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ORIGINAL RESEARCH

GESTO- MAP-H: A Preeclampsia Outcome Prediction Model using HDP Gestosis Score, Mean Arterial Pressure and Serum Homocysteine - a Retrospective Randomized Case Control Pilot Study

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ABSTRACT

Background: Hypertensive disorders of pregnancy (HDP) affect approximately 10% of pregnancies and remain a significant contributor to maternal mortality. Current predictive tools lack both cost-effectiveness and diagnostic accuracy. This study aims to develop a cost-effective prediction model for preeclampsia outcomes utilizing the HDP Gestosis score, Mean Arterial Pressure (MAP), and serum homocysteine levels.

Methods: Conducted at the Department of Obstetrics and Gynaecology, Government Medical College and Hospital, Tiruppur, a tertiary care facility in South India, this retrospective randomized control pilot study involved 60 patients. Patients were categorized retrospectively into low, medium, and high-risk groups based on HDP Gestosis score. Mean arterial pressure at 20-24 weeks gestation and serum homocysteine levels were recorded.

Results: Analysis of data from 60 patients revealed varying diagnostic accuracies: HDP Gestosis score alone (71.67%), mean arterial pressure alone (55%), and serum homocysteine levels alone (55%). Serum homocysteine levels demonstrated the highest positive predictive value (96.67%) and were significantly elevated in the preeclampsia group compared to the low-risk group ($p<0.0001$). The combined GESTO-MAP-H model showed moderate positive correlation ($r=0.6$) and a cutoff value of 100 exhibited 93.3% sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy in predicting preeclampsia-related complications.

Conclusion: While prevention remains a future goal, early prediction and identification of preeclampsia, coupled with timely delivery, are crucial in reducing maternal morbidity and mortality. GESTO-MAP-H emerges as a promising, economical, user-friendly predictive tool, aiding in standardized decision-making to mitigate preeclampsia-related complications.

Keywords: Preeclampsia, Hypertensive disorders of pregnancy, Gestosis score, Mean arterial pressure, Serum homocysteine, Prediction model

INTRODUCTION

Hypertension complicates approximately 10% of pregnancies and remains a significant contributor to preventable maternal mortality, constituting the second leading cause thereof[1]. Despite

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concerted governmental efforts, its prevalence has surged notably from 67.2 to 81.4 per 1000 deliveries, with hypertension in pregnancy accounting for a staggering 19% of maternal deaths globally[2, 3].

Preeclampsia, characterized by multisystem endothelial dysfunction attributed to improper placentation, poses a formidable challenge in high-risk obstetrics[4]. Its impact extends to critical end organs such as the liver, kidneys, and brain. Predicting preeclampsia remains a gray area, prompting extensive research into its etiology, prediction, and prevention over the past few decades[5].

The primary pathogenesis of preeclampsia can be traced to abnormal trophoblastic invasion and defective spiral artery remodeling[6]. This leads to maladaptation of maternal circulation, transitioning from high resistance, low-flow circulation to low resistance, high-flow circulation upon establishment of placental circulation. While delivery of the placenta serves as a cornerstone in treatment, the degree of maternal organ damage remains notoriously unpredictable[7].

In this context, there is an urgent need to develop a tool that can reliably predict maternal outcomes and facilitate delivery planning, striking a delicate balance between maternal condition and fetal maturity. Such a tool would fill a critical gap in obstetric care, ensuring uniformity in decision-making processes across diverse clinical settings.

Various prediction tools have been explored globally, with the HDP-Gestosis score emerging as a promising screening tool endorsed by FOGSI. However, its sensitivity and positive predictive value exhibit considerable variability within the Indian context. Blood pressure measurement, a fundamental skill in antenatal care, now encompasses new terminologies such as white coat hypertension and masked hypertension, necessitating consideration of 24-hour ambulatory pressure monitoring for comprehensive assessment[8].

Moreover, mean arterial blood pressure, calculated as the sum of diastolic blood pressure and one-third of the difference between systolic and diastolic blood pressure, has been touted for its superior predictive value in preeclampsia. The vascular and inflammatory theories of preeclampsia underscore the role of imbalance between proangiogenic and antiangiogenic factors, with biomarkers such as sFlt-1 and sEng indicative of endothelial dysfunction. Hyperhomocysteinemia further exacerbates endothelial dysfunction, boasting a significant positive predictive value and cost-effectiveness[9].

Despite advancements, several nonspecific tests and biochemical markers await routine clinical integration due to resource limitations. Our study aims to bridge this gap by developing an economical, simple, and reliable tool with high diagnostic accuracy, facilitating standardized decision-making in predicting preeclampsia outcomes and optimizing maternal-fetal health.

MATERIALS & METHOD

The study included 60 patients admitted at the Department of Obstetrics and Gynaecology, GMC, Tiruppur. 30 patients with good pregnancy outcome, 30 patients with various spectrum of outcome related to hypertensive disorders of pregnancy such as preeclampsia with severe features, Antepartum eclampsia, Abruption, HELLP, Postpartum eclampsia, Postpartum hypertension. All the patients delivered after 34 weeks of gestation. All patients gave informed consent to participate in the study. The study has been approved by the Institutional Ethics committee.

Clinical data collection and analysis: A standardized computer data sheet has been used to record socio-demographic characteristics, past medical history, the history of the current pregnancy and pregnancy outcome. Patient was classified on the basis of HDP- Gestosis score as Low risk (<3); high risk (≥ 3).

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a. HDP- Gestosis score at the booking visit:

MILD RISK FACTORS (SCORE 1)
1. Age older than 35 years
2. Age younger than 19 years
3. Maternal anaemia
4. Obesity (BMI >30)
5. Primigravida
6. Short duration of paternity (Cohabitation)
7. Woman born as small for GA
8. PCOS
9. Interpregnancy interval >5 years
10. Conceived with ART (IVF/ ICSI)
11. MAP >85
12. Chronic vascular disease (dyslipidemia)
13. Excessive weight gain during pregnancy
MODERATE RISK FACTORS (SCORE 2)
1. Maternal hypothyroidism
2. Family H/o preeclampsia
3. GDM
4. Multiple pregnancy
5. Obesity (BMI>35)
6. Hypertensive disease during previous pregnancy
SEVERE RISK FACTORS (SCORE 3)
1. Pregestational DM
2. Chronic Hypertension
3. Mental disorder
4. Inherited/ acquired Thrombophilia
5. Maternal chronic kidney disease
6. Autoimmune disease (SLE/APLA/RA)
7. Pregnancy with ART (OD or Surrogacy)

b. Mean arterial blood pressure at 20-24 weeks (Burton's formula): $MAP = DBP + 0.33 \times PP$ (SBP-DBP) where PP is the pulse pressure, SBP is systolic blood pressure and DBP is diastolic blood pressure. MAP >90 mm Hg was considered to be high. MAP score- 1 (85-90 mm Hg); 2 (90-100 mm Hg)); 3(>100 mm Hg)

c. Serum Homocysteine: 2 ml of EDTA sample was taken from the patient on the day of delivery and Serum Homocysteine levels measured by Enzyme based immunoassay test. A Cut off >10 µmol/L (4) was considered to be increased.

d. GESTO-MAP-H: GESTO-MAP-H score was calculated as a product of Gestosis score x MAP Score x Serum homocysteine levels

Statistical analysis: All the data collected were entered in the Microsoft Excel spread sheet. The sensitivity, specificity, positive predictive value, negative predictive value were calculated using 2x2 table at MedCalc Software Ltd (12). Serum homocysteine levels were expressed as µmol/L. Comparison of Serum homocysteine levels were performed using non parametric T tests (Mann-

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Whitney U test) using SPSS version 20. The co-relation of GESTO-MAP-H with the outcome of preeclampsia was performed using ROC curve SPSS version 20

RESULTS

A total of 60 patients who consented for the study were enrolled. All the patients delivered as Government Medical College and Hospital, Tiruppur. Their gestational age was > 34 weeks at the time of delivery. Out of 60 patients, 30 patients had normal pregnancy outcome. Other 30 patients, 13 patients had mild preeclampsia, 8 patients had preeclampsia with severe features, 4 cases had Abruptio placenta, 3 cases of antepartum eclampsia, 1 case with HELLP, 1 case with postpartum eclampsia.

The clinical history in detail was collected from the past records and HDP Gestosis score at the booking visit was applied. All the 60 patients were classified as either low risk (<3); high risk (>3). The corresponding maternal outcome was also entered. Figure 1 summarises the sensitivity (60%); specificity (80%); Positive predictive value (68%); negative predictive value (73%) and diagnostic accuracy (71%).

Statistic	Value	95% CI
Sensitivity	60.00%	38.67% to 78.87%
Specificity	80.00%	63.06% to 91.56%
Positive Likelihood Ratio	3.00	1.44 to 6.26
Negative Likelihood Ratio	0.50	0.30 to 0.83
Disease prevalence (*)	41.67%	29.07% to 55.12%
Positive Predictive Value (*)	68.18%	50.66% to 81.73%
Negative Predictive Value (*)	73.68%	62.76% to 82.31%
Accuracy (*)	71.67%	58.56% to 82.55%

Figure 1: The Predictive value of HDP Gestosis score at booking visit in predicting preeclampsia and its complications.

The mean arterial pressure at 20-24 weeks was collected from the past records. All the 60 patients were classified as either Normal (MAP<90 mm Hg) or high MAP (>90 mm Hg). The corresponding maternal outcome was also entered. Figure 2 summarises the sensitivity (13%); specificity (96.7%); Positive predictive value (80%); negative predictive value (52.7%) and diagnostic accuracy (55%).

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Statistic	Value	95% CI
Sensitivity	13.33%	3.76% to 30.72%
Specificity	96.67%	82.78% to 99.92%
Positive Likelihood Ratio	4.00	0.47 to 33.73
Negative Likelihood Ratio	0.90	0.77 to 1.05
Disease prevalence (*)	50.00%	36.81% to 63.19%
Positive Predictive Value (*)	80.00%	32.17% to 97.12%
Negative Predictive Value (*)	52.73%	48.85% to 56.57%
Accuracy (*)	55.00%	41.61% to 67.88%

Figure 2: The Predictive value of Mean arterial blood pressure (MAP) in predicting preeclampsia and its complications

The serum Homocysteine level was measured on the day of delivery. A value of > 10 µmol/L was considered as hyperhomocysteinemia. The corresponding maternal outcome was also entered. Figure 3 summarises the sensitivity (52.7%); specificity (80%); Positive predictive value (96.7%); negative predictive value (13.3%) and diagnostic accuracy (55%). Further more, the absolute values of Serum Homocysteine estimated between the two groups was compared. The mean value of low risk cohort was 22.6 µmol/L+11.04 µmol/L and the mean value of HDP cohort was 52.74 µmol/L + 8.45 µmol/L. The difference between the two groups were found to be statistically significant ($p<0.0001$).

Statistic	Value	95% CI
Sensitivity	52.73%	38.80% to 66.35%
Specificity	80.00%	28.36% to 99.49%
Positive Likelihood Ratio	2.64	0.45 to 15.49
Negative Likelihood Ratio	0.59	0.35 to 0.99
Disease prevalence (*)	91.67%	81.61% to 97.24%
Positive Predictive Value (*)	96.67%	83.15% to 99.42%
Negative Predictive Value (*)	13.33%	8.38% to 20.55%
Accuracy (*)	55.00%	41.61% to 67.88%

Figure 3: The Predictive value of serum Homocysteine levels in predicting preeclampsia and its complications

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GESTO- MAP-H: GESTO-MAP-H score was calculated using the formula HDP Gestosis score x MAP Score x Serum homocysteine. The numerical outcome of the formula was correlated with the maternal outcome. The severity of maternal outcome was numbered as 1- preeclampsia without severe features; 2- preeclampsia with imminent features; 3- Abruption; HELLP; Antepartum eclampsia; Postpartum eclampsia; Postpartum hypertension. Figure 4 represents the receiver operator curve. The **r value of 0.6** is a moderate positive correlation which means there is a tendency for high X variable scores go with high Y variable scores and vice versa. The value of R^2, the coefficient of determination is 0.3669 ($p<0.00001$).

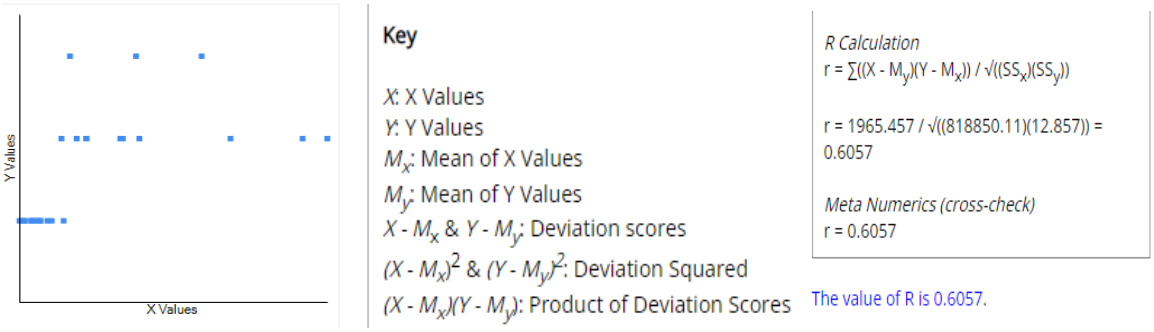

Figure 4: ROC of the GESTO-MAP-H correlating with the maternal outcome.

GESTO-MAP-H score cut off when fixed at 100, the sensitivity (93.3%); specificity (93.3%); Positive predictive value (93%); negative predictive value (93.3%) and diagnostic accuracy (93.3%) was achieved as illustrated in figure 5.

Statistic	Value	95% CI
Sensitivity	93.33%	77.93% to 99.18%
Specificity	93.33%	77.93% to 99.18%
Positive Likelihood Ratio	14.00	3.66 to 53.59
Negative Likelihood Ratio	0.07	0.02 to 0.27
Disease prevalence (*)	50.00%	36.81% to 63.19%
Positive Predictive Value (*)	93.33%	78.53% to 98.17%
Negative Predictive Value (*)	93.33%	78.53% to 98.17%
Accuracy (*)	93.33%	83.80% to 98.15%

Figure 5: The Predictive value of GESTO- MAP-H in predicting preeclampsia and its complications

DISCUSSION

Our study delved into the predictive efficacy of various parameters, including the Gestosis score, Mean Arterial Pressure (MAP), and serum homocysteine levels, in anticipating complications related to hypertensive disorders of pregnancy (HDP). Our findings shed light on the nuanced interplay between these parameters and their potential implications for clinical decision-making.

Recent literature has highlighted the Gestosis score as a unique early signal for predicting the onset of preeclampsia (PE) (6-8). Studies have demonstrated its favorable sensitivity, specificity,

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positive predictive value (PPV), and negative predictive value (NPV), underscoring its potential utility in clinical practice (6). However, our study revealed a lower sensitivity and positive predictive value, indicating limitations in its ability to effectively predict complications associated with HDP. While the Gestosis score may serve as a valuable tool for initiating aspirin prophylaxis, its efficacy in predicting adverse outcomes remains debatable.

MAP emerged as a parameter with high specificity and positive predictive value in our study. However, its effectiveness was hampered by low sensitivity and negative predictive value, leading to a notable proportion of false negatives. This discrepancy raises concerns regarding the reliability of MAP as a standalone predictor of HDP complications. Further research is warranted to elucidate the underlying factors contributing to these discrepancies and refine its predictive accuracy.

The correlation between serum homocysteine levels and the severity of HDP has been well-established in previous studies. However, our findings revealed a sensitivity and negative predictive value that were lower than anticipated. This discrepancy may be attributed to various factors, including patient compliance with folic acid intake, which can influence homocysteine levels and confound the predictive accuracy of this parameter. Future studies exploring the impact of dietary and lifestyle factors on serum homocysteine levels in the context of HDP prediction are warranted.

The cornerstone of our study lies in the development of the Gesto-MAP-H predictive model, which integrates multiple parameters to anticipate complications associated with HDP. Our model demonstrated superior sensitivity, specificity, PPV, and NPV compared to individual parameters analyzed. The simplicity of calculation and numerical outcome of our model offer significant advantages, minimizing individual bias and enhancing clinical applicability. By combining the background risk of the patient, the impact of placentation on blood pressure, and the degree of endothelial dysfunction into a numerical value, Gesto-MAP-H represents a promising approach to HDP prediction and risk stratification.

This study underscores the complex interplay between various parameters in predicting complications related to HDP. While individual parameters exhibit limitations in isolation, the integration of multiple parameters into a comprehensive predictive model holds considerable promise in enhancing the accuracy of HDP prediction and guiding clinical decision-making. Further validation and refinement of predictive models such as Gesto-MAP-H are warranted to optimize maternal and fetal outcomes in the management of HDP.

Despite the promising findings, our study has several limitations. Firstly, the retrospective design introduces inherent biases and limits causal inference. Secondly, the sample size was relatively small, potentially impacting the generalizability of our findings. Thirdly, the study was conducted at a single tertiary care center, potentially limiting the external validity of our results. Additionally, the reliance on retrospective data collection may have introduced inconsistencies or missing data. Finally, the complexity of HDP and the multifactorial nature of its prediction may not have been fully captured by our model.

CONCLUSION

In a developing country like India, where the majority of maternity care is provided by the public sector at no cost to patients, the Gesto-MAP-H predictive model holds significant promise. By offering a quantitative means to predict preeclampsia-related complications, this tool can facilitate uniform decision-making across healthcare settings. The establishment of an action line based on Gesto-MAP-H could serve as a standardized protocol for preventing preeclampsia-related morbidity and mortality, even at the primary and secondary care levels. Moving forward, larger

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cohort studies are warranted to validate the efficacy and reliability of the Gesto-MAP-H model in diverse clinical settings.

REFERENCES

1. Hutcheon JA, Lisonkova S, Joseph KS. Epidemiology of pre-eclampsia and the other hypertensive disorders of pregnancy. Best Pract Res Clin Obstet Gynaecol 2011;25(4):391–403
2. Kuklina EV, Ayala C, Callaghan WM. Hypertensive disorders and severe obstetric morbidity in the United States. Obstet Gynecol 2009;113(6): 1299–306.
3. Imam ST. Improvement in the cases of hypertensive disorders of pregnancy with help of HDP-Gestosis score ‘, Int J Reprod Contracept Obstet Gynaecol. 2023. Mar; 12(3), 671-674.
4. Sunita G, Sheela J, Bhavna K. A study of serum homocysteine levels during normal pregnancy and pre eclampsia. J South Asian Fed Obstet Gynaecol. 2011;3(2):71–74.
5. Maru L, Verma M, Jinsiwale N. Homocysteine as predictive marker for pregnancy induced hypertension- A comparative study of homocysteine levels in normal versus patients of PIH and its complications, J Obstet Gynaecol India. 2016 Oct; 66 (suppl 1): 167-171.
6. Yadav A, Agarwal J, Shwetha K. FOGSI Gestosis score’ as a predictor of pre-eclampsia: An observational study’, Intrnational Journal of Pharmaceutical and clinical research 2023; 15(5); 1655-1665. e-ISSN: 0975-1556.
7. Gupta M, Yadav P, Yaqoob F. A Prospective Study to Determine the predictive Ability of HDP- Gestosis Score for the Development of Pre-eclampsia’, J Obstet Gynaecol India, 2022 dec; 72(6):485-491. Doi:10.1007/s13224-022-01704-0.
8. Hypertensive Disorders of Pregnancy ISSHP Classification, Diagnosis, and Management Recommendations for International Practice. Mark A. Brown, Laura A. Magee, Louise C. Kenny, S. Ananth Karumanchi, Fergus P. McCarthy, Shigeru Saito, David R. Hall, Charlotte E. Warren, Gloria Adoyi, Salisu Ishaku; on behalf of the International Society for the Study of Hypertension in Pregnancy (ISSHP). Hypertension. 2018;72:24-43. doi: 10.1161/HYPERTENSIONAHA.117.10803.
9. Cnossen JS, Vollebregt KC, Vrieze ND, Riet GT, Mol BWJ, Franx A, Khan KS. Vander post JAM, Accuracy of mean arterial pressure and blood pressure measurements in predicting pre-eclampsia: systematic review and meta-analysis’ BMJ 2008 May 17; 336(7653):1117-1120. doi: 10.1136/bmj.39540.522049.BE PMID: 18480117.