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The evaluation of patient blood management in lung resection under thoracotomy

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Abstract

Objective Unnecessary blood preparation by surgeons adversely affects blood bank stocks and the healthcare system in many ways. In this study, it is aimed to evaluate the patient blood management strategy in patients in whom we performed lobectomy and pneumonectomy with thoracotomy.

Methods A total of 87 patients have been included in this study. Patient specific data, such as demographic information, laboratory information, preoperative blood ordering, and blood transfusion information have been recorded.

Results All patients were cross-matched, but only 32 (36.7%) of the patients received blood transfusions. Although a total of 264 units of blood had been reserved, the amount of blood used for transfusion was 68 (25.7%) units. The cross-match / transfusion rate was 3.88, the transfusion index was 0.78, and the transfusion probability was 36.7%. There is a positive and statistically significant correlation between the amount of blood allocated ($r=0.591$, $p=0.00$) and the duration of intensive care and hospital stay ($r=0.266$, $p=0.013$). There was also a positive and statistically significant correlation between the amount of blood used and the duration of intensive care and hospital stay ($r=0.422$, $p=0.00$) ($r=0.474$, $p=0.00$).

Conclusion In elective lung resection performed by thoracotomy, the amount of blood wasted during the patient's blood preparation process is high. During the patient blood preparation process, institution-controlled programs should be implemented instead of subjective evaluation at the discretion of the surgeon Planning a patient-specific blood preparation process to alleviate the burden on the healthcare system may prove to be more efficient.

Keywords Thoracic surgery, Thoracotomy, Lobectomy, Pneumonectomy, Blood transfusion

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Introduction

Preparations for the required blood transfusion during elective surgeries vary according to operation types [1–3]. Several studies report that the blood pre-demanded in elective surgeries exceeds the actual need. This causes the bloodstock for emergency surgeries to be consumed and the costs of healthcare to increase [4].

There is almost a consensus on restrictive blood transfusion strategies worldwide. Studies show that the reason why surgeons demand excessive blood is that they cannot accurately estimate the amount of blood needed [1, 4]. To avoid this excessive use, various guidelines and strategies have been reported [4, 5]. Cross-match / transfusion rate (C/T), transfusion index (TI), transfusion probability (%T), and Maximum Surgical Blood Ordering Schedule (MSBOS) have been frequently used to reduce unnecessary blood product demand [4, 5].

Thoracic surgery is complex. Therefore, even patients with minimal transfusion risk might require serious transfusion as a result of major injury [1, 6, 7]. In recent studies, although the transfusion rate in lung resection is low, up to 20% transfusion is performed in open surgery [6]. In this study, it is aimed to evaluate our blood transfusion management in patients underwent lobectomy or pneumonectomy via thoracotomy.

Methods

Design

Patients underwent elective lobectomy and pneumonectomy between 2019 and 2023 were included in this retrospective, single center study. Ethics committee approval is received for the study protocol with the decision number of E1/22/2674. A written informed consent was also obtained from the patients and/or their guardians. The study was conducted following the World Medical Association Declaration of Helsinki.

Data

Demographic and perioperative data such as patients' age, gender, comorbidities, type of surgery, pathology results, number of blood units cross-matched before the operation, number of blood units transfused, chest tube follow-up period, duration of stay in the intensive care unit, duration of hospital stay, complications, average international normalized rate (INR), mean prothrombin time (PT), mean partial thromboplastin time (PTT), platelet and hemoglobin values were scanned from the hospital system.

Inclusion and exclusion parameters

Patients with missing data, patients age 18 years or over, patients who underwent a preoperative blood transfusion, patients with bleeding diathesis disorders, recurrent thoracic surgery.

Patient management

In line with our clinical practice, if patients were to undergo lobectomy, cross-match and two units of blood were reserved, and if pneumonectomy was to be performed, cross-match and three units of blood were reserved. Based on the expectation of blood loss during the operation, the amount of reserved blood was increased according to the decision of the surgical team. There was no hospital protocol for blood preparation before the operation and the management of blood preparation was entirely at the discretion of the surgeon. All surgeries were performed by the same surgical team. In patients without comorbidities, a blood transfusion was performed if the hemoglobulin value was <7 g/dL in the intraoperative and postoperative periods. Transfusion was performed if the hemoglobulin value was ≤ 10 g/dL at the discretion of the surgeon without waiting for these hemoglobulin values in the intraoperative and postoperative period, especially in patients with heart disease (Fig. 1).

Statistical analysis

The data have been evaluated in the statistical package program IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA). Descriptive statistics are given as mean ± standard deviation for normally distributed data, and median (M), minimum (min), and maximum (max) values for non-normally distributed data. The normal distribution of the data of numerical variables has been evaluated with the Shapiro-Wilk normality test. The homogeneity of variances has been evaluated with the Levene test. In comparing numerical variables with two-category variables, an independent two-sample t-test has been used if the data are normally distributed, and the Mann-Whitney U test has been used if the data are not normally distributed. Calculations for C/T, TI, %T and MSBOS are done according to the formulas in Table 1. Meads' criteria have been used when making recommendations for MSBOS [5, 8]. In all comparisons, a p-value of <0.05 is considered to be statistically significant.

Results

There were 87 patients, 30 (34.5%) women and 57 (65.5%) men, in our study. The mean age was 58.60 ± 12.31 (min: 22– max: 78) years. Right lower lobectomy was performed on 14 (16.1%) of the patients, left upper lobectomy was performed on 20 (23%), and left lower lobectomy was performed on 22 (25.3%) of the patients (Table 2). The average of reserved blood was 3.03 ± 0.23 (min: 3– max: 5) units, and the average of transfused blood was 0.78 ± 1.27 (min: 0– max: 5) units.

In our study, all patients were cross-matched. Blood transfusion was performed in 32 (36.7%) of the patients.

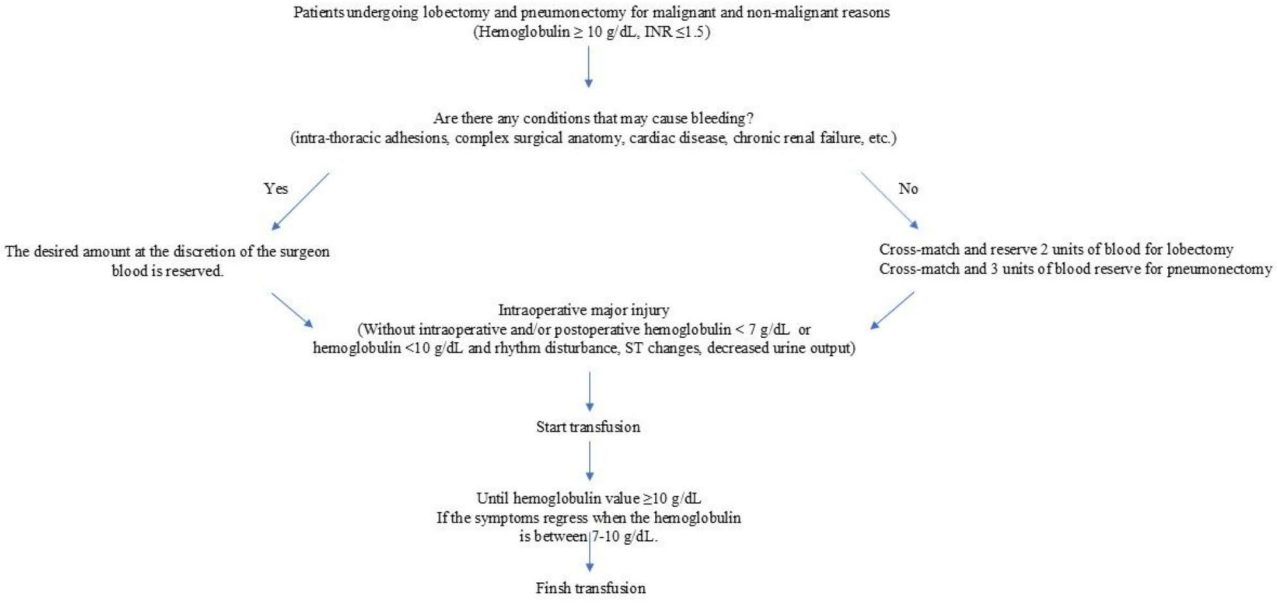

Fig. 1 Schematic of blood management

Table 1 Blood transfusion indexes

Indexes	Formula	Standard value
C/T	Cross-matched unit / Transfused unit	< 2.5
%T	Transfused patient x 100 / Cross-matched patient	%30
TI	Transfused unit / Cross-matched patient	> 0.5
MSBOS	TI x 1.5	Institutionalized

C/T: This ratio is used to assess the adequacy of the amount of blood transfused and the effectiveness of the transfusion in relation to how much blood transfusion the patient needs. TI: It is a measure used to determine how clinically necessary a blood transfusion is. %T: It is used to determine the effectiveness of blood transfusion or the rate of successful transfusion. MSBOS: Maximum Surgical Blood Ordering Schedule (This is a guideline used in surgeries that specifies which blood types and how much blood the patient needs before surgery, taking into account potential blood loss) [1, 4, 5]

A total of 264 units of blood were reserved and 68 (25.7%) units were transfused to the patients. It is found that the CT ratio is found to be 3.88, %T percentage is 36.78%, and the TI ratio is 0.78. Our current protocol, MSBOS recommendations and the protocol we plan to implement after the review are described in Table 3.

When comparing the blood products reserved and used with the type of resection, no statistically significant relationship is found ($p = 0.464$, $p = 0.70$). When the correlation of these data with laboratory data (INR, PT, PTT, platelet, and hemoglobulin) is examined, it is seen that there is no statistically significant relationship (p values were > 0.05 when all data were compared). There is a positive and statistically significant correlation between the amount of blood allocated ($r = 0.591$, $p = 0.00$) and the duration of intensive care and hospital stay ($r = 0.266$, $p = 0.013$). There is a positive and statistically significant relationship between the amount of blood used and the duration of intensive care unit and hospital stay ($r = 0.422$, $p = 0.00$) ($r = 0.474$, $p = 0.00$).

Discussion

In this study, all patients were cross-matched before the operation, but only 36.7% of these patients received blood transfusions. There are a limited number of studies in the literature investigating blood management in patients undergoing lung resection [1, 6]. Previous studies have reported blood transfusion rates of 13–27% in patients undergoing lobectomy and up to 25–30% in patients undergoing pneumonectomy. Rates vary widely due to the characteristics of patient populations [1, 6, 7, 9].

Recently, Abdelsattar et al. have reported that they performed transfusion in 7.1% of 6280 patients who underwent non-cardiac thoracic surgery. This study represents the most comprehensive analysis of transfusion needs among patients undergoing non-cardiac thoracic surgery to date. This study has also been the largest evaluating the need for type & screen (TS) in patients undergoing elective non-cardiac thoracic surgery. Only 50% of the patients had TS performed before the operation [1]. In another comprehensive study, Azizgolshani et al. argued that routine TS is not necessary before esophagectomy and lung resection [7].

The blood transfusion rates in this study have partially been consistent with the literature, and we found that we were wasting blood in our blood management process. We did not apply institutional supervision-based procedures to estimate blood loss during our elective operations. This led to the surgeon making subjective estimates for blood preparation at his discretion. This caused us

Table 2 Patient characteristics and perioperative data

	***n*(%)**
Gender	
Female	30 (34.5)
Male	57 (65.5)
Age, **(year)**	58.60 ± 12.31
Pathology	
Adenocarcinoma	34 (39.1)
Squamous cell carcinoma	18 (20.7)
Carcinoid tumor	6 (6.9)
Large cell neroendocrine tumor	4 (4.6)
Others	8 (9.1)
Preoperative blood values,	
Hemoglobulin, (g/dL)	13.31 ± 2.01
Platelet, (μL)	265.34 ± 85.57
INR	1.04 ± 0.09
PT, (seconds)	15.64 ± 19.42
PTT, (seconds)	36.71 ± 92.47
Operation carried out	
Right upper lobectomy	15 (17.2)
Right lower lobectomy	14 (16.1)
Bilobectomy superior	2 (2.3)
Bilobectomy inferior	4 (4.6)
Left upper lobectomy	20 (20.3)
Left lower lobectomy	22 (25.3)
Right pneumonectomy	5 (5.7)
Left pneumonectomy	5 (5.7)
Number of patients cross-matched	87 (100)
Number of units cross-matched	3.03 ± 0.23
Number of patients transfused	32 (36.7)
Number of transfusion units	0.78 ± 1.27
C/T	3.88
%T	36.78
TI	0.78
Complications	
No	53 (60.9)
Empyema	8 (9.2)
Bleeding	12 (13.8)
Expansion defect	8 (9.2)
Prolonged air leakage	6 (6.9)
Duration of intensive care unit stay, **(days)**	1.31 ± 1.40
Duration of hospitalization, **(days)**	11.95 ± 6.26
Mortality	6 (6.8)

n: number of patients, %: percentage, $\underline{x}$: mean, sd: standard deviation, C/T: Cross-match/transfusion ratio, TI: transfusion index, %T: transfusion probability

to routinely cross-match and reserve blood in high-risk lobectomy and pneumonectomy operations. Considering that, especially in developed countries, TS is often preferred instead of cross-match and that this is not performed on all patients [1, 6, 10], it is concluded that our clinical practices must be altered.

When the indices in this study were evaluated, it was seen that we reserved too much blood and caused blood waste (CT: 3.88, %T: 36.7, TI: 0.78). Many indices have been introduced since the 1970s to assess correct blood use. In 1975, we first used the CT ratio. An ideal ratio of 1.0 signifies the transfusion of all cross-matched blood.

Table 3 Our current protocol, MSBOS recommendations and new protocol plan

	Our clinical practice	**MSBOS**	**Our Recommendation**
Upper lobectomy	Cross-match and reserve 2 units	1.33	Cross-match and reserve 1 unit
Lower lobectomy	Cross-match and reserve 2 units	1.12	Cross-match and reserve 1 unit
Pneumonectomy	Cross-match and reserve 3 units	0.75	Cross-match and reserve 1 unit

MSBOS: Maximum Surgical Blood Order Schedule

A ratio of ≤ 2.5 indicates appropriate blood use. Proposals emerged in the 1980s to evaluate the effectiveness of blood transfusion using T%. A value of ≥ 30% indicates significant blood use. In 1975, they introduced another index, TI. A value of ≥ 0.5 indicates significant blood use [5, 8]. Griffiths et al. found the CT rate to be 4.02 in patients to whom they performed thoracotomy. Meads et al. reported the T% rate as 5% in patients who underwent thoracotomy Another study found this rate to be 47.7% for lobectomy and pneumonectomy [8, 11]. We think that the literature is diverse because the need for blood transfusion lung resection varies widely and there are different procedures even in the same specialty. Although the rates in our study seem to be better than those in the literature, it is thought that cross-matching all patients, the number of transfused units, and the low number of transfused patients have caused these results. Therefore, we are planning to develop a new blood preparation strategy to enhance the results.

In this study, there was a positive correlation between the amount of blood allocated and used and the length of hospital and intensive care unit stays for the patients. We think that this actually indicates that patients with bleeding have a prolonged length of stay in the intensive care unit and in the hospital. In addition to the burden of bleeding on the healthcare system, it has been reported in many studies that blood transfusion preparation and blood transfusion itself are a burden on the healthcare system [1, 4, 12]. Turkey estimates the annual cost of blood transfusion at 100 million dollars. With the studies started in 2019 to improve blood management, the transfusion rate was reduced by 23.24% and the total cost by 15% [12, 13]. We came to the same conclusion again: we need to use audit-based methods to predict blood loss or do patient-specific blood management. This is because long hospital and intensive care stays put a lot of stress on the healthcare system, and blood preparation is not always necessary.

The limitations of our study are that it is retrospective and single-center and that our number of patients is

small. Our choice of thoracotomy might be considered a limitation for the study, as minimally invasive surgical techniques are more common, but this also makes our study valuable. Our hospital is a tertiary hospital with a blood bank, so access to blood products is easy and fast. Our study gives the idea that surgeons should not overdo blood preparation when performing lobectomy and pneumonectomy with thoracotomy in similar hospitals.

Conclusion

This study suggest that the hospital patient blood management protocol needs revision. It is obvious that crossmatching all patients creates a serious burden on the healthcare system. Inevitably, reserved blood cannot be used in emergency and the blood stock status will be affected. Therefore, if elective lobectomy and pneumonectomy will be performed with thoracotomy, we recommend the use of controlled blood preparation programs and even patient-specific blood management.

Author contributions

SAA: Conceptualization, data curation, formal analysis, methodology, writing - original draft, writing - review & editing. KBC: Conceptualization, data curation, formal analysis, writing - original draft, writing - review & editing. BOC: Conceptualization, data curation, methodology, writing - original draft, writing - review & editing. AG: Data curation, methodology, writing - original draft, writing - review & editing. YA: Methodology, resources, supervision, writing - original draft, writing - review & editing. BK: Methodology, resources, writing - original draft, writing - review & editing.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval

Ethics committee approval is received for the study protocol with the decision number of E1/22/2674. The study has been conducted in accordance with the World Medical Association Declaration of Helsinki.

Consent for publication

A written consent has been obtained from the patients and/or their guardians.

Competing interests

The authors declare no competing interests.

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