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Research of the assessable method of postpartum hemorrhage

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Abstract.
BACKGROUND: Postpartum hemorrhage (PPH) is the most common cause of parturient death worldwide [1]. However, most cases of PPH can be avoided.
OBJECTIVE: This paper employs statistical methods to screen risk factors of PPH and calculate relevant parameters.
METHODS: Multivariable logistic regression analysis was applied to obtain the regression equation and odds ratio (OR) value. The determined risk factors were assigned comprehensive and reasonable scores according to scientific relevance and reasoning according to the OR value. P_{PPH} values were calculated in order to assess the morbidity of PPH.
RESULTS: The scores of pregnant women could be intuitively used to show the risk of getting PPH.
CONCLUSIONS: Through the above methods, a comprehensive risk evaluation method of detecting PPH was developed.

Keywords: Postpartum hemorrhage, high risk factors, comprehensive scores

1. Introduction

Postpartum hemorrhage is a condition of excessive vaginal bleeding ($>$ 500 mL) following delivery [2]. Due to the great blood loss over a short period of time, parturient patients may suffer from anemia, infection and other complications, even if loss of life can be avoided [3–5]. If a parturient patient experiences severe shock for a long duration, sever renal insufficiency, Sheehan syndrome and encephalomalacia may occur [6]. Because of the sudden and rapid onset of PPH, earlier identification of risk factors may allow doctors to enact appropriate measures to reduce risk. Uterine inertia is the most common cause of PPH, accounting for 70%$\sim$75% of reported cases [7–11]. This study analyzed, evaluated and predicted the risk of PPH from three perspectives: epidemiological, placental, and biochemical.

2. Materials and methods

This study utilized a retrospective case study as a control to locate the data of 923 parturient patients with complete prenatal examination data, all of whom gave birth in a Beijing hospital in 2007 or 2008. The normal group consisted of 476 parturient patients, while the PPH group consisted 447 parturient patients.

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Table 1
Screening results of influential factors

Risk factors	χ^2	OR	P
Age	63.125	6.462	0.000
BMI	10.426	2.695	0.000
MP	35.503	9.008	0.000
HFH	25.686	2.483	0.000
AMH	13.431	2.609	0.000
AOH	38.415	9.572	0.000
HDCP	39.167	16.705	0.000
GDM	11.02	2.086	0.000
GB	32.05	4.553	0.000
AF	27.908	7.518	0.000
MOU	40.02	4.894	0.000
PP	58.59	66.026	0.000
PA	15.712	10.773	0.000
RP	37.732	22.801	0.000
AP	38.502	32.632	0.000
TPL	51.77 (fisher)	–	0.000
APC	30.367	10.731	0.000
HBG $\leqslant 100$	5.35	1.732	0.000
PC $< 100 \times 10^9$	9.732	7.536	0.000
CD	221.786	9.057	0.000
PF	107.584	34.283	0.000

MP: Multiplets; HFH: Hypertension family history; AMH: Adverse maternal history; AOH: Abdominal operation history; HDCP: Hypertensive disorder complicating pregnancy; GDM: Gestational diabetes mellitus; GB: Giant baby; AF: Amniotic fluid; MOU: Myoma of uterus; PP: Placenta praevia; PA: Placental abruption; RP: Retained placenta; AP: Adherent placenta; TPL: Threatened premature labor; APC: Abnormal pelvic canal; HBG: Hemoglobin; PC: Platelet count; CD: Cesarean delivery; PF: Placenta factor.

Table 2
Logistic regression analysis of risk factors related to postpartum hemorrhage

Risk factors	B	S.E.	Wald	Sig.	OR
MP	2.258	0.529	18.189	0.000	9.566
HFH	0.954	0.227	17.633	0.000	2.595
AMH	0.870	0.362	5.780	0.016	2.386
AOH	1.659	0.492	11.389	0.001	5.253
HDCP	2.771	0.639	18.837	0.000	15.979
GB	2.055	0.331	38.447	0.000	7.803
AF	2.334	0.489	22.826	0.000	10.319
MOU	1.402	0.326	18.487	0.000	4.064
APC	2.713	0.566	22.956	0.000	15.070
TPL	2.242	0.796	7.943	0.005	9.414
HBG $\leqslant 100$	0.684	0.292	5.492	0.019	1.983
PC $< 100 \times 10^9$	2.701	0.811	11.090	0.001	14.892
Age $\geqslant 35$	1.556	0.314	24.516	0.000	4.741
BMI $\geqslant 25$	0.693	0.412	2.828	0.093	2.001
PBH	0.608	0.226	7.247	0.007	1.836
Constant	-1.563	0.132	140.843	0.000	0.210

MP: Multiplets; HFH: Hypertension family history; AMH: Adverse maternal history; AOH: Abdominal operation history; HDCP: Hypertensive disorder complicating pregnancy; GB: Giant baby; AF: Amniotic fluid; MOU: Myoma of uterus; TPL: Threatened premature labor; APC: Abnormal pelvic canal; HBG: Hemoglobin; PC: Platelet count; PBH: Pregnancy bleeding history.

Table 3
ROC curve information and the effective screening of the model

Area	Standard error	P-value	95% Confidence interval	
			Lower limit	Upper limit
0.868	0.012	0.000	0.844	0.892
Boundary value	Sensitivity	Specificity	Accuracy	
5.1	$\frac{419}{496} \times 100\% = 88\%$	$\frac{330}{447} \times 100\% = 74\%$	$\frac{739}{912} \times 100\% = 81\%$	

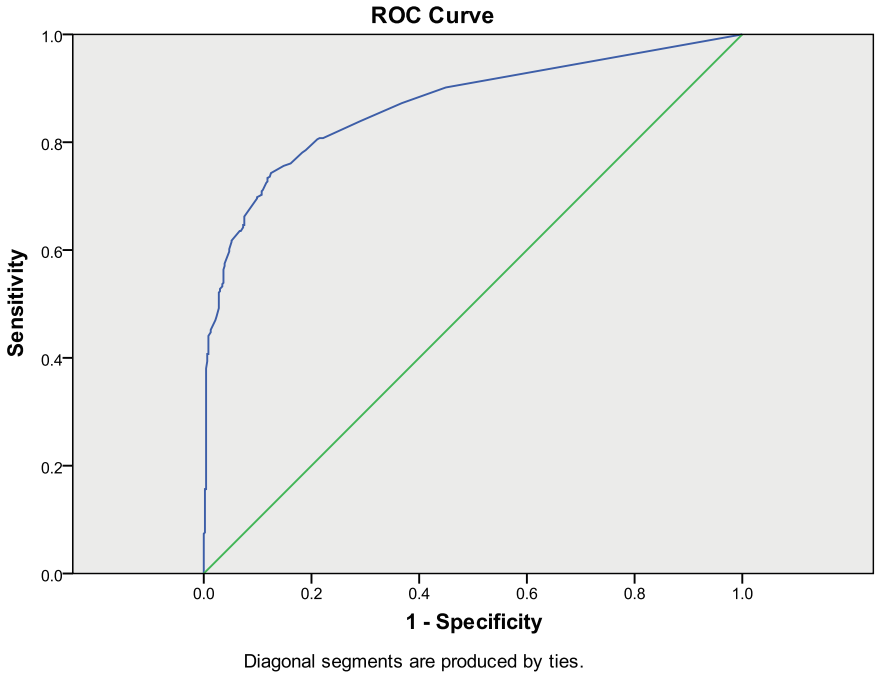

Fig. 1. The ROC curve of postpartum hemorrhage score.

Case information was input into statistical analysis software, and case information was divided into epidemiological factors, placental factors and biochemical factors. Each factor was quantified as a "0" or "1" value. Then chi-squared tests and U-texts were used to identify the risk factors related to PPH ($P < 0.05$). The results are shown in Table 1. In order to determine the factors which influenced PPH while acknowledging that multiple factors exist simultaneously, a logistic regression model of binary classification was used for analysis. OR values were calculated as shown in Table 2. The logistic regression equation is expressed in the following form:

$$LogitP = Constant + B_1 \times X_1 + B_2 \times X_2 + B_3 \times X_3 + B_4 \times X_4 \ldots B_m \times X_m \quad (1)$$

Where B is the partial regression coefficient of each high risk factor; and X_1, X_2, X_3 ..... X_m indicate the existence of the multiple factors, where "1" expresses existence and "0" represents absence.

According to Eq. (1), P_{PPH} value was calculated according to Eq. (2), which was used to predict the morbidity of PPH.

$$P_{PPH} = \frac{e^{LogitP}}{1 + e^{LogitP}} \quad (2)$$

The calculated P_{PPH} value can be used to intuitively reflect the degree of risk of PPH.

Each high risk factor was assigned a score based on the OR value, as shown in Table 2, and each parturient was categorized according to their OR score. The ROC curve of the scores is shown in Fig. 1. The maximum cutoff point of the sum of sensitivity and specificity was selected as the boundary value to obtain the screening efficiency of the model. When the boundary value was equal to 5.1, the sensitivity and specificity of the model were 88% and 74%, respectively. The ROC curve and the effective screening as predicted by the model are shown in Table 3. A total of 99.7% of patients with calculated scores exceeding 22 were ill; therefore a score of 22 was determined to represent the dangerous threshold of the model. Combining the calculated score with the calculated P_{PPH} value allows the greatest accuracy in predicted PPH morbidity.

All statistical work was accomplished with the use of SPSS18.0.

3. Discussion

PPH is closely related to antepartum factors such as hypertensive disorders which complicate pregnancy, amniotic fluid, placenta praevia, etc. These complications account for 65% of PPH cases [12]. The primary goal of this study was to determine parturients at high risk of PPH in order to reduce mortality. The risk factors are shown in Table 1, and experimental results are consistent with the reported literature [13–16]. Blood clotting function tests include fibrinogen (FIB), plasma prothrombin time detection (PPTD) and so on [17–20]. In the PPH group in the current study, 103 parturient patients presented placental factors, with a morbidity rate of 23%. Due to the existence of placental factors, the contribution of epidemiologic factors and biological factors to PPH may be overlooked, but in fact these factors played a very important role in the incidence of PPH.

4. Conclusions

This research comprehensively predicted high risk factors of PPH. Statistical methods were employed to assign a score to each risk factor based on OR values, intuitively demonstrating the influence of each individual risk factor. The model developed in this study can aid doctors in the development of prevention and intervention techniques to support early detection of PPH, thus effectively reducing the morbidity and mortality of PPH.

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