Risk Score for Prediction of Postpartum Hemorrhages in Normal Labor at Chonburi Hospital

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Background: *Postpartum hemorrhage (PPH) is major cause of morbidity and mortality globally. Although the majority of PPH could be avoided through the use of pharmacologic prevention during the third stage of labor, the maternal mortality rate from PPH is unchanged and the blood transfusion rate is increasing. In rural hospital or primary care unit, most health care workers are general practitioners and intern doctors, they are inexperienced in managing PPH case and lack of medication, blood component, medical instrument, and surgical team. Most deaths are from delay and incorrect treatment in the primary hospital. Thus, early detection of PPH could decrease maternal morbidity and mortality.*

Objective: *To develop a risk score based on maternal clinical characteristics and medical history for prediction of postpartum hemorrhage (PPH) in normal labor in the antepartum period. The present study was a part of risk management developing system that conform to service plan of the Public Health Ministry.*

Material and Method: *A retrospective cohort study reviewed the medical charts for normal labor between September 1, 2012 and October 31, 2015, at Chonburi Hospital, Thailand. Risk factors were identified and analyzed by multivariable logistic regression. Risk score was conducted according to adjusted odds ratio of each significant variable in regression model.*

Results: *Among 650 women, advanced maternal age, body mass index before pregnancy, pregnancy induced hypertension and diabetes mellitus types 2 were significantly associated with PPH in normal labor. These factors were incorporated into a risk score that could be predicted PPH in normal labor with sensitivity 81.3% and specificity 50.8% at optimal cut-off score equal or greater than 4.*

Conclusion: *Applying developed PPH risk score is a practical way to identify patients who are at high-risk for developing PPH for an early detection, treatment, and transfer.*

Keywords: *Postpartum hemorrhage, PPH, Normal labor, Normal delivery, Risk score, Prediction*

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The primary cause of nearly one quarter of all maternal deaths globally is postpartum hemorrhage (PPH)[1]. In Thailand, in 2001 and 2013, maternal mortality ratio from PPH (per 100,000 live births) was 10.1 and 9.48[2]. Although the majority of PPH could be avoided through the use of pharmacological prevention during the third stage of labor, the maternal mortality rate from PPH is unchanged and the blood transfusion rate is increasing[3]. In rural hospital, most doctors are general practitioner or intern, they are inexperienced to manage PPH case and lack of medication, blood component, and medical instrument. Thirty percent of the patients died from delay and incorrect treatment in the primary hospital. Most deaths occur in the antepartum or intrapartum period[2]. Thus, primary detection of PPH could decrease maternal morbidity, morality, and cost from PPH complication treatment.

There has been no study that incorporates risk factors into a risk score to predict the possibility of PPH in normal labor. Purpose of the present study was to set a tool for early detection PPH in antepartum period. This study was part of risk management system, conforming to the service plan of the Public Health Ministry. We hope, this might be a useful tool, especially for health care workers and general practitioners in primary health care unit and rural hospitals.

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Material and Method

The study was approved by the Chonburi Hospital Ethics Committees, Thailand, Protocol Code 38/2558. Before performing the present study, we conducted a pilot investigation on retrospective cohort study of labor record data in our hospital between July 1, 2013 and June 30, 2014. The estimated blood loss in our hospital was assessed by measured volume of

blood used in bag. This study included pregnant women that had estimated blood loss equal or more than 500 ml as PPH from normal labor[1]. Based on pilot study, odds ratio was 3.56. Sample size estimation was calculated with base on odds ratio and power 0.95 by using G Power version 3.1 program[4]. The total number of pregnant women in each group was 279 and then added 10% drop out rate. The sample size of each group was at least 310 pregnant women.

Based on the selective criteria, medical records of pregnant women with normal labor, vertex, and singleton in our hospital between September 1, 2012 and October 31, 2015 were studied. The exclusion criteria were incomplete data records, cesarean delivery, or other obstetric procedure (vacuum extraction, forceps extraction, etc.) and non-vertex presentation. Data collection included maternal age, parity, gestational age[5], hematocrit at the first antenatal care visit[6], body mass index before pregnancy[7,8], history of previous postpartum hemorrhage[9], pregnancy induce hypertension[10,11], and diabetes mellitus (DM) history[12]. These were significantly associated with PPH in normal labor.

Statistical analysis was performed with IBM SPSS software version 22. Continuous variables were presented as mean with standard deviation. Categorical variables were presented as frequency and percentage. Chi-square test was used to compared categorical

Table 1. Baseline characteristics of pregnant women who underwent normal labor with or without PPH

Characteristic	n = 650				
	PPH (%)	No PPH (%)	Odds ratio	95% CI	*p*-value[a]
Number of women	325 (50)	325 (50)			
Age (years)			2.70	1.69 to 4.34	<0.001
<35	259 (79.7)	297 (91.4)			
≥35	66 (20.3)	28 (8.6)			
Mean ± SD	27.58±7.01	25.17±6.75			
Parity			0.964	0.71 to 1.31	0.814
Nulliparous, multipara (≥4)	158 (48.6)	161 (49.5)			
2,3	167 (51.4)	164 (50.5)			
Mean ± SD	0.85±0.90	0.88±0.99			
Gestational age (weeks)			1.201	0.79 to 1.83	0.392
<37, ≥41	56 (17.2)	48 (14.8)			
37-40	269 (82.8)	277 (85.2)			
Mean ± SD	38.33±2.67	38.27±2.05			
Hematocrit (%)			0.817	0.56 to 1.20	0.293
<32%	64 (19.7)	75 (23.1)			
≥32%	261 (80.3)	250 (76.9)			
Mean ± SD	34.86±4.07	34.18±3.86			
Pre-pregnant BMI[b] (kg/m^2)			1.746	1.24 to 2.46	0.001
<25	212 (65.2)	249 (76.6)			
≥25	113 (34.8)	76 (23.4)			
Mean ± SD	23.66±4.88	22.22±4.50			
History of previous postpartum haemorrhage			3.407	0.93 to 12.50	0.050
No	315 (96.9)	322 (99.1)			
Yes	10 (3.1)	3 (0.9)			
Pregnancy induce hypertension			3.813	2.25 to 6.46	<0.001
No	260 (80)	291 (93.9)			
Yes	65 (20)	20 (6.2)			
Overt diabetes mellitus			4.874	1.83 to 12.99	0.001
No	302 (92.9)	320 (98.5)			
Yes	23 (7.1)	5 (1.5)			

[a] Chi-square test, [b] Body mass index (BMI [kg/m^2]) = weight (kg)/height $(m)^2$

variables. Univariable analysis was performed to determine risk factors, which were significantly relate to PPH. Secondly, only significant factors ($p<0.05$) were applied to multivariable analysis in order to determine adjusted odds ratio value of PPH in each factor. The variables that were significantly associated with PPH by Chi-square test were entered into logistic regression model. Each adjusted odds ratio was diving by the lowest value and rounded to the nearest integer. A risk score was developed from the sum of each significant adjusted odds ratio value. A receiver operating characteristic (ROC) curve and area under the curve (AUC) were calculated to determine the optimal score for prediction PPH. Sensitivity and specificity with associated 95% confidence interval (CI) of each cut off point were presented.

Results

Among 818 pregnant women included in the present study, 159 women had incomplete medical records and nine had fetal death in utero. Thus, 650 women were included for analysis. Baseline characteristics of the women in the present study were shown in Table 1.

According to baseline characteristics, we found the significant factors associated with PPH in normal labor, advanced maternal age, pre-pregnant BMI, pregnancy induce hypertension, and diabetes type 2. In multivariable analysis (Table 2, 3), based on final model, their adjusted odds ratio values were 1.947 (95% CI 1.18 to 3.21), 1.481 (95% CI 1.03 to 2.12), 2.996 (95% CI 1.74 to 5.17), and 3.235 (95% CI 1.17 to 8.95), respectively. Their weight scores were assigned to each factor based on its adjusted odds ratio value. Each adjusted odds ratio was divided by 1.481 (the lowest value) and rounded to the nearest integer, which were 1, 1, 2, and 2, respectively. The total score range from 0 to 6. The sensitivity and specificity with associated 95% confidence interval (CI) of the risk score at different cut-off value were presented in Table 4.

Table 2. First full model of multivariable analysis to determine adjusted odds ratio for risk factor of PPH in normal labor

Characteristic	First full model		
	Adjusted odds ratio	95% CI	*p*-value
Age (years)			
<35	Reference	-	
≥35	2.703	(1.69 to 4.36)	<0.001
Parity			
2, 3	Reference	-	
Nulliparous, multipara	0.964	(0.71 to 1.31)	0.814
Gestational age (weeks)			
37-41	Reference	-	
<37, ≥41	1.201	(0.79 to 1.83)	0.392
Hematocrit (%)			
≥32%	Reference	-	
<32	0.817	(0.56 to 1.20)	0.293
Pre-pregnant BMI (kg/m^2)			
<25	Reference	-	
≥25	1.794	(1.28 to 2.53)	0.001
History of previous postpartum haemorrhage			
No	Reference	-	
Yes	3.407	(0.93 to 12.15)	0.064
PIH[a]			
No	Reference	-	
Yes	3.812	(2.25 to 6.46)	<0.001
DM type 2[b]			
No	Reference	-	
Yes	4.874	1.83 to 12.99	0.002

[a] PIH = Pregnancy induce hypertension, [b] DM type 2 = Diabetes mellitus type 2

Table 3. Final model of multivariable analysis to determine adjusted odds ratio for risk factor of PPH in normal labor

Characteristic	Final model				Score[c]
	Adjusted odds ratio	95% CI	*p*-value	Transformed adjusted odds ratio	
Age (years)					
<35	Reference	-	-	-	0
≥35	1.947	(1.18 to 3.21)	0.009	1.31	1
Pre-pregnant BMI (kg/m^2)					
<25	Reference	-	-	-	0
≥25	1.481	(1.03 to 2.12)	0.032	1	1
PIH[a]					
No	Reference	-	-	-	0
Yes	2.996	(1.74 to 5.17)	0	2.02	2
DM type 2[b]					
No	Reference	-	-	-	-
Yes	3.235	(1.17 to 8.95)	0.024	2.18	2

[a] PIH = Pregnancy induce hypertension
[b] DM type 2 = Diabetes Mellitus type 2
[c] Score = Point was assigned to each factor based on its adjusted odds ratio. Each coefficient was diving by 1.481 (the lowest value) and rounded to the nearest integer

Table 4. Performances of the risk score at different cut-off values to predict PPH in normal labor

Cut off value ≥	Number of women with score at cut-off level	AUC[a]	% sensitivity	% specificity	95% CI	*p*-value
0	370	0.390	40.5	52.5	0.35 to 0.43	<0.001
1	156	0.517	52.6	50.8	0.47 to 0.57	0.525
2	51	0.601	68.6	51.6	0.52 to 0.68	0.160
3	49	0.638	75.5	52.1	0.56 to 0.71	0.001
4	16	0.660	81.3	50.8	0.54 to 0.78	0.028
5	6	0.752	100	50.5	0.64 to 0.87	0.303
6	2	0.751	100	50.2	0.55 to 0.95	0.220

[a] AUC = Area under the curve

The ROC curve of a risk score for prediction PPH in normal labor demonstrated an overall AUC of 0.660 (95% CI 0.54 to 0.78) (Fig. 1). The cut-off score was 4 or greater, which had a sensitivity of 81.3% and specificity of 50.8%.

Discussion

The prevalence of PPH undergoing normal labor in the study population was 4.95%[13]. This related to the report of the World Health Organization, which is approximately 6%[1,14]. The potentially important risk factors in the present study include advanced maternal age, obesity before pregnancy, pregnancy induce hypertension, and diabetes mellitus type 2. The significant risk factors for PPH observed in our study were confirmed by previous studies. Sosa CG reported an association of advanced maternal age with an increased risk of PPH[7]. This relationship might explain why elderly women are prone to be overweight, and have hypertension and diabetes. These might be the conditions that increase the probability of poor uterine contraction leading to uterine atony.

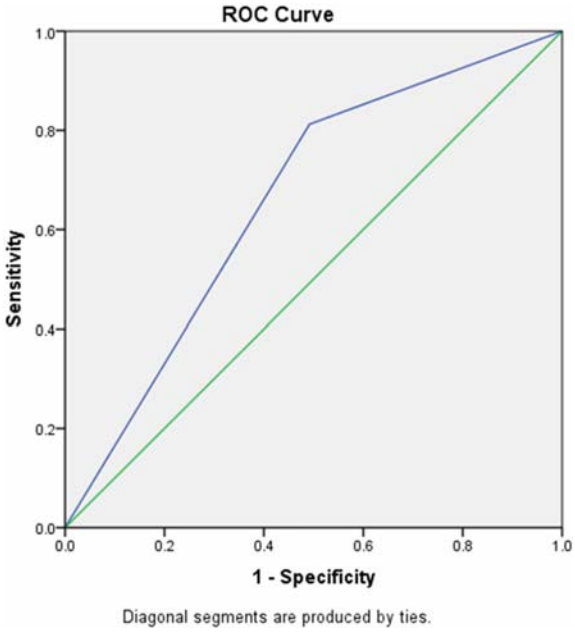

Fig. 1 The ROC curve of the risk score for prediction PPH in normal labor.

PPH is a major cause of morbidity and mortality globally. The present study applied the basic knowledge of postpartum hemorrhage risk factors into risk score for prediction PPH in normal labor. We aimed to develop a simple and effective tool that could be easily used in clinical practice for predicting PPH in normal labor, during the antepartum period. The rural area hospitals in Thailand do not have a blood bank for preparation of the blood component. Furthermore, they lack medications (i.e. prostaglandin E1, E2), colloid solution, surgical instruments, and obstetrics and gynecologic doctors. In emergency case, patients are resuscitated then transferred to a medical center that have available blood component, medications, and obstetrics and gynecologic doctors. However, this delay in transferring the patient due to long distance from rural hospital to medical center could cause a patient's death. In actual practice, if the health care workers knew that they were taking high-risk PPH women case, they would prepare management in appropriate time such as early transfer the patient to the medical center and preparing the blood component before delivery. That could decrease maternal morbidity and mortality and save the cost from complication treatment of PPH. Our risk score can be easily obtained from history taking and physical examination. The purpose of the present study was to create a screening test that would have high sensitivity to detection PPH in normal labor. At cut-off score of 4 or greater, it yields a sensitivity of 81.3%. However, this study was conducted only in Thai women, a Southeast Asia population. This risk scores need further study to validate in practical performance.

Conclusion

Applying PPH risk score is a practical way to identify patients who are at high-risk of developing PPH for an early detection, treatment, and transfer.

What is already known on this topic?

Many studies have found the factors that significantly associated with PPH. However, there has been no study that incorporates risk factors into a risk score to predict the possibility of PPH in normal labor.

What this study adds?

The study set up a tool for early detection of PPH in antepartum period, which is part of risk management developing system conforming to the service plan of the Public Health Ministry. The authors hope that this study might be a useful tool, especially for health care workers and general practitioners in primary health care and the primary hospital.

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Potential conflicts of interest

None.

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การให้คะแนนความเสี่ยงเพื่อทำนายโอกาสตกเลือดหลังคลอดจากการคลอดปกติทางช่องคลอดในโรงพยาบาลชลบุรี

วนิชา สิทธิปาน, ธีระ ศิวดุลย์

ภูมิหลัง: การตกเลือดหลังคลอดนับเป็นปัญหาสำคัญอันดับแรกของการคลอด ซึ่งพบเป็นสาเหตุหลักของการเสียชีวิตและการเจ็บป่วยของมารดาทั่วโลก สำหรับในประเทศไทยอัตราการเสียชีวิตของมารดาจากการตกเลือดหลังคลอดยังคงไม่มีแนมโน้มลดลง แม้จะมีการให้การรักษาเพื่อป้องกันการตกเลือดหลังคลอดแล้วก็ตาม มารดาส่วนใหญ่เสียชีวิตในระยะก่อนคลอดโดยเฉพาะในโรงพยาบาลระดับปฐมภูมิซึ่งไม่มีแพทย์เฉพาะทาง ธนาคารเลือด รวมทั้งเครื่องมือทางการแพทย์ จึงทำให้ผู้ป่วยได้รับการรักษาล่าช้าและไม่เหมาะสมเท่าที่ควร

วัตถุประสงค์: เพื่อเป็นการพัฒนาระบบคัดกรองความเสี่ยงซึ่งสอดคล้องตามนโยบายของกระทรวงสาธารณสุข ผู้นิพนธ์จึงได้สร้างเครื่องมือเพื่อใช้ในการทำนายโอกาสตกเลือดหลังคลอดจากการคลอดปกติทางช่องคลอดตั้งแต่ในระยะก่อนคลอด ทั้งนี้เพื่อการดูแลรักษาและส่งต่อผู้ป่วยได้อย่างทันท่วงที

วัสดุและวิธีการ: เป็นการศึกษาย้อนหลังจากเวชระเบียนของสตรีที่มาคลอดบุตรทางช่องคลอดที่โรงพยาบาลชลบุรีระหว่างวันที่ 1 กันยายน พ.ศ. 2555 ถึง 31 ตุลาคม พ.ศ. 2558 จำนวน 650 คน โดยใช้การวิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนาและสมการถดถอย

ผลการศึกษา: ปัจจัยเสี่ยงที่มีผลต่อการเกิดภาวะตกเลือดหลังคลอดจากการคลอดปกติทางช่องคลอดอย่างมีนัยสำคัญทางสถิติ คือ มารดาที่มีอายุมากกว่าหรือเท่ากับ 35 ปี, ดัชนีมวลกายก่อนคลอดมากกว่า 25 กิโลกรัม/ตารางเมตร, ความดันโลหิตสูงขณะตั้งครรภ์ และเบาหวานชนิดที่ 2 เมื่อนำปัจจัยเสี่ยงทั้ง 4 ปัจจัยมาวิเคราะห์คะแนนความเสี่ยงและพื้นที่ใต้เส้นโค้ง ROC พบว่าที่คะแนนความเสี่ยงเท่ากับ 4 มีความไวและความจำเพาะในการทำนายการเกิดภาวะตกเลือดหลังคลอดจากการคลอดปกติทางช่องฃลอดเท่ากับ 81.3 และ 50.8 เปอร์เซ็นต์ตามลำดับ

สรุป: การให้คะแนนความเสี่ยงจากเครื่องมือดังกล่าวสามารถนำไปใช้ทำนายโอกาสตกเลือดหลังคลอดจากการคลอดปกติทางช่องคลอดในทางปฏิบัติได้ ซึ่งช่วยในการประเมินแนวทางการรักษาและส่งต่อผู้ป่วยได้อย่างเหมาะสม