Risk factors of postpartum hemorrhage due to uterine atony: a retrospective cohort study

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Abstract

Background: *Postpartum hemorrhage (PPH) continues to be a significant global burden leading to high maternal mortality and morbidity rates. Uterine atony is the most prevalent cause of postpartum hemorrhage, accounting for 75% to 90% of cases.*

Aim: *Research uterine atony related PPH at Hospital of Hue University of Medicine and Pharmacy's Department of Obstetrics and Gynecology.*

Materials and methods: *In this study, we conducted a retrospective case-control study to determine the risk factors for PPH among a cohort of women who gave birth between August 2020 and June 2021 at the Department of Obstetrics and Gynecology, Hue University of Medicine and Pharmacy Hospital. PPH was defined as an estimated blood loss ≥500 mL. Logistic regression analysis was used to identify independent risk factors for PPH.*

Results: *After the vaginal deliveries, we collected data from 147 patients, including 49 women with PPH caused by uterine atony and 98 without PPH. Maternal characteristics significantly associated with PPH included: pre-delivery anemia (adjusted OR [aOR] 4.0, 95% Confidence interval [CI]: 1.7 - 11.2), macrosomia (aOR = 4.3; 95%CI 1.1 - 16.8) and grand parity (aOR = 4.7; 95%CI: 1.7 - 13.9).*

Conclusions: *All pregnant women should have their risks associated with postpartum hemorrhage evaluated and monitored during their pregnancies' prenatal, labor, and postpartum stages.*

Keywords: *postpartum hemorrhage, risk factors, atonic uterine.*

1. INTRODUCTION

Postpartum hemorrhage (PPH) is one of the five most prevalent obstetric complications. The study conducted by the World Health Organization revealed a PPH rate of 10.5%. The Vietnamese Ministry of Health reported 5,445 cases of PPH in 2015, including 56 maternal deaths [1]. According to the Department of Maternal Health and Children's report, the maternal death rate in 2018 was 120 cases, with PPH accounting for 54.3% [1]. Despite appropriate management, approximately 3 percent of vaginal births will result in severe postpartum hemorrhage. It is the most prevalent cause of maternal morbidity in developed nations and a leading cause of death globally [2].

Uterine atony is the leading cause of PPHs, accounting for 75% to 90% of incidences [3]. The traditional definition of primary PPH, the most common type of significant obstetric hemorrhage, is blood loss of 500 ml or more from the genital tract within 24 hours following a vaginal delivery or 1000 ml or more after cesarean delivery. PPH can be classified as either minor (between 500 and 1000 ml) or major (more than 1000 ml), and significant PPH can be further subdivided into moderate (between 1000 and 2000 ml) and severe PPH (more than 2000 ml) [4]. There is no definitive agreement among experts about the definition of obstetrical hemorrhage. Evaluation of uterine atony-related factors is critical for preventing and immediately managing PPH. Anemia in pregnancy, fetal macrosomia, multiple pregnancy, polyhydramnios, and grand multiparity are all potential risk factors for uterine atony; however, uterine atony can nevertheless occur in women who do not have these risk factors. Several guidelines suggest that all pregnant women should be assessed and monitored for the risk of PPH at the time of antepartum, intrapartum, and postpartum. Active management of the third stage of labor is a viable, low-cost method for preventing 60-70 percent of atonic PPH. Monitoring pulse, blood pressure, and bleeding during the fourth stage of labor will track maternal physiological parameters that aid in the early detection and treatment of the acutely unwell patient, which is essential for preventing morbidity and mortality. Managing PPH caused by uterine atony involves pharmacological and surgical interventions. Ineffective management of PPH resulting from uterine atony can lead to various problems and even death in the mother if treatment is delayed [5].

The primary aim of this study was to determine factors associated with PPH among features of women and births, as well as components of initial PPH management for women with PPH due to uterine atony following vaginal during 10 months at the Obstetrics and Gynecology Department of Hue University of Medicine and Pharmacy.

2. MATERIALS AND METHODS

2.1. Materials

Patients hospitalized in the Obstetrics & Gynecology Department at Hue University Hospital from August 2020 to June 2021. We conducted case-control research to determine PPH risk variables.

- Selection criteria:

• Case group included (1) Vaginal delivery, (2) Estimated blood loss of ≥ 500 mL [4], (3) PPH due to uterine atony: Inadequate involution of the uterus after delivery.

• Control group included vaginal delivery without PPH

- Exclusion criteria were (1) Antenatal or intrapartum hemorrhage, (2) Patients diagnosed with PPH before being admitted to the Department of Obstetrics and Gynecology, Hue University Hospital, (3) PPH not resulted by uterine atony: retained placenta and retained parts of placenta, and abnormal placentation, lacerations, coagulation disorders.

For our sample size estimation, we considered macrosomia as a risk factor for PPH. For both sample size estimates, we consider a case:control ratio of 1:2. According to research by Elie Nkwabong et al. (2020), the rate of exposure to the risk factor was p = 0.25 and OR = 5.95, the sample size was calculated by the formula [6]:

$$n = \frac{(r+1)^2 C}{r\ln(OR)^2 p(1-p)}$$

The sample size of this study was 147, with 49 of cases of PPH and 98 deliveries without PPH. We selected random controls after removing the cases of PPH from the total number of deliveries at the hospital.

2.2. Methods

We registered patient data, including characteristics of the patient, pregnancy, labor, delivery, and PPH management based on information from hospitals' medical records of every delivery with confirmed PPH.

Estimated blood loss for calculating the amount of blood loss by:

- Place a calibrated delivery drape under the mother's buttocks immediately after delivery to quantify the bleeding volume. Postpartum hemorrhage was identified when the blood loss was less than 500 mL.

- According to the Royal Society of Obstetricians and Gynecologists (RCOG), mild, moderate, and severe blood loss correspond to blood loss of 500 to 1,000, 1,000 to 2,000 mL, and 2,000 mL, respectively [7].

We considered potential risk factors in our analyses based on the literature review. Prenatal factors included grand multiparity, uterine anomalies, previous uterine surgery, previous cesarean section, and history of PPH. Current pregnancy conditions included maternal age, anemia, multiple pregnancies, polyhydramnios, macrosomia, prolonged delivery, ...

2.3. Data analysis

All 147 completed risk assessment tools (49 cases and 98 controls) were recorded in an Excel spreadsheet before being converted to SPSS version 26.0 for data analysis. Data were cleaned to ensure that there were neither errors nor missing data.

The PPH risk factors maternal age, BMI, birth weight, and maternal hemoglobin were recorded as continuous variables for descriptive purposes and inclusion in the final analysis model. Maternal age was divided into 3 groups below 20, 20-34, and above. Infant birth weight was grouped into two categories: <3500g and ≥3500g. At the time of admission to labor, the patient's Hb level was divided as either anemia (Hb <11g/dL) or non-anemia (Hb ≥11g/dL). The Ministry of Health defined grand parity as occurring when a pregnant woman has delivered more than 3 times [1].

We performed univariable analysis to evaluate candidate variables as PPH risk factors. The odds ratio (OR) and 95% confidence interval were used to quantify the associations between potential risks and PPH. Finally, independent PPH risk variables were identified using multivariable logistic regression with manual backward elimination. Calibration and discrimination were used to assess the model's predicted accuracy. The Hosmer and Lemeshow (H-L) goodness-of-fit test was utilized to evaluate calibration, which quantifies the model's capacity to assign the suitable risk. A non-significant H-L result (P > 0.05) shows that the model makes accurate predictions on average. Analysis of the area under the receiver analysing characteristic (ROC) curve was used to determine discrimination, which assesses the model's ability to distinguish between individuals with and without PPH. If the area under the curve is more than 0.70, it can be concluded that the model has a sufficient capacity for discrimination.

3. RESULTS

3.1. Characteristics of patient's medical history and sociodemographic

During the research, we enrolled 49 women with PPH and 147 without PPH. Some sociodemographic and obstetrical variables of the study were given in Table 1. 75.5% of the cases were between the ages of 20 - 34, while 14.3% were older than 35 and 10.0% were younger than 20. The average age of the cases was 28.6 ± 5.1%, whereas the average age of the control group was 27.2 ± 4.7. For the place of residence, 57.1% of the case's residents reside in urban areas, while 64.3% of the control group live in urban areas (p<0.05). The proportion of grand parity was 32.7% in the PPH group. The study group's prenatal BMI ≥23 kg/m2 was

14.3%. 10.2% and 12.2%, respectively, were the rates of postpartum bleeding history and old incisions in the study group. The number of pregnancies ≥3 accounted for 32.7% in the study group and 7.1% in the control group. The difference is statistically significant with p<0.05.

Table 1. Characteristics of patient's medical history and sociodemographic

Characteristics		Cases (n = 49)		Controls (n = 98)		p-value
		n	%	n	%	
Maternal age	< 20	5	10.2	11	11.2	0.544
	20 - 34	37	75.5	66	67.3	
	≥ 35	7	14.3	21	21.5	
Place of residence	Urban	28	57.1	63	64.3	0.401
	Rural	21	42.9	35	35.7	
Parity	< 3	33	67.3	91	92.9	0.001
	≥ 3	16	32.7	7	7.1	
Prenatal BMI	< 23 kg/m^2	42	85.7	69	80.6	0.296
	≥ 23 kg/m^2	7	14.3	19	19.4	
Previous PPH	Yes	5	10.2	3	3.1	0.117
	No	44	89.8	95	96.9	
Previous Cesarean section	Yes	6	12.2	6	6.1	0.201
	No	43	87.8	92	93.9	

The case group's prenatal BMI ≥ 23 kg/m^2 was 14.3%. The case group's previous PPH and previous cesarean section rates were 10.2% and 12.2%, respectively. The proportion of grand parity ≥3 accounted for 32.7% in the case group and 7.1% in the control group (p < 0.05).

3.2. Characteristics of clinical antepartum and intrapartum

The rate of pre-delivery anemia in the case group was 29.0%. Gestational hypertension accounted for 8.2% of the case group and 12.2% in the control group. Polyhydramnios was 4.1% and 3.1%, respectively, in the PPH group and the without - PPH group. There were 6.1% in the case group and 14.3% in the control group with a history of internal diseases (p > 0.05); gestational age from 37^0 to 41^{+6} weeks accounted for 93.9%; control group 87.8%. The pregnancy proportion ≥ 42^0 weeks in the PPH group was 2.0%, and the control group was 4.0% (p > 0.05). The percentage of fetal weight ≥ 3,500 grams in the case group was 38.8%, and the control group was 15.3%.

Table 2. Characteristics of clinical antepartum and intrapartum

Characteristics		Cases (n = 49)		Controls (n = 98)		p-value
		n	%	n	%	
Pre-delivery anemia	Yes	8	16.3	4	4.1	0.061
	No	41	83.7	94	95.9	
Gestational hypertension	Yes	4	82	12	12.2	0.578
	No	45	91.8	86	87.8	
Multiple pregnancies	Yes	0	0.0	1	1.0	p > 0.05
	No	49	100%	97	99.0	
Polyhydramnios	Yes	2	4.1	3	3.1	0.258
	No	47	95.9	95	96.9	

Internal diseases	Yes	3	6.1	14	14.3	0.179
	No	46	93.9	84	85.7	
Gestational age	≤ 36^0 week	2	4.1	8	8.2	0.513
	37^0 - 41^{+6} week	46	93.9	86	87.8	
	≥ 42^0 week	1	2.0	4	4.0	
Fetal weight	< 3,500	30	61.2	88	84.7	< 0.001
	≥ 3,500	19	38.8	10	15.3	
Oxytocin use in labor	Yes	3	6.1	10	10.2	0.545
	No	46	93.9	88	89.8	
$MgSO_4$	Yes	5	10.2	16	16.3	0.317
	No	44	89.8	82	83.7	
Assisted delivery	Yes	47	95.9	88	89.8	0.338
	No	2	4.1	10	10.2	

In the study group, 6.1% of participants used oxytocin, compared to 10.2% in the control group. 10.2% of the research group utilized MgSO4. The spontaneous delivery method accounted for 95.9% of cases and 89.8% of controls. In contrast, the assisted delivery rate in the PPH group was 4.1%.

3.3. The odds ratio of postpartum hemorrhage due to atony uterine:

The distribution of potential risk factors is presented in Figure 2. In the univariate analysis, women with the following medical and obstetric characteristics were more likely to develop PPH: grand parity (OR = 6.3; 95%CI 2.4 - 16.7), macrosomia (OR = 5.6; 95%CI 2.3 - 13.3) and pre-delivery anemia (OR = 4.6; 95%CI 1.3 - 16.1).

There was no difference in mean maternal age; however, women aged 35 and older had a higher risk for uterine atony. Also, women who received tocolytics during the latent phase of labor, $MgSO_{4,}$ were not at risk of UA. For the historical profile of PPH, high BMI, internal disease, and previous cesarean sections were not the risk factors of PPH, with the difference being statistically insignificant.

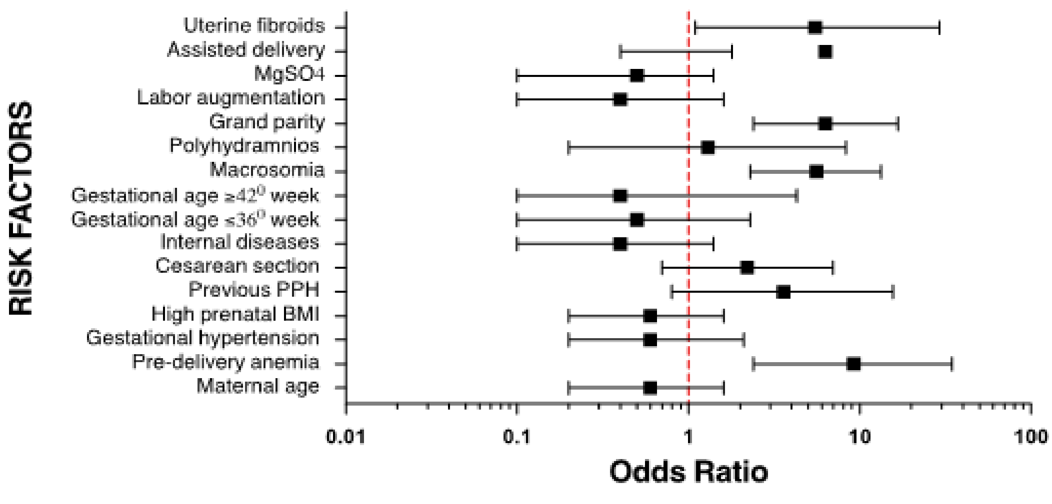

Figure 2. The odds ratio of postpartum hemorrhage due to atony uterine

3.4. Multivariable logistic model for postpartum hemorrhage due to uterine atony

Figure 3 presents the risk factors identified as being independently associated with PPH. The most vital independent risk factors were having grand parity (≥3) with an adjusted Odds ratio (aOR) = 4.7 and 95% Confidence interval (CI): 1.7 - 13.9. In addition, having a large fetal weight (P ≥3,500g) and having pre-delivery anemia are also characteristics that are regarded to be independent risk factors for experiencing postpartum hemorrhage caused by uterine atony, which the aOR of 4.3 (95%CI 1.1 - 16.81) and 4.0 (95%CI 1.7 - 11.2), respectively.

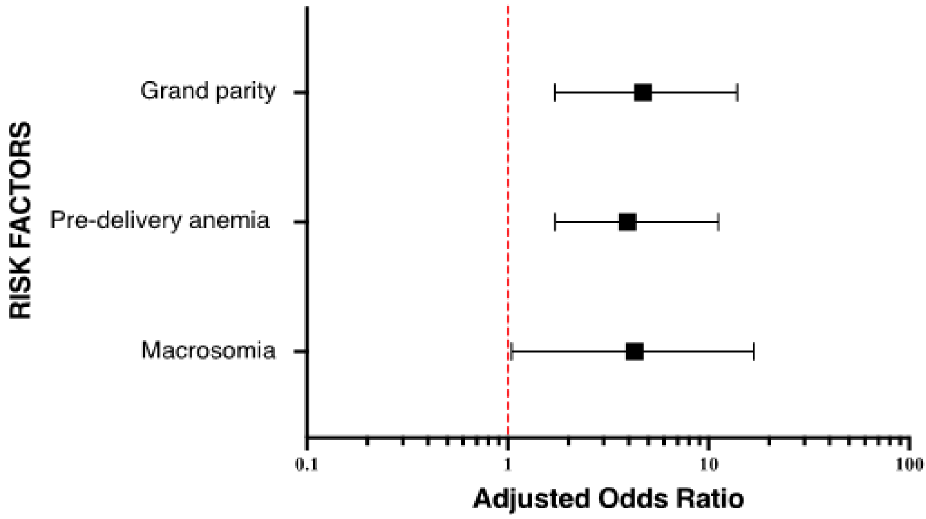

Figure 3. Multivariable logistic model for postpartum hemorrhage due to uterine atony

The H-L goodness-of-fit test resulted in a non-significant result (chi-square = 8.89, P = 0.064), which indicates that the model fits correctly. With a value of 0.7494 for the area under the ROC curve, the discriminatory capability was found to be significant.

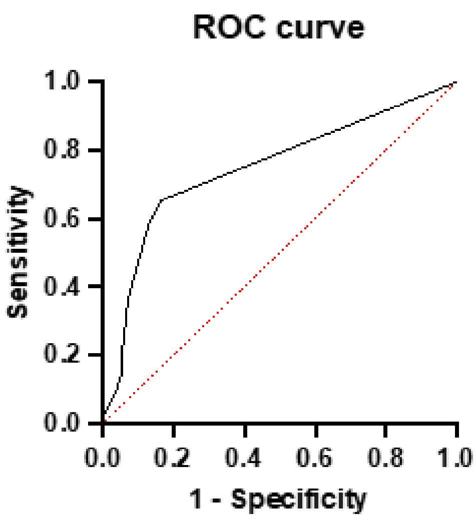

Figure 4. The ROC curve of the multivariate logistic regression model

4. DISCUSSION

4.1. Clinical characteristics maternal:

In this study, 75.5% of people in the study group were between the ages of 20 and 34; the oldest participant was 42 years old, and the youngest participant was 17 years old. The age range that is of primary interest is the younger age group. According to Cameron et al., postpartum hemorrhage related to uterine atony concerns age >35 [8]. The number of pregnant women with a parity ≥3 accounted for 32.7%; this rate is 4.3% higher than Lill Trine's study in Norway. Differences are present between the two studies due to the author's location and research subject selection. Lill Trine's research revealed a correlation between the number of pregnancies and the severity of postpartum hemorrhage, particularly heavy postpartum hemorrhage. The rate of the study group having a history of postpartum hemorrhage was 10.2%; this result is lower than the cohort study by Oberg, A.S. on a prediction model of postpartum hemorrhage (14.2%) [64]. Another study found that 2.0% of patients with postpartum hemorrhage had a history of postpartum bleeding, which is lower than our findings [9]. The percentage of the study group with previous cesarean section was 12.2%. Compared to Lill Trine's case-control study on risk factors for significant postpartum hemorrhage in Norway, the rate of previous cesarean section in our research was 12.2% higher than 9.8% [10].

Our research shows a spontaneous birth rate of 95.9%; minimal cases require forceps or vacuum delivery. The proportion of fetal weight ≥3,500 grams in the study and control groups was 38.8% and 15.3%, respectively. In the study group, the average fetal weight was 3353 ± 340 grams, 3198 ± 252 grams greater than in the control group.

4.2. Significant risk factors for PPH

Although previous population-wide investigations have indicated UA as a primary cause of PPH, risk factors for hemorrhage-related morbidity among women with UA have been inadequately investigated. In this case-control study, we evaluated risk factors for PPH. In our research, having a grand parity was the most significant independent risk factor. Our data shows that pregnant women with an elevated risk of PPH due to uterine atony can be diagnosed when both antepartum and intrapartum characteristics are considered.

Compared with the study in Uganda, the risk factor for postpartum bleeding from moderate to severe anemia has OR = 2.14 with p = 0.04 [6]. Severe anemia weakens the process of uterine contractions due to a decrease in the transport of blood cells to the tissues, causing the tissues and cells to lack blood and oxygen. In the research by Lill Trine, having a fetal weight greater than 4,500 grams was found to increase the risk of significant postpartum bleeding by an odds ratio of 1.77 (95% confidence interval: 1.2–2.6) [10]. In the United Kingdom, a pregnancy weighing more than 4,000 grams was associated with a 2.01-fold increased risk of postpartum hemorrhage. In the United States, a fetal weight between 4,000 and 4499 grams was associated with a 1.69-fold increased risk of postpartum hemorrhage [8, 11]. Author Tran Dinh Vinh performed a retrospective analysis and found that birth weights greater than 3,500 grams were responsible for 60.7% of all postpartum hemorrhage cases. According to the data collected by Luisa A, author of the study, women who have had more than 4 births had an increased likelihood of postpartum hemorrhage (OR = 1.4), with $p<0.05$. Based on the findings of a study conducted at the Australian Obstetrics and Gynecology Center, there is a significant correlation between the number of pregnancies and the level of postpartum hemorrhage caused by uterine atony [12].

Studies of 15 factors were associated with postpartum hemorrhage, as shown by the meta-analysis of 27 studies on risk factors for postpartum hemorrhage caused by uterine atony by Holly B Ende et al. History of postpartum hemorrhage and many pregnancies are the most significant risk factors for postpartum hemorrhage due to uterine atony. In the risk assessment tools for postpartum hemorrhage, some novel risk factors, including gestational hypertension, gestational diabetes, and ethnicity-related factors, have not been included. In addition, the study revealed that neither obesity nor the usage of MgSO4 increased the incidence of postpartum hemorrhage due to uterine atony [13]. The previous literature review is contradicted by the findings of our research, which found that a history of PPH was not a risk factor for PPH. This distinction can be explained by the active management of the third stage of labor and careful monitoring of patients at our hospital who have PPH factors; as a result, the number of PPH patients has lowered. After performing a review and meta-analysis of 15 different models for predicting postpartum bleeding, C. Neary and colleagues concluded that none of the models have been proven beneficial in predicting postpartum bleeding in the general obstetric population [14]. The thesis is consistent with the findings of other studies that revealed a high proportion of women experiencing postpartum hemorrhage despite the absence of any risk factors [15].

4.3. Strengths and limitations

The quality of the data source was this case-control study's main strength. By evaluating medical records, we were able to examine potential risk factors for PPH using a wide range of clinical variables that may not have been easily acquired from registries. This study's weakness is the retrospective evaluation of risk factors. The PPH cases and a random sample of controls were drawn from the same source population to reduce selection bias. There is a chance that some patients were incorrectly classified. Blood loss was estimated visually, and the estimate may have been underestimated

Our work is subject to the limitations inherent to an observational study methodology. Our findings were based on deliveries at Hue University of Medicine and Pharmacy Hospital in Vietnam. Our results may not be generalizable since they were derived from women who gave birth at a single tertiary obstetric center. The majority of urban, non-obese pregnant in our study lived in metropolitan areas. Due to the misclassification of the exposures, information bias is possible. However, neither the resident obstetrician nor the midwife was aware of our research objectives; therefore, the potential for misclassification of risk factors would be non-differential, resulting in a null bias.

5. CONCLUSIONS

In this study, the most substantial risk factors for PPH were grand parity, macrosomia, and pre-delivery anemia. Including these risk factors in clinical guidelines could help identify women with a high risk of PPH before delivery. Including these risk factors in clinical guidelines could help to identify women with increased risk of PPH before delivery. By identifying these women, adequate resources and staff could be mobilized to prepare for severe bleeding during delivery.

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