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Massive transfusion in obstetric hemorrhage: What are the risk factors and can they be predicted?

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ABSTRACT

Objectives: This study aims to identify the risk factors associated with massive transfusion in obstetric hemorrhage and evaluate their predictive value to facilitate early intervention and improve maternal outcomes.

Methods: A retrospective cohort study was conducted on 1305 women who received blood transfusions for obstetric hemorrhage at Etlik City Hospital between October 2022 and December 2024. Patients were categorized into two groups: those who required massive transfusion (≥10 units of blood products) and those who received at least one unit of transfusion. Demographic, clinical, obstetric, and hematological parameters were analyzed. Statistical comparisons were performed using chi-square, Fisher's exact, Mann-Whitney U, and independent sample t-tests.

Results: A history of recurrent miscarriage, two or more previous cesarean sections, congenital uterine abnormalities, and uterine rupture were significantly associated with massive transfusion (P<0.01). Severe anemia (Hb<9 g/dL) and thrombocytopenia were also identified as critical hematological predictors (P<0.001). Socioeconomic factors, including low educational attainment and unemployment, were significantly correlated with the need for massive transfusion (P<0.001). Obstetric complications such as postpartum atony (P<0.001) and premature rupture of membranes (P=0.04) also contributed to increased transfusion risk.

Conclusions: Identifying key risk factors for massive transfusion can aid in early recognition and timely intervention for obstetric hemorrhage. Integrating these predictors into clinical protocols may enhance maternal care by improving preparedness and reducing maternal morbidity and mortality.

Keywords: Obstetric hemorrhage, massive transfusion, risk factors, postpartum atony, anemia, cesarean section, maternal morbidity

Postpartum hemorrhage and associated maternal morbidity and mortality remain significant challenges for obstetricians globally. Maternal mortality rates vary between industrialized and poor nations. Despite a dramatic decline from 1 in 73 to 1 in 180, this rate remains one of the highest in devel-

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oping nations. 99% of total maternal mortality occurs in developing countries [1]. The primary etiologies of antepartum bleeding are placental abruption, placenta previa, and uterine rupture. This disease is the most common cause of blood and blood product transfusions [2].

Severe postpartum hemorrhage is typically described as bleeding exceeding 1000 ml within 24 hours, despite varying interpretations of the diagnosis [3]. The Royal College of Obstetricians and Gynaecologists (RCOG) defines moderate bleeding as 500-1000 ml, major bleeding as exceeding 1000 ml, and severe postpartum hemorrhage as ranging from 1500 to 2000 ml 4). Signs of massive hemorrhage, such as tachycardia and hypotension, may be noticed late, even if the blood loss is 25% (corresponding to approximately 1.5 liters of bleeding for a pregnant woman), and may cause a delay in the intervention time. Therefore, when bleeding occurs, active management should be initiated immediately [5, 6]. The active management of the third stage of labor is the key approach for mitigating postpartum hemorrhage. This treatment encompasses many medical interventions and invasive techniques that persist until hemostasis is achieved. The medical components of these procedures include fluid resuscitation, placental extraction, bimanual uterine massage, administration of uterotonics, tranexamic acid, and transfusion of blood products. The surgical procedure includes the treatment of genital tract injury, insertion of balloon tamponade into the uterus, laparotomy, uterine devascularization, application of compression sutures, and hysterectomy [7].

The transfusion of blood and blood products is a crucial intervention for postpartum hemorrhage. Massive transfusion is characterized by the administration of 10 or more units of red blood cell suspensions during 24 hours [8]. Accurately assessing blood loss at the proper time is essential for selecting, preparing, and providing suitable blood and blood products to the patient, thereby preventing maternal mortality. Despite insufficient evidence, it has been proposed that early aggressive replacement of blood and blood products during bleeding may yield superior outcomes compared to conventional methods [9, 10]. Despite inadequate prospective data, numerous institutions in the United States have implemented massive transfusion protocols for patients experiencing acute hemorrhage [10]. In cases where maternal hemorrhage is very severe, a few blood and blood product transfusions may not be sufficient to prevent morbidity and mortality. Interventions within the initial 48 hours are crucial for mitigating morbidity and death in both the mother and the newborn. Nearly fifty percent of maternal and neonatal fatalities transpire within this 48-hour timeframe [11].

In planning our study, we aimed to investigate the predictors of maternal massive blood transfusion, identify preventative measures, and establish preliminary protocols for blood and blood product transfusion in obstetric emergencies. This approach could facilitate clinicians in making expedited and informed decisions, thereby enhancing patient referral to appropriate higher-level care facilities. Therefore, we aimed to identify the factors that predict massive transfusion.

METHODS

Study Design

This study encompassed patients who received blood transfusions for obstetric hemorrhage at Etlik City Hospital from October 2022 to December 2024. This research adhered to the Helsinki Declaration on Research Involving Human Subjects and received clearance from the hospital's Ethics Committee (approval number: AESH-BADEK–2024-1198).

Study Participants

The study consisted of 1,305 women who either gave birth after the 24th week of pregnancy or were within the first 6 weeks postpartum and received blood transfusions owing to obstetric hemorrhage. These women were divided into 2 groups: those who received massive blood transfusion and those who received at least 1 unit of blood transfusion. A total of 49 patients received massive blood transfusions, while 1,256 patients received at least 1 blood and/or blood product transfusion. Women experiencing bleeding necessitating transfusion, except those with maternal hemorrhage, were omitted from the study. Cases with a gestational age under 24 weeks or those undergoing transfusion owing to ectopic pregnancy were likewise excluded. Furthermore, individuals who did not deliver at our hospital and possessed inadequate data

were excluded from the study. Demographic, clinical, laboratory, and ultrasonographic data of the cases were retrospectively acquired through the hospital data management system.

Obstetric hemorrhage is characterized by a recorded estimated blood loss over 1500 ml (milliliters) or a reduction in hemoglobin concentration greater than 3 g/L (grams/deciliter) necessitating blood transfusion [12].

A massive blood transfusion is defined as the administration of 10 or more units of blood and blood products during a 24-hour period [13].

Statistical Analysis

IBM Corporation SPSS version 22.0 (IBM Corporation, Armonk, NY, USA) was used to conduct the statistical analysis. The conformance to the normal distribution was examined using the Kolmogorov-Smirnov test. For continuous variables having a normal distribution, descriptive statistics are displayed as "mean±standard deviation". Fisher's exact test or the chi-squared test was used to compare categorical variables. The independent samples t-test was used to compare continuous variables that were regularly distributed. For all tests, a P-value of less than 0.05 was considered statistically significant.

RESULTS

Our study evaluated the demographic and clinical characteristics, pregnancy problems, birth outcomes, and hematological parameters of pregnant women who required ≥10 units of blood transfusion and re-

Table 1. Comparison of characteristics of the pregnant women included in the study

	Transfusion ≥10 units		P value
	Yes (n=49)	No (n=1256)	
Maternal age (year)	29.6±6.6	28.5±6	0.2[a]
BMI>30 (kg/m^2)	2 (4.2)	143 (11.3)	0.1[b]
Gravida	2.3±1.5	2.4±1.6	0.8[a]
Parity	1±1.4	1.1±1.3	0.8[a]
History of abortion	33 (67.3)	380 (30.2)	**<0.01[c]**
Recurrent abortion	9 (18.3)	78 (6.2)	**<0.01[c]**
Congenital uterine anomalies	2 (4.1)	0 (0)	**<0.01[b]**
Previous cesarean section	2±2.2	0.5±0.9	**<0.01[a]**
Education status, n (%)			**<0.01[c]**
İlleterate	7 (14.2)	111 (8.8)	
Primary school	13 (26.5)	105 (8.3)	
Secondary school	16 (32,6)	186 (14.8)	
High school	13 (26.5)	739 (58.8)	
University	0 (0)	115 (9.1)	
Tobacco use	5 (10.2)	106 (8.4)	0.1[c]
Working Status			
Housewife/Unemployment	49 (100)	841 (66.9)	**<0.001[b]**
Duration of hospitalization (days)	3.4±4	3.5±3.5	0.8a
Duration of hospital readmission	1 (2)	21 (1.6)	0.8[b]

Data are shown as mean±stqandard deviation or n (%) where appropriate.

[a]Independent samples t-test, [b]Fisher's exact test, [c]Pearson chi-square.

ceived at least one blood and/or blood product transfusion. Although the average age of pregnant women requiring massive blood transfusion was higher than the other transfused groups, this difference was not found to be statistically significant (P=0.2). Despite a reduced number of patients with a body mass index (BMI) >30 kg/m² in the cohort receiving ≥10 units of blood transfusion, no statistically significant change was seen (P=0.1). It was concluded that there was no significant difference between the two groups for gravida and parity (P>0). Nevertheless, the incidence of miscarriage and repeated miscarriage rates were markedly elevated in the cohort necessitating massive transfusion (P<0.01 and P<0.01, respectively). Nonetheless, congenital uterine abnormalities and a history of two or more prior cesarean sections were markedly elevated in the massive transfusion cohort (P<0.01) (Table 1). Upon assessment of educational attainment, it was noted that none of the women who got ≥10 units of blood transfusion were university graduates, with the majority being primary and secondary school graduates. When the employment status was examined, it was determined that all patients who received massive transfusions were unemployed or housewives (P<0.001). No significant difference was found between the two groups in terms of tobacco use (P=0.1) (Table 1).

Upon evaluating pregnancy problems, the incidence of gestational diabetes was elevated in the group necessitating massive transfusion; nevertheless, no statistically significant difference was observed (P=0.07). No notable difference was observed between the two groups regarding fetal growth retardation, hypertensive disorders (gestational hypertension, chronic hypertension, preeclampsia, and eclampsia), and placental abnormalities (P>0.05).

The incidence of anemia was markedly reduced in individuals who had ≥10 units of blood transfusion (P<0.001). Moreover, the incidence of Premature Rupture of Membrane (PROM) and uterine rupture was markedly elevated in the massive transfusion cohort (P=0.04 and P<0.001, respectively) (Table 2).

No significant difference was found between the two groups in terms of birth week (P=0.7). Upon eval-

Table 2. Pregnancy complications of the women included in the study

	Transfusion ≥10 units		P value
	Yes (n=49)	No (n=1256)	
Gestational diabetes mellitus, n (%)	5 (10.2)	59 (4.6)	0.07[a]
Fetal growth restriction, n (%)	2 (4.1)	81 (6.4)	0.5[b]
Hypertension, n (%)			
Gestational hypertension	0	50 (3.9)	0.2[b]
Chronic hypertension	0	17 (1.3)	
Preeclampsia	1 (2)	43 (3.4)	
Eclampsia	1 (2)	3 (0.02)	
Anemia, n (%)	3 (6.1)	568 (45.2)	**<0.001[b]**
Preterm birth, n (%)	6 (12.2)	272 (21.6)	0.1[a]
EMR, n (%)	3 (6.1)	24 (1.9)	**0.04[b]**
Uterine rupture, n (%)	18 (36.7)	12 (0.9)	**<0.001[a]**
IUFD, n (%)	1 (2)	21 (1.6)	0.8[b]
Plasenta Previa, n (%)	3 (6.1)	90 (7.1)	0.9[b]
Plasental abruption, n (%)	1 (2.1)	54 (4.2)	0.7[b]
Placenta accreta spectrum, n (%)	1 (2)	36 (2.8)	0.9[b]

EMR=Early Membrane Rupture, IUFD=Intrauterine Fetal Demise

[a]Pearson chi-square, [b]Fisher's exact test.

Table 3. Birth characteristics and neonatal outcomes of the newborns

	Transfusion ≥10 units		P value
	Yes (n=49)	No (n=1256)	
Gestational age at delivery (week)	37.2±3.8	36.5±4.2	0.7[a]
Mode of delivery			
Normal spontaneous vaginal birth	44 (89.7)	346 (27.5)	**<0.01[b]**
Cesarean section	5 (10.2)	890 (70.8)	**<0.01[b]**
Operative delivery	0 (0)	20 (1.6)	0.3[c]

Data are shown as mean±stqandard deviation or n (%) where appropriate.
[a]Independent samples t-test, [b]Pearson chi-square, [c]Fisher's exact test.

uating the method of delivery, it was shown that the rate of normal spontaneous vaginal delivery was significantly elevated in the group receiving ≥10 units of blood transfusion (P<0.01), whereas the rate of cesarean sections was dramatically reduced (P<0.01). There was no significant difference between the two groups in terms of operative vaginal delivery (P=0.3) (Table 3).

Upon analysis of hematological parameters, hemoglobin levels in patients necessitating massive transfusion were comparable to those in the transfusion group (P=0.7). The incidence of severe anemia (Hb<9 g/dL) was markedly elevated in the massive transfusion group (P<0.01). Additionally, the incidence of thrombocytopenia was significantly higher in the massive transfusion group (P<0.001) (Table 4).

Analysis of obstetric emergencies necessitating blood transfusion revealed a significantly elevated requirement due to postpartum atony, uterine rupture, and miscarriage (all P<0.001). No substantial difference was observed between the two groups regarding causes such as placental abruption, placenta accreta spectrum, and trauma (P>0.05) (Table 5).

DISCUSSION

Our investigation showed significant risk variables related to the necessity for large blood transfusion in cases of postpartum hemorrhage. Specifically, we identified that a history of recurrent miscarriage, two or more prior cesarean sections, congenital uterine abnormalities, and uterine rupture were significantly correlated with the necessity for massive transfusion (P<0.01). Moreover, severe anemia (Hb<9 g/dL) and thrombocytopenia were identified as crucial hematological factors influencing the necessity for massive transfusion (P<0.001). In the assessment of obstetric complications, preterm mem-

Tablo 4. Hematological Parameters at the time of hospital admission

	Transfusion ≥10 units		P value
	Yes (n=49)	No (n=1256)	
Hemoglobin (g/dL)	10±1.1	9.8±1.7	0.7[a]
Severe anemia (Hb<9 g/dL)	34 (69.3)	348 (27.7)	**<0.01[b]**
Hematocrit (%)	31.5±3.6	31.6±4.5	0.9[a]
Platelet count (×10⁹/L)	247±73	254±84	0.7[a]
Thrombocytopenia	15 (30.6)	28 (2.2)	**<0.001[b]**

Data are shown as mean±standard deviation or n (%) where appropriate.
[a]Independent samples t-test, [b]Pearson chi-square.

Table 5. Main triggering event for blood transfusion

	Transfusion ≥10 units		P value
	Yes (n=49)	No (n=1256)	
Postpartum atonia, n (%)	16 (32.6)	1124 (89.4)	**<0.001[a]**
Plasental abruption, n (%)	1 (2.1)	54 (4.2)	0.7[b]
Uterine rupture, n (%)	18 (36.7)	12 (0.9)	**<0.001[a]**
Placenta accreata spectrum, n (%)	1 (2)	36 (2.8)	0.9[b]
Abortion, n (%)	12(24.4)	15 (1.1)	**<0.001[a]**
Ectopic pregnancy, n (%)	0 (0)	3 (0.02)	1[b]
Trauma, n (%)	1 (2)	12 (0.9)	0.4[b]

[a]Pearson chi-square, [b]Fisher's exact test.

brane rupture (P=0.04) and particularly postpartum atony (P<0.001) emerged as significant determinants for massive transfusion. Furthermore, an assessment of work status revealed that all patients necessitating massive transfusion were either unemployed or housewives (P<0.001), indicating that socioeconomic considerations may exert an indirect influence. Our findings indicate that these characteristics may significantly influence the prediction of obstetric hemorrhage and the necessity for massive transfusion, underscoring the critical relevance of early diagnosis of at-risk pregnancies for maternal health.

Despite numerous research aimed at predicting postpartum hemorrhage and transfusion, it remains a reality that this obstetric emergency might arise in the absence of risk factors and preventive measures. It is essential to assess the necessity for transfusion by identifying discernible risk factors and implementing appropriate safeguards. Results of a recently published 20-year analysis showed that the most common causes of postpartum hemorrhage and transfusion were placental disorders (previa, accreta spectrum, and abruption) and several previous cesarean deliveries [14]. In their study in 2019, Ouh *et al*. [15] found that the risk factors requiring transfusion were maternal age, increased gravida and cesarean section, fetal gender, preterm birth, and preeclampsia. They also found factors that elevate the risk of transfusion, including placental abruption, and aberrant placentation such as previa, anemia, and smoking [15]. One of the most significant consensuses identifies risk factors for postpartum hemorrhage, which include multiple pregnancies, a prior history of postpartum hemorrhage, chorioamnionitis, genital tract injuries, operative vaginal delivery, emergency cesarean section, and pregnancy-induced hypertension [16]. Another study identified anemia during pregnancy, a higher incidence of cesarean sections, severe preeclampsia, emergency cesarean sections, and placental abnormalities as significant risk factors for transfusion [17]. Oya *et al*. [18] discovered in their research that, with placenta previa and maternal age, a history of recurrent dilatation and curettage may constitute a risk factor for transfusion. The RCOG guidelines for managing postpartum hemorrhage emphasize that the platelet count must be sustained at 50,000 or more, and prenatal hemoglobin levels should be preserved at 10 or above to treat anemia [19]. In our analysis, while the number of prior cesareans was 2 or more, a history of recurrent miscarriage and uterine anomalies were related to massive transfusion, only uterine rupture was found to be associated with massive transfusion among obstetric complications. Again, in the literature, hematological markers such as Hb values of 9 and less and the presence of thrombocytopenia were analyzed as predictors of major transfusion.

Wu *et al*. [20] conducted a study examining postpartum hemorrhage and transfusion from an alternative perspective, revealing that pre-birth cross-matching of patients with certain risk factors and the preparation of blood at a blood bank influenced and decreased the transfusion rate. In a separate study, preoperative blood preparation was advised just in the presence of risk factors associated with cesarean sec-

tion. The fatality rate from maternal hemorrhage is notably low in women without other risk factors undergoing elective cesarean sections [21]. Numerous investigations have assessed that elective cesarean birth does not elevate the risk of transfusion or postpartum hemorrhage, and it has been determined that cesarean delivery alone does not heighten the necessity for postpartum hemorrhage management or transfusion. Factors including the presence of risk factors associated with cesarean delivery, placenta previa, preeclampsia, and emergency cesarean delivery in patients monitored for normal delivery have been demonstrated in numerous studies to elevate the necessity for transfusion [17, 21]. Breyman [22] asserted in their study that the risk of maternal mortality during cesarean birth is minimal, with only concomitant conditions potentially leading to significant maternal bleeding. Our study indicated that the number of cesarean sections, specifically two or more, rather than cesarean section alone, was a risk linked to massive transfusion. These results underscore the significance of adopting prompt precautions by predicting postpartum hemorrhage and boost the importance of our study. We believe that the absence of placental anomalies as a contributing factor to the risk of massive transfusion in our study can be ascribed to our institution's status as a tertiary center, the prompt accessibility of the blood center, the routine communication with our blood bank upon patient admission for blood and blood product reservations with cross-matching, and our center's expertise in managing surgical conditions, particularly those related to placenta previa and the accreta spectrum.

The occurrence of preoperative anemia has been significantly correlated with bleeding and the necessity for transfusion in numerous investigations [17, 21]. During pregnancy, Hb <11 mg/dl is defined as anemia, and <9 mg/dL is defined as severe anemia [22, 23]. Alongside the management of anemia, a significant predictor of transfusion and a contributor to the risk of postpartum hemorrhage during pregnancy, research has indicated that anemia, postpartum hemorrhage, and transfusion are correlated with socioeconomic status and educational attainment [24]. However, in one study, they did not find a higher rate of maternal death in women with anemia [25]. Tort *et al*. [26] indicated in their study that the mortality risk from postpartum hemorrhage is sevenfold greater in pregnant women with anemia. A significant correlation exists between anemia and depression during pregnancy, which is a critical factor for postpartum hemorrhage and postpartum depression, and this link is also influenced by women's socioeconomic situation and educational attainment. The prevalence of fatalities resulting from anemia and postpartum hemorrhage is significantly greater in underdeveloped nations compared to developed nations [27, 28]. Our research indicated that the incidence for massive transfusion was markedly elevated among women with severe anemia, homemakers, and individuals with limited educational attainment. Furthermore, the correlation between the rise in pregnancy rates and miscarriage rates with women's education and socioeconomic status elucidates the elevated incidence of massive transfusion among these women, corroborating existing literature.

Limitations

Our research possesses several limitations. Firstly, the retrospective methodology of the study may result in missing data and recording errors, hence limiting the generalizability of the results, which require validation in diverse populations. Nonetheless, the advantages of our investigation encompass a substantial patient cohort, a thorough examination of the determinants necessitating massive transfusion owing to maternal hemorrhage, and alignment with previously established risk variables in the literature. Our data highlight the correlation between socioeconomic and hematological factors and excessive transfusion, which may inform clinical treatment. Furthermore, our center's expertise in obstetric emergency management and adherence to established blood reserve protocols enhance the dependability of the results achieved.

CONCLUSION

These findings show that the need for massive transfusion due to obstetric hemorrhage has a strong relationship with a history of miscarriage, uterine rupture, postpartum atony, education and employment status. It supplies critical information for forecasting obstetric hemorrhage and discerning patients necessitating massive transfusion at an early stage, hence enabling the

implementation of requisite safeguards. This study may assist clinicians in managing obstetric emergencies and aid in formulating preventive programs for at-risk populations to enhance maternal health.

Ethical Statement

The Ankara Etlik City Hospital's Ethics Committee gave its permission to the study protocol (approval number: AESH-BADEK-2024-1198). The Declaration of Helsinki's guidelines were followed in the conduct of this study.

Authors' Contribution

Study Conception: GA; Study Design: GA, GK; Supervision: SÇ, ÇS; Funding: N/A; Materials: ŞÇ, EY, KÖ; Data Collection and/or Processing: GA, GK, NY, ÖDÇ; Statistical Analysis and/or Data Interpretation: ŞÇ, YC; Literature Review: GA, GK, ŞÇ, ÇS; Manuscript Writer: GA; Critical Review: GA, GK.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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