied 77 consecutive patients submitted to cardiac surgery with use of blood salvage and cardiopulmonary bypass from November 2010 to June 2012. The sample was divided in three groups, depending on the time of cardiopulmonary bypass. In group A, the time of cardiopulmonary bypass was smaller than 45, in group B from 45 to 90 and in group C greater than 90 minutes. We analyzed the volume of red cells recovered and infused, the pre, intra and post-operative hemoglobin, the number of packed red cells units which were transfused and hematocrit and hemoglobin blood infused.**

Results: **The average group age was 60.44±12.09 years old, of whom 71.43% were males. The group A was formed by 5.19% of the patients, B by 81.82% and C by 12.99%. The volume of erythrocytes recovered and infused was respectively 1,360.50±511.37 ml and 339.75±87.71 ml in group A, 1,436.63±516.06 ml and 518.83±183.0 ml in B and 2,137.00±925.04 ml and 526.20±227.15 ml in C. About packed red cells transfusions, in group A 1,00±2,00 packed red cells were transfused, in B 1.27±1.85 packed red cells and in C 2.56±2.01 packed red cells. The infused blood had a hematocrit of 50.97±12.06% and hemoglobin of 19.57±8.35 g/dl.**

Conclusion: **That blood salvage can be used in patients submitted to cardiovascular surgery with cardiopulmonary bypass. However, it is only cost-effective in surgeries in which the time of cardiopulmonary bypass is greater than 45 minutes.**

Descriptors: **Operative Blood Salvage. Cardiovascular Surgical Procedures. Cardiopulmonary Bypass.**

Resumo

Objetivo: **Avaliar se o uso de recuperadores de hemácias está indicado nos pacientes submetidos à cirurgia cardiovascular com o uso de circulação extracorpórea.**

Métodos: **Foram estudados 77 pacientes submetidos a cirurgias cardíacas com uso de recuperadores de hemácias e circulação extracorpórea de novembro de 2010 a junho de 2012. A amostra foi subdividida em três grupos, conforme o tempo de circulação extracorpórea. No grupo A , o tempo de circulação extracorpórea foi menor que 45, no grupo B, de 45 a 90 e, no grupo C, maior que 90 minutos. Analisou-se o volume recuperado e infundido de hemácias, a hemoglobina de pré, trans e pós-operatório, número de unidades de concentrado de hemácias transfundidas, volume globular e hemoglobina do sangue infundido.**

Resultados: **A idade média, dos pacientes, foi de 60,44±12,09 anos, sendo 71,43% do sexo masculino. O grupo A é formado por 5,19%, o B por 81,82% e o C por 12,99% dos pacientes. O volume recuperado e infundido foi, respectivamente, de 1.360,50±511,37 ml e 339,75±87,71 ml no grupo A, 1.436,63±516,06 ml e 518,83±183,0 ml no B e 2.137,00±925,04 ml e 526,20±227,15 ml no C. Em relação às transfusões de concentrado de hemácias, no grupo A foram transfundidas 1,00±2,00 concentrado de hemácias, no B 1,27±1,85 concentrado de hemácias e no C 2,56±2,01 concentrado de hemácias. O sangue infundido tinha um volume globular de 50,97±12,06% e hemoglobina de 19,57±8,35 g/dl.**

Conclusão: **O recuperadores de hemácias podem ser usados em pacientes submetidos à cirurgia cardiovascular com circulação extracorpórea, mas somente em cirurgias com tempo de circulação extracorpórea acima de 45 minutos o reaproveitamento de sangue é custo/efetivo.**

Descritores: **Recuperação de Sangue Operatório. Procedimentos Cirúrgicos Cardiovasculares. Ponte Cardiopulmonar.**

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Abbreviations, acronyms and symbols	
CPB	cardiopulmonary bypass
RBC	Red blood cells
ASD	Atrial septal defect
CABG	Coronary artery bypass surgery
Hb	Hemoglobin
SRBC	Salvaged RBC
PCV	Packed cell volume

INTRODUCTION

The operative blood salvage (BS) or red blood cell (RBC) salvage have been used for almost 30 years and have innovated in the field of autotransfusion. BS salvage are used for the intraoperative recovery and re-administration of erythrocytes in most cases, but it can also be used postoperatively[1]. These salvage systems have mainly benefited autologous blood surgical procedures where major blood loss occurs. The benefit is demonstrated by studies that ensure the safety and the quality of the salvaged blood, and it significantly reduces the need for homologous transfusions during surgery and especially in cardiovascular surgery[1,2]. It is known that blood transfusions increase morbidity and mortality in patients undergoing cardiovascular surgery[3,4].

Risks associated with blood transfusions, such as transmission of viruses, also volunteered to search for improvement of these methods to further reduce patient exposure to homologous blood.

Another aspect to the use of BS is related to religious beliefs and the right of choice, which have led some patients to refuse the transfusion of blood or its products in any circumstance. But in multicultural health care system of today, patients seeking alternatives to blood transfusion are not only motivated by religious reasons[1].

Several studies have shown that when BS are used a reduction occurs in blood transfusions in patients undergoing cardiovascular surgery[5,6]. However, other authors reported that the use of BS has no clinical benefit in a particular group of patients because it is not cost-effective[7] and does not reduce the need for homologous blood transfusion[8].

In order to clarify the benefit of BS, this study aims to assess if the use of this technique is indicated in patients undergoing cardiovascular surgery with cardiopulmonary bypass (CPB).

METHODS

This is a descriptive, prospective study performed at the Institute of Cardiovascular Surgery of do Oeste do Paraná, in a group of 77 consecutive patients undergoing cardiovascular surgery with CPB and HR, from November 2010 to April 2012. In this study all patients who underwent reoperations were excluded. The sample was divided into group A, B and C, according to the duration of CPB. In group A, CPB time was less than 45 in group B between 45 and 90 and in group C greater than 90 minutes.

All patients made use of partial hemodilution and hemofiltration on CPB and underwent anesthetic induction with use of midazolam and remifentanil and for maintenance sevoflurane was used. After median sternotomy and confection of bags for cannulation, patients received heparin at 300 U/kg in order to obtain an activated clotting time greater than 400 seconds; controls were performed every 60 minutes. It was also used an adult membrane oxygenator (Braile Biomédica, São José do Rio Preto, SP, Brazil), with a total fill volume of 500 ml. We used antegrade blood cardioplegia for infusion. The RBCs salvage used throughout the surgery was autoLog Autotransfusion System (Medtronic, Minesota, USA), and at the end the blood of the CPB system was processed by HR.

The criterion for transfusion of red blood cells (RBC) was concentrated hemoglobin (Hb) below 8 g/dl or 9 g/dl when there was hemodynamic instability. The number of units of plasma, platelets and cryoprecipitate used were not assessed because it is not the aim of the study. A blood count was obtained before surgery, on arrival of the patient to the intensive care unit (ICU), and 24 hours after the day of discharge. The packed cell volume (PCV) and Hb were tabulated, as well as the volume of blood aspirated by HR, the volume of blood infused, the number of RBC transfused, the type of surgical procedure and CPB time.

The study was approved by the Research Ethics Committee of the Faculdade Assis Gurgacz, under the protocol number 154/2012.

Statistically continuous variables are represented by the mean and the standard deviation, which was used in the Fischer test to assess the variables in this study, with a confidence interval of 95%. We use the statistical variables of age, gender, type of surgery, CPB, hemoglobin and unit of RBC transfused, to know whether the use of BS is indicated in all patients undergoing cardiovascular surgery with CPB.

RESULTS

The age of patients ranged from 26-84 years with a mean of 60.44±12.09 years. Group A consisted of 5.19% (n=4) of patients, 81.82% by B (n=63) and 12.99% by C (n=10). The majority of subjects were male, but presented different predominance in relation to groups, being 25.00% in group A, group B 76.19% and 70.00% in group C.

The mean CPB time was 35.00±7.66 minutes in group A, 65.38±10.31 in B and 112.00±22.79 in C. In group A one patient underwent surgery coronary artery bypass graft (CABG), one aortic valve replacement, one mitral valvuloplasty and one correction of an atrial septal defect (ASD); in B 76.19% (n=48) underwent CABG, 20.63% (n=13) valve replacement, 1.59% (n=1) removal of left atrial myxoma

and 1.59% (n=1) aneurysm; in C 80.00% (n=8) underwent CABG and 20.00% (n=2) aneurysm (Table 1).

The salvaged volume and infused was respectively 1360.50±511.37 ml and 339.75±87.71 ml in group A, 1,436.63±516.06 ml and 51.83±183.00 ml in B and 2,137.00±925.04ml and 526.20±227.15ml in C (Table 2). The salvaged volume was statistically significant when related to the CPB time in group B (*P*=0.008) and group C (*P*<0.001). The volume infused was not significant (Table 2).

Regarding RBC transfusions, four units of were used in group A, in group B 80 and 23 in group C. The average usage of RBC units was 1.00±2.00, 1.27±1.85 and 2.56±2.01, in groups A, B and C, respectively (Table 2). Only one patient in group A needed blood transfusion. In B, 31 of 63 subjects needed 2.58 units of RBC. In group C, as a postoperative death occurred for neurological reasons, this patient did not enter the counting of patients who needed or not RBC, thus 77.77% of patients (n=7) required 3.28 RBC units. The RBC units transfused was related to duration of CPB in each group, but not statistically significant (Table 2).

In groups A, B and C, the mean preoperative Hb were 113.45±1.39, 13.58±3.31, 13.0±1.52 g/dl, transoperative Hb of 11.10±1.88, 10.87±1.73, 10.45±1.57 g/dl, postoperative 9.78±1.79, 9.84±1.30, 10.54±1.39 g/dl and Hb at discharge of 10.80±1.18, 9.35±1.10, 9.13±0.93 g/dl. (Table 2). The pre-, trans- and postoperative Hb levels were high and were related to the duration of CPB in each group, with significant high Hb in group B (*P*=0.049) and group C (*P*=0.028) (Table 2).

Table 1. Type of surgeries.

	Type of surgeries								
	GROUP A	F-TEST	*P* VALUE	GROUP B	F-TEST	*P* VALUE	GROUP C	F-TEST	*P* VALUE
CABE	25% (n=1)	1.212	0.274	76.19% (n=48	0.650	0.422	80% (n=8)	0.182	0.670
Aortic valve replacement	25% (n=1)	29.899	<0.001	20.63% (n=13)	0.036	0.112	0%	0	
Mitral repair	25% (n=1)	29.899	<0.001	0%	6.228	0.014	0%	0	0
Removal of left atrial myxoma	0%	0.176	0.274	1.59% (n=1)	0.036	0.848	0%	3.137	0 0.080
Aneurysm repair	0%	0.468	0.496	1.59% (n=1)	6.774	0.011	20% (n=2)	3.137	0.080
Interatrial communication repair (IAC)	25% (n=1)	29.899	<0.001	0%	6.228	0.014	0%	0	0

Table 2. Mean and standard deviation of the salvaged volume, infused volume, Hb infused blood, VG infused blood, preoperative Hb, transoperative Hb, postoperative Hb, high Hb, RBC unit.

	Mean standard deviations								
	GROUP A	F-TEST	*P* VALUE	GROUP B	F-TEST	*P* VALUE	GROUP C	F-TEST	*P* VALUE
Salvaged volume	1360.50 ± 511.37 ml	0.288	0.593	1436.63 ± 516.06 ml	7.36	0.008	2137.00 ± 925.04 ml	12.96	<0.001
Infused Volume	339.75 ± 87.71 ml	3.571	0.062	518.83 ± 183.02 ml	0.665	0.417	526.20 ± 227.15 ml	0.082	0.774
Hb of infused blood	18.13 ± 3.11 ml	0.149	0.700	17.54 ± 2.91 ml	2.824	0.097	20.00 ± 8.90 ml	4.583	0.035
VG of infused blood	53.56 ± 9.46 ml	0.966	0.328	52.76 ± 8.62 ml	1.576	0.213	51.00 ± 12.58 ml	4.064	0.047
Preoperative Hb	13.45 ± 1.39 g/dl	0.001	0.972	13.58 ± 3.31 g/dl	0.182	0.670	13.08 ± 1.52 g/dl	0.217	0.642
Transoperative Hb	11.10 ± 1.88 g/dl	0.109	0.741	10.87 ± 1.73 g/dl	0.209	0.648	10.45 ± 1.57 g/dl	0.555	0.458
Postoperative Hb	9.78 ± 1.79 g/dl	0.001	0.972	9.84 ± 1.30 g/dl	0.300	0.585	10.54 ± 1.39 g/dl	0.367	0.546
High Hb	10.80 ± 1.18 g/dl	0.010	0.919	9.35 ± 1.10 g/dl	3.971	0.049	9.13 ± 0.93 g/dl	4.98	0.028
RBC units	1.00 ± 2.00	0.176	0.675	1.27 ± 1.85	1.394	0.241	2.56 ± 2.01	2.718	0.103

The infused blood had a VG of 50.97±12.06% and 19.57±8.35 Hb g/dl, mean with their standard deviations, and the minimum values of PCV and Hb respectively 22.8% and 7.40 g/dl and maximum of 66.00% and 22,00g/dl. Hb and PCV of the infused blood were 18.13±3.11 ml and 53.56±9.46 ml in group A, 17.54±2.91 ml and 52.76±8.62 ml in B and 20.00±8.90 and 51.00±12.58 ml in group C, with Hb statistical significance (*P*=0.035) and VG (*P*=0.047) in group C (Table 2).

DISCUSSION

The use of SB was started in 1970 in the USA, in response to the increasing number of cardiovascular surgery and at the end of the last century, the use was expanded to Europe[9]. Since then this technique is being discussed[10]. Early in the 80s, some authors have already positioned themselves against the indiscriminate use of SB, because it did not decrease both costs and the use of homologous blood[11].

However, the inherent complications of blood transfusion such as increased risk of infectious events, episodes of atrial fibrillation, acute renal failure, stroke and increased hospital stay[12], or their byproducts, associated with benefits in reducing this use makes that before administering a transfusion, all alternative resources available are tempted. The benefits are: avoid the drastic reduction of the blood supply available, the best result of the treatments, disputes, religious fundamentals, motivation for a more restrictive transfusion practices, satisfaction of the medical-surgical team and still meeting the preferences of patients[1,13]. In addition, there is a reduction in the overall cost of the treatments, as more controls are needed to prevent the transmission of diseases by blood increasing costs of homologous transfusions. This improves the cost-effectiveness of the SB[14].

The aim of BS is to recover the blood that was shed in the surgical field in order to reduce the need for allogeneic transfusion. According to some writers, the BS can be indicated in many types of elective surgery, such as cardiovascular surgery, hip, spine and liver transplants[15,16], and emergency when the blood loss must be at least 800 -1000 mL[2]. Other authors claim that the blood loss can be between 600-800 mL[17]. All our patients were advised to use BS as the minimum of recovered blood was 749 mL, agreeing with the guidelines used by the National Health Service, which states that the use of BS in cardiovascular surgery with CPB should be performed at the surgeon's discretion and can be cost effective[18].

As, on average, one-third of the recovered blood is infused[17], all patients in this study benefited from the use of BS, but only in groups B and C the BS was cost effective because the volume of blood infused was sufficient to costs which would overcome by the use of RBC. Moreover, the longer the CPB, the greater the volume of blood recovered and, as previously reported[1,2], this blood recovered has quality, the PCV 50.97±12.06% and Hb 19.57±8.35 g/dl.

Several studies have examined the benefits of BS in cardiac surgery using cardiopulmonary bypass[5,19]. It has been reported that the use of BS in on-pump surgery reduces the need for transfusions compared to patients who undergo cardiac surgery without the use of BS[6,20]. This study showed that the duration of CPB is related to the greater use of RBC, with an average of 2.56 units of RBC in group C, 1.27 in B and 1.00 in A, however, it was not a significant factor, and the majority (n=7) from group C required RBC (2.56), 49.21% in group B and a minority (n=1) in group A.

The major aim in the use of BS is to present the ability to decrease the use of units of RBC in patients and thus reduce inflammatory reactions and mortality, with no complications or contraindication for the use of the method. This care must be taken simultaneously with a perfect hemostasis both in the initial dieresis as before synthesis in cardiovascular surgery[20].

CONCLUSION

BS can be used in patients undergoing cardiovascular surgery with CPB in view there is no contraindication or morbidity resulting from its use, but only in surgery with CPB time greater than 45 minutes the reuse of blood is cost-effective.

Author's roles & responsibilities	
MS	Review of medical records, filling out spreadsheets, research references, drafting the text and tables
RMSA	Formatting the study, preparation of spreadsheets, literature review, research references, final revision of the text
MHZC	Statistical analysis, text review, aid in the preparation of tables

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