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Original Research Article

Retrospective Evaluation of Perioperative Blood Transfusion Requirements and Associated Risk Factors in Major Surgical Procedures

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Abstract:

Background: Perioperative blood transfusion is an integral component of major surgical care for managing acute blood loss and maintaining adequate tissue oxygenation. However, inappropriate transfusion practices may increase postoperative complications, healthcare costs, and resource utilization. Identifying factors associated with blood transfusion is essential for optimizing perioperative blood management and improving patient outcomes.

Aim: To evaluate perioperative blood transfusion requirements and identify associated risk factors among patients undergoing major surgical procedures.

Methodology: A hospital-based retrospective observational study was conducted over one year at a Netaji Subhas Medical College and Hospital in Bihta, Patna, Bihar. A total of 145 adult patients undergoing major elective surgical procedures were included. Data regarding demographic characteristics, clinical profile, laboratory parameters, surgical details, perioperative blood transfusion, and postoperative outcomes were collected from hospital records. Statistical analysis was performed using IBM SPSS version 26.0, with $p < 0.05$ considered statistically significant.

Results: Among the 145 patients, 46 (31.7%) required perioperative blood transfusion, while 99 (68.3%) did not. Packed Red Blood Cells were the most frequently transfused blood component. Lower preoperative haemoglobin levels, intraoperative blood loss exceeding 500 mL, and operative duration greater than three hours were identified as significant independent predictors of perioperative blood transfusion ($p < 0.05$).

Conclusion: Perioperative blood transfusion was commonly required in major surgical procedures and was significantly associated with preoperative anaemia, excessive blood loss, and prolonged surgery. Adoption of Patient Blood Management strategies and restrictive transfusion practices may improve patient outcomes and optimize blood utilization.

Keywords: Perioperative blood transfusion, Major surgery, Patient blood management, Preoperative anaemia, Blood loss, Risk factors, Packed red blood cells.

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Introduction

Large blood losses are common in major surgery and blood transfusion is often part of the care provided during surgery. The transfusion of blood is essential in restoring the blood volume, maintaining optimum tissue oxygenation and preventing the problems associated with acute anaemia before and after surgery. While transfusion of allogenic blood has made major surgical interventions safer, it is also known to have several detrimental effects such as transfusion reactions, immunomodulation, transmission of infectious agents, length of hospital stay, health care costs and higher postoperative morbidity and mortality [1]. Thus, current practice in the perioperative arena no longer involves routine replacement of surgical blood loss with allogenic blood transfusion, but rather evidence-based methods to reduce unnecessary transfusion while achieving best patient outcomes.

This paradigm shift highlighted the need for the correct transfusion practice and the need for patient management in the peri-operative period. Patient Blood Management (PBM) has become an integrated and multi-disciplinary strategy to maximize care for patients who may require blood transfusion over the last 20 years. PBM is the use of evidence-based medical and surgical strategies to maintain hemoglobin concentration, optimize hemostasis and reduce blood loss in a timely fashion to enhance clinical outcomes. PBM is not just about blood

replacement but about correction of any anemia before surgery, careful surgery to minimize the need for blood during surgery, judicious use of blood transfusion and postoperative blood conservation measures. Many international studies have shown that PBM programs are an effective means of reducing transfusion needs, postoperative complications, hospital stay and improving patient survival without any effect on patient safety [2].

Although restrictive transfusion practice is gaining popularity, the issue of blood transfusion in the perioperative period is a complicated clinical one. Guidelines for transfusion have been published by a number of professional bodies which suggest restrictive hemoglobin thresholds and individual assessment of the patient based on clinical parameters, not just laboratory support [3]. Significant interhospital, interspecialty, inter-anesthesiologist and individual variability is still found, however, in transfusion practice. This is because there is variation in institutional protocols, surgeon preference, clinical judgment, expected blood loss, and blood product availability. This results in the administration of unnecessary transfusions in many patients and delay of transfusion in others with considerable blood loss. These discrepancies illustrate the need for ongoing assessments of transfusion services across various healthcare settings to pinpoint areas for improvement and the need for standardized PBM protocols [4].

Several factors, related to the patient and surgery, influence the risk of needing a blood transfusion during or after surgery. Increasing age, female gender, low preoperative hemoglobin concentration, presence of underlying co-morbidities, coagulation abnormalities, nutrition deficiencies, emergency surgeries, long operation duration, large tissue dissection and high intraoperative blood loss are recognized as factors of importance in transfusion [5]. Likewise, the extent of surgery and the type of surgery to be performed significantly affects transfusion needs; transfusion requirements for major hepatobiliary surgery, cardiovascular surgery, orthopedic surgery, oncological surgery, gastrointestinal surgery, and trauma surgery are higher than those for the less invasive surgeries. Identifying these risk factors early allows clinicians to optimize patients prior to surgery, optimize blood ordering schedules, reduce unnecessary cross matching and use appropriate blood conservation measures.

There are risks associated with blood transfusion. While complications due to transfusion have significantly decreased with improvement in donor selection, infectious disease testing and transfusion safety, allogenic blood transfusion remains linked to adverse clinical outcomes. Transfused patients have been shown to be at higher risk for infections after surgery, transfusion-related acute lung injury (TRALI), transfusion-associated circulatory overload (TACO), immunosuppression, thromboembolic events, longer hospital stays, higher health care costs and decreased long-term survival. Preoperative and postoperative allogenic blood transfusion has been associated in the field of oncological surgery with immunomodulatory effects, which can lead to higher risk of tumor recurrence and have a negative impact on long-term prognosis. These findings have reinforced the recommendations for restriction of transfusion and proper use of blood products in so far as is clinically possible [6].

Several techniques have been developed to prevent unnecessary allogenic blood transfusion, such as the pre-operative treatment of anemia with iron therapy or the use of erythropoietin, autologous blood donation, and intraoperative cell salvage, acute normovolemia hemodilution, and the use of antifibrinolytic agents and restrictive transfusion thresholds. Although some of these interventions have shown promising results in specific patient groups, their implementation is not consistent due to issues of cost-effectiveness, feasibility, and inconsistent clinical effects. In addition, the rise of the demand for blood products, the reduction of the numbers of donors in some countries, and the pressures on the health system highlight the need to optimize blood use and minimize avoidable transfusion [7]. Multiple large observational cohort studies have made efforts to assess blood use during surgery and to determine factors affecting perioperative use.

The Turkish National Perioperative Transfusion Study (TULIP-TS) has been conducted with the aim of evaluating the postoperative outcomes, incidence and indications of blood transfusion, understanding the transfusion practices in Turkey and establishing transfusion practice standards for the country, and to provide evidence for future health care planning [8]. Similarly, in patients undergoing elective liver surgery, the rate of blood transfusion is 10–33% despite all the improvement in the surgical technique and peri-operative care. Low preoperative hemoglobin levels expected blood loss, large resections, long operative time, and patient comorbidities have been important factors predicting the need for transfusion in these investigations. Besides, risk prediction for transfusion has been demonstrated to enhance the management of blood banks by minimizing the number of unnecessary cross matching and by allowing the proper use of packed red blood cells [9].

The overall information on peri-operative blood transfusion practices in India is relatively scanty, especially in resource constrained tertiary care hospitals. Significant regional variations in patient population, disease load, type of surgical cases, availability of blood bank, institutional transfusion habits, etc., can have a profound effect on the way blood is being used. Hence, the need to assess transfusion needs and transfusion risk factors in local health care is crucial to enhance patient safety and evidence-

based transfusion practice. The present retrospective study is an attempt to address the questions of blood transfusion requirement at peri-operative period of patients undergoing major surgical procedures, identification of factors associated with transfusion and transfusion practices which will help in the implementation of better Patient Blood Management strategies and in optimizing the use of blood products in a tertiary care hospital of Bihta, Patna, Bihar

Methodology

Study Design: A hospital-based retrospective observational study was conducted to evaluate perioperative blood transfusion requirements and associated risk factors among patients undergoing major surgical procedures. The study involved a review of hospital records to assess transfusion practices, indications for transfusion, perioperative blood utilization, and factors influencing transfusion requirements. The primary outcome was the incidence of perioperative blood transfusion, while secondary outcomes included identification of predictors of transfusion, number of blood units transfused, postoperative complications, length of hospital stay, and clinical outcomes.

Study Area: The study was conducted at Department of Anesthesiology, Netaji Subhas Medical College and Hospital in Bihta, Patna, Bihar, India. The hospital provides comprehensive surgical services, including General Surgery, Orthopaedic Surgery, Urology, Neurosurgery, Obstetrics and Gynecology, and other specialties performing major elective surgical procedures. The institution has a well-established blood bank that follows national transfusion guidelines for blood collection, storage, compatibility testing, and blood component therapy.

Study Duration: The study was conducted over a period of one year from January 2024 to December 2024.

Sample Size: A total of 145 patients (N = 145) who fulfilled the eligibility criteria were included in the study.

Study Population: The study population comprised adult patients who underwent major elective surgical procedures requiring admission to the operating theatre during the study period. Patients from various surgical specialties, including General Surgery, Orthopedics, Urology, Neurosurgery and Obstetrics & Gynecology, were included irrespective of whether they received perioperative blood transfusion. Including both transfused and non-transfused patients enabled identification of factors associated with perioperative blood transfusion.

Data Collection: Data were collected retrospectively from the medical records of patients who underwent major elective surgical procedures during the study period. Information was retrieved from hospital case files, operation theatre registers, anesthesia records, laboratory reports, blood bank records, and discharge summaries using a structured data extraction proforma. The collected variables included demographic characteristics (age and gender), medical comorbidities, preoperative hemoglobin concentration, platelet count, coagulation profile, blood group, type of surgery, duration of surgery, estimated intraoperative blood loss, number of packed red blood cell (PRBC) units cross-matched and transfused, transfusion indications, timing of transfusion, postoperative hemoglobin level, postoperative complications, intensive care unit (ICU) admission, duration of hospital stay, and discharge outcome. Perioperative blood transfusion was defined as any transfusion administered during surgery or within 48 hours following surgery. All collected information was reviewed for completeness and accuracy before data entry to ensure data quality and consistency.

Inclusion Criteria: Patients fulfilling all the following criteria were included:

- Adult patients aged 18 years and above
- Patients who underwent major elective surgical procedures
- Patients with complete perioperative medical records
- Patients with documented preoperative laboratory investigations
- Patients with complete blood bank transfusion records
- Both transfused and non-transfused patients

Exclusion Criteria: Patients meeting any of the following criteria were excluded:

- Patients undergoing emergency surgery
- Patients younger than 18 years
- Minor surgical procedures not requiring major operative intervention
- Patients with incomplete medical or blood bank records
- Patients referred to after surgery from another institution
- Patients with missing perioperative laboratory investigations
- Patients discharged against medical advice before completion of treatment

Study Procedure: All eligible patients who underwent major elective surgical procedures during the one-year study period were reviewed retrospectively. Patients satisfying the inclusion criteria were enrolled consecutively until the required sample size of 145 was achieved. Demographic details, clinical history, laboratory investigations, operative findings, anaesthesia records, blood bank records, and postoperative outcomes were extracted from the hospital information system and patient case files. The preoperative hemoglobin value recorded immediately before surgery was considered the baseline

hemoglobin concentration. The number of blood units cross-matched and transfused during the perioperative period was obtained from blood bank records, while intraoperative blood loss and surgical details were collected from operative notes and anaesthesia charts. Blood transfusion practices were evaluated according to institutional transfusion protocols, with transfusion generally considered for patients having hemoglobin levels below 8 g/dL or below 10 g/dL in those with symptomatic anemia or significant cardiovascular disease. Patients were subsequently categorized into transfused and non-transfused groups, and perioperative variables along with postoperative outcomes were compared to identify factors associated with blood transfusion requirements.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), whereas categorical variables were presented as frequencies and percentages. Comparisons between transfused and non-transfused patients were performed using the independent Student's t-test or Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Variables showing statistical significance in univariate analysis ($p < 0.05$) were entered into a multivariable binary logistic regression model to identify independent predictors of perioperative blood transfusion. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. The goodness-of-fit of the regression model was assessed using the Hosmer–Lemeshow test, and the predictive performance of the model was evaluated by receiver operating characteristic (ROC) curve analysis with calculation of the area under the curve (AUC). A two-tailed p-value < 0.05 was considered statistically significant.

Result

Table 1 shows the baseline demographic and clinical characteristics of the study participants. Among the 145 patients, the highest proportion belonged to the 46–60 years age group (32.4%), with a mean age of 49.8 ± 14.6 years. Males constituted 60.7% of the study population. Most patients had preoperative haemoglobin levels of ≥12 g/dL (40.0%), while 64.1% had one or more comorbidities.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Participants (N = 145)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–30	22	15.2
31–45	38	26.2
46–60	47	32.4
>60	38	26.2
Gender		
Male	88	60.7
Female	57	39.3
Preoperative Haemoglobin (g/dL)		
<8	12	8.3
8–9.9	29	20
10–11.9	46	31.7
≥12	58	40
Comorbidity Present	93	64.1
No Comorbidity	52	35.9

Table 2 presents the distribution of patients according to the type of major surgical procedure. General surgery accounted for the highest proportion (31.7%), followed by orthopaedic surgery (20.0%) and obstetrics & gynaecology (16.6%). The study included patients from various surgical specialties, providing a comprehensive assessment of perioperative transfusion practices.

Table 2: Distribution of Patients According to Type of Major Surgical Procedure (N = 145)

Surgical Specialty	Frequency (n)	Percentage (%)
General Surgery	46	31.7
Orthopaedic Surgery	29	20
Obstetrics & Gynaecology	24	16.6
Urology	18	12.4
Neurosurgery	15	10.3
Gastrointestinal Surgery	13	9
Total	**145**	**100**

Table 3 demonstrates the perioperative blood transfusion characteristics of the study population. Out of 145 patients, 46 (31.7%) required blood transfusion, whereas 99 (68.3%) did not. Among transfused patients, Packed Red Blood Cells (PRBCs) alone were the most frequently administered blood component (67.4%), followed by PRBC with Fresh Frozen Plasma.

Table 3: Perioperative Blood Transfusion Characteristics (N = 145)		
Variable	**Frequency (n)**	**Percentage (%)**
Patients Receiving Blood Transfusion	46	31.7
Patients Not Receiving Blood Transfusion	99	68.3
Blood Component (n=46)		
PRBC only	31	67.4
PRBC + FFP	10	21.7
PRBC + Platelets	3	6.5
PRBC + FFP + Platelets	2	4.4

Table 4 compares transfused and non-transfused patients. Patients receiving blood transfusion had significantly higher mean age, lower preoperative haemoglobin levels, greater intraoperative blood loss, and longer operative duration than those who did not receive transfusion ($p < 0.05$). However, the presence of comorbidities was not significantly associated with blood transfusion ($p = 0.189$).

Table 4: Comparison of Clinical Variables Between Transfused and Non-Transfused Patients			
Variable	**Transfused (n=46)**	**Non-Transfused (n=99)**	**p-value**
Mean Age (years)	55.4 ± 13.1	47.2 ± 14.4	0.003*
Hb <10 g/dL	26 (56.5%)	15 (15.2%)	<0.001*
Blood Loss >500 mL	29 (63.0%)	18 (18.2%)	<0.001*
Duration of Surgery >3 hours	24 (52.2%)	22 (22.2%)	0.001*
Presence of Comorbidity	33 (71.7%)	60 (60.6%)	0.189

Table 5 shows the independent predictors of perioperative blood transfusion. Preoperative haemoglobin <10 g/dL, intraoperative blood loss >500 mL, and operative duration >3 hours were identified as significant predictors of blood transfusion ($p < 0.05$). The regression model demonstrated a good fit (Hosmer–Lemeshow $p = 0.61$) with good predictive accuracy (AUC = 0.84)

Table 5: Multivariable Logistic Regression Analysis of Risk Factors Associated with Perioperative Blood Transfusion			
Variable	**Adjusted OR**	**95% CI**	**p-value**
Preoperative Hb <10 g/dL	4.83	2.01–11.62	<0.001*
Blood Loss >500 mL	5.62	2.37–13.29	<0.001*
Duration of Surgery >3 hours	2.71	1.16–6.31	0.021*
Age >60 years	2.08	0.94–4.62	0.071

Discussion

The aim of this retrospective study was to assess the blood transfusion requirement and risk factors for blood transfusion in patients undergoing major surgical procedures in a tertiary care hospital. Of the 145 patients, 31.7% needed period blood transfusion and 68.3% didn't need any transfusion. This transfusion rate is similar to previous reports which showed blood transfusion rates in major surgery of 28% to 33% depending on the type and complexity of surgery. In addition, a high rate of blood transfusion in patients undergoing major elective surgery was reported in the Turkish National Perioperative Transfusion Study (TULIP-TS), highlighting that blood transfusion is still a major part of peri-operative management despite the advances in surgical and anaesthetic techniques" (Iskender et al., 2020) [10].

Most of the patients in the current study were in the age group of 46–60 years with the mean age of 49.8 ± 14.6, and 60.7% were male. Cockbain et al (2010) reported similar demographic data, with middle aged and elderly patients being the largest population that received blood transfusion during surgery. Transfusion needs have consistently been linked to increasing age as older patients often have a number of co-morbidities, a decreased physiological reserve and increased surgical complexity [11] . In this study, low preoperative Haemoglobin was found to be an independent risk factor for peri-operative blood transfusion with Adjusted OR = 4.83 at

p<0.001 and ~28.3% of patients had preoperative Haemoglobin levels < 10 g/dL. This is consistent with the TULIP-TS findings that almost one-third of all surgical patients were anaemic before surgery and that reducing preoperative haemoglobin was associated with a higher risk for transfusion with red blood cells perioperatively. Similarly, Cockbain et al. found that low preoperative haemoglobin (Hb<12.5 g/dL) was one of the strongest risk factors for perioperative transfusion and Pulitanò et al. added low Hb concentration to their transfusion risk score for liver surgery. All these observations emphasize how vital it is to have a proper diagnosis and management of anaemia in the pre-surgery period as one of the bases of Patient Blood Management (PBM) [12].

Packed Red Blood Cells (PRBCs) was found to be the most transfused blood group with 67.4% of cases in the present study. Similar results were seen in TULIP-TS with red blood cell transfusion as the most common blood component used during the peri-operative period, while Fresh Frozen Plasma and platelet transfusions were limited to patients with major blood losses or coagulation disorders. This similarity is reflective of the ongoing use of PRBC transfusion to correct perioperative anaemia and restore oxygen-carrying capacity [13]. A comparison of transfused and non-transfused patients showed that the age and amount of blood loss as well as the duration of surgery and the preoperative concentration of haemoglobin were significantly associated with blood transfusion during surgery. In the current study, the blood loss was significantly higher with transfusion rates and excessive blood loss was the most significant independent predictor of transfusion (Adjusted OR = 5.62; p<0.001). Cockbain et al. made similar observations, and identified extensive surgical resection, larger tumour size, and technically difficult procedure as important determinants of blood loss and transfusion requirement. Similarly, Pulitanò et al. showed that complex surgical procedures, involving large dissection, had a significant impact on the risk of blood transfusion [14].

In the present study, the length of the operation (p=0.021; Adjusted OR=2.71) was also found to be an independent predictor of transfusion. The duration of surgery tends to correlate with the complexity of the procedure, amount of handling of tissues, and cumulative blood loss during surgery and hence the need for transfusion. However, other studies have also shown a positive correlation between blood transfusion and prolonged operative time, as seen by Quan et al. (2020) who reported that multiple perioperative factors such as the complexity of the surgery, preoperative haemoglobin level and others significantly affected blood transfusion risk in liver resection patients [15].

The patients with associated comorbidities had a higher transfusion rate in the present study, but this was not statistically significant (p=0.189). The TULIP-TS, on the other hand, showed that certain cardiovascular comorbidities, especially coronary artery disease and heart failure, were also associated with higher transfusion requirements perioperatively, because they have lower haemoglobin thresholds for adequate tissue oxygenation. This discrepancy in study results may be due to variation in patient characteristics, sample size, and comorbid condition distribution [16]. The logistic regression model created in the present study exhibited good predictive ability, showing an AUC of 0.84 which is considered satisfactory for the discrimination of the model to predict blood transfusion during surgery. This finding is favourable in comparison to the predictive model reported by Cockbain et al. (ROC = 0.77) and the transfusion risk score developed by Pulitanò et al. which showed excellent predictive accuracy in high-risk surgical patients. These findings validate the application of the predictive models in optimizing blood ordering, minimizing unnecessary cross matching and increasing the utilization of blood resources [17].

In general, the results of the present study corroborate the principles of Patient Blood Management as they focus on the correction of preoperative anaemia, a careful assessment of the risk to transfusion, minimising blood loss during surgery and following a restrictive transfusion policy. Adoption of uniform PBM practices and evidence-based transfusion guidelines in tertiary hospitals could lead to greater efficiency in the use of scarce blood bank resources, better patient outcome, and fewer unnecessary blood transfusions. The findings agree with recommendations from recent multicenter studies which call for transfusion decision making to be personalized as well as more extensive use of PBM programmes in surgical practice.

Conclusion

The present study affirms that perioperative blood transfusion is still an integral part of the management of patients subjected to major surgical procedures and nearly one-third of patients require transfusion during the period of perioperative. Preoperative anemia, and a high amount of blood loss in the operating room and longer operating time were found to be significant independent risk factors for blood transfusion. Based on these findings, it is important to have a thorough pre-op assessment, early detection and correction of anemia, careful surgical haemostasis and evidence-based restrictive transfusion policies for better blood utilization. Patient Blood Management (PBM) principles can help minimize unnecessary transfusions, enhance peri-operative outcomes and use scarce blood resources more efficiently in tertiary care hospitals. More prospective multi-center trials with larger numbers of patients are warranted to verify these results and

enhance transfusion practices in various surgical fields.

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