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PROGNOSTIC ASPECTS OF THE DEVELOPMENT OF LATE POSTPARTUM OBSTETRIC HEMORRHAGE

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ABSTRACT: Late postpartum hemorrhage (PPH), defined as excessive bleeding occurring after the first 24 hours and up to six weeks postpartum, remains a significant cause of maternal morbidity. This prospective multicenter observational study aimed to identify prognostic factors associated with the development of late PPH and to evaluate their predictive value. A total of 650 postpartum women were enrolled and followed for six weeks postpartum. Data collected included clinical characteristics, obstetric history, laboratory parameters, and imaging findings. Multivariate logistic regression analysis identified key predictors, including uterine subinvolution, retained products of conception, infection markers, and coagulation profile abnormalities [1]. The presence of these factors was significantly associated with an increased risk of late PPH (adjusted odds ratios ranging from 2.1 to 3.5, $p < 0.001$). These findings underscore the need for targeted surveillance and early intervention strategies in high-risk populations to improve maternal outcomes [2].
Keywords: Late postpartum hemorrhage, prognostic factors, uterine subinvolution, retained products of conception, obstetric hemorrhage, maternal morbidity.

INTRODUCTION

Background - Postpartum hemorrhage is a leading cause of maternal morbidity and mortality worldwide. While immediate PPH—occurring within the first 24 hours postpartum—has received considerable attention, late PPH, which occurs from 24 hours up to six weeks postpartum, also poses significant risks. Late PPH is often underrecognized, with etiologies including uterine subinvolution, retained placental fragments, endometritis, and coagulation disorders.

Rationale - Early identification of women at risk for late PPH is crucial for prompt management and prevention of severe complications. Despite advances in obstetric care, prognostic indicators for late PPH are less well defined compared to immediate hemorrhage. A systematic evaluation of clinical, laboratory, and imaging markers could enhance our ability to predict and intervene in cases of late PPH.

Objective - This study aims to: Identify prognostic factors associated with the development of late postpartum hemorrhage. Evaluate the predictive accuracy of these factors. Develop a prognostic model to aid in clinical decision-making and early intervention in high-risk postpartum women [3].

MATERIALS AND METHODS

Study Design and Setting - A prospective, multicenter observational study was conducted across three tertiary care hospitals from January 2018 to December 2020. Ethical approval was obtained from the Institutional Review Boards of all participating centers, and written informed consent was obtained from all participants.

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Participants - A total of 650 postpartum women aged 18–45 years with singleton deliveries were enrolled. Women were included if they were within 24 hours postpartum at the time of enrollment and willing to participate in follow-up assessments up to six weeks postpartum. Exclusion criteria were: Preexisting coagulation disorders. Known uterine anomalies. Emergency postpartum hysterectomy. Inability to attend follow-up visits.
Data Collection - Data were collected at baseline (within 24 hours postpartum) and during follow-up visits at 2, 4, and 6 weeks postpartum. Information recorded included: Clinical Data: Maternal age, parity, body mass index (BMI), obstetric history, mode of delivery, and complications during labor. Laboratory Parameters: Hemoglobin levels, platelet counts, coagulation profiles (PT, aPTT, fibrinogen), and inflammatory markers (C-reactive protein, white blood cell count). Imaging: Transvaginal or pelvic ultrasound evaluations to assess uterine involution and the presence of retained products of conception. Outcome Measures: Occurrence of late PPH, defined as blood loss exceeding 500 mL after 24 hours postpartum accompanied by clinical signs of hemodynamic instability, need for transfusion, or surgical intervention [4].
Statistical Analysis - Statistical analyses were performed using SPSS version 27.0. Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range) and compared using the Student's t-test or Mann–Whitney U test as appropriate. Categorical variables were expressed as frequencies and percentages, and comparisons were made using the chi-square test or Fisher's exact test. Prognostic factors were assessed using univariate analysis, and those with $p < 0.10$ were included in a multivariate logistic regression model to identify independent predictors of late PPH. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated, and a p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics - Of the 650 women enrolled, 620 (95.4%) completed the six-week follow-up. The mean age was 30.2 ± 5.4 years, and 62% were multiparous. The distribution of mode of delivery was 60% vaginal and 40% cesarean section. Baseline characteristics were similar between women who later developed late PPH and those who did not (Table 1).

Table 1. Baseline Demographic and Obstetric Characteristics (n = 620)

Characteristic	Late PPH (n = 80)	No Late PPH (n = 540)	p-value
Mean Age (years)	31.0 ± 5.6	30.0 ± 5.3	0.08
Multiparity (%)	70%	60%	0.10
Cesarean Section (%)	45%	38%	0.15
Mean BMI (kg/m²)	26.8 ± 3.2	26.0 ± 3.0	0.06

Prognostic Factors - Univariate analysis revealed several factors associated with the development of late PPH: Uterine Subinvolution: Women with delayed uterine involution on ultrasound at 2 weeks postpartum had a higher incidence of late PPH ($p < 0.001$). Retained Products of Conception: The presence of retained placental fragments was significantly associated with late PPH ($p < 0.001$). Infection Markers: Elevated C-reactive protein (CRP) and white blood cell (WBC) count at baseline were more common in the late PPH group ($p < 0.01$). Coagulation Abnormalities: Abnormal coagulation profiles, including prolonged PT/aPTT and low fibrinogen levels, were observed in a greater proportion of women with late PPH ($p < 0.05$).
In the multivariate logistic regression model, independent predictors of late PPH were: Uterine Subinvolution (adjusted OR 3.5, 95% CI 2.1–5.8, $p < 0.001$). Retained Products of Conception

(adjusted OR 3.0, 95% CI 1.8–4.9, p < 0.001). Elevated CRP (adjusted OR 2.1, 95% CI 1.3–3.4, p = 0.002). Abnormal Coagulation Profile (adjusted OR 2.4, 95% CI 1.4–4.0, p = 0.001).
Outcome Measures - Late PPH was documented in 80 (12.9%) of the 620 women completing follow-up. Among these, 65% required blood transfusion and 20% underwent surgical intervention (e.g., dilation and curettage or uterine artery embolization). The median time to the onset of late PPH was 18 days postpartum (IQR 14–24 days).

DISCUSSION

Principal Findings - This study identified key prognostic factors associated with late postpartum hemorrhage. Uterine subinvolution, retained products of conception, elevated inflammatory markers (CRP), and abnormal coagulation profiles emerged as independent predictors of late PPH. These findings highlight the multifactorial nature of late PPH and the importance of a comprehensive evaluation in the postpartum period [5].
Pathophysiological Implications - Uterine subinvolution may indicate impaired myometrial contraction and delayed recovery following delivery, predisposing to bleeding. Retained products of conception can serve as a nidus for infection, further exacerbating uterine atony and coagulopathy. Inflammatory markers such as CRP reflect systemic inflammation, which may interfere with normal coagulation and healing processes. Additionally, coagulation abnormalities can compound bleeding risks by impairing clot formation. The interplay of these factors contributes to the development of late PPH.
Clinical Implications - Our findings underscore the need for routine postpartum monitoring that extends beyond the immediate 24-hour period, especially in high-risk women. Ultrasound evaluation for uterine involution, along with laboratory assessments of inflammatory and coagulation markers, should be considered in postpartum follow-up protocols. Early detection of uterine subinvolution or retained products of conception may prompt timely interventions such as medical management with uterotonics or surgical procedures, thereby reducing the risk of severe hemorrhage.
Comparison with Previous Studies - Previous studies have predominantly focused on immediate postpartum hemorrhage, with limited data on late PPH. Our study expands on the current literature by providing a detailed analysis of prognostic factors specific to late PPH. The identified predictors align with the known pathophysiology of postpartum uterine recovery and highlight similar risk factors found in earlier investigations, though our multivariate analysis offers a more refined understanding of their relative contributions [6].
Strengths and Limitations - Strengths of this study include its prospective design, multicenter participation, and comprehensive assessment of both clinical and laboratory parameters. However, limitations include the observational nature of the study, which limits causal inferences, and potential variability in follow-up intervals and management practices across centers. Additionally, while our sample size was adequate for identifying significant predictors, larger studies may be needed to validate these findings further.
Future Directions - Future research should focus on interventional studies that evaluate the effectiveness of targeted management strategies for women identified as high risk for late PPH. Randomized controlled trials investigating the role of prophylactic interventions in patients with predictors such as uterine subinvolution or retained products of conception could provide valuable insights. Furthermore, exploring the utility of novel biomarkers and integrating them into a predictive model may enhance risk stratification and individualized care.

CONCLUSION

This study demonstrates that late postpartum hemorrhage is a multifactorial condition influenced by several prognostic factors. Uterine subinvolution, retained products of conception, elevated inflammatory markers, and abnormal coagulation profiles are independently associated with an increased risk of late PPH. These findings underscore the need for extended postpartum surveillance that includes both clinical assessment and targeted laboratory and imaging evaluations.

Early identification of at-risk women allows for timely intervention, which may include the use of uterotonic agents, evacuation of retained products, or correction of coagulation abnormalities. Implementing comprehensive postpartum follow-up protocols could lead to a reduction in the incidence and severity of late PPH, thereby improving maternal outcomes and reducing the need for emergency interventions.

In clinical practice, the integration of these prognostic indicators into routine postpartum care can facilitate a more proactive approach. Healthcare providers should consider incorporating ultrasound evaluations for uterine involution and laboratory tests for inflammatory and coagulation markers in the postpartum period. Such strategies are critical for early detection and intervention, ultimately contributing to enhanced maternal safety and better long-term outcomes.

Overall, our findings advocate for a paradigm shift in postpartum care that extends monitoring beyond the immediate period after delivery, emphasizing the importance of early prognostic assessment to mitigate the risks associated with late postpartum hemorrhage.

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