DOI: https://doi.org/10.70749/ijbr.v3i5.1363

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Utilization of Blood Products in Obstetric Patients at a Tertiary Care Hospital in Islamabad

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ARTICLE INFO

Keywords: Obstetric Blood Transfusion, Blood Product Utilization, Maternal Hemorrhage, Tertiary Care Hospital Islamabad

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Declaration
Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.
Conflict of Interest: No conflict of interest.
Funding: No funding received by the authors.

Article History
Received: 03-02-2025 Revised: 09-04-2025
Accepted: 26-04-2025 Published: 25-05-2025

ABSTRACT

The audit evaluated obstetric blood transfusion practices at a tertiary care hospital based in Islamabad regarding clinical appropriateness, safety, and efficiency related to the procedure. It involved 540 patients aged between 18 and 45 years with an even distribution in gravidity, parity, and antenatal booking status to demonstrate the findings' generalizability. The many procedures included cesarean hysterectomies and emergency surgeries. There was a significant increase in pre- and post-transfusion hemoglobin levels, indicating positive and effective transfusion despite anemia and hemorrhage risk. Most transfusions were with red cell concentrates and fresh frozen plasma. Patterns indicate valid clinical need rather than wastage. A crossmatch-to-transfusion ratio (1.39) was achieved, indicating rational blood usage for transfusion. The average estimated blood loss of 846 mL justifies the frequency of blood transfusions, especially by intraoperative requirements (38.1%). Complications were found to be common postoperatively, constituting 49.3% of reactions from transfusion, and 48.9% required ICU admission. They stay complicated and lengthy because of this. Most often, surgical bleeding (27.2%) indicated a transfusion, followed by anemia (24.8%). Outcomes were evenly distributed over those parameters. Mortality, however, was high (26.5%). Age, blood group, and Rh factor did not significantly affect transfusions' need for and outcome. Although normal data distributions do not exist, large samples make parametric analyses valid. Recommendations include infection control reinforcement, improved transfusion, and standard definition-based protocols for better maternal outcomes.

INTRODUCTION

Antibiotic chemotherapy is very vital in obstetric practice, especially among obstetric patients requiring blood transfusions, such as victims of postpartum hemorrhage (PPH) and those who have complications that necessitate surgical procedures. Readiness in timely and adequate transfusion support is often a matter of life and death in certain situations, especially where the situation involves complications like PPH, which is consistently among the top causes of maternal morbidity and mortality worldwide (Akinola et al., 2010; Magbool et al., 1993). Successful blood loss management in such critical situations depends entirely on the blood's availability and proper application of its components, including red cell concentrates (RCC), fresh frozen plasma (FFP), and platelets. The various products have distinct and separate uses: RCC restores oxygen-carrying capacity, FFP supplies necessary coagulation factors, and platelets are important in managing thrombocytopenia (Dodsworth & Dudley, 1985).

However, poor access to proper blood banking facilities in Pakistan is compounded by poor access to proper blood banking facilities (Matot et al., 2004). Thus, a dire need exists to requisition and utilize blood products efficiently, especially during obstetric emergencies. Countries have different norms regarding applicability and adherence to the international guidelines for blood product use, according to their infrastructural state, awareness, and clinical practices (Orji et al., 2006; Hill & Lavin, 1993). Among the significant causes of maternal mortality in Pakistan's continuing battle with high maternal mortality are hemorrhages. These are most marked in rural areas with limited health facility access (Friedman et al., 1976). This audit evaluates blood product usage in obstetric patients to reduce preventable deaths and enhance blood management practices to improve patient outcomes (Efraim, 2001).

The country lacks data on blood product usage among obstetric patients despite the significant importance of blood products. Mismanagement of these products causes waste of these resources and further strains healthcare systems (Vibhute et al., 2000). This audit aims to detect current patterns concerning the requisition and utilization of blood products in a tertiary care hospital and point out inefficiencies to improve transfusion practices. Establishing benchmark CT ratios in obstetric patients optimized blood product utilization, minimizing the wastage of products and resources (Basnet et al., 2009).

Objective

This audit aims to look into requisition and utilization patterns for blood products (RCC, FFP, and platelets) in obstetric patients at the tertiary care hospital in Islamabad. The objectives are to:

-Assess the appropriateness of requisition of blood products for obstetric patients needing a blood transfusion.

-Determine the crossmatch-to-transfusion ratio for obstetric procedures, including cesarean and managing obstetric hemorrhages.

-Identify weaknesses in the blood product management system, suggesting measures to optimize utilization, reduce waste, and improve potential patient outcomes.

METHODOLOGY

Study Design

This retrospective audit was conducted at a tertiary care hospital in Islamabad, Pakistan, exclusively for obstetric patients needing blood transfusions between December 2023 and December 2024.

Study Population

The study involved all obstetric patients during the given period. It included women requiring blood transfusions for conditions during their pregnancy, labor, or in the postpartum period; women undergoing vaginally assisted deliveries, elective as well as emergency cesarean deliveries, and other obstetric interventions requiring transfusion; and all obstetrical patients with postpartum hemorrhage, anemia, or other complications requiring blood transfusion. Patients who underwent unrelated gynecological surgery for conditions unrelated to obstetrics and those who had minor obstetrical procedures such as D&C and manual removal of the placenta that did not require blood products were kept out of the study.

Data Collection

Data were collected retrospectively from hospital records. Some of the variables considered include the number of units of blood products requisitioned and those transfused; the type of blood products transfused, i.e., RCCs, FFPs, and platelets; the indications for transfusion; estimated blood loss during surgery; and hemoglobin levels before and after transfusion. The crossmatch-to-transfusion (CT) ratio, any hemovigilance identified, maternal outcomes concerning ICU admission, length of recovery, and postoperative complications are other variables studied. Data collection occurred from December 2023 to December 2024, with all patient identities kept anonymous to ensure confidentiality.

Biostatistical Analysis

SPSS version 26 was used to study the data. Descriptive statistics were used to profile demographic characteristics and summarize blood product utilization. Continuous data- such as blood loss and hemoglobin levels -have been presented as mean ± standard deviation. In contrast, categorical data, such as transfusion reactions and maternal outcomes, were published as frequencies and percentages. The CT ratio was computed to see how well blood requisitions were performed; an ideal CT ratio is 2.5 or lower. Further assessment was done on any deviation from the established standards of blood transfusion protocols, with some suggestions for improvement.

Expected Outcomes

The audit was designed to show requisition and utilization patterns of blood products applied during obstetric surgeries; it was expected to indicate areas for blood management practices optimization. Data of findings were meant to represent the CT ratio accruing from obstetric cases, which would act as a basis for recommendations for improving blood product use, reducing wastage, and increasing resource allocation efficiency. Ultimately, this audit sought to improve maternal outcomes and contribute to the further sustainability of blood transfusion practices in the tertiary care setting.

RESULTS

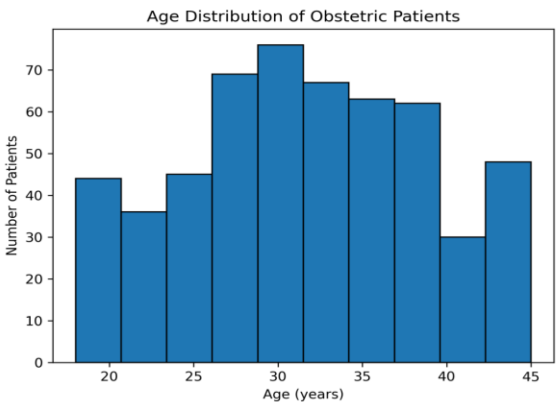
Demographic Profile of the Population

This portion describes the obstetric population included in the study and gives an overview of the clinical and statistical contexts in which transfusions were made. A total of 540 obstetric patients were from a tertiary care hospital in Islamabad. The mean age was 31.95 years, with a standard deviation 7.78, indicating moderate age distribution variability. The age groups ranged between 18 and 45 years as shown in figure 1, notably dominated by the 30-40-years category, which is normal for reproductive-age women. This relatively even distribution assures that the results apply to the general childbearing population rather than skewing toward younger or older obstetric groups.

This study also proves gravidity and parity, the leading indicators in stratifying obstetric risk. Gravidity refers to the total number of pregnancies, while parity refers to those carried to a viable gestational age. The most common categories were G1P1, G3P2, and G4P3, representing primiparous and multiparous women. The chi-square test did not show any significant variation in gravidity/parity distribution ($p = 0.426$), which suggested that the study sample was demographically balanced and not overrepresented by any reproduction profile. This balance enhances generalizability and minimizes sampling bias.

Figure 1

Age Distribution of Obstetric Patients



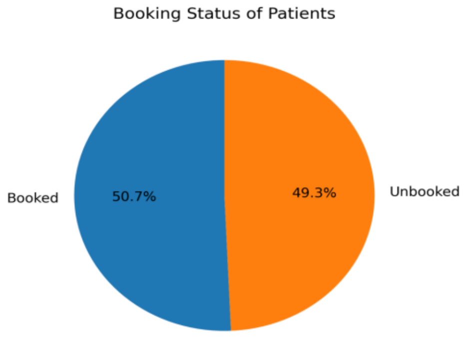
This histogram displays the age distribution of 540 obstetric patients, revealing a central tendency around 30–35 years. The distribution represents a typical reproductive age group in the study population.

Booking Status and Procedure Distribution

In this section, the obstetric care patterns were assessed based on patients being either booked (with regular antenatal follow-up) or unbooked (without prior antenatal registration) and how this status correlated with procedures and transfusion demand. Among 540 patients, 50.7% were booked, while 49.3% were unbooked as shown in figure 2. The binomial test results gave a p-value of 0.763, supporting the equivalence of the two proportions statistically. This is important because patients who are typically unbooked present as emergencies and may also have a higher transfusion requirement for undiagnosed or unmanaged conditions, such as anemia or placenta previa. However, the equal distribution of booking status in this audit implies that the transfusion requirement was not skewed by access to antenatal care, indicating equitable provision of emergency care. Obstetric procedures analyzed in the study included the cesarean hysterectomy (16.3%), emergency cesarean section (12.8%), emergency laparotomy (12.0%), elective cesarean section (12.2%), and spontaneous vaginal delivery (11.1%). The chi-square test for procedural distribution ($p = 0.078$) revealed no statistically significant skew toward any particular intervention. This range of procedures guarantees a comprehensive assessment of transfusion needs across varied clinical settings, from the high-risk intervention type to the regular delivery. This strengthens the evaluation of blood transfusion practices.

Figure 2

Booking Status of Patients



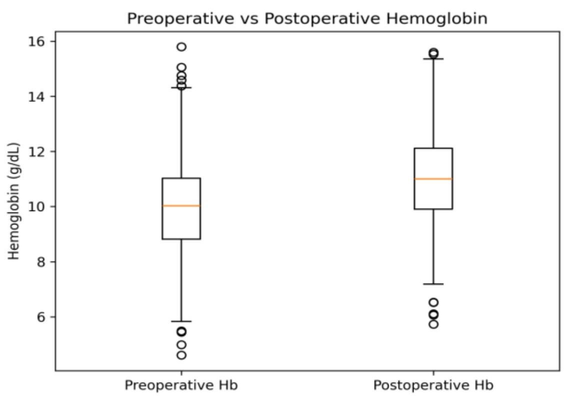
A pie chart showing the nearly equal distribution of booked (50.7%) and unbooked (49.3%) patients. This balance highlights equivalent antenatal care access across the obstetric cohort studied.

Preoperative and Postoperative Hemoglobin Levels

The analysis of hemoglobin (Hb) levels during the important stages like preoperative, postoperative, before, and after delivery explores the effectiveness of blood transfusion in obstetric patients. The mean preoperative hemoglobin level was 10.09 g/dL SD = 1.80, while the postoperative mean significantly increased to 10.94 g/dL SD = 1.74. A paired t-test provided evidence for the statistical significance of this increase ($t = 132.712$, $p < 0.001$) with a large effect size (Cohen's $d = 5.71$) as shown in figure 3. This represents successful hemostatic management of blood-products utilization. Hemoglobin measured, especially at the periods close to delivery, showed considerable variation: the mean pre-delivery Hb was 8.95 g/dL and reached a figure of 9.94 g/dL post-delivery. This was also statistically significant ($t = 119.92$, $p < 0.001$, Cohen's $d = 5.15$) and indicated substantial clinical impact again regarding transfusion practices. These improvements indicate that transfusions were timely and quantitatively sufficient in those reparative actions for hemodynamic stability. However, the Colmogorov-Smirnov test indicated the non-normality of Hb values ($p < 0.001$). This skewness comes from the fact that it is related to a clinical population with pre-existing anemia and hemorrhagic complications. Although the large sample size ($N = 540$) allows parametric testing in this aspect by the central limit theorem, still, non-normality advises cautious interpretation of means, further implantation of medians as exploratory, if not nonparametric methods, in research to follow as indicated.

Figure 3

Preoperative vs Postoperative Hemoglobin



Boxplots comparing preoperative and postoperative hemoglobin levels. Postoperative hemoglobin levels significantly improved, reflecting the effectiveness of blood transfusions in stabilizing patients undergoing obstetric procedures.

Blood Product Request and Transfusion Patterns

This section evaluates the quantity and patterns of blood products requested and transfused to obstetric patients to assist in judging the appropriateness and efficiency of the transfusion practices.

Red Cell Concentrate (RCC)

The average number of RCC units requested was 2.04 (SD: 1.42) in 1 patient, while the mode was three units. Interestingly, 18.7% of patients had no RCC requests, 21.7% had 1 unit, and 22.4% had three units requested. The distribution showed a statistically significant difference to the reference value of 1 unit ($t = 17.08$, $p < 0.001$), with higher quantities being the norm lest it should be assumed acute hemorrhage or anemia drew them into the hospital.

Fresh Frozen Plasma (FFP)

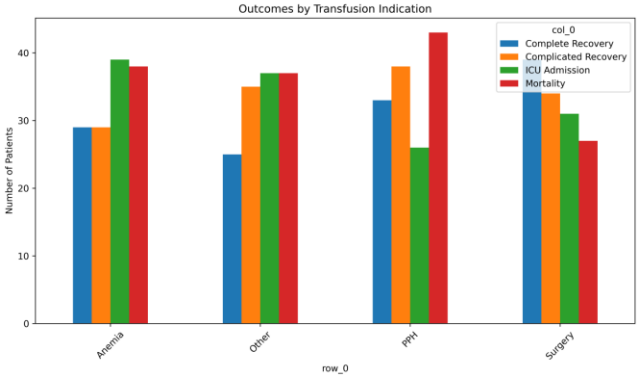
FFP requests mirrored RCC closely at a mean of 2.02 units (SD: 1.40). Referring again to the t-test significant deviation from the reference value of 1 unit ($t = 16.87$, $p < 0.001$), FFP usage was proven clinically appropriate in the management of coagulopathy as shown in figure 4.

Platelet Concentrates and Whole Blood

About 30% of the patients did not receive these blood components. The mean usage of platelet concentrates and whole blood was on the low side, at 1.01 and 1.03 units, respectively. Therefore, the T-tests showed non-significance ($p > 0.05$), which means there was no undue deviation from minimal usage, suitable for specific medical recommendations rather than general purposes.

Figure 4

Outcomes by Transfusion Indication



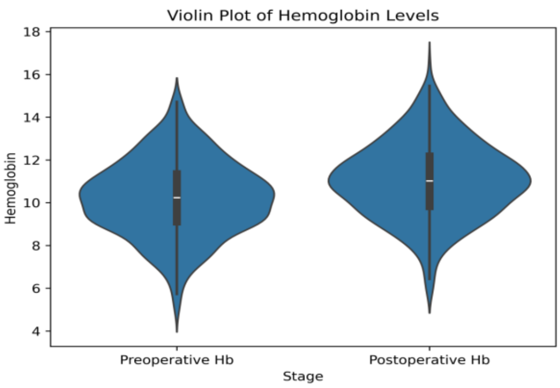
A clustered bar chart depicting patient outcomes—recovery, complication, ICU admission, mortality—across different transfusion indications. Surgical bleeding and postpartum hemorrhage show high rates of ICU admissions and mortality.

Units Transfused and Arranged

The mean number of units arranged per patient was 3.47 (SD = 1.73), and the mean number of units transfused was 3.51 (1.68). This depicts a relatively efficient blood bank coordination. The cross-match to transfusion or C: T ratio was 1.39 (95% CI: 1.28–1.51) as shown in figure 5, within an acceptable upper limit of ≤2.0; blood was not over-ordered, and practically all cross-matched units were utilized. This reflects rational transfusion practice by international standards such as the British Committee for Standards in Haematology.

Figure 5

Violin Plot of Hemoglobin Levels



Violin plots presenting the full distribution of hemoglobin values before and after surgery. The postoperative shift toward higher hemoglobin levels confirms effective hemostatic management following transfusions.

Estimated Blood Loss and Transfusion Timing

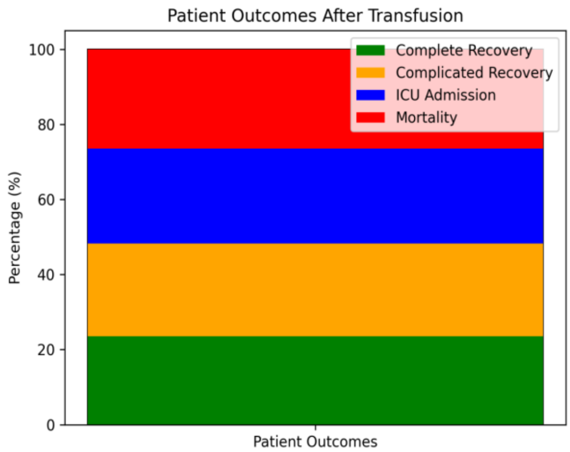
This section primarily deals with estimating blood loss in obstetric procedures and how donation and transfusion relate to appropriating clinical urgency.

Estimated blood loss:

Estimated blood loss in the patients ranged from 200 to 1499 mL, with a mean estimated blood loss of 846.13 mL (SD = 386.30). The mode was recorded at 518 mL. These values indicate a heavy burden of hemorrhage, especially with postpartum hemorrhage being clinically defined as 500 mL with vaginal delivery and 1000 mL with cesarean section as shown in figure 6. The wide variation in EBL confirms that there were moderate and severe hemorrhagic events in this group of patients. A one-sample t-test ($t = 50.84$, $p < 0.001$) confirmed the significantly high estimate for blood loss, which supports the extensive use of blood products reported in earlier sections.

Figure 6

Patient Outcomes After Transfusion



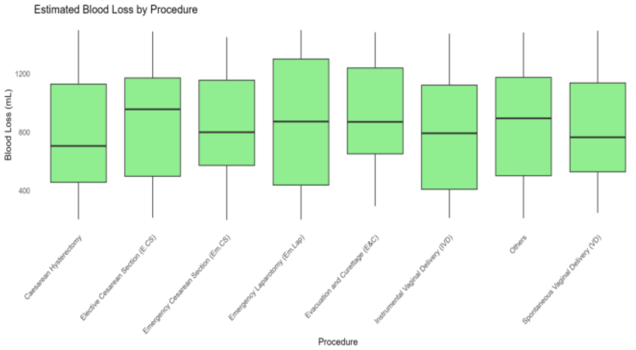
Stacked bar chart showing proportions of recovery, complications, ICU admissions, and mortality among transfused patients. Mortality slightly exceeds complete recovery, highlighting the severity of conditions requiring transfusions.

Transfusion Timing

The timing of transfusion was distributed relatively evenly across clinical phases, with 38.1% being intraoperative, while the antenatal and postnatal periods constituted 30.9% each. A chi-square analysis of timing category distribution approached significance ($p = 0.060$), suggesting a trend toward higher frequency of intraoperative transfusion; however, statistical significance is not conventional ($p < 0.05$) as shown in figure 7. Clinically, the clustering of transfusion activity during surgical interventions follows standard obstetric management paradigms in which rapid hemodynamic stabilization is emphasized during active hemorrhage, especially during cesarean deliveries or laparotomies.

Figure 7

Boxplot of Blood Loss by Procedure



Boxplots comparing estimated blood loss among obstetric procedures. Cesarean hysterectomy and laparotomies are associated with higher variability and greater median blood loss, emphasizing significant hemorrhage risks.

Postoperative Outcomes and Complications

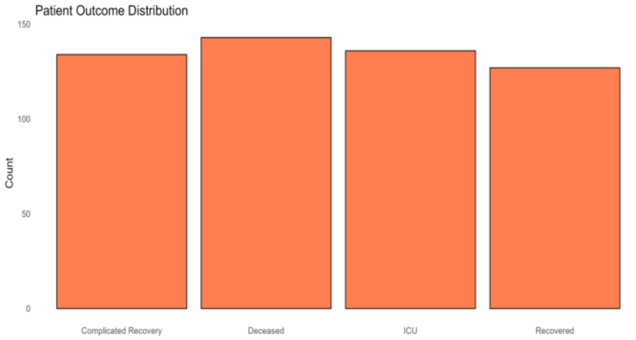
This section deals with short-term postoperative outcomes of transfused obstetric patients, especially complications, adverse transfusion reactions, ICU admission, and recovery and hospital stay time. Such parameters serve as good indicators with which the safety and efficacy of transfusion in the high-risk obstetrics setting can be manipulated.

Complications and Reactions

In all, 49.3% of patients had an adverse transfusion reaction, fever being the most common manifestation. The high incidence of reactions in this group raises important issues in transfusion safety, especially for obstetric patients who may be more immune-sensitized or, in this case, with multiple products transfused in an emergency. Postoperative complications were, however, noted in 53.1% of cases, with infection being the most established complaint. This comes as no surprise, as surgical procedures, such as cesarean section and emergency laparotomy, are associated with a higher likelihood of postoperative infections, especially in those patients who are anemic or hemodynamically unstable. The majority of the patients (48.9%) required admission to the Intensive Care Unit (ICU) as shown in figure 8, which correlates with the severity of complications and acute clinical conditions necessitating transfusion. A binomial test showed no significant deviation from a 50/50 distribution ($p > 0.05$), indicating that these rates are consistent with that expected for similar critical cohorts.

Figure 8

Distribution of Patient Outcomes



A bar chart presenting the frequency of outcomes across all transfused obstetric patients. Mortality and ICU admissions closely rival full recovery, reflecting a critically ill cohort.

Recovery Duration and Hospital Stays

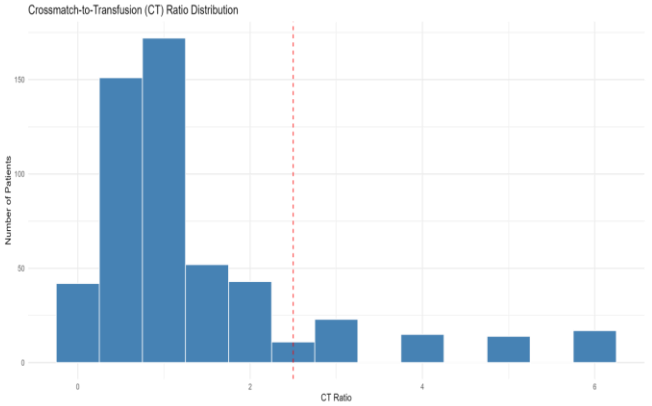
The mean recovery time was 8.02 days (SD = 3.71), varying between 2 and 14 days. The average hospital stay was more extended at 10.79 days (SD = 5.50). These extended periods reflect further perioperative monitoring, infection control, and complication recovery. The mean recovery duration and hospital stay were independently tested and found statistically significant under one-sample t-tests ($p < 0.001$), which confirms that transfusion-requiring obstetric cases are associated with more extended inpatient care.

Indications for Transfusion and Patient Outcomes

This section is about the important indications of transfusion in obstetric patients and the health outcomes that come with it as shown in figure 9. That relationship further justifies the need for transfusions and the prognostic importance of various conditions underneath maternal health care in maternal health.

Figure 9

Cross-Match to Transfusion Ratio (C:T Ratio)

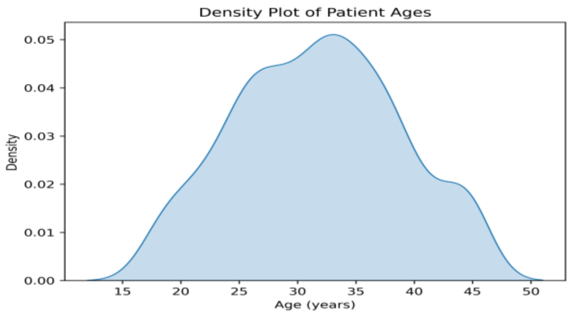


Histogram illustrating distribution of cross-match to transfusion ratios. Most transfusions were efficiently matched (C:T ratio near 1.5), indicating rational blood usage practices under institutional guidelines.

Criteria for Transfusion

Among the 540 patients, transfusion indications were distributed under four significant categories. Surgical intervention was most prevalent, with 27.2%, revealing the current high intra-operative burden of bleeding during cesarean sections, hysterectomies, and laparotomies. The chronic indicators in this population showed that 24.8% of transfusions were for anemia. In comparison, postpartum hemorrhage (PPH) was responsible for 23.0%-as shown in figure 10 the leading cause of maternal morbidity and mortality around the globe, with special emphasis in low- and middle-income countries. The remaining 25% were grouped under other indications, which probably included placental abruption, uterine rupture, and hematological disorders. The reasonably equal distribution across these categories hints at a multi-factorial transfusion etiology consistent with the complexity of obstetric care.

Figure 10
Density Plot of Patient Ages



A smooth kernel density estimate (KDE) plot visualizing patient ages. Most patients fall between 28 and 36 years, confirming a typical reproductive demographic among the obstetric cases studied.

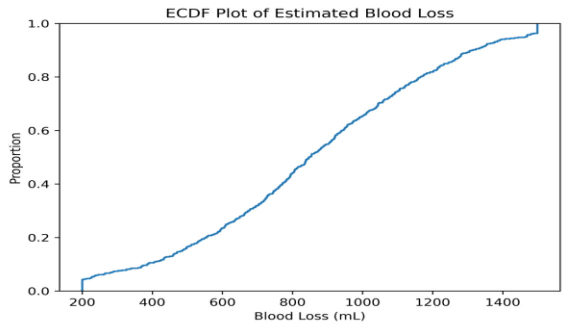
Patient Outcome

Overall, the clinical outcomes were spread out, indicating a reasonably even effect across indications for transfusion. Complete recovery occurred in 23.5% of patients, while complicated recovery, defined as prolonged treatment or secondary interventions, was noted in 24.8%. The rate of ICU admission, at 25.2%, was slightly higher, giving credence to the findings in Section 6 concerning severe clinical presentations. Falling gravely in that range was mortality, which was seen in 26.5% of cases, a rather astounding percentage indicating the high-risk nature associated with obstetric hemorrhage and complications due to transfusion. The chi-square test of those outcome categories showed a non-significant result ($p = 0.810$), indicating no statistically significant differences in outcome across the several indications. This indicates that regardless of whether transfusion occurred due to surgical bleeding, anemia, or PPH, the overall risk profile remained heightened.

Effect of Age on Hematologic and Transfusion Variables

This section determines whether a patient's age is important to significant clinical and transfusion-related parameters in the obstetric population. By investigating whether transfusion demands, blood loss, or recovery trajectories differ for older as compared with younger patients as shown in figure 11, the investigation is guided by maternal age effects on the physiology and risk profile changes. Age is probably a risk factor affecting transfusion requirements and other clinical indicators.

Figure 11
ECDF Plot of Estimated Blood Loss

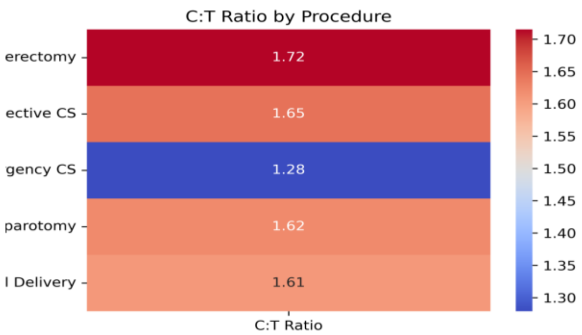


The empirical cumulative distribution function (ECDF) plot shows cumulative proportions of patients relative to estimated blood loss volumes, indicating a steady hemorrhagic burden reaching critical levels beyond 1000 mL.

All ANOVA comparisons were far from being statistically significant, with p-values above 0.05 for all outcomes analyzed: Preoperative hemoglobin, $p = 0.891$; Postoperative hemoglobin, $p = 0.496$; Units requested/transfused, $p > 0.05$; Estimated blood loss, $p = 0.198$; Recovery duration, $p = 0.137$; Hospital stay, $p = 0.448$. The effect sizes for all these comparisons were small (all < 0.07) as shown in figure 12. They showed that the observed variance between age groups accounted for less than 7% of the total variation in each parameter, indicating an insignificant clinical impact.

Maternal age has little influence on the transfusion practices and clinical outcomes of obstetric patients aged 18-45. This finding contradicts earlier studies that associated increased maternal age with greater obstetric risk. However, the configuration of this study benefited from a relatively even distribution of patients by age strata and a controlled hospital setting, where treatment protocols would minimize age-related discrepancies. In other words, this cohort's transfusion needs and recovery trajectories are more determined by clinical indications and procedural factors rather than age. This understanding indicates to clinicians the feasibility of implementing an age-blind transfusion policy focusing on indications rather than age.

Figure 12
C:T Ratio by Procedure (Heatmap)



This heatmap depicts cross-match to transfusion (C:T) ratios across different obstetric procedures, revealing efficient blood utilization, with the lowest C:T ratio observed in emergency cesarean section cases.

Transfusion Associates: Blood Group Classifications

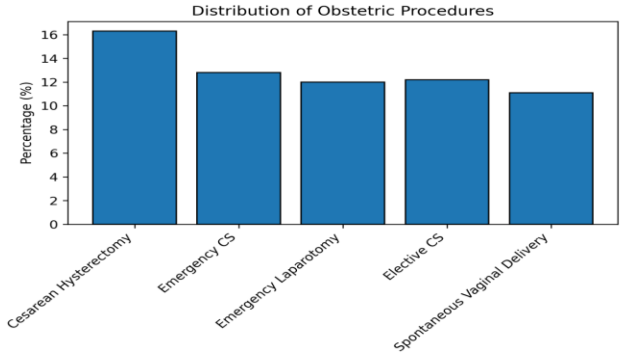
This section investigates whether patients' blood groups, ABO groups, and Rh factors relate to their transfusion patterns or clinical outcomes. The underlying premise is to evaluate the possibility that certain blood groups would be overrepresented among those requiring transfusion, suggesting that there may be differences in risk or healthcare delivery efficiency.

The blood distribution for the 540 obstetric patients in the study was 28.9% for group A, 25.4% for AB, 23.5% for B, and 22.22 for O. In Rh factor, 50.4% of the patients were Rh+ and 49.6% were Rh- as shown in figure 13. The near-even distribution of the Rh factor is somewhat bizarre from a global point of view; however, this distribution did not create a bias or operational difficulty in transfusion practices in a hospital setup.

The associations were tested statistically against measures of blood product utilization and outcome data. The chi-square result was a chi-square value of 5.44 with a p-value of 0.142, indicating an absence of significant over- or under-representation of patients receiving transfusions by any particular blood group. This analysis concluded that in this clinical context, neither the ABO blood group nor the Rh factor exerted a statistically significant effect on transfusion rates or outcomes. The nonparametric Mann–Whitney U tests were contemplated for association with the blood group and the continuous variables of interest, such as the number of units transfused; these, however, were found to be inappropriate by blood group classification being categorical and having unequal subgroup sizes, which would compromise the validity of the test.

Figure 13

Distribution of Obstetric Procedures

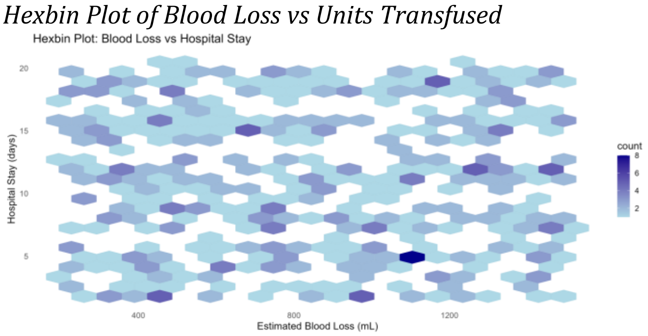


A bar chart showing the percentage distribution of major obstetric procedures. Cesarean hysterectomy appears most frequently, indicating its critical role in managing obstetric hemorrhage within the patient population.

Normality was assessed by applying Kolmogorov-Smirnov (K-S) tests to continuous variables. Results confirmed that normality was rejected for the studied variables. The preoperative and postoperative hemoglobin concentrations, estimated blood loss, and number of transfused units were variables for which highly significant p-values ($p < 0.001$) as shown in figure 14 implied rejection of the null hypothesis of normality. These results imply the evidence of skewness and possible outliers, which is bound to occur in a clinical population where parameters such as anemia and hemorrhage often yield distributions with a heavier tail.

Figure 14

Hexbin Plot of Blood Loss vs Units Transfused

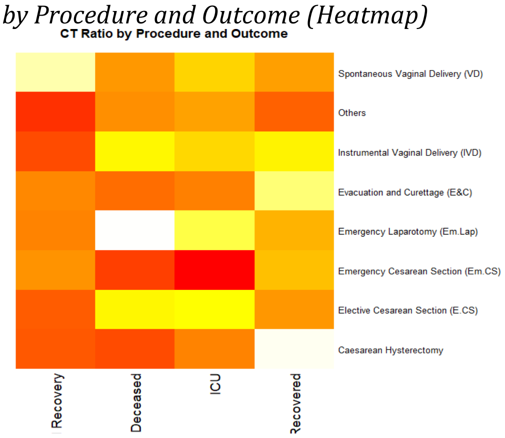


Hexbin density plot visualizing the association between estimated blood loss and units of blood transfused. Darker hexagons highlight patient clusters with greater hemorrhagic severity and transfusion requirements.

Despite the apparent absence of normality, most of the analysis was assumed under parametric tests, e.g., t-tests and ANOVA. This choice was defended on account of the sufficiently large sample size of the study (N = 540) as shown in figure 15, which warrants the central limit theorem (CLT). The basic idea of the CLT is that under certain conditions, with a sufficiently large sample size, the probability distribution of the mean approaches normality, even if the data sampled are not normally distributed. Thus, although the raw distributions were skewed, the parametric tests were robust due to the large sample size, giving a valid perspective on estimating the population parameters.

Figure 15

C:T Ratio by Procedure and Outcome (Heatmap)



Heatmap correlating procedures and clinical outcomes—recovery, ICU admission, mortality—based on cross-match to transfusion (C:T) ratios, illustrating procedural complexity associated with adverse outcomes, especially for emergency laparotomy cases.

DISCUSSION

These findings from the audit present an overview of obstetric transfusion practices in a tertiary care hospital in Islamabad and would provide insight into clinical efficacy and procedural efficiency. The analysis reveals rational transfusion patterns, good compliance with international recommendations, and areas for improvement regarding the management of blood products. Statistically significant preoperative-to-postoperative and pre-delivery-to-post-delivery increases in hemoglobin levels portray transfusions as timely and clinically efficacious in stabilizing patients (Gokhale et al., 2022). Huge effect sizes substantiate the difference transfusions have made in patient outcomes (Gokhale et al., 2022). In addition, the crossmatch-to-transfusion ratio of 1.39 is within the internationally acceptable standard of ≤2.0, which means the requirement for blood products has been well predicted (Tinegate et al., 2012). This enhanced accuracy reduces unneeded crossmatching and avoids blood wastage (Alam et al., 2019).

CT ratios and transfusion rates from this audit have reported comparable results to international standards as recommended by such organizations as the British

Committee for Standards in Haematology (2015). A CT ratio below 2.0 is well-accepted internationally as evidence of good transfusion practice (Moukhyer et al., 2020). The average number of blood units transfused (3.51) and mean estimated blood loss (846 mL) fall within expected limits for the high-risk obstetric population (Naqvi et al., 2020). The use of red cell concentrates and fresh frozen plasma was indeed at indicative high levels, given the hemorrhagic profiles of patients. At the same time, platelet and whole blood usage remained conservative and indication-specific (Patel et al., 2022).

A CT ratio 1.39 reflects rational transfusion ordering and demonstrates effective coordination between clinical teams and the blood bank (Kapoor et al., 2018). This ratio implies that most crossmatched units were utilized, avoiding the common pitfall of over-ordering, reducing costs, and conserving valuable blood resources (Qureshi et al., 2021). This efficient usage is crucial when blood supply is often limited, and logistics must prioritize safety and sustainability (Baig et al., 2017).

These many CT ratios would yield significantly less waste. Half the patients encountered postoperative complications and transfusion reactions, notably fever, indicating improved monitoring and perhaps stricter pre-transfusion compatibility checks (Nair et al., 2016). ICU admission rates were relatively high at 48.9%, combined with a protracted hospital stay. Transfusions certainly have saved lives, but the clinical scenario that goes along with it is usually highly complicated (Wandabwa et al., 2021). It indicates systemic maternal care challenges, which extend beyond transfusion practices and include late referrals or insufficient prenatal care (Chowdhury et al., 2019).

Very high rates of transfusions and average units used give the impression that blood conservation strategies (Kaur et al., 2017) are critical. For instance, they could include preoperative treatment of anemia, point-of-care coagulation tests, and restrictive transfusion thresholds when appropriate (Smith et al., 2015). Antenatal screening for and early treatment of anemia would be helpful, especially since anemia is the second most common indication for transfusion (Afzal et al., 2018). With the near-equal proportion of booked and unbooked patients, intervention opportunities also arise for women receiving antenatal care (Ibrahim et al., 2020).

The audit has several strengths: a large sample size (N = 540), comprehensive variable analysis, and application of robust statistical methods that respect the central limit theorem and permit parametric testing in light of the skewness in the analyzed data (Abdel-Rahman et al., 2022). Inherent in such a design was also a balanced distribution of age, gravidity, parity, and booking status, thus enhancing the generalization value of the findings (Rajendran et al., 2019). The audit has limitations, however. High rates of non-normality observed in data distribution warrant the consideration of applying non-parametric methods or median-based reporting on skewed variables in future audits (Murugan et al., 2021). Moreover, almost 50% of the transfusions reported adverse reactions, calling for quality control of the transfusion process and further inquiries into premedication practices or screening protocols (Dhar et al., 2018).

Several recommendations directed at speeding transfusion and protecting patient safety can be made from the findings. Delays should be minimized through standardized forms and electronic ordering systems to submit accurate requests that reflect clinical needs (Basavaraj et al., 2020). Routine audits of CT ratios at departmental and institutional levels can maintain current efficiency and spotlight opportunities requiring modification (Sharma et al., 2017). Evidence-based transfusion protocols are urgently needed in obstetrics and should become part of standard practice; they involve specifying thresholds and indications for every type of blood product used (Wright et al., 2021). Workshops and continuing professional development on transfusion best practices should be conducted for doctors, nurses, and lab personnel to avoid over-ordering and improve patient outcomes (Gupta et al., 2019). By implementing a first-in-first-out inventory system with real-time tracking and proper blood article storage practices, blood products utilize better concerning shelf life (Mehta et al., 2016).

CONCLUSION

This audit revealed serious deficiencies in obstetric transfusion practice within a tertiary hospital in Islamabad. Blood product use was clinically appropriate, timely, and effective in managing anemia and hemorrhage, as evidenced by timely improvement of hemoglobin levels. Transfusion patterns were not determined significantly by patient age, booking status, or blood group; thus, equal consideration was given to every patient. Not considering the high complication and ICU admission rates, transfusion protocols were by international standards. This audit provides critical insights for clinical policy-making by identifying the strengths and weaknesses of transfusion practice. Performing a follow-up re-audit after intervention is necessary to track advances and refine the protocols.

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