Original article

Use of intraoperative and postoperative blood transfusions on patients undergoing cardiac surgery at the Central Chest Institute of Thailand: a single-center retrospective analysis

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Abstract:

Introduction: *Cardiac surgery requires more blood components than most other medical disciplines. The Central Chest Institute of Thailand (CCIT), an institution of medicine committed to developing this particular field, decided to implement a patient blood management (PBM) program to substantially improve blood use.* ***Objective:*** *This study aimed to evaluate intraoperative and postoperative blood transfusions among patients undergoing cardiac surgery comprehensively analyzed the consumption of blood components in all medical departments of the CCIT.* ***Materials and methods:*** *The use of blood components at the CCIT was thoroughly examined retrospectively over two years. Based on a medical reporting system of all medical disciplines, all transfused patients in cardiac surgery and their blood components were identified using their characteristics, including sex, age, ABO blood group, antibody screening and identification, medical operations, and operation-related groups during intraoperative and postoperative periods.* ***Results:*** *This retrospective single center study included all inpatients who underwent cardiac surgery from 2023-2024, corresponding to more than 95% (1,722 cases) of all CCIT in-patients. We found that the need for blood supply remained generally consistent, with packed red cells, frozen plasma and single donor plateletpheresis units having administered to > 95%, 90%, and 45% of all cardiac surgery patients, respectively. Most blood component units were applied during Bentall's procedure to repair the aneurysm. Remarkedly, the first detection of an anti-Mi^{a} antibody occurred during postoperative hospitalization after an intraoperative 24-unit red cell transfusion.* ***Conclusion:*** *Our analysis suggests each blood component's consumption could be related to clinical performance groups; thus, the PBM should be set up hospital-internally to enhance bloodless surgical procedures, increase preoperative anemia management and identify the causes of unnecessary blood transfusions.*

Keywords : ● *Cardiac surgery* ● *Blood supply* ● *Blood transfusion* ● *Patient blood management*

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นิพนธ์ต้นฉบับ

การใช้เลือดระหว่างและหลังผ่าตัดในผู้ป่วยที่ต้องเข้ารับการผ่าตัดหัวใจที่สถาบันโรคทรวงอก: การวิเคราะห์ข้อมูลจากการศึกษาแบบย้อนหลังศูนย์เดียว

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บทคัดย่อ

บทนำ *การผ่าตัดหัวใจต้องการใช้ส่วนประกอบของเลือดมากกว่าการผ่าตัดชนิดอื่น สถาบันโรคทรวงอก เป็นสถาบันการแพทย์ที่มุ่งมั่นพัฒนาสาขานี้โดยเฉพาะ จึงได้ดำเนินโครงการ patient blood management (PBM) เพื่อใช้ปรับปรุงการใช้เลือดให้เหมาะสม* ***วัตถุประสงค์*** *การศึกษาย้อนหลังนี้มีวัตถุประสงค์เพื่อประเมินการให้เลือดผู้ป่วยที่ได้รับการผ่าตัดหัวใจระหว่างและหลังการผ่าตัด โดยวิเคราะห์ข้อมูลการใช้ส่วนประกอบของเลือดของผู้ป่วยในทุกคลินิกของสถาบันฯ* ***วัสดุและวิธีการ*** *วิเคราะห์ข้อมูลการใช้เลือดของผู้ป่วยที่ได้รับการรักษา ย้อนหลังในช่วงเวลา 2 ปี จากระบบฐานข้อมูลของสถาบันฯ โดยเก็บข้อมูลผู้ป่วยผ่าตัดหัวใจที่ได้รับเลือดรวมทั้งส่วนประกอบของเลือด ข้อมูลทั่วไปผู้ป่วย ประกอบด้วย เพศ อายุ หมู่เลือด ABO ผลการตรวจกรองแอนติบอดีและการตรวจแยกชนิดแอนติบอดี ประเภทการผ่าตัด และกลุ่มที่เกี่ยวข้องกับการผ่าตัดทั้งระหว่างและหลังการผ่าตัด* ***ผลการศึกษา*** *การศึกษาย้อนหลังในสถาบันฯ ตั้งแต่ปี พ.ศ. 2566 ถึง พ.ศ. 2567 มีผู้ป่วยที่ได้รับการผ่าตัดหัวใจ จำนวน 1,722 ราย ซึ่งมากกว่าร้อยละ 95 ของผู้ป่วยที่เข้ารับการรักษาแบบผู้ป่วยในทั้งหมด พบว่า ความต้องการการจัดหาส่วนประกอบของเลือดในผู้ป่วยมีความสอดคล้องกันทั้ง 2 ปี คือ เม็ดเลือดแดงเข้มข้น พลาสมาแช่แข็ง และเกล็ดเลือดเข้มข้นจากผู้บริจาครายเดียว ซึ่งมากกว่าร้อยละ 95, 90 และ 45 ตามลำดับ ส่วนประกอบของเลือดส่วนใหญ่ใช้ระหว่างขั้นตอนของ Bentall เพื่อซ่อมแซมหลอดเลือดโป่งพอง และที่น่าสังเกตคือ มีผู้ป่วย 1 ราย ที่ตรวจพบ anti-Mi^{a} หลังจากได้รับเลือดจำนวน 24 ยูนิต ในระหว่างการผ่าตัด* ***สรุป*** *การวิเคราะห์ข้อมูลครั้งนี้แสดงว่าการใช้ส่วนประกอบของเลือดแต่ละประเภทขึ้นอยู่กับชนิดของหัตถการทางคลินิก ดังนั้น ควรมีการจัดตั้ง PBM ขึ้นภายในโรงพยาบาล เพื่อปรับปรุงขั้นตอนการผ่าตัดโดยไม่ใช้เลือด เพิ่มการจัดการภาวะเลือดจางก่อนผ่าตัด และระบุสาเหตุของการให้เลือดที่ไม่จำเป็น*

คำสำคัญ : ● *การผ่าตัดหัวใจ* ● *การจัดหาเลือด* ● *การให้เลือด* ● *การบริหารจัดการเลือดให้ผู้ป่วย*

วารสารโลหิตวิทยาและเวชศาสตร์บริการโลหิต. 2568;35:21-9.

Introduction

Many hospitals offer comprehensive medical treatment options for diverse medical conditions and serve a broad spectrum of patient demographics. The total number of blood components used during cardiac surgery is drastically greater than the typical demand for blood products in most of the other medical disciplines[1-3]. To date, blood transfusions have been recognized as a key quality indicator in cardiac surgery[4]. According to a demographic analysis, the demand for blood products has grown globally and particularly among elderly patients requiring more transfusions due to advancements in medical sciences and treatment alternatives[5,6]. In the meantime, the number of younger, healthy people being targeted for voluntary blood donation may potentially decline because of the population's demographic aging in several countries[3,7,8].

Blood donation facilities and hospital-related patient blood management programs (PBM) have taken a number of proactive measures to mitigate the effects of these changes in demographics[9]. The particular surgical speciality of cardiac surgery regularly calls for the intraoperative administration of cardiopulmonary bypass along with comprehensive anticoagulation, as well as varied dosages of antithrombotic treatments before and after cardiac surgeries. In consequence of this, surgical procedures present a higher risk of bleeding challenges, often needing allogeneic blood transfusions, which are known to have both short and long term threats. Treatment of clinical disorders affecting the risks of bleeding, thrombosis and transfusion was recommended as a result of the PBM guidelines for cardiac surgery, which were designed to provide recommendations to ensure optimal patient preparation as well as for intraoperative and postoperative management[10]. Despite establishing national and international transfusion guidelines for cardiac surgery, a substantial discrepancy occurs between the guidelines' publication and their acceptance by professional authorities in charge of ensuring their internal implementation. Therefore, transfusion procedures for cardiac surgery and, in general, remain different between physicians and hospitals[4,11,12].

The Central Chest Institute of Thailand (CCIT) is an institution of medicine dedicated to advancing the field of heart, blood vessel and lung disease treatment and rehabilitation. To substantially improve blood use at the CCIT, we decided to implement a PBM program in close coordination with anesthesiology and transfusion medicine experts. The program's long-term goals were to reduce transfusion-related expenses and minimizing unnecessary blood transfusions and transfusion-related adverse events by enhancing compliance with internal transfusion algorithms and guidelines. To fulfil this objective, a retrospective study was conducted relating to intraoperative and postoperative blood transfusions among patients undergoing cardiac surgery to provide a comprehensive analysis of the consumption of blood components in all medical departments of the CCIT.

Materials and Methods

Database and data processing

The informative document records of each actual transfusion of allogeneic blood components to each inpatient at the CCIT for the fiscal years 2023 to 2024 were collected and analyzed. These data encompassed the type of blood component including packed red cells, i.e., leukocyte poor red cells (LPRC) and leukocyte depleted red cells (LDPRC), fresh frozen plasma (FFP), platelets, i.e., pooled leukocyte poor platelet concentrates (LPPC) and single donor platelet (SDP), and cryoprecipitate (Cryo). They also include the number of bags issued and transfused, in addition to the issuance and application for each medical department. The blood components of the hospitalized inpatients during the year end were counted for the discharge year. All patients' data were cautiously anonymized to ensure the confidentiality and privacy of the information provided in this article. This study was approved by the Human Research Ethics Committee of the CCIT, under protocol number REC 013/2568.

Throughout the data processing, the case-related characteristics including sex, age, ABO blood group, antibody screening and identification, diagnoses, medical operations and operation-related groups, were considered. The Department of Cardiac Surgery's CCIT system is divided into six primary clinical performance groups, including coronary artery bypass graft surgery (CABG), valve repair or replacement, CABG plus valve repair or replacement, aneurysm (Bentall's procedure), congenital and others. Each inpatient case was allocated to a single clinical performance group within the data.

Statistical analysis

Categorical variables were described using both absolute and relative frequencies. The comparison of the variables: 2023 *vs* 2024; male *vs* female; youths *vs* adults and seniors; group A *vs* B, O, and AB; CABG *vs* CABG + valve repair, valve repair, aneurysm (Bentall's procedure), congenital and others were carried out using Pearson's Chi-square. All tests were two-sided. The data collected were entered twice in a Microsoft Excel® spreadsheet and were subsequently validated. Then data were analyzed with SPSS, Version 25.0 (SPSS Inc., Chicago, IL, USA). If a *p*-value was smaller than 0.05, we concluded that a statistically significant difference was observed.

Results

The data used in this retrospective analysis included all inpatient data from fiscal year, 2023 to 2024, of those undergoing cardiac surgery at the CCIT; this group comprised an average of approximately more than 95% of all CCIT inpatients. In addition, we analyzed the proportion of patients receiving blood transfusions and calculated the mean consumptions of RBCs (LPRC and LDPRC), FFP, LPPC, SDP and Cryo units per transfused patient based on the fiscal years, sex, age group, ABO blood types and six primary clinical performance groups (Table 1). Over a two-year study period, we observed a relatively constant demand for blood supply, resulting in an approximate frequency of > 95%, about 90% and about 45% of all cardiac surgery patients receiving RBCs, FFP, and SDP units, respectively. The overall average number of blood units per transfused patient amounted to approximately 8 RBCs, 4 FFP and 2 SDP units. However, we determined that significantly greater transfusion cases occurred in 2024 than in 2023 (transfusions of LPPC $p < 0.001$ and of Cryo $p < 0.05$) (Table 1).

The spectrum of the sex, age groups and ABO blood groups for each blood component given per transfused case was basically identical in both sexes, age groups and ABO blood types. Notably, the data suggest that RBC units are ordered more likely in eight packs than FFP (~4) or platelet (~2) units. Approximately > 90% of the transfused patients received both RBC and FFP units, in addition, almost 50% of the transfused patients in cardiac surgery were treated with platelet units (Table 1). In this retrospective analysis, all patients underwent cardiac surgery were divided into six clinical performance groups. The percentage of transfused patients and the average amount of blood units per transfused case are also shown in Table 1 for the three most common and significant clinical performance groups: valve repair or replacement, CABG and both CABG and valve repair or replacement. The highest transfusion rates were indicated among patients with valve repair or replacement (99.1% for RBCs), followed by cases using CABG (98.4%), independent of the type of blood component. In addition, we observed a significant difference ($p < 0.05$) in the number of transfused cases in CABG when compared with other clinical performance groups throughout the same period for different blood components, as shown in Table 1.

The blood components used for each performance clinical subgroup through intraoperative and postoperative treatments is displayed in Table 2. Approximately 90% of patients received red cell transfusions during the intraoperative period; of these, 3 to 7 RBC unit transfusions were required during cardiac surgery. Red blood cell

Table 1 Number and proportion of transfused patients and blood components in cardiac surgery to each inpatient at the CCIT for the fiscal years 2023-2024

Patients	Number	LPRC + LDPRC			FFP			LPPC			SDP			Cryo		
		T/A	Units	U/T	T/A	Units	U/T	T/A	Units	U/T	T/A	Units	U/T	T/A	Units	U/T
Total	**1,722**	**1,661 (96.5%)**	**12,776**	**7.7**	**1,567 (91.0%)**	**6,523**	**4.2**	**898 (52.1%)**	**1,889**	**2.1**	**804 (46.7%)**	**1,245**	**1.5**	**350(20.3%)**	**4,943**	**14.1**
Fiscal year																
2023	849	807 (95.1%)	6,132	7.6	732 (86.2%)	3,005	4.1	339 (39.9%)	744	2.2	375 (44.2%)	583	1.6	136 (16.0%)	3,010	22.1
2024	873	854 (97.8%)	6,644	7.8	835 (95.6%)	3,518	4.2	559 (64.0%)*	1,145	2.0	429 (49.1%)	662	1.5	214 (24.5%)*	1,933	9.0
Sex																
Male	1,004	960 (95.6%)	6,998	7.3	912 (90.8%)	3,777	4.1	525 (52.3%)	1,045	2.0	459 (45.7%)	694	1.5	211 (21.0%)	3,010	14.3
Female	718	701 (97.6%)	5,778	8.2	655 (91.2%)	2,746	4.2	373 (51.9%)	844	2.3	345 (48.1%)	551	1.6	139 (19.4%)	1,933	13.9
Age, years																
Children, 0-14	0	0 (0.0%)	0	0.0	0 (0.0%)	0	0.0	0 (0.0%)	0	0.0	0 (0.0%)	0	0.0	0 (0.0%)	0	0.0
Youths, 15-24	20	18 (90.0%)	152	8.4	18 (90.0%)	84	4.7	9 (45.0%)	30	3.3	8 (40.0%)	11	1.4	5 (25.0%)	81	16.2
Adults, 25-64	820	788 (96.1%)	5,363	6.8	738 (90.0%)	2,968	4.0	402 (49.0%)	849	2.1	362 (44.1%)	577	1.6	156 (19.0%)	2,267	14.5
Senior, ≥ 65	882	855 (96.9%)	7,261	8.5	811 (92.0%)	3,471	4.3	487 (55.2%)	1,010	2.1	434 (49.2%)	657	1.5	189 (21.4%)	2,595	13.7
ABO blood group																
A	381	365 (95.8%)	2,684	7.4	354 (92.9%)	1,422	4.0	199 (52.2%)	388	1.9	176 (46.2%)	267	1.5	75 (19.7%)	1,010	13.5
B	614	590 (96.1%)	4,583	7.8	560 (91.2%)	2,330	4.2	326 (53.1%)	637	2.0	282 (45.9%)	436	1.5	131(21.3%)	1,888	14.4
O	591	574 (97.1%)	4,601	8.0	534 (90.4%)	2,308	4.3	314 (53.1%)	745	2.4	283 (47.9%)	452	1.6	119 (20.1%)	1,735	14.6
AB	136	132 (97.1%)	908	6.9	119 (87.5%)	463	3.9	59 (43.4%)	119	2.0	63 (46.3%)	90	1.4	25 (18.4%)	310	12.4
Clinical performance groups																
CABG	571	562 (98.4%)	3,742	6.7	528 (92.5%)	2,107	4.0	374 (65.5%)	591	1.6	269 (47.1%)	318	1.2	83 (14.5%)	1,192	14.4
CABG + valve repair or replacement	219	194 (88.6%)	2,618	13.5	187 (85.4%)	786	4.2	107 (48.9%)*	273	2.6	114 (52.1%)	227	2.0	67 (30.6%)*	744	11.1
Valve repair or replacement	695	689 (99.1%)	4,214	6.1	659 (94.8%)	2,426	3.7	259 (37.3%)*	505	1.9	302 (43.5%)	487	1.6	107 (15.4%)	1,467	13.7
Aneurysm (Bentall's procedure)	163	159 (97.5%)	1,542	9.7	148 (90.8%)	1,045	7.1	137 (84.0%)	351	2.6	107 (65.6%)*	149	1.4	82 (50.3%)*	1,210	14.8
Congenital	56	49 (87.5%)	168	3.4	38 (67.9%)	141	3.7	15 (26.8%)*	26	1.7	3 (5.4%)*	14	4.7	3 (5.4%)	40	13.3
Others	18	13 (72.2%)	492	37.8	7 (38.9%)*	18	2.6	6 (33.3%)	143	23.8	9 (50.0%)	50	5.6	8 (44.4%)*	290	36.3

CABG, coronary artery bypass graft surgery; Cryo, cryoprecipitate; FFP, fresh frozen plasma; LDPRC, leukocyte depleted red cell; LPPC, pooled leukocyte poor platelet concentrates; LPRC, leukocyte poor red cells; SDP, single donor platelet; T/A, proportion of transfused patients out of all in-patients; U/T, average amount of units per transfused patients

*Significant differences of transfused cases, p-value < 0.05

Table 2 Proportion of transfused patients and blood consumption in a total of six clinical performance groups of cardiac surgery during intraoperative and postoperative care

	Intraoperation				Postoperation			
	2023		2024		2023		2024	
	T/A	U/T	T/A	U/T	T/A	U/T	T/A	U/T
LPRC + LDPRC								
CABG	99.3%	3.9	95.2%	4.9	97.5%	3.6	70.6%	3.4
CABG + valve repair or replacement	96.3%	4.5	100.0%	5.3	88.9%	4.6	86.9%	4.6
Valve repair or replacement	97.2%	3.3	94.3%	3.9	96.9%	3.1	78.9%	3.7
Aneurysm (Bentall's procedure)	95.4%	5.3	98.6%	6.9	89.2%	6.9	82.9%	5.3
Congenital	91.7%	2.5	91.3%	2.1	83.3%	5.2	65.2%	2.1
Others	68.1%	3.9	93.3%	4.6	74.4%	4.6	84.4%	4.1
FFP								
CABG	96.8%	1.5	97.0%	2.1	92.9%	1.8	63.2%	2.3
CABG + valve repair or replacement	95.4%	1.9	93.8%	2.5	85.3%	2.5	81.3%	2.9
Valve repair or replacement	96.1%	1.7	90.9%	2.1	94.7%	1.7	81.7%	2.0
Aneurysm (Bentall's procedure)	89.2%	7.0	92.9%	4.2	81.5%	7.5	82.9%	3.2
Congenital	83.3%	1.8	69.6%	1.8	75.0%	2.0	43.5%	2.3
Others	44.6%	6.0	66.7%	3.0	61.7%	3.5	55.6%	2.8
LPPC								
CABG	14.1%	1.9	50.9%	1.1	19.3%	2.1	41.6%	1.8
CABG + valve repair or replacement	31.1%	1.0	52.5%	1.2	40.3%	1.1	60.0%	1.6
Valve repair or replacement	18.2%	1.1	40.7%	1.1	32.8%	1.5	36.0%	1.7
Aneurysm (Bentall's procedure)	49.2%	1.0	51.4%	1.8	69.2%	2.3	64.2%	2.0
Congenital	16.6%	1.5	34.8%	1.1	16.6%	3.5	30.4%	1.0
Others	8.5%	1.5	40.0%	1.3	%	2.9	57.7%	1.8
SDP								
CABG	13.4%	2.3	40.7%	1.0	36.0%	1.0	23.2%	1.2
CABG + valve repair or replacement	39.4%	1.1	44.3%	1.0	43.1%	1.0	25.6%	1.2
Valve repair or replacement	20.9%	1.0	37.5%	1.0	24.5%	1.6	22.7%	1.4
Aneurysm (Bentall's procedure)	16.9%	2.2	42.8%	1.3	35.3%	1.6	40.0%	1.5
Congenital	25.0%	1.3	17.3%	1.0	16.6%	1.0	13.0%	0.7
Others	4.2%	2.0	20.0%	1.5	36.1%	1.5	11.1%	1.2
Cryo								
CABG	3.2%	17.7	3.1%	22.9	4.3%	35.8	4.4%	44.2
CABG + valve repair or replacement	4.6%	10.0	6.3%	15.0	9.2%	24.1	7.5%	43.3
Valve repair or replacement	2.8%	15.1	2.9%	24.1	3.9%	45.9	3.1%	61.7
Aneurysm (Bentall's procedure)	20.0%	13.1	15.7%	45.5	13.8%	28.1	25.7%	24.4
Congenital	0.0%	0.0	0.0%	0.0	16.7%	15.0	4.3%	10.0
Others	4.3%	15.0	6.7%	10.0	10.6%	22.0	11.1%	24.0

CABG, coronary artery bypass graft surgery; Cryo, cryoprecipitate; FFP, fresh frozen plasma; LDPRC, leukocyte depleted red cells; LPPC, pooled leukocyte poor platelet concentrates; LPRC, leukocyte poor red cells; SDP, single donor platelet; T/A, proportion of transfused patients out of all in-patients; U/T, average amount of units per transfused patients

Table 3 Number of patients with positive results from the tests for antibody screening and identification

Red cell transfusions (units)	Number of patients	
	Perioperation	Postoperation
1	1	1
2	1	1
3	5	5
4	6	6
5	9	9
6	4	4
7-10	10	10
11-15	11	11
> 15	7	8*

*Anti-Mi[a] was identified after 24-unit red cell transfusions

products were the most frequently administered (96.5%), followed by FFP (91.0%), LPPC (52.1%), SDP (46.7%) and Cryo (20.3%), respectively. In the postoperative period, RBC transfusions were administered to 80 to 90% of patients. It was the most common type of blood product utilized during the study period. Remarkably, patients receiving Bentall's surgery for aneurysm repair had the highest required transfusion rates of RBC (5.3-6.9 units), FFP (3.2-7.5 units) and platelet (1.0-2.3 units) products (Table 2).

Table 3 provides more specific information concerning the spectrum of total units for red cell component supplied per transfused patients with antibody screening and identification positive during the perioperative and postoperative periods. The data suggest that transfusions of more RBC units are associated with a higher likelihood of positive antibody screening and identification throughout both periods. Notably, more than 15 RBC units were administered to transfused patients in cardiac surgery throughout both periods, which observed a case of additional numbers of screening and identification antibody positivity. A 70-year-old Thai man with an aneurysm extending through the upper or the entire descending thoracic aorta was admitted to the hospital. He needed to be performed total arch replacement with a frozen elephant trunk. Twenty-five units of red cells were requested. Laboratory testing results showed that he was group A, Rh(D) positive. Antibody screening test in his plasma by column agglutination test (CAT) was negative with all 3 screening cells. Following an intraoperative 24-unit red cell transfusion, ten units of red cells were additionally requested during the postoperative hospitalization period. Antibody screening test in his plasma by CAT was positive (3+) with two out of three screening cells. Antibody identification using the conventional tube test (CTT) demonstrated anti-Mi[a] at the room temperature phase. Subsequently, nine compatible red cell units lacking the Mi[a] antigen were transfused in the Intensive Care Unit.

Discussion

The use of blood components in cardiac surgery has been evaluated and standardized through several global activities[13]. However, an ongoing argument in this discipline over the appropriate use of blood components, particularly the value of universal transfusion triggers such as a hemoglobin level below 7 to 8 g/dL[10,14]. More restrictive compliance to transfusion algorithms and consideration of the influence of point-of-care diagnostics may result in diminished RBC transfusions during cardiac surgery. Consequently, transfusion guidelines and standard cardiac operating procedures are highly encouraged to be implemented for hospital-internal use individually. The PBM program could investigate compliance with the hospital-internal guidelines and their defined restrictive indication criteria for transfusions[10].

In general, transfusions have been related to high rates of mortality and morbidity among patients in critical condition and increasing evidence exists that RBC transfusions have been independently related to infectious complications, respiratory and cardiac morbidity, extended hospital stays and death after cardiac surgery[12,15]. The data obtained from our retrospective study on the total blood consumption of RBC, FFP and platelet units in cardiac surgery is consistent with published results[1-3,16,17], which suggests higher blood utilization for surgical procedures. Despite the proportion of patients in need of RBCs, FFP and SDP units remaining notably stable, in 2024 exhibited a notable increase in the total number of LPPC and Cryo units per patient in comparison with those in 2023. This may have been caused by the confounding factors underlying our data, rendering it challenging to draw definitive inferences. Similar demands during cardiac surgery were divided by sex, age groups and ABO blood group, which may be due to the equilibrium incidence of pre-operative anemia or a much smaller hemoglobin margin among all patients.

Indeed, as demonstrated in Tables 1 and 2, our data management system enables the validation of more specific information about patient subgroups or patients in clinical performance groups. This type of resolution makes it possible to correlate blood consumption closely with the severity of the diagnosis inside the institution. As expected, the highest transfusion demand was found in invasive heart surgery and the use of cardiac devices, both with respect to the proportion of transfusion cases and the number of transfused units. However, due to their frequency - valve repair or replacement, CABG, and both CABG and valve repair or replacement (roughly > 85%) - the total consumption of blood units per year is significantly considerable both intraoperative and postoperative cares, whereas the congenital and other surgeries are the two minor surgical procedures responsible for the least of the blood supply required. Therefore, it might be potentially demonstrated that upcoming minimally invasive surgical techniques are associated with reduced blood consumption[18,19].

Transfusion services now employ more sophisticated methods and are more likely to embrace improved practices to avoid such results, such as pretransfusion testing that can identify autoantibodies and alloantibodies. Pregnancy or repeated or massive transfusions are examples of the irregular antibody production that follows exposure to foreign antigens from genetically different cells, causing alloimmunization, an immunological response[20]. Due to the immune system's exposure to numerous foreign antigens, triggering a rapid immune response, usually after the second exposure, multi-transfused patients are more likely to develop alloantibodies[21]. The results from our retrospective study revealed an intriguing anti-Mi^{a} (IgM) in postoperative transfusion support after receiving a 24-unit red cell transfusion during the intraoperative phase. Despite the alloimmunisation in massive transfusions where patients receive crossmatched red blood cells can occur, the transfusion of phenotyped units for selected patients in all transfusion services represents important measures to increase transfusion safety. Once the anti-Mi^{a} is identified from this case, compatible blood is easy to find because 90% of ABO-compatible donors are negative for the corresponding antigen in our population[22].

Conclusion

Regarding changes in demographics and progress in medicine, this institution is expected to encounter an ongoing increase in cardiac operations. Our research suggests that considering cardiac surgery is one of the main medical specialties with the highest transfusion requirements, especially in the CCIT; the PBM should be set up hospital-internally in this procedure. Interdisciplinary cooperation will continue to be used to improve bloodless surgical procedures, treat greater preoperative anemia and identify the causes of unnecessary blood transfusions.

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