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EXPERIENCES IN THE USE OF INTRAOPERATIVE BLOOD-SAVING TECHNIQUES AND TRANSFUSION REQUIREMENTS IN CARDIOVASCULAR SURGERY: A STUDY IN A HIGH COMPLEXITY CENTER IN BOGOTÁ (2019- 2021)

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Abstract: *Introduction:* Cardiovascular surgery is one of the specialties with the highest demand for allogeneic hemo-components, due to its complexity and type of pathologies, added to the exposure of the patient to the alteration of coagulation physiology with extracorporeal circulation, this influences the increase of bleeding and consequently increases the use of blood units and blood derivatives. The blood- saving techniques Acute Normovolemic Hemodilution (ANH), autologous retro purging (APR), and cell salvage (CS) are a set of multimodal techniques that allow the conservation of autologous blood intending to reduce the use of blood transfusions in the patient undergoing cardiovascular surgery. *Objective: to* analyze the results of intraoperative blood-saving techniques and their relationship with transfusion requirements in patients undergoing cardiovascular surgery in a high-complexity institution in the city of Bogota 2019-2021. *Methodology:* a quantitative, single-center, analytical observational cross-sectional study will be carried out. It will include 138 elderly patients operated on by the cardiovascular surgery service of Los Cobos Medical Center in the period from March 2019 to December 2021. Variables related to the clinical characteristics of the patients and the use of hemocomponents will be measured. Descriptive statistics will be applied, and hypothesis tests of comparison of proportions and confidence intervals for the estimators, the statistical significance value is 0.05. *Results:* Among the most relevant findings, it was identified that, in the center's experience, HNA was one of the most widely used blood-saving techniques, with an average recovery of between 300 and 1200 mL. Concerning re-interventions due to bleeding, the highest prevalence was found in patients who underwent CS. *Discussion:* Blood conservation in cardiac surgery using blood-saving techniques requires more effort and a team approach, which will allow the reduction of complications due to allogeneic transfusion, cost reduction, and better use of blood components available in the institution.

INTRODUCTION

Cardiovascular surgery is one of the specialties with the highest risk of intraoperative hemorrhage; approximately 18% of the blood components available in institutions providing highly complex health services are used in this type of procedure, which implies an increase in the demand for units of blood and blood components in transfusion services (1). The literature indicates that up to 60% of patients undergoing these procedures are transfused and that about 20% of blood products in blood banks are used to meet this need (2). On the other hand, in 2010 the Pan American Health Organization (PAHO) reported that for cardiovascular surgery an average of 10.60 units of blood are needed for each patient (3).

Bearing in mind that bleeding is an influential determinant in the use of blood products, it is important to identify the risk factors associated with its occurrence from the preoperative evaluation, in which the patient's condition and pathologies are studied, and intraoperatively and postoperatively by monitoring the patient's evolution during extracorporeal circulation (ECC). In this sense, it is essential to recognize that although the use of ECC is oriented to mechanically simulate circulation, gas exchange, water-electrolyte balance, and acid-base status (4,5), it can also trigger coagulopathies and bleeding derived from the active manipulation of the coagulation cascade and the exposure of the patient's blood components to inert materials lacking endothelium such as pipes, membranes and oxygenators, which implies the need to recover blood volume using allogeneic blood transfusions (6,7).

In response to the need to reduce allogeneic blood transfusions in cardiovascular surgery, blood-saving techniques have been implemented, which are focused on reducing the use of hemocomponents and contribute to the reduction of pulmonary complications and hospital stays (8). The most widely applied intraoperative blood-saving techniques are pharmacological agents (tranexamic acid, aprotinin), intraoperative normovolemic hemodilution (NIVH), Autologous Retro Purge (APR), cell saver (CELL-SAVER) (9). These techniques represent benefits for the patient in the optimization and conservation of his blood components.

This study aims to describe the experience of a tertiary institution in terms of the results of intraoperative blood-saving techniques and their relationship with transfusion requirements in patients undergoing cardiovascular surgery.

METHODOLOGY

Analytical, observational, retrospective, cross-sectional, quantitative, retrospective, cross-sectional study. We included 140 adult patients who underwent surgery for cardiovascular surgery procedures in the period from March 2019 to December 2021. A non-probabilistic, purposive, convenience sampling was performed. All patients operated on in the service who met the inclusion and exclusion criteria were included: adult patients who had undergone cardiovascular surgery procedures during the period 2019 - 2021 at Los Cobos Medical Center and, Patients who had been subject to the use of blood-saving techniques for surgical intervention.

The following exclusion criteria were considered: patients in whom extracorporeal circulation (Cardiopulmonary Bypass) was not used and patients with no report of baseline clinical characteristics or for whom there is no information on the requirement of postoperative blood products.

MECHANISMS FOR SELECTING THE STUDY POPULATION:

The patient's data were collected based on the patient's medical records. The variables included in the study were classified as follows: sociodemographic and baseline clinical variables related to the procedure and use of blood-saving techniques, use of blood products, and clinical outcomes (Table 1).

For the descriptive analysis plan, measures of central tendency, variation, and range will be applied for quantitative variables, and absolute and percentage frequencies for qualitative variables. For the comparison of averages between techniques, the normality of the variables will be evaluated by applying Kolmogorov-Smirnov tests with Lilliefors or Shapiro-Wilk correction, followed by Student's t-tests or ANOVA. For the comparison of proportions between samples, the Z test will be applied. The statistical significance level was 0.05. Microsoft Excel 365 was used for data collection, and SPSS version 26 was used for data analysis.

The project was approved by the Institutional Research Ethics Committee of Universidad El Bosque (CIE-2023-001), and by the Research Committee of Los Cobos Medical Center (Coord Inv/107).

RESULTS

Of the patients registered in the clinical history databases, two were excluded because they died during the surgical procedure. Regarding the distribution of the sex variable, the highest proportion corresponded to the female with 75.36% (n=104), and in terms of age, an average of 65.29±11.34 was found with an interval of [18 - 87] years and a coefficient of variation of 17.34%.

Ranking	Variable	Operational definition
Sociodemographic and clinical baseline	Age	Number of years of age of the patient at the time of surgery
	Sex	The biological condition of the patient concerning their reproductive functions at the time of surgery.
	Body mass surface area	Body surface area measured in m2 of the patient at the time of surgery
Related to the procedure and use of blood-saving techniques	Baseline pathology	A medical condition that led the patient to undergo surgery
	Preoperative weight	Mass magnitude in kg of the individual at the time of the intervention.
	Surgery performed	Surgical intervention the patient underwent to treat his underlying condition
	Applied blood-saving technique	The blood-sparing technique used in the patient (RAP, CS, HNA, or combined)
Use of blood products	Use of post-EC platelets	Platelet unit requirement after cardiopulmonary bypass and up to hospital discharge
	Use of red blood cells post CE	Red blood cell unit requirement after cardiopulmonary bypass and until discharge from the hospital
	Use of post-CE plasma	Plasma unit requirement after cardiopulmonary bypass and until discharge from hospital
Clinical outcomes	Days of hospital stay	Patient days of hospital stay from admission for surgery to discharge
	Days of stay in ICU	Patient days of hospital stay from admission for surgery to discharge
	Reintervention for bleeding	Days of patient stay in ICU from postoperative period to discharge from ICU
	Hospital mortality	Occurrence of mortality during the patient's hospital stay

Table 1. Variables included in the study.

USE OF BLOOD-SAVING *TECHNIQUES*

About the use of the different blood-saving techniques, it was identified that the highest proportion of patients who underwent HNA (Acute Normovolemic Hemodilution) represented 42.03% (n=58) of the intervened patients, followed by the combination of HNA and RAP (Retrograde Autologous Purge) with 26.81% (n=37) of the patients, followed by the combination of CS (Cell Saver) and RAP (Autologous Retrograde Purge) with 6.52% (n=9) of the patients.81% (n=37) of the patients, followed by the combination between CS (Cell Saver) and HNA which was represented in 6.52% (n=9), the use of RAP with a proportion of 5.80% (n=8) and finally, the combination between RAP, CS, and HNA with 1.45% (n=2) of the patients. 14.49% (n=20) did not undergo any blood-sparing technique.

Regarding the volume in milliliters of blood units recovered in the use of each, it was found that in HNA an average of 492±148 mL [300 - 1200] was recovered, in the use of CS an average of 818±568 [250 - 1360] was recovered, in RAP 400±0 [400].

Regarding the combined techniques, it was identified that in the use of CS and HNA a higher average volume was recovered by CS with 818±186 mL [396 - 900], in the use of RAP and HNA the highest volume was recovered with HNA with 427±64 mL [300 - 500], finally, in the combination of the three RAP, CS and HNA, the highest average volume was recovered by CS with 630±183 mL [500 -759] (Table 2).

CLINICAL CHARACTERISTICS OF PATIENTS

Table 3 describes the baseline characteristics of the patients who underwent each of the blood- sparing techniques, including those who did not undergo any technique.

Regarding the sex variable, it was identified that the patients to whom the HNA technique was applied the highest proportion was male with 81.03% (n=47), while in those who

Techniques	RAP Volume				CS Volume				Extracted Volume HNA			
	Med	DE	Min	Max	Med	DE	Min	Max	Med	DE	Min	Max
None	0	0	0	0	0	0	0	0	0	0	0	0
HNA	0	0	0	0	0	0	0	0	492	148	300	1200
CS	0	0	0	0	818	568	250	1360	0	0	0	0
CS and HNA	0	0	0	0	688	183	396	900	450	100	300	650
RAP	400	0	400	400	0	0	0	0	0	0	0	0
RAP and HNA	272	70	100	400	0	0	0	0	427	64	300	500
RAP, CS, and HNA	250	71	200	300	630	183	500	759	450	71	400	500

Table 2. Volumes in milliliters were used in the techniques *employed.*

underwent CS the male sex was more frequent with 75.00% (n=8), likewise in those who underwent RAP and HNA 78.38% (n=29) and, RAP, CS and HNA with 100.00% (n=2) the male sex was representative. In the patients who applied RAP, the female sex was more representative with 75.00% (n=6). Finally, the female sex was more representative of the patients who did not undergo any technique, with 60.00% (n=13) of the sample (Table 3).

In terms of the average age of the patients it was identified that the group of patients who intervened with RAP, CS, and HNA had a higher average of 82±7.07 and the lowest average was in the RAP patients with 59.75±7.21, the group with the highest heterogeneity was the group of patients intervened with CS and HNA with a coefficient of variation (CV) of 20.39%, the most homogeneous group was the group of patients with CS with a CV=6.95%.

Regarding preoperative weight, the group with the highest average was that of CS and HNA with 86.44±14.66 kg and the lowest average was found in the group that did not apply any technique with 64.75±10.7 kg. The most heterogeneous group was that of patients operated with RAP, CS, and HNA with a CV=22.55% and the most homogeneous group was that of CS with a CV=9.39%. Regarding body surface area, the highest average was found in patients with CS and HNA at 1.99±0.17 m2 and the lowest average was found in the RAP group at 1.65±0.18 m2 (Table 3).

Meanwhile, about the underlying pathologies, for the patients who did not undergo any technique and those who underwent ANH, it was found that the highest proportion of patients presented Acute Myocardial Infarction with 30.00% (n=6) and 34.48% (n=20) respectively, in patients with CS, it was found that patients presented in greater proportion: Acute Myocardial Infarction, Aortic Stenosis, Unspecified Chest Pain and Unspecified Shock each with 25.00% (n=1) of the cases (Table 3).

The patients who underwent CS and HNA had a higher proportion of acute myocardial infarction, atherosclerotic heart disease, aortic valve stenosis, aortic valve insufficiency, aortic valve stenosis with insufficiency, unspecified aortic valve disorder, complete atrioventricular block, aortic dissection, and thoracic aortic aneurysm, each with 11.11% (n=1). In patients who underwent RAP 25.00% (n=2) presented aortic stenosis (valve), in patients who underwent RAP and HNA it was identified that the highest proportion had acute myocardial infarction with 32.43% (n=12), and finally, in patients with RAP, CS and HNA patients presented aortic (valve) insufficiency and unspecified heart failure (Table 3).

Statistically significant differences were found between the proportions of RAP and HNA (p=0.010) and combined RAP HNA (p=0.047) in female patients.

Variable		None n=20 (14,49%)		HNA n=58 (42,03%)		CS n=4 (2,90%)		CS and HNA n=9 (6,52%)		RAP n=8 (5,80%)		RAP and HNA n=37 (26,81%)		RAP, CS, and HNA n=2 (1,45%)	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
Sex	Female	7	35,00%	11	18,97%	1	25,00%	1	11,11%	6	75,00%	8	21,62%	0	0,00%
	Male	13	65,00%	47	81,03%	3	75,00%	8	88,89%	2	25,00%	29	78,38%	2	100,00%
Age	Mean (SD)	66,8	9,7	64,6	13,42	65,75	4,57	60,11	12,26	59,75	7,21	67,43	8,5	82	7,07
Preoperative weight (Kg)	Mean (SD)	64,75	10,7	74,33	13,62	64,75	6,08	86,44	14,66	61	11,19	72,84	14,3	69	15,56
Body surface (m2)	Mean (SD)	1,71	0,16	1,84	0,17	1,72	0,09	1,99	0,17	1,65	0,18	1,82	0,19	1,77	0,22
Baseline pathology (ICD-10)	I059	1	5,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I060	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I088	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I120	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I200	1	5,00%	6	10,34%	0	0,00%	0	0,00%	1	12,50%	3	8,11%	0	0,00%
	I209	2	10,00%	2	3,45%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I210	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I212	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I213	2	10,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I214	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I219	6	30,00%	20	34,48%	1	25,00%	1	11,11%	1	12,50%	12	32,43%	0	0,00%
	I251	1	5,00%	1	1,72%	0	0,00%	1	11,11%	0	0,00%	0	0,00%	0	0,00%
	I252	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I255	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I259	1	5,00%	3	5,17%	0	0,00%	0	0,00%	1	12,50%	0	0,00%	0	0,00%
	I340	1	5,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I341	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
	I349	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
	I350	2	10,00%	6	10,34%	0	0,00%	1	11,11%	2	25,00%	5	13,51%	0	0,00%
	I351	0	0,00%	5	8,62%	0	0,00%	1	11,11%	0	0,00%	1	2,70%	1	50,00%

I352	0	0,00%	1	1,72%	0	0,00%	1	2,70%	0	0,00%
I358	0	0,00%	0	0,00%	1	11,11%	0	0,00%	0	0,00%
I359	0	0,00%	0	0,00%	1	11,11%	2	5,41%	0	0,00%
I428	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%
I442	0	0,00%	0	0,00%	1	11,11%	2	5,41%	0	0,00%
I471	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
I48X	0	0,00%	0	0,00%	1	12,50%	0	0,00%	0	0,00%
I500	1	5,00%	3	5,17%	0	0,00%	0	0,00%	0	0,00%
I509	0	0,00%	0	0,00%	0	0,00%	1	2,70%	1	50,00%
I710	0	0,00%	0	0,00%	1	11,11%	0	0,00%	0	0,00%
I712	0	0,00%	0	0,00%	1	11,11%	0	0,00%	0	0,00%
Q211	1	5,00%	0	0,00%	0	0,00%	0	0,00%	0	0,00%
Q253	0	0,00%	0	0,00%	1	25,00%	1	12,50%	0	0,00%
R072	1	5,00%	0	0,00%	0	0,00%	1	12,50%	1	50,00%
R074	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
R204	0	0,00%	0	0,00%	1	25,00%	0	0,00%	0	0,00%
R55X	0	0,00%	1	1,72%	0	0,00%	0	0,00%	0	0,00%
R570	0	0,00%	0	0,00%	0	0,00%	1	2,70%	0	0,00%
R579	0	0,00%	0	0,00%	1	25,00%	0	0,00%	0	0,00%

Table 3. Baseline characteristics of patients included in the study.

CLINICAL *OUTCOMES*

In terms of clinical outcomes, when evaluating the days of hospital stay, it was identified that the technique with the highest average number of days of hospital stay was reported in those who underwent CS and HNA with 29.89±20.03 with a CV=69.33% and the lowest was reported in HNA with 15.9±7.82 with a CV=49.18%. Regarding days of stay in ICU, the highest average was reported in patients operated with CS and HNA with 11.67±8.93 CV=76.52% and the lowest in RAP with 4.75±1.91 CV=40.21%. In both parameters, the analysis of variance (ANOVA) showed statistically significant differences, for hospital stay p=0.039 and ICU stay p=0.016 (Table 4).

When evaluating the prevalence of complications, it was identified that, in terms of reinterventions due to bleeding, the highest prevalence was found in patients who underwent CS with 75.00% (n=3), while hospital mortality was higher in patients who did not undergo any technique with 15.00% (n=3) (Illustration 1).
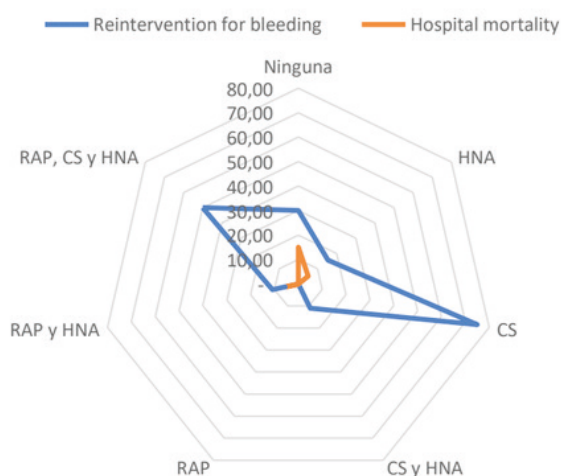

Illustration 1. The proportion of patients with complications by blood-saving technique.

USE OF BLOOD PRODUCTS AFTER EXTRACORPOREAL CIRCULATION (ECC)

Regarding the use of blood products post-CPB, it was found that 54.34% (n=75) of the patients did not require the use of blood products. Meanwhile, 28.98% (n=40) of patients required red blood cell units, 25.36% (n=35) required plasma units, and 16.66% (n=23) of patients required platelet units. When evaluating the differences between the use of these blood products in each of the techniques, statistically significant differences were identified in all three, by analysis of variance (ANOVA) with results of p<0.001 in all (Table 5).

D -*DISCUSSION*

Among the most relevant findings it was identified that, in the center's experience, HNA was one of the most used blood-saving techniques, on average between 300 and 1200 mL were recovered, however, the cell saver was the one that recovered more blood with an average of between 250 and 1360 mL, Frank SM in 2020 identified the cell saver as a safe and high-quality blood-saving technique, which reduces the risks associated with allogeneic transfusion, this is due to the fresh preservation of cells (10). For his part, Arana A in 2017 determined that the cell saver recovers, centrifuges, and stores 50 to 60% of the blood loss of the patient undergoing a cardiovascular procedure (11).

However, RAP is one of the recommended techniques, according to Hofmann B (2018) identified the advantage of applying RAP in patients undergoing cardiovascular surgery and the decrease in the transfusion of allogeneic hemo-components, where the intraoperative transfusion rate was 3.7% (2 of 54 patients), as an important finding they mention that for RAP to be effective, no less than 350 mL should be collected, in contrast to the results obtained,

Variable	None (n=20)		HNA (n=58)		CS (n=4)		CS and HNA (n=9)		RAP (n=8)		RAP and HNA (n=37)		RAP, CS, and HNA (n=2)	
	x	DE	x	DE	x	DE	x	DE	x	DE	x	DE	x	DE
Days of hospital stay	22,2	16,28	15,9	7,82	19,75	5,68	29,89	20,03	16,5	10,46	19,43	12,62	25	19,8
Days of stay in ICU	6,4	3,57	5,48	3,24	8,75	5,12	11,67	8,93	4,75	1,91	9,92	10,63	9,5	3,54

Table 4. Distribution of days of hospital stay and ICU stay by the blood-sparing technique *employed.*

Savings techniques	Red blood cells post CPB n=40				Post-ECC plasma n=35				Platelets post CPB n=23			
	n	%	Med (IQR)	[Min - Max]	n	%	Med (IQR)	[Min - Max]	n	%	Med (IQR)	[Min - Max]
None	13	32,50	2 (0)	1-4	6	17,14	3 (2)	1-6	4	17,39	2 (1)	1-2
HNA	13	32,50	2 (1)	1-4	12	34,29	3 (1)	1-4	5	21,74	2,5 (1)	1-2
CS	3	7,50	4 (3)	2-5	3	8,57	6 (1)	5-6	4	17,39	5 (1)	1-2
CS and HNA	4	10,00	3,5 (1,5)	2-4	5	14,29	4 (1)	3-6	4	17,39	3 (1)	1-2
RAP	2	5,00	1,5 (1)	1-2	1	2,86	3 (0)	3-3	0	0,00	0	0-1
RAP and HNA	5	12,50	1 (2)	1-7	7	20,00	4 (3)	3-7	5	21,74	3 (1)	1-2
RAP, HNA, and CS	0	0,00	0 (0)	0-0	1	2,86	4 (0)	4-4	1	4,35	4 (0)	1-1
F test statistic (ANOVA)			4.972				4.379				4.997	
P-value			0.000				0.000				0.000	

Table 5. Use of blood products by blood-saving technique.

approximately 400 mL were recovered (12). Likewise, the meta-analysis performed by Sun P in 2013 mentions that the use of small circuits and autologous retro-purge provides a significant reduction in the use of hemo-components and that it is recommended as an effective saving technique (13).

It was also identified that CS and HNA techniques were applied in patients who had mainly pathologies such as Acute Myocardial Infarction, Atherosclerotic Heart Disease, Aortic (Valve) Stenosis, Aortic (Valve) Insufficiency, Aortic (Valve) Stenosis with Insufficiency, Unspecified Aortic Valve Disorder, Complete Atrioventricular Block, Aortic Dissection and Thoracic Aortic Aneurysm.

And this finding may be related to the fact that in these techniques there were higher averages in days of hospital stay and ICU since studies such as that of Zhou Z (2017) speak of the fact that the average length of hospital stay in patients with these pathologies is usually higher. However, he also mentions that there are no statistically significant differences in average days of hospital stay and mortality when using HNA or RAP (14).

Concerning reinterventions due to bleeding, the highest prevalence was found in patients who underwent CS. According to Vonk A (2013), cell salvage is an effective and quality preservation technique, and he mentions that it is indicated in patients who are going to undergo major surgeries (aortic dissections, valvular changes). He also describes that

patients with coagulopathies are candidates for its use (15). On the other hand, Amanvermez Senarslan D (2022), in the study of efficacy and cost-effectiveness of CS in thoracic aortic repairs, identified no significant relationship between the groups to determine that the use of CS is related to reoperation due to bleeding; but the relationship that may exist between reoperation, the procedure or the patient's underlying pathologies does exist (16).

Regarding the use of blood products, a comparison was made with the results presented in studies such as the one by Vonk A in 2014 and 2017 in the first one, the results of the use of blood products during cardiovascular surgery procedures with extracorporeal circulation in a tertiary hospital are presented and, the second study analyzed blood products in cardiac surgery, which identified that the median consumption of red blood cells was 1 to 5 units in anemic patients and 0 to 3 in anemic patients, limits that are within those identified in this study (17).

In this same study, it was identified that the use of a cell saver is a protective factor for the risk of red blood cell administration with an HR=0.15 p<0.001, which contrasts with this study, as it was identified that the use of combined technique presented the lowest amount of blood units.

In the study by Vonk, 2017 they reported that the transfusion rate of patients in cardiovascular *bypass* surgery was 56.9% in the present study a proportion of 54.34% was identified which is, somewhat coincident, even though in this study this proportion was not calculated by the type of procedure (18).

One of the main limitations of the study is the quality of the medical records, since the report may contain errors in the registry. In the study, a clinical validation was performed with the specialist to try to control this bias; however, a residual bias can be assumed, which is difficult to control.

Meanwhile, a possible bias of the study consists in the classification of the patient's baseline blood pathologies, which may generate some type of overestimation or underestimation of the effect of the blood technique on the consumption of blood products.

Finally, the highest proportion of patients underwent surgery with ANH. This high prevalence may have some influence on the results of the study, and it is recommended that multivariate statistical methods be applied in future research to deal with the confounding phenomenon; however, this type of analysis was not part of the objectives of the study.

In this sense, it is recommended to perform comparative studies that can involve baseline clinical characteristics related to coagulation disorders and blood components, as well as studies with multivariate methods that can provide more evidence regarding the effectiveness of blood-sparing techniques in the context of cardiovascular surgery.

Blood conservation in cardiac surgery through blood-saving techniques requires more effort and a team approach, which will allow the reduction of complications due to allogeneic transfusion, cost reduction, and better use of blood components available in the institution.

Guidelines or protocols should be generated to identify and apply the appropriate technique in patients, which will reduce reactions to allogeneic transfusions, reduce transfusion costs, save units of hemocomponents, and benefit the patient.

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