Original Article

Blood Arrangement and Frequency of Blood Transfusion in Women Undergoing Cesarean Section

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Abstract

Objective: To determine the frequency of preoperative blood arrangement and actual blood transfusion in women undergoing elective cesarean section.

Methodology: This descriptive cross-sectional study was conducted in Department of Obstetrics and Gynecology, Pakistan Railways Hospital, IIMCT, Rawalpindi, from July 31, 2021, to January 30, 2022. This study included 250 pregnant women of 18-40 years of age having singleton pregnancies at ≥37 weeks of gestation who were scheduled for elective cesarean section and consecutively enrolled after ethical approval and informed consent. Women with antepartum/postpartum hemorrhage, known anemia (Hb < 10 g/dL), bleeding disorders, uterine fibroids, placenta previa/accreta spectrum, or emergency cesarean were excluded. A structured proforma was used to record demographic and obstetric variables, blood reservation (cross-match) status, and transfusion within 24 hours postoperatively. Data were analyzed with SPSS 26; continuous variables were summarized as mean ± SD, and categorical variables were summarized as frequency and percentage. Chi-square test was applied for stratified analysis. $p < 0.05$ was taken as statistically significant.

Results: The mean age was 30.1 ± 4.6 years, mean BMI 28.4 ± 3.0 kg/m², and mean preoperative Hemoglobin 12.1 ± 0.9 g/dL. Blood was cross-matched in 99 (39.6%) women, while 41 (16.4%) required actual transfusion. Blood transfusion and blood reservation and transfusion were significantly associated with maternal anemia, higher parity and multiple previous cesareans (all $p < 0.05$).

Conclusion: Preoperative blood ordering substantially exceeded actual transfusion requirements, indicating over-utilization of blood bank resources. A risk-based blood ordering strategy, incorporating type and screen for low-risk cases and reserving cross-matching for identifiable risk factors, is recommended to optimize resource use without compromising maternal safety.

Keywords: Blood ordering, Blood transfusion, Cesarean section, Patient blood management, Postpartum hemorrhage

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Introduction

Caesarean section is amongst the most commonly performed obstetric procedures and carries a higher risk of postpartum hemorrhage (PPH) as compared to vaginal delivery.[1] Studies show the PPH rate for cesarean sections to be 13% as compared to 4% for vaginal deliveries.[2] Average blood loss during cesarean section ranges from 800–1000 mL, nearly double that of vaginal birth.[3] Although most pregnant women can physiologically tolerate this blood loss owing to a 30–50% increase in blood volume during pregnancy[4], transfusion may be required when hemorrhage is excessive or unexpected.

Postpartum hemorrhage (PPH) is a life-threatening obstetric emergency that complicates about 1–10% of all deliveries. It is one of the leading causes of maternal mortality and morbidity throughout the world.[5] Every year, millions of women suffer from PPH, accounting for over 20% of all maternal deaths reported globally.[6,7] Despite global advances, predicting PPH remains challenging; almost two-thirds of women who develop PPH do not have any identifiable risk factors.[8]

In many institutions, especially in low-resource settings

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where emergency blood availability is limited, it is a common practice to routinely arrange blood before a cesarean section. This practice is primarily driven by fear of unexpected hemorrhage, medico-legal concerns, and logistical delays in obtaining blood in an emergency. However, evidence from multiple centers shows that actual transfusion rates in low-risk elective cesarean deliveries are much lower than the proportion of blood reserved. For example, studies have reported transfusion rates as low as 6–7% compared with cross-matching rates of 35–40%.[9] These statistics show that a major proportion of the patients undergoing caesarean section did not receive blood transfusions during or after caesarean section, although a large number of units of blood were reserved and made available in the theatre during surgery.

Unnecessary blood reservation has significant implications. It contributes to wastage of limited blood bank resources, creates artificial shortages for genuine emergencies, increases financial burden on both patients and the healthcare system, and leads to long-term depletion of already scarce blood supplies.[10] In Pakistan, where voluntary blood donation rates are low and demand is high, the efficient utilization of blood products becomes even more critical. Most of the hospitals rely on family replacement donations, necessitating the need for rational blood ordering policies essential for ensuring safe and timely availability of blood.

Based on the abovementioned challenges, it is important to evaluate whether the common practice of routine cross-matching for elective cesarean sections is evidence-based and necessary. There is limited local data assessing the actual utilization of cross-matched blood in low-risk obstetric patients in our setting. Moreover, no standardized Maximum Surgical Blood Ordering Schedule (MSBOS) exists for elective cesarean sections in many public and teaching hospitals. This creates variability in clinical practice and may lead to over-ordering without improving patient outcomes. Therefore, this study aims to determine the proportion of elective cesarean section patients for whom blood is arranged and the proportion who actually receive transfusion during cesarean section. By quantifying this gap, the study aims to provide local evidence that can guide the development of a more rational, selective blood-ordering policy, reduce unnecessary burden on the blood bank, and improve resource allocation in obstetric care.

Methodology

A descriptive cross-sectional study was conducted in the Department of Obstetrics and Gynecology, Pakistan Railways Hospital, IIMCT, Rawalpindi, from July 31, 2021, to January 30, 2022, after taking ethical approval from the Ethical Review Board (Ref No. Riphah/IIMC/ IRC/120). The study included pregnant women scheduled for elective cesarean section who fulfilled the eligibility criteria. The study included women within the age group of 18-40 years, with a singleton pregnancy at a gestational age of 37 weeks or more, who were undergoing elective cesarean section. All included patients were hemodynamically stable and categorized as low-risk for postpartum hemorrhage. Women with a history of postpartum or antepartum hemorrhage, known anemia with Hb <10g/dl, uterine fibroids, coagulation or bleeding disorders, placenta previa or placenta accreta spectrum, or undergoing emergency cesarean section were not included in the study.

The WHO sample size calculator was used for sample size calculation with an anticipated transfusion rate of 6% in elective low-risk cesarean sections, based on previous studies,[9] a 95% confidence level, and a precision of 3%. A total number of 250 women undergoing elective cesarean section at the Department of Obstetrics & Gynecology, Pakistan Railways Hospital, IIMCT Rawalpindi, fulfilling the Inclusion criteria were selected using non-probability consecutive sampling and informed written consent.

A structured proforma was used to record demographic details (age, BMI, parity, gestational age), obstetric history (number of previous cesarean sections, comorbidities such as PIH or GDM), and perioperative information. For each participant, it was noted whether blood was arranged or cross-matched preoperatively and whether transfusion was administered intraoperatively or within 24 hours postoperatively.

Senior faculty or senior residents under consultant supervision performed all cesarean deliveries. Standard intraoperative and postoperative monitoring protocols were followed, including estimation of blood loss, hemodynamic status, and clinical signs requiring transfusion.

Data was analyzed using SPSS version 26. Age, gestational age, BMI, number of Cesarean sections, parity, and pre-operative hemoglobin levels were presented as mean and standard deviation. Pregnancy induced hypertension, gestational diabetes mellitus, blood reserved (cross-matched), and blood transfusion were presented as frequency and percentage. Effect modifiers like age, gestational age, BMI, number of CS, parity, pre- operative hemoglobin levels, pregnancy induced hypertension, and gestational diabetes mellitus were controlled through post stratification using chi square test. A p-value of <0.05 was considered statistically significant. Continuous variables were presented as means and standard deviations

Variables found significant on univariate analysis were entered into a multivariate logistic regression model to identify independent predictors of blood transfusion. Adjusted odds ratios (AOR) with 95% confidence intervals were calculated after controlling for potential confounders.

Results

A total of 250 women undergoing elective cesarean section were included in the study. The mean age was 30.10 ± 4.61 years, with 67.2% of the participants falling between 18 and 30 years of age. The mean gestational age was 38.82 ± 1.86 weeks, and 68% of participants included in the study had a parity range of 2-3. Mean BMI was 28.40 ± 3.04 kg/m², and 70.4% of the participants had a BMI ≤ 30 kg/m. 74.4% of the participants had ≤1 previous cesarean section. The mean pre-operative hemoglobin level was 12.10 ± 0.89 g/dL. PIH was observed in 16.4% and GDM in 17.6% of women. (Table I)

Table I: Baseline Characteristics of Participants (n = 250)

Variable	Category / Mean ± SD	n (%)
Age (years)	30.10 ± 4.61	—
Age groups	18–30	168 (67.2)
	31–40	82 (32.8)
Gestational age (weeks)	38.82 ± 1.86	—
Gestational age groups	37–39	180 (72.0)
	40–41	70 (28.0)
Parity	2.91 ± 1.11	—
Parity groups	2–3	170 (68.0)
	4–5	80 (32.0)
BMI (kg/m²)	28.40 ± 3.04	—
BMI groups	≤30	176 (70.4)
	>30	74 (29.6)
Previous CS	1.40 ± 0.93	—
Number of CS	≤1	186 (74.4)
	>1	64 (25.6)
Pre-operative Hb (g/dL)	12.10 ± 0.89	—
Hemoglobin groups	≤12	140 (56.0)
	>12	110 (44.0)
Confounding variables	PIH	41 (16.4)
	GDM	44 (17.6)

Blood was arranged (reserved and cross-matched) for 99 patients (39.6%), whereas the actual need for blood transfusion was observed in 41 patients (16.4%). (Table II)

Table II: Frequency of Blood Arrangement and Transfusion (n = 250)

Outcome	Yes n (%)	No n (%)
Blood reserved / cross-matched	99 (39.6)	151 (60.4)
Blood transfused	41 (16.4)	209 (83.6)

Blood reservation was significantly more frequent in women with higher parity (p = 0.021), more than one previous cesarean section (p < 0.001), pre-operative hemoglobin ≤12 g/dL (p < 0.001), and PIH (p = 0.004). No statistically significant association was observed with age (p = 0.884), gestational age (p = 0.345), or GDM (p = 0.133) (Table III).

Table III: Stratification of Blood Arrangement Based on Clinical Variables.

Variable	Cross-matched Yes n (%)	No n (%)	p-value
Age 18–30	66 (39.3)	102 (60.7)	0.884
Age 31–40	33 (40.2)	49 (59.8)	
Gestational age 37–39	68 (37.8)	112 (62.2)	0.345
Gestational age 40–41	31 (44.3)	39 (55.7)	
Parity 2–3	59 (34.7)	111 (65.3)	0.021
Parity 4–5	40 (50.0)	40 (50.0)	
BMI ≤30	79 (44.9)	97 (55.1)	0.008
BMI >30	20 (27.0)	54 (73.0)	
Previous CS ≤1	59 (31.7)	127 (68.3)	< 0.001
Previous CS >1	40 (62.5)	24 (37.5)	
Pre-op Hb ≤12	79 (56.4)	61 (43.6)	< 0.001
Pre-op Hb >12	20 (18.2)	90 (81.8)	
PIH Yes	8 (19.5)	33 (80.5)	0.004
PIH No	91 (43.5)	118 (56.5)	
GDM Yes	13 (29.6)	31 (70.4)	0.133
GDM No	86 (41.8)	120 (58.2)	

On univariate analysis, age 31–40 years (p = 0.017), higher parity (p < 0.001), BMI ≤30 kg/m² (p < 0.001), more than one previous cesarean section (p < 0.001), and preoperative hemoglobin ≤12 g/dL (p < 0.001) were significantly associated with actual blood transfusion during cesarean sections. Gestational age (p = 0.088), PIH (p = 0.556), and GDM (p = 0.054) were not significantly associated (Table IV).

To identify independent predictors of blood transfusion and adjust for potential confounding, variables significant on univariate analysis were entered into a multivariate logistic regression model.

Table IV: Univariate Analysis Showing Factors Associated with Blood Transfusion. (n = 250)

Variable	Transfused Yes n (%)	No n (%)	p-value
Age 18–30	21 (12.5)	147 (87.5)	0.017
Age 31–40	20 (24.4)	62 (75.6)	
Gestational age 37–39	34 (18.9)	146 (81.1)	0.088
Gestational age 40–41	7 (10.0)	63 (90.0)	
Parity 2–3	1 (0.6)	169 (99.4)	< 0.001
Parity 4–5	40 (50.0)	40 (50.0)	
BMI ≤30	40 (22.7)	136 (77.3)	< 0.001
BMI >30	1 (1.4)	73 (98.6)	
Previous CS ≤1	1 (0.5)	185 (99.5)	< 0.001
Previous CS >1	40 (62.5)	24 (37.5)	
Pre-op Hb ≤12	34 (24.3)	106 (75.7)	< 0.001
Pre-op Hb >12	7 (6.4)	103 (93.6)	
PIH Yes	8 (19.5)	33 (80.5)	0.556
PIH No	33 (15.8)	176 (84.2)	
GDM Yes	11 (26.8)	30 (73.2)	0.054
GDM No	30 (14.6)	176 (85.4)	

Table V: Multivariate Logistic Regression Analysis Showing Independent Predictors of Blood Transfusion (n = 250)

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Age (31–40 vs 18–30)	2.10	1.05 – 4.18	0.035
Parity (≥4 vs 2–3)	5.80	2.90 – 11.60	<0.001
BMI (≤30 vs >30)	3.40	1.10 – 10.20	0.032
Previous CS (>1 vs ≤1)	6.70	3.20 – 14.00	<0.001
Pre-op Hb (≤12 vs >12 g/dL)	2.90	1.30 – 6.30	0.008
PIH (Yes vs No)	1.20	0.50 – 2.90	0.680
GDM (Yes vs No)	1.90	0.90 – 4.00	0.082

Higher parity (≥4), more than one previous cesarean section, and preoperative hemoglobin ≤12 g/dL remained strong independent predictors of blood transfusion. Age 31–40 years and BMI ≤30 kg/m² also showed statistically significant associations. However, PIH and GDM were not identified as independent predictors after adjustment (Table V).

Overall, blood transfusion was required in a relatively small proportion of patients compared to the number of cases where blood was preoperatively arranged. Independent predictors of transfusion included higher parity, multiple previous cesarean sections, and lower preoperative hemoglobin levels. A considerable proportion of cross-matched blood remained unutilized, indicating potential over-ordering of blood in low-risk elective cesarean sections.

Discussion

PPH is one of the leading causes of both maternal morbidity and mortality, especially in settings with limited, timely access to blood products. Mode of delivery is an important contributing factor for PPH during delivery, with a higher chance of intraoperative blood loss during cesarean section as compared to vaginal delivery. Therefore, a clear understanding of transfusion patterns is required for safe perioperative care. The increasing global emphasis on patient blood management (PBM), optimization of antenatal hemoglobin, and rational transfusion thresholds has given importance to the evaluation of local transfusion practices. This study evaluates the transfusion rates and their determinants in our population, highlighting the areas where strengthening perioperative planning and standardized protocols may improve maternal outcomes and avoid unnecessary blood arrangements.

This study evaluated the frequency of blood arrangement and actual transfusion requirements among women undergoing elective cesarean section in a low-risk obstetric population. The results showed that blood was cross-matched in 39.6% of patients, whereas transfusion was ultimately required in only 16.4%, demonstrating a significant gap between reservation and utilization of blood. The literature reports a similar study conducted by Saleem et al. showing a blood transfusion rate of 6.09% as compared to a blood arrangement rate of 37%.[9] A transfusion rate of 9.2% was reported in another study conducted by Shahida et al.[11] These findings highlight the need to revise routine cross-matching practices, particularly in low-risk elective procedures. Another research conducted by Ngamchuen et al. concluded that routine cross-matching of two units of blood for elective caesarean section of low-risk PPH patients seemed to be inappropriate, and over-ordering led to unnecessary expenses and time consumption.[1,12]

The stratified analysis of the current study revealed that several patient factors were significantly associated with both increased likelihood of blood reservation and actual transfusion. Maternal anemia emerged as a strong predictor of blood transfusion in this study. This aligns with extensive evidence demonstrating that antenatal anemia increases the risk of peripartum transfusion, even in elective procedures. A 20-year retrospective study conducted by Saifon et al.

demonstrated that anemic mothers undergoing cesarean section had a significantly higher risk of transfusion.[13] Another study conducted by Maimoona et al. included patients with hemoglobin (Hb) levels of less than 8g/dl undergoing cesarean section, and the results showed that reduced preoperative packed cell volume was significantly linked with an increased rate of blood transfusions.[14] These findings show that strengthening antenatal screening and timely correction of iron deficiency have a key role in modern PMB practices.

High parity and multiple previous cesarean sections also emerged as strong predictors of transfusion requirement. Similar results have been reported by studies conducted by Maimoona et al.[14], Bushra et al.[15], and Hu P et al.[16]. A systematic review and meta-analysis conducted by Kinza et al. concludes that booking status, preoperative hematocrit, placenta previa, placental abruption, emergency C-section, and multiple gestations were the risk factors most significantly associated with blood transfusion during cesarean section.[1] These factors are known to increase intraoperative blood loss owing to adhesions, abnormal placentation, and reduced physiological reserve. The strong association of placenta previa with both blood arrangement and transfusion aligns with international recommendations advocating pre-operative blood availability for such high-risk cases.[17]

In contrast, gestational age, pregnancy-induced hypertension (PIH), and gestational diabetes mellitus (GDM) did not significantly predict transfusion in this cohort. The lack of association with PIH contrasts with some studies showing increased hemorrhagic risk associated with blood transfusion in patients with preeclampsia[18], possibly because only a small proportion of women in this sample had severe disease or HELLP syndrome. A study conducted by Changqing et al reported no significant difference in maternal BMI and gestational age between the mass blood transfusion and non-mass blood transfusion groups.[19] These variations emphasize that context-specific evaluation is important when developing blood-ordering protocols.[20]

Overall, the results of this study recommend that a risk-based ordering strategy should be adopted instead of routine preoperative cross-matching for all elective cesarean sections. A type and screen (T&S) policy should be used for low-risk women, while cross-matched blood should be reserved for patients with identifiable risk factors such as anemia, increased BMI, high parity, multiple previous cesarean deliveries, or placenta previa, allowing more efficient utilization of blood bank resources. This approach is in line with international patient blood management principles, and it will help to reduce unnecessary blood reservation without compromising maternal safety.

This study was a single-center, descriptive study, limiting its generalizability. Additionally, only low-risk patients undergoing elective cesarean section were included in this study, so the results could not be extrapolated to emergency cesarean deliveries or high-risk obstetric patients. Also, “The number of blood units transfused per patient was not recorded, which limits precise assessment of transfusion burden and resource utilization. However, as this study included only hemodynamically stable, low-risk elective cesarean section patients, institutional transfusion practices typically involve administration of 1–2 units of packed red blood cells. Furthermore, review of clinical records did not identify any cases requiring massive transfusion. Despite these limitations, the study provides important local data on blood utilization patterns in elective cesarean section.

Conclusion

The results of this study showed that the rate of preoperative blood ordering (39.6%) substantially exceeded the actual transfusion requirement (16.4%) in low-risk women undergoing elective cesarean section. This indicates that routine cross-matching of blood in low-risk patients was of limited clinical benefit, causing overutilization of blood bank resources. On the other hand, maternal anemia, higher parity, and multiple previous cesareans were significant predictors of blood transfusion during cesareans. Therefore, it is recommended that a risk-based blood ordering strategy be adopted, incorporating type and screen for low-risk patients and reserving cross-matched blood for those with identifiable hemorrhagic risk factors, to optimize resource utilization without compromising safety. Further multicenter studies with blood utilization indices and cost-effectiveness analysis are required to form institutional guidelines and national policy for rational blood management in obstetric care.

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