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ASSESSMENT OF BLOOD UTILISATION IN SURGICAL PATIENTS AT A TERTIARY CARE CENTRE: A RETROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Rational utilisation of blood components is an essential aspect of transfusion medicine, specifically in areas where blood resources are limited. An excessive preoperative crossmatching may lead to unnecessary depletion of blood bank stocks and increased laboratory workload, while insufficient availability may result in delayed transfusions during unplanned emergency surgical haemorrhage. The Crossmatch-to-Transfusion (C/T) ratio and Transfusion Probability (TP) are widely used indicators of blood utilisation efficiency.

Methods: This study was a retrospective observational study conducted at Saveetha Medical College and Hospital from November 1, 2023, to January 31, 2024. Data pertaining to surgical patients for whom packed red blood cells (PRBCs) were crossmatched were collected from blood requisition forms, crossmatch and issue registers, and digital medical records. Demographic characteristics, surgical speciality, number of units crossmatched, and number of units transfused were recorded. Blood utilisation was assessed using the C/T ratio and TP. The C/T ratio was calculated as the number of units crossmatched divided by the number of units transfused, while TP was calculated as the percentage of patients transfused among those crossmatched.

Results: Out of 1,031 surgical admissions during the study period, 837 patients underwent PRBC crossmatching, involving 1,233 units. Of these, 274 patients received transfusion, with a total of 499 PRBC units transfused. The overall C/T ratio was 2.47, while the overall TP was 32.7%. Considerable variation was observed among surgical specialities. Cardiothoracic and Vascular Surgery demonstrated efficient utilisation, with a C/T ratio of 1.19 and TP of 65.2%, whereas Obstetrics and Gynaecology had a C/T ratio of 5.1 and TP of 19.2%, suggesting substantial over-ordering and underutilization of crossmatched blood. Among transfused patients, 164 underwent elective procedures, and 110 underwent emergency procedures.

Conclusion: The overall blood utilisation was within normally accepted C/T and TP benchmarks; however, interdepartmental variation was identified. Departments demonstrating inefficient blood utilisation, reflected by high C/T ratios (>2.5) and low transfusion probability (<30%), may benefit from procedure-specific and risk-stratified blood ordering practices, including implementation of Maximum Surgical Blood Ordering Schedules (MSBOS), Type and Screen protocols, regular blood utilisation audits, and clinician education. These measures may reduce unnecessary crossmatching, improve blood availability, and promote effective patient blood management.

KEYWORDS: Blood utilisation; Crossmatch-to-transfusion ratio; Transfusion probability; PRBC; Blood ordering; MSBOS; Patient blood management; Surgical patients; Tertiary care hospital.

INTRODUCTION

Blood transfusion has evolved substantially since the early experimental transfusions reported by Richard Lower in 1666 and James Blundell's successful human-to-human transfusion in 1818. The discovery of the ABO blood group system by Karl Landsteiner in 1901 subsequently established the scientific basis for compatibility testing and significantly improved transfusion safety. [1,2]

Modern transfusion medicine encompasses not only the provision of safe blood components but also their appropriate and efficient utilisation. Despite improvements in blood collection, testing, component preparation, and transfusion safety, access to blood remains unequal worldwide. According to the World Health Organisation (WHO) Global Status Report on Blood Safety and Availability 2025, based predominantly on data from 2023, approximately 120.4 million blood donations were collected globally. High-income countries accounted for 36% of these donations despite representing approximately 15% of the world's population. The median blood donation rate was 28.9 per 1,000 population in high-income countries compared with 18.2, 8.5, and 4.5 per 1,000 population in upper-middle-income, lower-middle-income, and low-income countries,

respectively.[3] These differences emphasise the importance of rational blood utilisation, particularly in healthcare settings where blood availability is still limited.

Requesting blood products preoperatively for use during perioperative resuscitation is standard practice in surgical patients. Physicians often order more units of blood than what's actually necessary to create a safety buffer in case of unexpected haemorrhage during surgical procedures or other medical interventions.[4-6] This practice is based on the fact that surgeries are unpredictable when it comes to bleeding volumes intraoperatively, which can vary depending on factors such as patient physiology, surgical complexity, and unforeseen complications. By requesting additional units of blood, doctors aim to pre-emptively address potential shortages that could arise if bleeding exceeds initial estimates. This precautionary approach aligns with the principle of ensuring patient safety and optimising clinical outcomes by minimising the risk of insufficient blood supply in critical situations. However, it's essential to balance this strategy with considerations of resource utilisation, cost-effectiveness, and avoiding unnecessary transfusions, thereby promoting efficient healthcare delivery while maintaining patient welfare.

Furthermore, preoperative blood requesting practices can potentially result in blood product wastage. Once PRBC units are crossmatched and reserved for a particular patient, their immediate availability for other patients may be restricted according to institutional reservation and inventory policies. Hence, indirectly, it leads to depletion of the already scarce resource, blood.[4,5]

The current blood product requesting system in our setup involves performing blood typing and complete blood counts for all surgical patients initially. Subsequently, cross-matched blood is prepared based on the estimated blood requirement of the patient, as determined by the operating surgeon, surgical resident, or anaesthesiologist/anaesthetist. Cross-matching is requested one day prior to the planned surgical procedure, and blood is issued from the blood bank on the day of the surgery if and when required.[4] When a blood bag is cross-matched, it is reserved for the patient for 48 hrs in our hospital. In many other hospitals, this reservation time can vary between 48 and 72 hours. Consequently, the blood becomes unavailable for other patients on the day of surgery and for 48 hours post-surgery.[4]

Thus, our study aims to assess and monitor the performance and outcomes of blood utilisation services in our hospital. Effective blood utilisation is assessed by various parameters, out of which 2 parameters, namely Crossmatch to Transfusion ratio (C/T ratio) and Transfusion Probability (TP), are more accurate in evaluating the efficacy of blood usage in surgical departments in our hospital.

MATERIALS AND METHODS

This was a retrospective observational study conducted at Saveetha Medical College and Hospital. The study period was from November 1, 2023, to January 31, 2024. All surgical patients admitted to our hospital during the study period were included, which came to be totally 1031 patients.

DATA COLLECTION

All packed red blood cell (PRBC) requests for all surgical patients during the study period were included. Data collected included age, gender, admitting department, ABO-Rh blood group, and the number of units requested for surgery. The number of units crossmatched and issued for transfusion on the day of surgery and postoperative day 1 was recorded. Data were collected from Blood requisition forms, Cross-match registers, Issue registers, and Digital Medical Records.

DATA ANALYSIS

Data were analysed with the help of SPSS software version 23. The following two indices were calculated using the data:

1)Crossmatch to Transfusion Ratio (C/T Ratio) = Number of units crossmatched / Number of units transfused

2)Transfusion Probability (TP) = (Total number of patients transfused / Total number of patients crossmatched) * 100

The use of crossmatch to transfusion (C/T) ratio was first recommended by Boral Henry in 1975.[7] Ideally, this ratio should be 1.0, but a ratio of 2.0 and below was suggested to be indicative of efficient blood usage.[6]

Other pertinent factors such as the indications for blood requests and demographic patterns were also studied with the obtained data.

RESULTS

Out of 1031 surgical patients, 837 patients required PRBC transfusion. A total of 1,233 PRBC units were crossmatched for the 837 patients. The sociodemographic characteristics of the patients are presented in Table 1. Out of these 837 patients, only 274 patients were transfused with 499 units. This indicates a significant gap between the requested and utilised blood units. This suggests that a considerable number of patients did not require transfusions despite blood being crossmatched for them.

Table 1: Sociodemographic Characteristics Of The Patients:

Characteristic	Number	Percentage
Male	364	43.5%
Female	473	56.5%
<18 years	180	21.5%

Characteristic	Number	Percentage
≥18 years	657	78.5%
Elective	595	71.1%
Emergency	242	28.9%

The utilisation pattern varied across different surgical departments. Some departments demonstrated better utilisation rates than others.
The overall C/T ratio was: 1233/499=2.47
Thus, approximately 2.47 units were crossmatched for every unit transfused. (Figure 1)
The overall TP was: 274/837×100=32.7%
Thus, approximately one-third of patients for whom blood was crossmatched ultimately received transfusion.

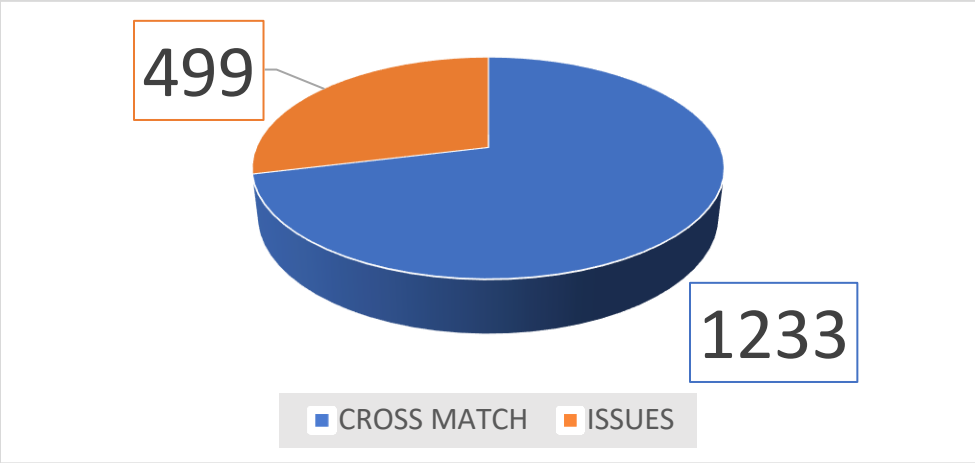

Figure 1: Overall CT ratio.

The overall TP, calculated as the percentage of patients transfused out of those crossmatched, was found to be 32.7%. Approximately one-third of crossmatched patients ultimately received transfusions, and TP was slightly above the commonly used 30% benchmark. A transfusion probability greater than 30% indicates efficient blood usage with scope for further optimisation.
Within different surgical departments, there were notable differences in blood utilisation. (Figures 2 and 3) The Cardiothoracic and Vascular Surgery (CTVS) department demonstrated efficient blood utilisation, with a C/T ratio of 1.19 and a TP of 65.2%. This suggests a more appropriate matching of blood orders to actual transfusion needs. Conversely, the Obstetrics and Gynaecology unit exhibited comparatively low utilisation, with a high C/T ratio of 5.1 and a low TP of 19.2%. This indicates the potential over-ordering of blood units or inappropriate transfusion practices within this department.

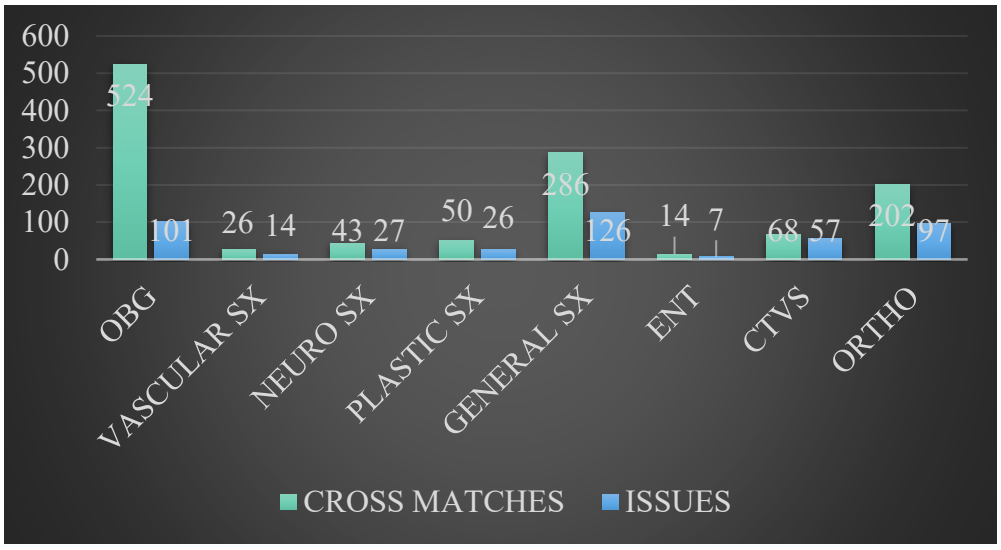

Figure 2: Crossmatch and issue patterns among surgical specialities

DEPARTMENT	C/T RATIO	TP
OBSTETRICS AND GYNAECOLOGY	5.1	19.2
VASCULAR SURGERY	1.85	46.6
NEURO SURGERY	1.59	52.6
PLASTIC SURGERY	1.92	48.3
GENERAL SURGERY	2.26	45.7
ENT	2	54.5
CARDIO THORACIC SX	1.19	65.2
ORTHO	2.08	52.52

Figure 3: Blood utilisation patterns among different surgical specialities

Overall, 274 patients were transfused with PRBCs. Out of which, 164 patients had elective procedures, and 110 patients had emergency procedures. Totally 324 PRBCs were transfused in elective surgeries, and 175 PRBCs were transfused in emergency procedures.

DISCUSSION

Blood utilisation is an important quality indicator in transfusion medicine. Blood components are limited resources, and inappropriate preoperative ordering may unnecessarily increase laboratory workload, restrict inventory availability, and contribute to wastage. At the same time, overly restrictive ordering can delay transfusion in patients experiencing unexpected haemorrhage. Therefore, the objective of blood utilisation monitoring is not simply to reduce blood ordering, but to achieve an appropriate balance between availability, safety, and resource conservation.

Our study evaluated blood utilisation in surgical patients using the C/T ratio and TP. The overall C/T ratio was 2.47. This means that approximately 2.47 units were crossmatched for every unit transfused. The ratio is within the accepted benchmark of ≤ 2.5, with scope for further improvement.[5,6,8]

Therefore, the overall result in the present study should be interpreted as the presence of excessive crossmatching with scope for optimisation. Nevertheless, the proximity to the upper limit indicates that there is scope to improve preoperative blood ordering practices. The overall TP was 32.7%, slightly above the conventional benchmark of 30%. This indicates that approximately one in three patients for whom blood was crossmatched ultimately received transfusion. Taken together, these indices suggest that overall utilisation in the institution was reasonable but could be optimised further, particularly in specific departments. One of the most important findings of the study was the marked variation in blood utilisation between surgical specialities.

CTVS demonstrated a C/T ratio of 1.19 and TP of 65.2%. A C/T ratio close to 1 indicates that the number of units crossmatched was closely aligned with the number ultimately transfused. The high TP further indicates that the majority of patients for whom blood was crossmatched actually required transfusion. In contrast, OBG demonstrated a C/T ratio of 5.1 and TP of 19.2%. This pattern indicates relatively low utilisation of crossmatched blood.

The reasons for this difference are likely multifactorial. Obstetric practice frequently requires preparedness for potentially life-threatening haemorrhage, including postpartum haemorrhage and placenta-related bleeding. Clinicians may therefore adopt a precautionary blood-ordering approach in patients considered to be at risk. However, routine multiple-unit crossmatching for patients with a low actual probability of transfusion may unnecessarily reserve blood. This is particularly relevant in settings where blood inventory is limited. The findings therefore support the development of procedure-specific and risk-stratified blood ordering protocols. Conversely, the relatively favourable CTVS indices may reflect established anticipation of blood requirements in procedures with predictable and relatively high transfusion rates. However, procedure-specific data would be necessary to establish this explanation.

The findings of the present study are comparable with previous studies demonstrating variability in blood utilisation between institutions and surgical departments. A study published in BMC Health Services Research evaluated blood utilisation in elective surgical patients and used C/T ratio ≤2.5, TP ≥30%, and TI ≥0.5 as indicators of appropriate blood utilisation.[5] These criteria are similar to those used in the present study. Other studies have reported C/T ratios above the recommended threshold in surgical departments, suggesting that preoperative blood ordering may frequently exceed actual transfusion requirements.[5,6,8]

Studies implementing MSBOS and Type and Screen strategies have demonstrated that institution-specific blood ordering protocols can reduce unnecessary crossmatching and improve blood utilisation.[9-11] In a recent Indian study of neurosurgical patients, implementation of an MSBOS was associated with a reduction in C/T ratio from 3.6 to 2.4 and an increase in blood utilisation from 27.4% to 41.55%.[9] Similarly, the introduction of Type and Screen and MSBOS protocols in another institution reduced the C/T ratio from 3.4 to 1.9 and reduced the number of expired RBC units.[10] These findings support the implementation of similar evidence-based blood ordering strategies in our institution.

In the present study, more patients who received transfusion underwent elective procedures (164 patients) than emergency procedures (110 patients), and the absolute number of PRBC units transfused was also higher in elective procedures. However, this finding should be interpreted cautiously. The number of patients undergoing each type of surgery differed, and absolute transfusion numbers do not account for the underlying number of patients crossmatched in each group.
Emergency surgery is often associated with acute haemorrhage, trauma, ruptured ectopic pregnancy, gastrointestinal bleeding, and other conditions in which the probability of transfusion may be higher. Consequently, emergency procedures may demonstrate better blood utilisation indices despite involving fewer total patients. Therefore, C/T ratio and TP should be calculated separately for elective and emergency procedures before making conclusions regarding comparative utilisation.

Education and training programs for healthcare providers on appropriate blood utilisation practices may also help improve blood management and reduce C/T ratios. These programs can focus on raising awareness about evidence-based transfusion guidelines, educating clinicians on the risks associated with unnecessary transfusions, and promoting interdisciplinary collaboration between surgeons, anaesthesiologists, and transfusion specialists to ensure judicious blood utilisation.[11,12] Furthermore, incorporating simulation-based training modules that simulate perioperative scenarios involving blood transfusions can enhance providers' decision-making skills and confidence in managing intraoperative blood loss.[13]

Continuous monitoring and audit of blood requisition and transfusion practices are essential to identify and address inefficiencies, ensuring optimal use of blood resources and maintaining an adequate blood inventory for transfusion when needed. Regular review of blood ordering patterns, transfusion triggers, and post-transfusion outcomes can help identify areas for improvement and guide targeted interventions to enhance blood utilisation efficiency.[14] Moreover, leveraging electronic health record systems and data analytics tools can facilitate real-time monitoring of blood utilisation metrics, enabling proactive interventions to address deviations from established guidelines and promote a culture of responsible blood stewardship within the healthcare institution.[11]

CONCLUSION

Overall blood utilisation was acceptable according to conventional C/T and TP benchmarks, but considerable variation between surgical specialities indicates opportunities for optimisation, particularly in departments with high C/T ratios and low TP. This highlights the need for targeted interventions to optimise blood ordering processes. Enforcing the hospital's Transfusion policy by the Hospital Transfusion Committee is imperative to ensure compliance with established guidelines and minimise over-ordering and unnecessary transfusions.[11] Regular auditing of blood components is essential to monitor transfusion practices across departments, enabling timely corrective actions and optimisation of blood utilisation. Adopting Type & Screen protocols can streamline the transfusion process by determining a patient's blood type and screening for antibodies before transfusion, reducing the need for crossmatching and expediting transfusions when appropriate.[7] Moreover, the integration of blood conservation strategies such as the Maximum Surgical Blood Ordering Schedule (MSBOS) can play a pivotal role in curtailing undue transfusions. By furnishing evidence-based directives for blood requisition, customised to the nuances of specific surgical interventions and patient profiles, the MSBOS serves as a valuable tool in streamlining transfusion practices. This proactive approach not only enhances patient care by minimising the risks associated with unnecessary blood transfusions but also optimises resource utilisation within healthcare facilities, ensuring a judicious allocation of blood products while adhering to stringent clinical standards.[10,15] These measures collectively aim to improve blood management practices, reduce waste, and enhance patient safety and outcomes in transfusion medicine.

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