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RESEARCH ARTICLE

Prediction of adverse maternal outcome in women with preeclampsia using fullPIERS model: observations from a tertiary care hospital

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ABSTRACT

Background: Globally about 10% of pregnancies are complicated by preeclampsia (PE) and other hypertensive disorders of pregnancy. PE is associated with higher near miss maternal morbidity and mortality. PIERS (Preeclampsia Integrated Estimate of Risk Scoring) model was designed for monitoring of women with preeclampsia and to do the risk stratification for improving the management. **Objectives:** This study was undertaken to analyze the adverse maternal outcome using fullPIERS risk prediction model in women with preeclampsia. **Methods**: It was a prospective cohort study over a period of one year. Women with PE, who gave consent were enrolled. All were subjected to fullPIERS calculator for predicting the risk of adverse maternal outcome after obtaining the predictor variables. **Results**: The number of obstetric admissions in our hospital during the period were 13,351. Of them 1389 (10.3%) women had PE. Amongst 150 enrolled women with PE, fullPIERS score of 35 gave the maximum performance in predicting adverse maternal outcomes. 36.6% women in our cohort experienced an adverse maternal outcome, including one maternal death. The relative risk for predicting adverse maternal outcomes in women with fullPIERS score of ≥ 35 was 4.6[95% CI (2.5-8.4)] and AUC for ROC was 0.854;[95% CI (0.78-0.91)]. **Conclusion:** In women with PE, fullPIERS score ≥ 35is significantly associated with adverse maternal outcome.

Keywords: Preclampsia, maternal, outcome, fullPIERS.

Hypertensive disorders of pregnancy (HDPs) are one of the commonest causes of maternal and perinatal morbidity and mortality globally. It complicates up to 10% of pregnancies worldwide and includes gestational hypertension, preeclampsia (PE)/ eclampsia, chronic hypertension with superimposed PE and chronic hypertension[1]. PE is a multisystem disorder unique to pregnancy. Approximately 50,000 to 60,000 PE related deaths occur every year worldwide[2]. For every PE related maternal death, there are many more women who experience near miss maternal morbidity. The maternal illness in PE may vary from mild asymptomatic hypertension to life threatening neurological, renal, and cardiopulmonary compromise in severe cases. Favorable maternal and perinatal outcomes for women with PE depends on early identification of the condition and its quick treatment. The maternal and fetal consequences of HDPs make them a global health burden, especially in the low and middle income countries (LMICs) where more than 90% of HDPs related deaths occur [2-4].

An accurate risk assessment of these women with PE, by applying evidence base tools will help in triaging women who are at high risk of adverse maternal outcomes. This may help in reducing the burden of HDP related maternal morbidity and mortality [5,6]. The PIERS (Preeclampsia Integrated Estimate of Risk Scoring) model was designed in 2011, for monitoring of women with PE[2]. The PIERS model was aimed at helping caregivers in triage, transport and

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treatment of pregnant women with PE in combination with an assessment of neonatal risk at that gestational age.

The fullPIERS model takes into account laboratory findings and the maternal signs and symptoms. The six predictor variables in fullPIERS model include gestational age at delivery, symptoms like dyspnea, and or chest pain; oxygen saturation by pulse oximetry; laboratory parameters like platelet count, serum creatinine, and serum aspartate transaminase. The components of the composite adverse maternal outcome predicted by the model were developed by the Delphi consensus. It includes maternal mortality or one or more of the serious central nervous systems, renal, hepatic, cardiovascular, hematological or other morbidity[7]. The fullPIERS model, validated in the setting of a high income tertiary hospital has an excellent discriminatory ability with an area under the receiver operating characteristic curve (AUC ROC) of 0.88 (95%, CI 0.84-0.92)[2].

We undertook this study to assess the performance of the fullPIERS model in prediction of adverse maternal outcomes in women with PE when the predictor variables were obtained within 24 hours of admission.

Materials and methods

It was a prospective cohort study conducted over a period of one year from August 2018 to July 2019 in the Department of Obstetrics and Gynaecology, King George's Medical University, Lucknow, UP, India. The study was approved by the Institutional Ethics Committee.

The pregnant women who fulfilled the criteria of PE and who gave consent for the enrollment in the study were included. Women who experienced the adverse outcome before the collection of predictor variables or who were in spontaneous labor or who did not give consent were excluded. All enrolled women underwent detailed history, clinical examination, and investigations like complete blood count (including platelet count), 75g oral glucose tolerance test, serum bilirubin, serum aspartate and alanine transaminases, serum alkaline phosphatase, lactate dehydrogenase, blood urea, serum creatinine, uric acid, urine albumin (dipstick), 24-hour urine protein and oxygen saturation by pulse oximetry in addition to other routine antenatal investigations.

All enrolled women were subjected to the fullPIERS risk prediction model. The six predictor variables include gestational age, chest pain and or dyspnea, oxygen saturation (SpO_2), platelet count, serum creatinine and serum aspartate transaminase (AST). All the predictor variables were obtained within the first 24 hours of hospital admission. We used the worst (either the highest or lowest where appropriate) values of the predictor variable data collected within the 24 hours to assess the performance of the fullPIERS model.

As per our hospital protocol, women with PE with gestational age <34 weeks received injection dexamethasone 6mg, four doses 12 hours apart for promoting fetal lung maturity. Women with PE with severe features received magnesium sulphate as anticonvulsant prophylaxis and antihypertensives to control the blood pressure. Fetal surveillance was done using the non-stress test, daily fetal movement count, ultrasonography for assessing fetal biometry and weight, amniotic fluid index, and doppler velocimetry of fetoplacental circulation every 14 days as and when required. As per our hospital protocol, we aim to deliver women with PE with non-severe features at ≥ 37 weeks and women with PE with severe features at ≥34 weeks. In cases with unfavorable cervix, cervical ripening agents used, and cesarean section was done only for obstetrical indications.

Statistical analysis -

The data are expressed as mean ±standard deviation (SD). The chi-square test compared the difference in proportion between the groups. The student "t" test compared the mean value between the groups. The area under the curve (AUC) of receiver operating characteristic (ROC) assessed the discriminative ability of the fullPIERS risk prediction model. AUC ROC was interpreted using the following criteria: noninformative (≤0.5), poor discrimination (0.5 <AUC ≤0.7) and good discrimination (AUC>0.7). Data were analyzed using SPSS statistical software 20.0 (SPSS, Chicago, IL, USA).

Results

The total number of obstetric admissions in our hospital during the study period was 13,531. Of them, 1389 (10.3%) women had PE. Amongst these, women who fulfilled the inclusion, exclusion criteria and gave consent were enrolled in the study. Of enrolled women, 94.7% had PE, while 5.3% women had PE superimposed on chronic hypertension. Amongst women with PE, 52.6% had PE with non-severe features while 47.3% had PE with severe features. Table 1 shows the demographic profile of all women. Of enrolled women, 53% were primigravida, and 47% were multigravida. In our cohort, 92% did not receive any antenatal care and were admitted in emergency. The mean systolic blood pressure was significantly higher in PE with

Table 1: Baseline characteristics of subjects

Characteristics	Adverse maternal outcome present (n=55)	Adverse maternal outcome absent (n=95)	p value
Mean age (±SD)	26.5±4.4	27.0±4.5	0.41
Mean GA (±SD)	36.1±3.2	36.6 ±3.2	0.36
Mean GA at delivery (±SD)	36.3± 3.1	37.0 ±2.7	0.21
SBP (±SD)	156.7 ±14.3	151.2 ±11.7	0.01
DBP (±SD)	102.6±10.8	99.2± 9.1	0.04
Parity (±SD)	1.4 ±0.5	1.4± 0.5	0.77
Hospital stay (±SD)	6.6± 3.8	6.7 ±6.2	0.93

GA: Gestational age; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; SD: Standard deviation

severe features than in PE with non-severe features subgroup (164.4±10.6 and 143.4 ±4.9 mm Hg respectively; p-value <0.001). The mean diastolic blood pressure also was significantly higher for PE with severe feature subgroup than in PE with non-severe features subgroup (107.9 ±11.3 and 93.4±3.4 mm Hg respectively; p<0.001).

In our cohort, the fullPIERS risk prediction model performed well in the prediction of adverse maternal outcomes in women with PE. The fullPIERS score at cut-off value of 30 had sensitivity and specificity of 96.4% and 53%

Table 2: Maternal symptoms, biochemical markers and adverse maternal outcome

Variables (n)	Adverse maternal outcome		OR (95%CI)	p value
	Present	Absent		
Symptoms				
Headache(48)	15	33	0.7(0.3-1.4)	0.34
Visual disturbances(3)	02	01	3.5(0.3-40.0)	0.30
Epigastric pain(30)	10	20	0.8(0.3-1.9)	0.67
Dyspnea(8)	08	00	34.1(1.9-604.8)	0.01
Biochemical parameters				
Platelet count<1.5l/ cmm (58)	31	27	3.2(1.6-6.5)	0.0009
AST>40IU/L (84)	41	43	3.5(1.7-7.3)	0.0007
Sr.creatinine>1.1mg/dl (11)	10	1	20.8(2.5-168.2)	0.004
Dipstick proteinuria ≥2+ (49)	25	24	2.4(1.2-4.9)	0.01

AST: Aspartate aminotransferase; OR: Odds ratio; CI: Confidence interval

Table 3: Univariate logistic regression analysis of predictors in the prediction of adverse maternal outcome in women with preeclampsia

Candidate predictor	Univariate Exp B (95%CI), p value
Age	1.0 (0.95-1.0),0.4
SBP	0.9(0.94-0.99),0.01
DBP	0.9(0.93-0.99),0.04
AST	0.9(0.95-0.98),0.001
ALT	0.9(0.96-0.98),0.001
SALP	0.9(0.99-0.99),0.001
Serum creatinine	0.2(0.04-0.97),0.04
>=2+ dipstick proteinuria	0.5(0.29-0.86),0.01

SBP: Systolic blood pressure; DBP: Diastolic blood pressure; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; SALP: Alkaline phosphatase; CI: Confidence intervals

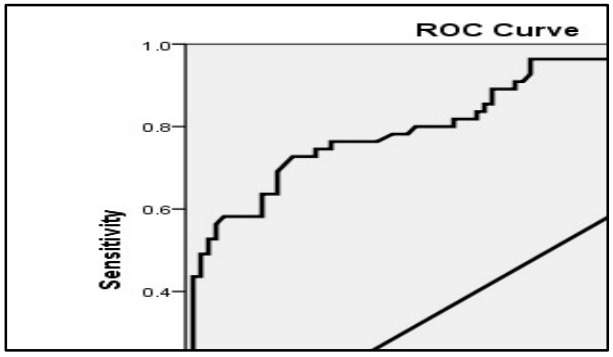

Figure 1: AUC ROC of the fullPIERS model in predicting adverse maternal outcomes, reveals AUC of 85.4%; [(95%CI 0.78-0.91): p=0.001];sensitivity 80% ; Specificity 70%.

respectively in predicting adverse maternal outcomes. However at a cut-off risk value of 35, the model gave maximum performance in prediction of adverse maternal outcomes with sensitivity and specificity of 80% and70% respectively. Further, the fullPIERS cut-off score at 40, had 69 % sensitivity & 88% specificity in predicting adverse maternal outcomes. In the study cohort, adverse maternal outcome was observed in 36.6% cases. A fullPIER score ≥35% correctly identified 81.8% of the women who subsequently experienced an adverse maternal outcome. The AUC ROC was 0.854(CI 0.78-0.92) with sensitivity, specificity as 80% and 70% respectively (figure 1). All women (n=74) with fullPIER score ≥35was prioritized for care. However, 60.8% (45/74) of them experienced an adverse outcome and majority of these ie. 91% (41/45)

women had PE with severe features. All women with PE with severe features received magnesium sulfate as seizure prophylaxis, antihypertensives, and were delivered when admitted at ≥34 weeks of gestation. Those <34 weeks, received inj. dexamethasone to accelerate fetal lung maturity, and delivered at 34 weeks or earlier if required.

Table 4: Correlation of fullPIERS with adverse maternal outcome

fullPIERS score	Adverse maternal outcome		RR [95% CI]; P - value
	Present n=55	Absent n=95	
≥ 35 (74)	45	29	4.6[2.5-8.4];
<35 (76)	10	66	<0.0001

The need for blood transfusion (23.3%) was the commonest adverse maternal event. The other adverse maternal events include women with GCS<13(12.7%), dyspnoea (5.3%), hepatic dysfunction (2%), renal dysfunction (2%), placental abruption (2%), and need for intubation and ventilatory support (2%). There was one maternal death, she presented with PE with severe features with oxygen saturation of 90%, needed ventilatory support during and after delivery and had multiorgan dysfunction.

Table 2 shows the maternal symptoms and biochemical parameters with adverse maternal outcome. The relationship between each predictor variables and the adverse maternal outcomes was assessed by univariate logistic regression (table 3). Table 4 shows the correlation of the fullPIERS score with the adverse maternal outcome. The sensitivity, specificity, PPV & NPV was found to be 81.8%, 69.4%, 60.8% & 87% respectively. Amongst women with fullPIERS score ≥35 (n=74), 45 experienced adverse maternal outcomes; among women with fullPIERS score <35(n=76), only 10 women experienced adverse maternal outcome [RR 4.6; (95% CI 2.5-8.4)].

Discussion

Our study aims at assessing the performance of the fullPIERS model in predicting the adverse maternal outcomes when the predictor variables are collected within 24 hours of admission. Of 150 women with PE enrolled in our study, 55 (36.6%) experienced an adverse maternal outcome. The mean age of enrolled women in our cohort was 26.8±4.5 years. The mean gestational age at diagnosis of PE was 36.5±3.9 weeks. The late gestational age at diagnosis reflects the lack of antenatal care or awareness regarding antenatal care among women living in far remote areas, as 64% of women in our cohort were from rural areas. The recent National Health Family Survey (NHFS) data shows that only 79% of women aged 15-49 years received antenatal care from a skilled provider at least once during their pregnancy. The reason may be illiteracy, poverty and living in far remote areas [8].

In women with PE, irrespective of the gestational age at diagnosis, presence of symptoms like dyspnea, epigastric pain or right upper quadrant pain, headache, nausea, vomiting, and visual disturbances all appear to be significantly associated with adverse maternal outcome. In systematic review of maternal symptoms in predicting outcome in women with PE, Thangaratinam et al found an increased sensitivity and specificity of symptoms, epigastric pain [0.34(95%CI 0.22-0.5) & 0.83(95%CI 0.76-0.89)] and visual disturbances [0.27 (95%CI0.007-0.65) & 0.81(95%CI 0.71, 0.88)] in predicting adverse maternal outcomes [9,10]. In our study, all women who had oxygen saturation <93% by pulse oximetry had an adverse maternal outcome. Srivastava S had a similar observation where 83.3% of women with PE with Spo_2<93% suffered an adverse outcome[11]. Millman et al. concluded in her study that SpO_2 <93% confers significant risk and successfully predicts the adverse maternal outcome [12].

Kozic et al in their PIER database analysis observed that 53% of women had atleast one abnormal liver function result, and the odds of having an adverse maternal outcome were higher among them as compared to those with normal liver function tests[13]. In other study thrombocytopenia, raised serum transaminases, uric acid, and creatinine, all significantly correlated with adverse maternal outcome [14].

The study by Agrawal S and Maitra N showed excellent performance of fullPIERS model in predicting adverse maternal outcomes. In their study, 18.3% women had adverse maternal outcome. Eclampsia was the commonest adverse outcome noted however, none of the women in our cohort had eclampsia. This may be attributed to administration of magnesium sulphate as seizure prophylaxis in all women with PE with severe features. The study by Bose S & Wagh G observed that fullPIERS was 37% sensitive, 100% specific with PPV & NPV of 100% and 89% respectively. The overall diagnostic accuracy reported was 90%[15].

In our cohort, fullPIERS score of ≥35% identified 81.8% of women who subsequently had adverse maternal outcome with PPV and NPV of 60.8% and 86.8% respectively. On the other hand, fullPIERS with predicted probability <35% correctly identified 86.8% of women who did not have any adverse outcome.

The severe consequences of HDPs make them a global health burden, especially in middle and low-income

countries. Risk assessment in these women possibly will guide the caregivers in planning the management in these high risk cases and possible transfer to higher level of care. It may serve as useful prediction tool for early detection and triage in country like ours where universal antenatal care coverage is still lacking.

Conclusion

The fullPIERS model showed excellent performance as a rule in test for developing adverse maternal outcomes in women with PE.

Conflict of interest: None. **Disclaimer:** Nil.

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