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Obstetric risk factors and outcome of pregnancies complicated with early postpartum hemorrhage: A population-based study

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Abstract

Objective. The study was aimed to identify obstetric risk factors for early postpartum hemorrhage (PPH) in singleton gestations and to evaluate pregnancy outcome.

Study design. A comparison between consecutive singleton deliveries with and without early PPH was performed. Deliveries occurred during the years 1988–2002 in a tertiary medical center. A multivariate logistic regression model was constructed in order to define independent risk factors for PPH.

Results. Postpartum hemorrhage complicated 0.4% ($n = 666$) of all deliveries enrolled in the study ($n = 154\,311$). Significant risk factors for PPH, identified using a multivariable analysis, were: retained placenta (OR 3.5, 95%CI 2.1–5.8), failure to progress during the second stage of labor (OR 3.4, 95%CI 2.4–4.7), placenta accreta (OR 3.3, 95%CI 1.7–6.4), lacerations (OR 2.4, 95%CI 2.0–2.8), instrumental delivery (OR 2.3, 95%CI 1.6–3.4), large for gestational age (LGA) newborn (OR 1.9, 95%CI 1.6–2.4), hypertensive disorders (OR 1.7, 95%CI 1.2–2.1), induction of labor (OR 1.4, 95%CI 1.1–1.7) and augmentation of labor with oxytocin (OR 1.4, 95%CI 1.2–1.7). Women were assigned into three different groups according to the assessed severity of PPH, assuming that the severe cases were handled by revision of the birth canal under anesthesia, and the most severe cases required in addition treatment with blood products. A significant linear association was found between the severity of bleeding and the following factors: vacuum extraction, oxytocin augmentation, hypertensive disorders as well as perinatal mortality, uterine rupture, peripartum hysterectomy and uterine or internal iliac artery ligation ($p < 0.001$ for all variables).

Conclusion. Hypertensive disorder, failure to progress during the second stage of labor, oxytocin augmentation, vacuum extraction and LGA were found to be major risk factors for severe PPH. Special attention should be given after birth to hypertensive patients, and to patients who underwent induction of labor or instrumental delivery, as well as to those delivering LGA newborns.

Keywords: *Early postpartum hemorrhage, blood transfusion, instrumental delivery, hypertensive disorders*

Introduction

During normal delivery women lose about 500 ml of blood, whereas following a cesarean section (CS) the blood loss may be as much as 1000 ml. Accordingly, early postpartum hemorrhage (PPH) is classically defined as loss of blood exceeding 500 ml within the first 24 hours after the end of second phase of delivery [1].

According to Prichard et al. 5% of all women who undergo vaginal delivery without complications lose more than 1000 ml of blood [2]. In addition, researchers suggest that the amount of blood lost during labor is commonly inaccurately assessed and is usually underestimated. Objective evaluation of the amount of bleeding after labor may be difficult, specifically with bleeding that is slow and steady or in the presence of intra-abdominal bleeding [3]. Moreover, the clinical signs of blood loss such as decrease in blood pressure and increased heart rate tend to appear late, only when the amount of blood loss reaches 1500 ml [1]. This is mainly due to the high blood volume of pregnant women [1].

Consequently, a more objective and accurate definition has been presented to determine PPH. The American College of Obstetricians and Gynecologists (ACOG) has suggested that a decrease greater than

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10% in hematocrit, or the need for blood transfusion after labor due to bleeding, will be defined as PPH [4].

Due to the difficulty in defining PPH and its inaccurate recognition, the precise incidence of PPH is unknown. According to several researchers, PPH is diagnosed in 4–8% of all vaginal deliveries [3,5,6]. Using the definition of a 10% decrease in hematocrit, Combs et al. [5] reported a PPH rate of 3.9% in 9500 vaginal deliveries. There are two forms of PPH: early PPH, which occurs within 24 hours from delivery, and late PPH, which takes place between 24 hours and 6 weeks after delivery.

The major risk factor for PPH is probably an over-distended uterus, which is responsible for 90% of PPH cases [6]. The average rate of blood flow to the uterus during delivery is 600 ml per minute. Hence, lack of contraction of the uterus can cause severe blood loss and even hypovolemic shock or death.

Uterine atony can occur in cases of an over-distended uterus such as hydramnios, multiple gestation, prolonged labor, the use of oxytocin, multiparity, and retained placenta [7]. Other risk factors for PPH are prolonged third stage due to abnormal placentation, such as placenta accreta or incerta, and perineal lacerations and episiotomy.

The present study was aimed to define the obstetric risk factors for early PPH in singleton gestations, and to determine the associated pregnancy outcome. In addition, we assigned the women into three different groups according to the assessed severity of early PPH, assuming that the severe cases were handled by revision of the birth canal under anesthesia, and the most severe cases required in addition treatment with blood products. A comparison was performed between the sub-groups of PPH.

Materials and methods

A population-based study was conducted comparing all singleton deliveries with or without PPH. Deliveries occurred between the years 1988 and 2002 at the Soroka University Medical Center, the sole hospital in the Negev, serving the entire obstetrical population of the southern part of Israel. Thus, we have an unbiased representative population-based cohort. Data were collected from the computerized perinatal database, which includes information provided immediately after delivery by the attending obstetrician. Specialist medical secretaries examine the information routinely before entering it into the database. Coding is done after assessing the medical prenatal care records as well as the regular hospital documents. These procedures ensure the completeness and accuracy of the database, which was recently validated with an excellent kappa of 88% [8].

Diagnosis of early PPH was based on the classical definition of blood loss above 500 ml that occurs within 24 hours from delivery [1]. Three groups of PPH were defined: group 1 consisted of women with PPH who did not require inspection of the birth canal or blood transfusion, group 2 consisted of women who required inspection and revision of the birth canal under anesthesia, and group 3 consisted of women with PPH who received blood transfusion because of bleeding.

The following clinical characteristics were analyzed: maternal age, parity, gravidity, gestational age and birth-weight. Large for gestational age (LGA) was defined as birth weight above the 90th percentile for gestational age and sex using local standards [9], and small for gestational age (SGA) was defined as birth weight below the 10th percentile using the same standards [9]. The following obstetric risk factors were examined: previous CS, hypertensive disorders [10,11], diabetes mellitus (gestational and pre-gestational [12]), hydramnios (amniotic fluid index (AFI) >24 cm), oligohydramnios (AFI <5 cm), recurrent abortions (two or more consecutive abortions [13]) and cervical incompetence (recurrent painless dilation and spontaneous midtrimester birth [14]). The following labor characteristics and complications were assessed: labor induction, placental abruption, placenta previa, failure to progress during the 1st and 2nd stages of labor [15,16], malpresentation, shoulder dystocia, mode of delivery, birth canal lacerations and uterine rupture. The following birth outcomes were recorded: Apgar score less than 7 at 1 and 5 minutes and perinatal mortality, peripartum hysterectomy, ligation of uterine or internal iliac artery, hemoglobin level at discharge from the hospital, and hospitalization days.

Statistical analysis was performed using the SPSS package (SPSS, Chicago, IL). Statistical significance was ascertained using the Chi-square test for differences in qualitative variables and the Student *t*-test for differences in continuous variables. A multivariate logistic regression model was constructed in order to find independent risk factors for PPH. Assuming that the severe cases were handled by revision of the birth canal under anesthesia, and the most severe cases required in addition treatment with blood products, the Mantel–Haenszel test for linear association was used to assess linear relationship between ordered risk factors and the severity of PPH. A p-value of <0.05 was accepted as statistically significant.

Results

Early PPH complicated 0.43% ($n=666$) of all singleton deliveries included in this study ($n=154\ 311$). Group 1 consisted of women with PPH who did not require revision of the birth canal or

blood transfusion ($n = 137$). Group 2 included women with PPH and uterine revision ($n = 330$). Group 3 consisted of women with PPH who required blood transfusion due to significant bleeding ($n = 199$). Women with PPH who needed both uterine revision and blood transfusion were included only in Group 3.

Table I presents demographic and clinical characteristics of pregnancies of the three groups in comparison to pregnancies without PPH. All categories of early PPH had higher rates of LGA as compared to the comparison group. Lower rates of SGA were found in all sub-groups of PPH as compared to the comparison group.

Table II compares the obstetrical risk factors between the groups. Pregnancies that were complicated with PPH had significantly higher rates of hypertensive disorders. A significant linear correlation was found between preeclampsia and the severity of PPH in the three sub-groups. In addition, recurrent abortions, cervical incompetence and previous CS were all risk factors for severe PPH.

Table III presents pregnancy and labor complication of pregnancies complicated by early PPH. Pregnancies complicated with severe PPH had higher rates of retained placenta, lacerations of birth canal, uterine rupture, manual extraction of placenta, placenta previa, failure to progress during the

Table I. Demographic and clinical characteristics of pregnancies complicated with postpartum hemorrhage.

Characteristics	PPH ($n = 137$)	PPH + revision ($n = 330$)	PPH + PC ($n = 199$)	Controls ($n = 153\,645$)	p-value
Fetal gender					
Female	46.0%	52.7%	51.8%	48.8%	0.162
Male	54.0%	47.3%	48.2%	51.2%	
Parity					
1	15.3%	17.9%	18.1%	19.9%	
2–4	56.9%*	44.8%	44.2%	47.6%	0.03
>5	27.7%*	37.3%	37.7%	32.5%	
Gravidity					
1	20.4%	22.7%	22.6%	23.7%	
2–4	57.7%	47.9%	49.2%	50.9%	0.128
>5	21.9%	29.4%	28.1%	25.4%	
Birth weight (g)					
<2500	2.9%	10.3%	11.1%	9.5%	
2500–3999	92.0%	84.2%	84.3%	85.9%	0.982
>4000	5.1%	5.5%	4.5%	4.6%	
SGA	4.4%*	3.3%*	5.5%*	6.4%	0.046
LGA	17.5%*	20.6%*	16.6%*	10.6%	<0.001
Maternal age (yr)	28.4 ± 5.7	28.8 ± 5.7	29.2 ± 6.1	28.4 ± 5.9	0.152

PPH, postpartum hemorrhage; PC, packed cells; SGA, small for gestational age; LGA, large for gestational age. Data are expressed as means ± standard deviation (SD), or percentages. *Statistically significant differences as compared to the controls.

Table II. Obstetrics risk factors and pregnancy complications of deliveries complicated with postpartum hemorrhage.

	PPH ($n = 137$)	PPH + revision ($n = 330$)	PPH + PC ($n = 199$)	Controls ($n = 153\,645$)	p-value
GDM	6.6%	6.7%	6.0%	6.1%	0.793
Non vertex presentations	7.3%	3.9%	5.0%	5.2%	0.629
Previous CS	2.2%	9.4%	19.6%*	10.5%	0.044
Shoulder dystocia	0	0.6%	0	0.2%	0.647
Recurrent abortions	8.0%*	4.5%	9.5%*	4.9%	0.014
HTN disorders					
Mild preeclampsia	1.5%	3.9%	6.5%	3.4%	0.066
Severe preeclampsia	0.7%	1.5%*	4.5%*	1.1%	<0.001
Chronic hypertension	3.6%*	3.3%*	3.0%*	1.7%	0.004
Hydramnion	5.1%	4.2%	3.0%	4.1%	0.708
Oligohydramnion	2.2%	2.4%	1.5%	2.1%	0.861
Cervical incompetence	1.5%*	0.6%	2.0%*	0.5%	0.004

PPH, postpartum hemorrhage; PC, packed cells; GDM, gestational diabetes mellitus; HTN, hypertension; PIH, pregnancy induced hypertension. *Statistically significant differences as compared to the controls.

second stage of delivery, labor induction and augmentation, and vacuum extraction and cesarean deliveries.

Table IV presents the results of a multivariate analysis. The outcome variable of the model was 'PPH', (i.e., blood loss above 500 ml which occurs within 24 hours from delivery) and we entered all significant risk factors found in the univariate analysis in any of the early PPH categories. Independent risk factors for early PPH using multivariate analysis were: retained placenta (OR 3.5, 95%CI 2.1–5.8), failure to progress during the second stage of labor (OR 3.4, 95%CI 2.4–4.7), placenta accreta (OR 3.3, 95%CI 1.7–6.4), lacerations (OR 2.4, 95%CI 2.0–2.8), instrumental delivery (OR 2.3, 95%CI 1.6–3.4), large for gestational age (LGA) newborn (OR 1.9, 95%CI 1.6–2.4), hypertensive disorders (OR 1.7, 95%CI 1.2–2.1), induction of labor (OR 1.4, 95%CI 1.1–1.7) and augmentation of labor with oxytocin (OR 1.4, 95%CI 1.2–1.7).

Selected pregnancy outcomes are presented in Table V. Higher rates of peripartum hysterectomy, and ligation of uterine or internal iliac artery were noted in pregnancies complicated with PPH as compared to the control group. Likewise, perinatal mortality was significantly higher among pregnancies complicated with severe PPH. A significant linear association, using the Mantel–Haenszel technique, was found between the severity of bleeding and perinatal mortality, uterine rupture, peripartum hysterectomy and uterine or internal iliac artery ligation ($p < 0.001$ for all variables).

Since we found higher rates of perinatal mortality in the PPH group, another multivariable analysis, with perinatal mortality as the outcome variable, was constructed. Controlling for possible confounders such as uterine rupture and placental abruption, no significant association was noted between PPH and perinatal mortality (OR 1.5, 95%CI 0.9–2.1, $p = 0.131$).

Table III. Labor complications in deliveries with and without postpartum hemorrhage.

	PPH ($n = 137$)	PPH + revision ($n = 330$)	PPH + PC ($n = 199$)	Controls ($n = 153\,645$)	*p-value*
Retained placenta	0	1.8%*	4.5%*	0.7%	<0.001
Lacerations	24.8%*	28.2%*	32.7%*	14.6%	<0.001
Uterine rupture	0	0.3%	3.0%*	0.04%	<0.001
Episiotomy	32.1%	23.9%	27.6%	23.6%	0.124
Failure to progress, 1st stage	1.5%	0	2.5%	1.9%	0.221
Failure to progress, 2nd stage	8.8%*	3.9%*	6.5%*	1.7%	<0.001
Placental abruption	0	0	2.5%	0.8%	0.355
Placenta previa	0	0	3.5%*	0.4%	<0.001
Placenta accreta	1.5%*	0.6%	2.5%*	0.4%	<0.001
Induction of labor					
Prostaglandin E2	11.7%	6.1%	6.5%	5.9%	0.320
Oxytocin	2.9%*	1.5%	5.0%*	1.9%	0.024
Foley catheter	8.8%*	7.6%*	7.5%*	5.7%	0.033
Oxytocin augmentation	21.2%*	23.0%*	27.6%*	18.1%	<0.001
Manual removal of placenta	1.5%*	2.1%*	6.0%*	0.5%	<0.001
Cesarean delivery	8.8%	0.6%*	14.6%	11.1%	<0.001
Vacuum extraction	3.6%*	2.7%*	6.5%*	1.9%	<0.001
Forceps delivery	1.5%	0.3%	0	0.1%	0.08

PPH, postpartum hemorrhage; PC, packed cells. *Statistically significant differences as compared to the controls.

Table IV. Factors associated with early PPH: results from a multiple logistic regression model.

	Odds ratio	95% CI	*p*-value
Retained placenta	3.5	2.1–5.8	<0.001
Failure to progress, 2nd stage	3.4	2.4–4.7	<0.001
Placenta accreta	3.3	1.7–6.4	<0.001
Lacerations	2.4	2.0–2.8	<0.001
Instrumental deliveries	2.3	1.6–3.4	<0.001
LGA	1.9	1.6–2.4	<0.001
Hypertensive disorders	1.6	1.2–2.1	<0.001
Induction of labor	1.4	1.1–1.7	0.002
Oxytocin augmentation	1.4	1.2–1.7	0.029

CI, Confidence interval; LGA, large for gestational age.

Table V. Perinatal outcome, procedures performed and maternal outcome in deliveries with and without postpartum hemorrhage.

	PPH ($n = 137$)	PPH + revision ($n = 330$)	PPH + PC ($n = 199$)	Controls ($n = 153\,645$)	p-value
Apgar score at 5 min <7	0	0.6%	0.5%	0.6%	0.751
Perinatal mortality	1.5%	1.8%	3.5%*	1.4%	0.029
Peripartum hysterectomy	0	0.3%*	7.5%*	0.03%	<0.001
Uterine or internal iliac artery ligation	0	0.9%*	3.5%*	0.03%	<0.001
Hospitalization days ± SD	2.88 ± 2.1	2.79 ± 1.4	2.86 ± 1.9	2.92 ± 1.6	0.952
Hemoglobin level mg/dL	10.8 ± 1.7	10.8 ± 1.5	10.8 ± 1.6	10.8 ± 1.5	0.683

PPH, postpartum hemorrhage; PC, packed cells. Data are expressed as means ± standard deviation (SD), or percentages. *Statistically significant differences as compared to the controls.

Discussion

Early PPH occurred in 0.43% ($n = 666$) of all singleton deliveries ($n = 154\,312$) in the Soroka University Medical Center between the years 1988 and 2002. The relative low rate of PPH may be attributed to the fact that the present study was focused only on early PPH in singleton pregnancies. Also, the attending physician made the diagnosis of early PPH based on evaluation of the amount of bleeding. Consequently, only the most severe cases were diagnosed and therefore the percentage of cases is relatively low. Another fact that strongly supports the assumption that our data detected PPH only in severe cases is that 49.5% ($n = 330$) of the women with PPH underwent revision of the birth canal under anesthesia and that 29.8% ($n = 199$) of the women with PPH received a blood transfusion.

This work shows evidence of an increase in neonatal mortality as the severity of the bleeding increases and reaches up to 3.5% in cases of PPH requiring blood products. However, the risk is probably attributed to the significant association between PPH and risk factors for perinatal mortality such as uterine rupture and placental abruption. Indeed, while controlling for these confounders, PPH was not independently associated with perinatal mortality.

The risk factors for severe PPH can be categorized into uterine atony and injury of soft tissue. Risk factors mentioned in literature for uterine atony include: induction of labor, prolonged labor, retained placenta, general anesthesia, the use of oxytocin, over-distended uterus due to multiparity, large fetus or hydramnion [3,6]. Injury of soft tissue can result from instrumental delivery and delivery of large fetus or laceration of vagina and perineum. Indeed, failure of the uterus to contract when labor ends is a well-known risk factor for PPH. At the last stages of pregnancy the blood supply to the uterus reaches up to 500–600 ml of maternal blood per minute. This volume is 10% of maternal cardiac output. At this stage, once the spiral blood vessels located in the area of the placental insertion fail to contract there is a rapid loss of blood.

Failure to progress during the second stage of labor was also an independent risk factor for PPH involving prolonged contractions that may result in uterine atony, and frequently an indication for labor augmentation or for an instrumental delivery. Both were found to be independent risk factors for PPH. This finding is supported by recent studies about dystocia during labor that demonstrated a strong relationship between lack of proper progress in the second stage of delivery and PPH [17,18]. Several studies pointed out an association between induction or augmentation of labor and PPH [3]. In this study, a significant relationship was noted between PPH and labor induction and the use of oxytocin. This association may be due to the effect of oxytocin, which causes strong and frequent contractions of the uterus that may lead to atony.

One of the indications for labor induction is preeclampsia. Preeclampsia is a definite risk factor for PPH, especially for severe bleeding which requires blood transfusion. A similar correlation was observed in the study of Combs et al. [5] where women with severe preeclampsia had a 5-fold increased risk for PPH and 4-fold risk for blood transfusion. Perhaps the association between preeclampsia and coagulopathy may worsen PPH. An injury to the soft tissue of the perineum is a risk factor for bleeding that can become more serious with an increase in the grade of laceration (OR 1.6 for grade 1, OR 8.3 for grade 3). Soft tissue injury is more common after instrumental deliveries and delivery of large newborns. Indeed, instrumental deliveries of neonates who weigh over 4000 g are associated with a higher rate of perineal laceration [19]. Interestingly, unlike other studies [3,6], episiotomy was not found as a risk factor for PPH in our study. This difference probably reflects the specific timing of the episiotomy, which is performed in our medical center only when the head

is crowning, specifically, when it is pressing against the perineum.

In summary, in our study the major risk factors for severe PPH were: retained placenta, failure to progress during the second stage of labor, hypertensive disorders, induction of labor and instrumental deliveries. Consequently, special attention should be given to women undergoing instrumental delivery of a large baby, those with hypertensive disorders and women requiring induction of labor.

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