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The Impact and Significance of Prenatal Blood Analysis on Postpartum Hemorrhage in Advanced-Age Primiparous Women

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Abstract: Objective: To investigate the correlation between prenatal plasma fibrinogen, D-dimer, hemoglobin, and platelet levels and postpartum hemorrhage in primiparous women of advanced maternal age. Methods: Fifty elderly primiparous women who delivered without postpartum hemorrhage and 50 who experienced postpartum hemorrhage were assigned to the control and experimental groups, respectively. Five milliliters of fasting venous blood were collected from each woman between 31 and 33 weeks of gestation. FIB, D-dimer, Hb, and PLT levels were measured using a fully automated hematology analyzer. Multivariate logistic regression analysis was performed, and ROC curves were plotted. Results: Compared with the control group, the experimental group showed statistically significant differences in FIB and Hb levels ($P < 0.05$), and extremely significant differences in PLT levels ($P < 0.01$). There was no statistically significant difference in D-D levels between the two groups ($P > 0.05$). FIB and PLT were identified as independent risk factors for postpartum hemorrhage, and both may contribute to the occurrence of postpartum hemorrhage. Conclusion: FIB and PLT showed significant correlations with postpartum hemorrhage, suggesting that FIB and PLT may contribute to the development of postpartum hemorrhage.

Keywords: Advanced Maternal Age; FIB; D-D; Hb; PLT; Postpartum Hemorrhage; Multivariate Logistic Regression Analysis; ROC Curve

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Postpartum hemorrhage (PPH) typically refers to vaginal bleeding exceeding 500 mL within 24 hours of delivery and is one of the most common complications in obstetrics. Statistics indicate that approximately 25% of maternal deaths worldwide are associated with postpartum hemorrhage. Even among survivors, sequelae such as puerperal infections, transfusion-related complications, postpartum mental disorders, and even Sheehan's syndrome may occur, severely impacting their quality of life [1]. Therefore, the effective prediction and prevention of postpartum hemorrhage have become a global priority in obstetric research. Advanced maternal age (AMA) generally refers to pregnant women aged 35 or older. In recent decades, the number of women delaying childbearing has been increasing worldwide. In the United States, the proportion of births among women aged 35–39 and 40–44 rose by 5% and 8%, respectively, between 2006–2007 and 2014–2015; by 2015, women aged 35 and older accounted for 15.7% of all births [2]. In England and Wales, the average age at first birth rose from 27.7 years in 1990 to 30.5 years in 2022. China has shown a similar trend, with the fertility rate for women aged 35–39 rising from 10.98‰ in 2005 to 18.60‰ in 2015, while the fertility rate for women aged 40–44 rose from 2.05‰ to 5.37‰ over the same period.

Recent studies indicate that the proportion of advanced-age pregnancies in China ranges from 10.00% to 20.24%. Postpartum hemorrhage is the leading cause of maternal mortality worldwide, and older primiparous women face a higher risk of postpartum hemorrhage due to their specific physiological characteristics [3].

The increased risk of complications during spontaneous delivery in older mothers stems primarily from age-related physiological changes, including declining ovarian function, impaired vascular function, a weakened immune system, and reduced uterine contractility. These changes make older mothers more susceptible to complications such as gestational hypertension, gestational diabetes, and postpartum hemorrhage [4]. The relationship between prenatal coagulation parameters and postpartum hemorrhage is receiving increasing attention. Plasma fibrinogen serves as a key substrate in the coagulation process; D-dimer reflects fibrinolytic system activity; hemoglobin reflects the body's oxygenation capacity and reserve function; and platelets are a core element of primary hemostasis [5]. This study analyzes the correlation between prenatal plasma fibrinogen, D-dimer, hemoglobin, and platelet levels and postpartum hemorrhage, examining the associations and trends between these factors. The aim is to provide a theoretical foundation for advancing the diagnosis and treatment of postpartum hemorrhage in the western Guangxi region, with the goal of offering insights for the early clinical detection and risk prediction of postpartum hemorrhage and laying the groundwork for further research.

1. General Information

Fifty elderly primiparous women who delivered at our hospital without postpartum hemorrhage were randomly selected as the control group, and fifty elderly primiparous women who delivered at our hospital with postpartum hemorrhage were randomly selected as the experimental group. Among them, cases with postpartum blood loss exceeding 1,000 mL were classified as severe postpartum hemorrhage, while cases with postpartum blood loss between 500 and 1,000 mL were classified as normal postpartum hemorrhage. This study must be submitted to the hospital's Institutional Review Board for review and approval.

Inclusion Criteria: Patients meeting the relevant diagnostic criteria outlined in *Obstetrics and Gynecology*; all patients were singleton pregnancies; maternal age > 35 years; patients in the observation group with postpartum blood loss exceeding 500 mL within 24 hours, etc.

Exclusion Criteria: Patients with pre-existing coagulation disorders [6].

2. Method

2.1 Sample Collection

Blood samples were collected from pregnant women between 31 and 33 weeks of gestation for testing. A 5-mL sample of fasting venous blood was drawn from each woman. Of this, 3 mL was collected into a vacuum-sealed anticoagulant tube, centrifuged at 3,000 rpm for 5 minutes to separate the plasma. Plasma fibrinogen (FIB), D-dimer (D-D), and hemoglobin (Hb) levels were measured using a fully automated hematology analyzer. The remaining 2 mL of venous blood was analyzed on the same instrument to determine platelet count (PLT). All procedures were conducted in strict accordance with the equipment manual and laboratory protocols, and all operations were completed within 2 hours [7].

2.2 Observation Indicators

FIB, D-D, Hb, and PLT levels were collected from both groups of parturients before and after delivery. The correlation between prenatal FIB, D-D, Hb, and PLT levels and postpartum hemorrhage was analyzed [8].

2.3 Statistical Methods

Statistical analysis was performed using SPSS 26 software. Continuous data are presented as mean ± standard deviation (X ± S). A test for homogeneity of variances was conducted for all groups. If variances were homogeneous, one-way ANOVA was used for comparisons of means across multiple groups, and the LSD method was used for pairwise comparisons between groups. If variances were heterogeneous, the Kruskal-Wallis rank-sum test was used. For continuous variables, the t-test for two independent samples was used; for categorical variables, the chi-square test or Fisher's exact test was used. A P-value < 0.05 was considered statistically significant.

3. Results

3.1 Comparison of FIB, D-D, Hb, and PLT Levels Between the Two Groups Before and After Delivery

FIB, D-D, Hb, and PLT levels were measured in both groups before and after delivery. Compared with the control group, the experimental group showed statistically significant differences in FIB and Hb ($P < 0.05$), and PLT levels in the experimental group were extremely significantly different ($P < 0.01$). There was no statistically significant difference in D-D levels between the two groups ($P > 0.05$). See Table 1 for specific data.

Table 1 Comparison of prenatal and postnatal FIB, D-D, Hb, and PLT levels between the two groups ($x \pm s$, n = 50)

Group	n	Control group		Experimental group	
		Prenatal	Postnatal	Prenatal	Postnatal
FIB (g/L)	50	4.63±0.72	2.64±0.94[a]	4.57±0.84	2.64±0.94[a]
D (mg/L)	50	6.26±0.29	5.75±0.50	5.98±1.02	5.73±0.50
Hb (g/L)	50	115.46±4.66	101.33±10.18[a]	113.08±3.35	98.74±16.93[a]
PLT (10^9/L)	50	149.89±11.59	125.10±11.89[b]	147.16±6.40	115.64±19.06[b]

Note: Compared with the control group, a) $P < 0.05$; b) $P < 0.01$.

3.2 Multivariate Logistic Regression Analysis

The four variables identified in the univariate analysis (FIB, D-D, Hb, PLT) were included in a multivariate binary logistic regression model. The results of the multivariate logistic regression analysis showed that FIB (OR = 0.961, 95% CI: 0.927–0.994, P = 0.026) and PLT (OR = 0.245, 95% CI: 0.079–0.721, P = 0.012) were independent risk factors for postpartum hemorrhage. Neither D-D nor Hb reached statistical significance in the multivariate analysis ($P > 0.05$), as shown in Table 2.

Table 2 Multivariate logistic regression analysis of rebleeding in non-traumatic SAH

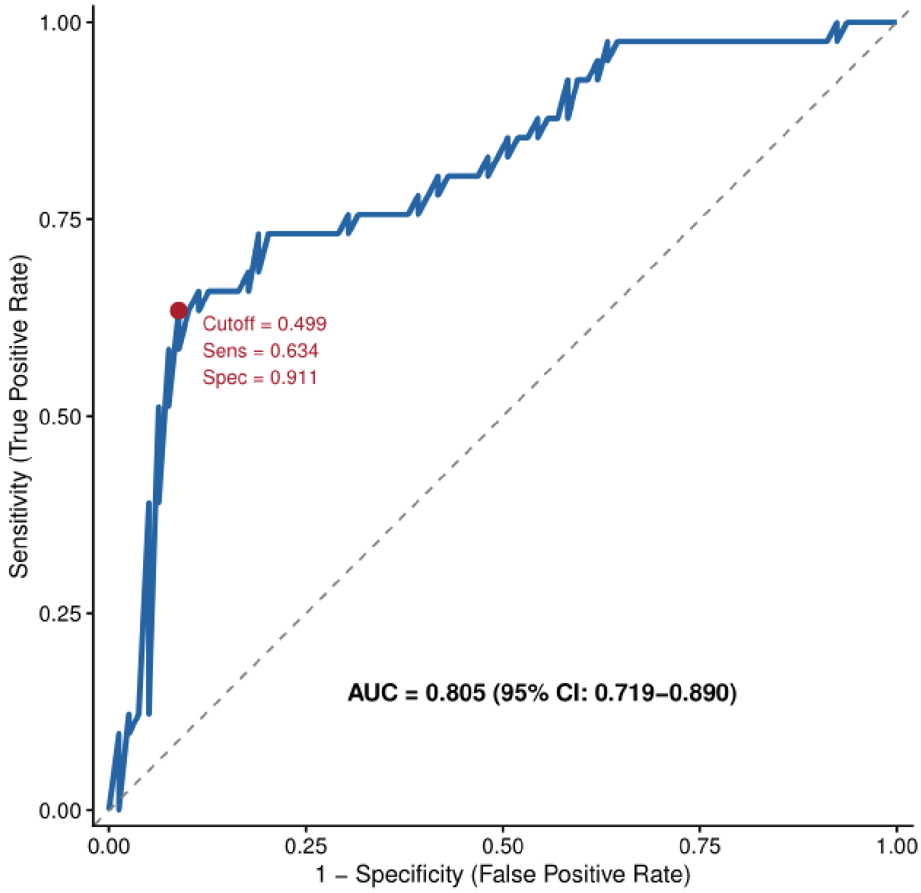
Variable	β	OR	95% CI	P-value
FIB	−0.040	0.961	0.927–0.994	0.026*
D-D	−0.004	0.996	0.982–1.009	0.560
Hb	0.111	1.117	0.959–1.313	0.164
PLT	−1.405	0.245	0.079–0.721	0.012*

Note: * indicates $P < 0.05$. OR: odds ratio; CI: confidence interval. Model AIC: 141.04.

3.3 ROC Curve Analysis

The results of the ROC curve analysis showed that AUC = 0.805 (95% CI: 0.719–0.890), indicating that the predictive model has good discriminatory ability. The optimal cutoff value determined using the Youden index was 0.499. At this optimal cutoff, the model's sensitivity was 63.4% and specificity was 91.1%. The results suggest that this predictive model exhibits high accuracy (specificity of 91.1%) in identifying patients with postpartum hemorrhage, providing a reference for early clinical screening and risk stratification. The fit of the logistic regression model is as follows: Null deviance: 154.11 (df = 119). Residual deviance: 119.04 (df = 109). AIC: 141.04. The residual deviance of the model was significantly lower than that of the null model (Δ deviance = 35.07, Δdf = 10), indicating that the inclusion of FIB and PLT significantly improved the model's ability to explain the occurrence of postpartum hemorrhage. The results are shown in Figure 1.

Figure 1 ROC curve for the postpartum hemorrhage prediction model



Note: The red dot indicates the optimal cutoff point determined by the Youden score (Cutoff = 0.499), corresponding to a sensitivity of 0.634 and a specificity of 0.911.

4. Discussion

Effective prevention and management of postpartum hemorrhage depend on the early identification and timely screening of high-risk populations. Currently widely used risk assessment tools for postpartum hemorrhage include those developed by the California Maternal Quality Collaborative (CMQCC), the Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN), and the New York State Obstetric Bleeding Safety Guidelines (NYSBOH), among others [9]. However, these assessment tools have moderate predictive performance and are primarily designed for high-risk obstetric patients undergoing cesarean section; there is currently a lack of reliable predictive models for postpartum hemorrhage following vaginal delivery in older mothers.

Age is a critical factor that cannot be overlooked during childbirth, as there are significant differences in physical function and physiological status among mothers of different age groups. Younger women are generally in better health, with physiological functions in optimal condition; they exhibit relatively stronger uterine contractility and coagulation function, and thus face a relatively lower risk of postpartum hemorrhage. However, as women age, their physical functions gradually decline, and they may develop chronic conditions such as hypertension and diabetes. These conditions can impair physical health and coagulation function, thereby increasing the likelihood of postpartum hemorrhage [10]. The elasticity of the uterine muscles in older mothers may decrease, and uterine atony is more common after delivery, which can easily lead to postpartum hemorrhage. Indicators such as FIB, D-D, Hb, and PLT play a critical role in assessing a mother's coagulation function and physical condition. FIB is a crucial coagulation factor; its level directly affects the blood's ability to clot. D-dimer is a product of fibrin degradation, and its concentration reflects the activity of the body's fibrinolytic system. Hb is a key indicator for assessing maternal anemia, as anemia can impair a mother's physical resistance and tolerance to bleeding [11]. PLT plays a crucial role in hemostasis and the coagulation process. By comparing the levels of these indicators in the two groups of women before delivery, we can identify differences in coagulation function and physical condition among different groups of women. The severity of postpartum hemorrhage varies, and different degrees of postpartum hemorrhage may be closely related to the levels of FIB, D-D, Hb, and PLT in the women's bodies. For women with mild postpartum hemorrhage, although FIB levels may decrease, they remain within a relatively normal range; D-D levels may only be slightly elevated, and changes in Hb and PLT levels are also relatively minor. In contrast, for women with moderate to severe postpartum hemorrhage, FIB levels may drop significantly, as massive bleeding leads to increased consumption of coagulation factors [12]. D-D levels will rise markedly, indicating excessive activation of the body's fibrinolytic system. Hb levels will drop rapidly as blood loss increases, leading to worsening anemia in the mother. PLT counts may also decrease, further impairing coagulation function. Excessively low FIB levels may indicate coagulation deficiency, making it difficult to control bleeding during delivery and thereby increasing the risk of postpartum hemorrhage [13]. Elevated D-dimer levels indicate a certain degree of thrombus formation and hyperfibrinolysis in the body, which may be related to the mother's hypercoagulable state and may also influence postpartum hemorrhage [14]. Low Hb levels indicate that the mother may be anemic; anemia can impair the function of various organs, including uterine contractility, thereby increasing the likelihood of postpartum hemorrhage. A reduced platelet count or platelet dysfunction can impair platelet aggregation and hemostatic function, similarly increasing the likelihood of postpartum hemorrhage [15]. By analyzing the correlation between these indicators and postpartum hemorrhage, we can establish corresponding predictive models to assess and predict the risk of postpartum hemorrhage, thereby enabling effective prenatal interventions to reduce its incidence.

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No

Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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