

Evaluation of crossmatch-to-transfusion ratio, frequency and types of acute reactions in the blood bank

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Abstract

Introduction: Blood transfusion can lead to complications, making accurate identification and recording of these reactions crucial for effective management and prevention. This study aimed to determine crossmatch-to-transfusion (C/T) ratio and the frequency of acute reactions to transfusion in the blood bank of Shahid Beheshti Hospital, Hamedan.

Methods: This cross-sectional descriptive study was performed on all transfusions in Shahid Beheshti Hospital, Hamedan, from March 20, 2022 to March 21, 2023. The data source was the previously filled transfusion forms. C/T ratio was calculated by dividing the number of crossmatched units to the number of transfused units. Also, the incidence of fever, chills, pruritus and redness of the skin, skin rash, back pain, hypotension, dyspnea, chest pain, hematuria, and cold sweat during or after transfusion were evaluated. Gender, blood group, and Rh of the blood recipients were also noted.

Results: A total of 3630 blood request forms were evaluated, of which 2145 (59.1%) were male and 3315 (91.3%) were Rh+. Also, 33.9% had A blood group, 21.9% B, 6.9% AB, and 37.7% O. Overall, 6906 units of blood had been crossmatched and 6611 units transfused. A total of 295 units were not used, among which 252 were from the Urology Ward, 17 from the Emergency Ward, and 26 from other wards of the hospital. As the higher C/T ratio (greater than 2:1) indicates that more units of crossmatched blood are prepared than are actually transfused C/T ratio was appropriate across all months of the year, it was the highest in Shahrivar (1.21) and the lowest in Khordad (1). On the other hand, the total C/T ratio was estimated at 1.04. The most frequent acute reaction was chills (0.3%), followed by fever and dyspnea (0.19% each), hypotension (0.11%), pruritus, redness and skin rash (0.08% each), and hematuria (0.03%). No one experienced back pain, chest pain, or cold sweat.

Conclusion: Based on the results of the current study, it can be inferred that the status of blood usage was good compared to the global standards and there were minimal acute reactions to transfusion. These results could influence transfusion practices or patient safety measures in the hospitals or similar settings.

Keywords: transfusion, crossmatch, acute transfusion reactions.

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Introduction

Excessive blood requests are a common issue in hospitals, leading to problems such as improper distribution of blood products among various centers, increased costs, and a higher workload for blood banks. This increased demand is driven by a fear of insufficient blood availability during surgeries. This fear stems from a lack of knowledge about the blood reserve and the products

available in hospital blood banks. Consequently, excessive blood and blood product requests lead to delays in certain surgeries¹.

Various studies have shown that not adhering to proper blood request protocols for surgeries causes artificial shortages, an increase in the age of stored blood in blood banks, decreased quality, and heavy laboratory

costs, as well as increased waste due to expiration. On the other hand, unnecessary transfusions of blood and its products increase the risk of contamination in the blood recipients. Many studies in this area have highlighted excessive and unwarranted blood and blood product requests, as well as their lack of use in many surgical procedures ^{2,3}.

The crossmatch test, or blood compatibility test, is a technique used to identify ABO blood group incompatibility and unexpected clinical antibodies against red blood cell antigens before blood transfusion ⁴. Given the limited number of blood bag units and the fact that using all of them renders the bag unusable, as well as the fact that multiple heating cycles can degrade the quality of blood, the maximum number of crossmatches for each bag is limited.

The C/T ratio in blood transfusion, typically referring to the coefficient of transfusion or more commonly the crossmatch to transfusion ratio, is an important measure used to evaluate blood utilization efficiency.

In 1975, Henry and Burol introduced the C/T ratio (crossmatch-to-transfusion ratio) to examine blood demand and consumption in hospital departments. The C/T ratio represents the number of crossmatched blood units to the number of units transfused. Researchers have described a ratio of 1/2 to 1/3 as optimal for blood use. In simple terms, in blood management, if the C/T ratio exceeds 2.5, it indicates that less than 40% of crossmatches were used for transfusions ^{5,6}.

In addition to matching supply and demand for blood, another critical issue is the adverse reactions caused by blood transfusions, which can prevent the use of crossmatched blood units for patients. These reactions are categorized into delayed reactions, transfusion-transmissible diseases, and acute reactions. Major delayed reactions include delayed hemolytic transfusion reactions, graft versus host disease, alloimmunization, post-transfusion purpura, and hemochromatosis ^{7,8}. Diseases such as syphilis, AIDS, malaria, cytomegalovirus, and various types of hepatitis can be transmitted to the patient through blood and its products. Acute hemolytic transfusion reactions and allergic reactions are also among the most important acute reactions ⁹. Given the importance of optimal blood unit usage and the high prevalence of transfusion-related complications, we conducted this study to examine the C/T ratio and the types and rates of acute reactions in the blood bank of Shahid Beheshti Hospital in Hamadan.

Methods

This descriptive cross-sectional study was conducted at Shahid Beheshti Hospital in Hamadan from March 2022 to March 2023 on all blood transfusion cases in the hospital.

Data Collection Tool: A researcher-made checklist, which included all study variables, was used. The sampling method was a census, and all blood requests during this time period were reviewed and included in the study.

This study, conducted from March 2022 to March 2023, aimed to include 5,000 samples based on similar periods in the previous year. However, 3,630 samples were ultimately included in the study due to limited patient population during the study period regarding the specific criteria or exclusion factors. Since the sampling method was a census, there was no need to calculate the sample size.

All the patients who need for blood transfusion and candidates for blood transfusion were included. If the patients had thalassemia or other diseases that require continuous and regular blood transfusions or in the case of incomplete reports they were excluded.

Data Collection Method

Data were collected retrospectively from forms and patient files. All patients who, according to the clinician's judgment, required a blood transfusion and were candidates for blood transfusion were included in the study, while thalassemia patients and others with diseases that require continuous and regular blood transfusions were excluded. Based on prior research, sufficient information was available in the relevant forms, so there was no need for a prospective study, and the data were analyzed retrospectively. The C/T ratio was calculated by dividing the number of crossmatched blood units by the total number of blood units transfused. Additionally, the occurrence of fever, itching and redness of the skin, rashes, back pain, chills, low blood pressure, shortness of breath, chest pain, hematuria, and cold sweats during each transfusion session was assessed. The age, gender, blood group, and Rh factor of the patients receiving blood were also recorded, along with the requesting department for the blood units. The collected data were then entered into the SPSS software (version 25) for analysis.

Data Analysis

The collected data were entered into SPSS software (Ver. 26). Given the descriptive nature of this study, the data were reported as frequencies (percentages), and charts were used for better description of the reports.

Research Limitations

Limitations of the study include incomplete and occasionally incorrect reports from the nursing system. To address this, continuous training on how to complete the reports should be provided. Additionally, incomplete reports, as mentioned in the exclusion criteria, were not included in the study.

Ethical Considerations:

Throughout the implementation of the study, the basic principles of the Helsinki Declaration (Ethical Principles in Medical Research Involving Humans) and the Ethics Committee of Hamadan University of Medical Sciences were followed. All patient information remained confidential and was not shared with any individual or entity.

Results

In the present study, 3,630 blood requests were evaluated over the course of one year at the blood bank. Of these, 2,145 (59.1%) were male and 1,485 (40.9%) were female. In total, 33.9% had blood group A, 21.9% had blood group B, 6.9% had blood group AB, and 37.3% had blood group O. Rh was positive in 91.3% and negative in 8.7% of the cases. The most common acute transfusion reactions reported were chills, shortness of breath, and fever, with frequencies of 0.3%, 0.19%, and 0.19%, respectively. Additionally, no individuals experienced back pain, chest pain, or cold sweats (Table 1).

Table 1. Baseline and clinical characteristics of individuals requesting blood over the course of one year

characteristics		Frequency (percentage)
Gender	Male	2145(59.1%)
	Female	1485(40.9%)
Blood types	A+	1125(31%)
	A-	105(2.9%)
	B+	721(19.9%)
	B-	72(2%)
	AB+	228(6.3%)
	AB-	21(0.6%)
	O+	1234(34%)
	O-	119(3.3%)
RH	+	3315(91.3%)
	-	315(8.7%)

characteristics	Frequency (percentage)	
Fever	7(0.19%)	
Itching and redness of the skin	3(0.08%)	
Skin rash	3(0.08%)	
Back pain	0(0%)	
Acute reactions to blood transfusion	Chills	11(0.3%)
	Hypotension	4(0.11%)
	Shortness of breath	7(0.19%)
	Chest pain	0(0%)
	Hematuria	1(0.03%)
	Cold sweat	0(0%)

On the other hand, the report on the number of crossmatched and transfused blood units by month revealed that the highest number of crossmatched blood units occurred in June, and the lowest in March. In total, there were 6,906 crossmatched blood units and 6,611 transfused units over the year. Therefore, the amount of wasted blood was 295 units, of which 252 units were related to the urology department, 17 units to the emergency department, and 26 units to other departments (Figure 1).

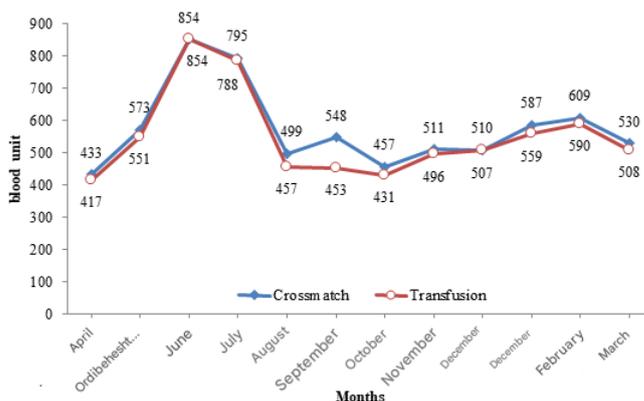


Figure 1. Number of crossmatched and transfused blood units by month of the year

Finally, the overall crossmatch-to-transfusion (C/T) ratio was 1.04. Evaluation of this ratio by month revealed that the C/T ratio was highest in Shahrivar with a value of 1.21, and lowest in Khordad with a value of 1 (Figure 2).

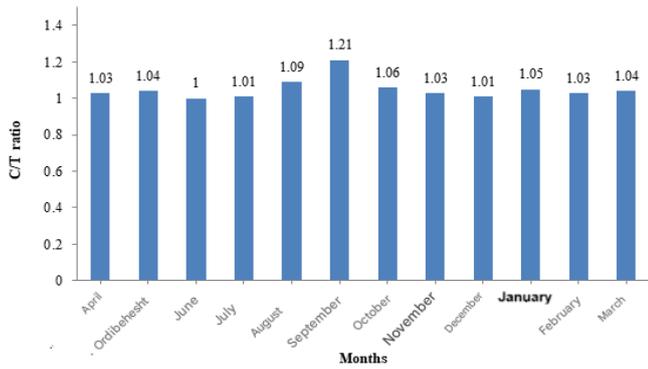


Figure 2. Crossmatch-to-transfusion (C/T) ratio by month of the year

Discussion

Excessive blood requests are a common problem in hospitals, leading to issues such as improper distribution of blood products among different centers, increased costs, and a higher workload for the blood bank. Henry and Burol introduced the C/T ratio (crossmatch-to-transfusion ratio) to assess the demand and consumption of blood in hospital departments. Researchers have described a C/T ratio of 1/2 to 1/3 as an optimal use of blood in the C/T varied between 1 and 1.21 across different months of the year. In June, with a ratio of 1, all crossmatched blood units were transfused, and in September, with a ratio of 1.21, the C/T ratio remained ideal. The overall C/T ratio for the entire year was 1.04, indicating that nearly all crossmatched blood units were transfused ^{5,6}. A higher C/T ratio (greater than 2:1) indicates that more units of crossmatched blood are prepared than are actually transfused. This suggests over-preparation, which can lead to unnecessary wastage of blood resources, increased costs, and possible delays in blood availability for other patients.

A lower C/T ratio (closer to 1:1) suggests that most or all of the crossmatched blood is being used appropriately, reflecting efficient blood utilization, better inventory management, and reduced wastage.

This figure is not only favorable compared to international standards but also when compared to figures reported in other studies ¹. For example, the C/T ratio in a hospital in India was 2.5, in an elective cesarean study in a hospital in Saudi Arabia it was 3.2, in North American hospitals it was 1.30 ± 0.34 , in three hospitals in Semnan it ranged from 1.34 to 1.77 ¹⁰, and in hospitals in Rasht, it was 1.9 ⁶. The difference among the figures reported in various studies can be attributed to the policies of each hospital, region, or country, and the protocols for determining the required blood units for each type of surgery.

Another finding from the present study was that the highest blood wastage was associated with the urology department. This contrasts with the study by Qarabaghian et al., where the highest wastage occurred in the surgical department, and the study by Raghuwanshi et al., where wastage was also highest in the surgical department ^{6, 11}. It appears that, considering the time frame of these two studies, acute reactions were higher in the older study, whereas the more recent study's results were closer to the figures found in the present study. This could be due to measures that have been taken in recent years in this regard.

In the present study, the most common complication was chills, observed in 11 individuals (0.3%), followed by fever and shortness of breath, each in 7 individuals (0.19%), hypotension in 4 individuals (0.11%), itching, skin redness, and skin rashes, each in 3 individuals (0.08%), and hematuria in 1 individual (0.03%). None of the individuals experienced back pain, chest pain, or cold sweats.

In a study conducted by Salimi et al. (2009), aimed at determining the incidence of acute reactions to the transfusion of blood and its processed products at the Urmia Blood Transfusion Center, acute reactions from 3,880 units of blood and its products were investigated. The most common reactions observed in patients following blood and blood product transfusion were chills (2.78%), skin itching (2.46%), and shivering (2.14%) (12). Badag Khan et al. studied 57,902 hospitalized patients at Namazi Hospital from 2009-2011 who received blood transfusions. They concluded that only 52 (0.08%) had acute transfusion reactions, while 57,850 had no complications. Among those with reactions, common symptoms included fever (25 cases), skin redness and rashes (15 cases), back pain (9 cases), chills (8 cases), low blood pressure (5 cases), shortness of breath (5 cases) and 1 case for each of chest pain hematuria, and cold sweats ¹³. Another study reported that the most transfused components were RBCs (70.25%), RDP (10.3%), and FFP (9.5%). Blood transfusion reactions included allergic (53.5%), febrile non-hemolytic (24%), dyspnea (10.25%), hemolytic (4.5%), hypotension (4.25%), TACO (1.75%), and others (2.75%). Receiving RBC components like whole blood, RBC concentrates, and leukoreduced RBCs was significantly linked to higher FNHTR incidence (14). The results of a study by Joon et al in India showed that the overall hospital C/T ratio was 2.33, which indicates excessive blood ordering. The Department of Obstetrics and Gynaecology had the highest C/T ratio of 5.14, followed by Oncology (3.09), Urology (2.9), General Surgery (2.26), and Orthopaedics (2.08). These high ratios showed significant overordering and underutilization of

crossmatched blood units that is more than due study which can be due to more population of the country ¹⁵.

This study provides insights into blood request patterns, transfusion reactions, and blood utilization efficiency over a one-year period at the blood bank. The findings showed that the majority of blood requests came from male patients (59.1%), consistent with previous studies indicating higher transfusion demands in males, possibly due to underlying conditions or demographic factors.

Blood group distribution revealed that blood type O positive was most common (34%), aligning with global and regional trends. The high prevalence of Rh-positive cases (91.3%) also reflects typical blood group distributions in the population.

The low incidence of transfusion reactions observed supports the safety of current transfusion protocols at the hospital. The near-ideal C/T ratio indicates efficient blood utilization, which is essential for optimizing resources and reducing waste. However, the observed wastage, particularly in the urology department, highlights opportunities for improving blood ordering practices.

Clinically, these findings underscore the importance of adopting evidence-based blood ordering guidelines tailored to departmental needs, such as using restrictive transfusion strategies when appropriate. Future research could focus on validating predictive models for transfusion requirements to further minimize wastage and enhance patient safety.

Conclusion

In conclusion, our findings suggest that blood transfusion practices at this hospital are generally safe and efficient. Emphasis on continuous staff training, improved blood ordering protocols, and better prediction of transfusion needs could further reduce wastage and enhance resource management.

Recommendations:

Implement or refine blood management protocols, including leukoreduction and stricter transfusion criteria, to reduce unnecessary crossmatching and wastage.

Promote staff training on blood ordering and transfusion safety to enhance adherence to best practices. Utilize hospital data to develop department-specific guidelines, especially for departments with higher wastage like urology.

Encourage periodic review of transfusion practices and outcomes to continuously improve efficiency and safety.

Highlights

What Is Already Known?

The crossmatch-to-transfusion (C/T) ratio is an established indicator of blood utilization efficiency, with higher ratios reflecting over-ordering and under-utilization of crossmatched units.

What Does This Study Add?

Emphasis on continuous staff training, improved blood ordering protocols, and better prediction of transfusion needs could further reduce wastage and enhance resource management.

Authors' Contributions

All the authors were equally contributed

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Conflicts of Interest Disclosures

the authors have no conflict of interest

Consent For Publication

The individuals involved in this study are aware of the planned publication and has given their consent for publication

Ethics approval

After approval from the Ethics Committee of Hamadan University of Medical Sciences (IR.UMSHA.REC.1401.007), all blood transfusion cases conducted at Shahid Beheshti Hospital in Hamadan from March 2022 to March 2023 were reviewed.

The extent of AI use

Not used

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