Original Article

Laboratory Ordering Practices in Pregnancy Induced Hypertension and Association of Haematological, Coagulation and Biochemical Parameters with the Severity of Pre-eclampsia

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Abstract

Background: Pregnancy induced hypertension (PIH) is a commonly encountered complication. The study aimed to evaluate the laboratory ordering practices for PIH at Shree Krishna Hospital (SKH), Karamsad to assess adherence to recommended guidelines for test ordering in PIH. By doing so, the study aims to standardize these practices across the Obstetrics and Gynaecology Department (OBGY). The study involves assessing laboratory parameters to differentiate between mild and severe pre-eclampsia. To evaluate the laboratory ordering practices in patients of pregnancy induced hypertension at the Department of Obstetrics and Gynaecology, Shree Krishna Hospital, Karamsad. To assess the association of haematological, coagulation and biochemical parameters with the severity of pre-eclampsia.

Methods: A retrospective and prospective observational study (DeC'22-Mar'24) included women with singleton pregnancies at 32-40 weeks gestation. Women with multiple pregnancies, chronic conditions, or a history of cardiac, liver, or renal disease were excluded. A total of 85 (30 mild and 55 severe PIH cases) participated in the study. The test ordering practices were assessed against FOGSI (Federation of Obstetric and Gynaecological Societies of India) guidelines. A perception survey was conducted targeting the residents and consultants of the OBGY Dept at SKH.

Results: The study demonstrated variable adherence to the recommended FOGSI guidelines. For coagulation tests 15.29%, for Serum Electrolytes 62.35% and for Urine Protein 84.70% compliance rate with guidelines was found. An amount of 89,050.0 Indian rupees was spent on additional laboratory tests. Survey response indicated that tests are often ordered "just to be safe". The statistical significance was found for haemoglobin, ALT, AST, and LDH levels between mild and severe PIH cases.

Conclusion: The study emphasizes a need for an improvement in managing PIH through better adherence to laboratory ordering guidelines as there was a notable inconsistency in following established protocols for laboratory testing that resulted in over utilization. The overall cost of these over-ordered tests was substantial enough (89,050 Rs) to impact both the hospital and the patients.

Keywords: Laboratory ordering practices; Perception survey; Cost assessment; Intervention

Introduction

Pregnancy induced hypertension (PIH) occurs after 20 weeks of gestation in women with previously normal blood pressure, defined as systolic blood pressure (SBP) >140 mm Hg and diastolic blood pressure (DBP) >90 mm Hg [1]. Further categorized into mild, moderate, or severe [2]. Depending on its severity, it can affect various haematological, coagulation, and biochemical parameters, resulting in significant alterations.

There is a felt need to study the laboratory ordering practices for pregnancy induced hypertension at Shree Krishna Hospital (SKH), Karamsad. This study is important to ensure that best practice guidelines and recommendations for ordering tests in

PIH are followed, so that they may be standardized across the Obstetrics and Gynaecology Department. It is anticipated that this would improve laboratory ordering practices, and reduce the burden on patients in terms of cost and time and better utilization of the laboratory resources.

Materials and Methods

This was a retrospective and prospective observational study conducted between December 2022 to March 2024. We assessed laboratory ordering practices at the Department of Obstetrics and Gynaecology to review compliance with the guidelines laid down by FOGSI [2].

- **Inclusion:** Women with singleton pregnancies at 32-40 weeks gestation. (85 cases of PIH comprising of 30 mild and 55 severe cases)
- **Exclusion:** Women with multiple pregnancies, chronic conditions, or a history of cardiac, liver, or renal disease

The following parameters were measured for association:

- **Haematological** - Haemoglobin level, Platelet count and Total leukocyte count
- **Coagulation** - Prothrombin time (PT-INR), Activated partial thromboplastin time (APTT) and Fibrinogen levels
- **Biochemical** - Liver function tests (Aspartate aminotransferase, Alanine aminotransferase, Alkaline phosphatase, Serum Protein, Serum Bilirubin), Lactate dehydrogenase, Serum Uric acid, Serum Creatinine, Serum Electrolytes and C-reactive protein (CRP)

The study also included an assessment of the cost of the commonly ordered laboratory tests in PIH, the rates of which were obtained from the Laboratory Information System (LIS).

Descriptive statistics [Mean (SD)] was used to depict the baseline profile of the study participants. To compare continuous variables between groups independent sample t test (compare Mean) was used. A p value of < 0.05 was considered statistically significant. Statistical software STATA 14.2 was used for data analysis.

A perception survey was conducted using Google Forms. There were 21 participants including residents and consultants of OBGY. In February 2025, an interdepartmental meeting and Clinico-Pathologic Conference (CPC) were conducted to evaluate the proposed intervention.

Results

Of 85 participants, the majority of the women were in age group between 21-30 years (71.78%), multigravida (58.82%) and presented between 35.1 to 38.0 weeks of gestation (43.52%). Blood pressure level was in a range of 150/100 for mild PIH and 160/110 mm Hg for severe PIH.

The data presented in Table 6 demonstrates higher mean CRP values in cases of severe PIH (13$\pm$42.6 mg/L) compared to mild PIH (7.5$\pm$3.03 mg/L). Although the difference in mean CRP levels between the two groups is not statistically significant ($p = 0.25$), the observed trend of elevated CRP levels in severe PIH suggests a potential relationship between CRP levels and the severity of the condition.

Table 7 details the total number of tests ordered and additionally performed which were not indicated by recommended guidelines. The total expenditure of additional tests amounted to a substantial sum of approximately Rupees 89,050.0. Patients with mild PIH (without thrombocytopenia) paid about 1550 Rs extra, while those with severe PIH (without thrombocytopenia) paid around 1025 Rs per patient additionally on an average for the above tests.

The responses of perception survey are as depicted below-

As per Figure 1, at least 18 out of 21 participants believe that unnecessary tests are being ordered.

As per Figure 2, 16 out of 21 participants believe that the tests are ordered “just to be safe”.

Figure 3 reveals that the majority of respondents, 81% (17 out of 21), feel that they adhere to PIH-specific clinical guidelines when ordering laboratory tests.

To the survey question “Are you aware of any guidelines or protocols specifically for laboratory testing in PIH?”, 85.7% of participants (18/21) responded ’Yes’ and 14.3% (3/21) responded ’No’.

To the survey question "Do you feel the need for an additional training for implementing laboratory ordering practices in PIH?", a significant number of respondents 76.2% (16) feel that additional training is needed for implementing laboratory ordering practices in PIH. Meanwhile, 23.8% (5) do not see the need for additional training.

The final open-ended question was to elicit qualitative and detailed feedback on the specific difficulties encountered. A total of 16 responses were received for this segment. The responses address clinical decision-making challenges, patient-specific factors, resource limitations, fear and past experiences. A major concern was regarding the patient's condition and prevention of progression of severity of disease.

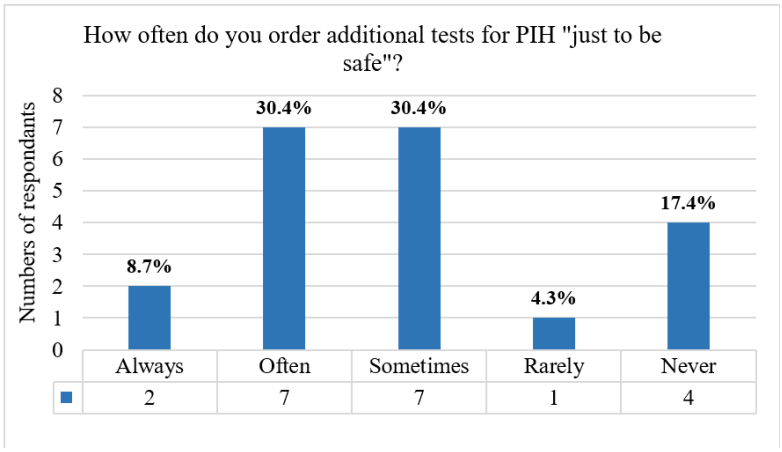

Figure 1: Frequency of unnecessary laboratory tests for PIH management

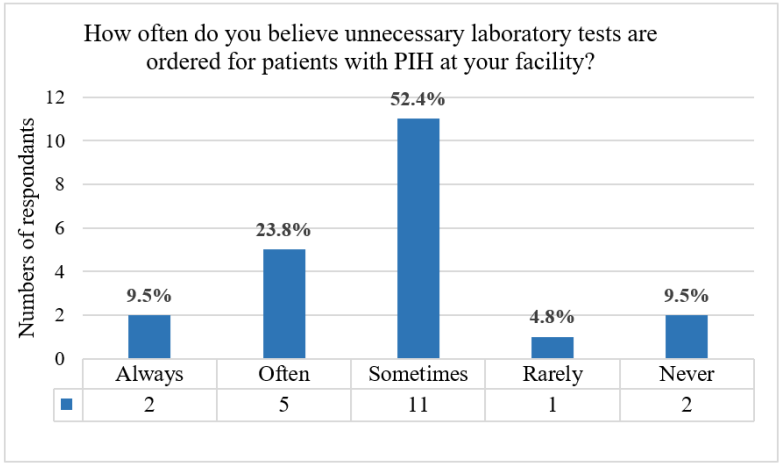

Figure 2: Frequency of ordering additional tests for PIH 'Just to be safe'

Table 1: Laboratory ordering practices in PIH

Laboratory tests	**Testing indicated as per guideline (Yes/No)**	**Number of patients tested additionally**	**Compliance with FOGSI guidelines**
Complete blood count	Yes	85	100%
"LFT (ALP, S. Bil, S. Pro, AST, ALT)"	Yes	85	100%
LDH	Yes	85	100%
Serum Creatinine	Yes	85	100%
Serum Uric Acid	Yes	81	95.20%
"Coagulation profile (PT-INR, APTT, Fibrinogen)"	"To be done when platelet count $< 1,00,000/\mu L$"	84	15.29%
Serum Electrolytes	To be done in severe cases	83	62.35%
Urine protein	Yes	72	84.70%

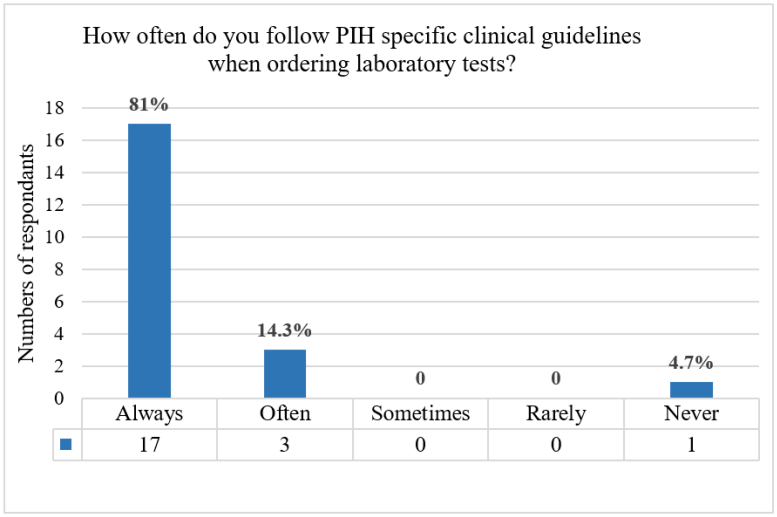

Figure 3: Frequency of following guidelines for ordering laboratory tests

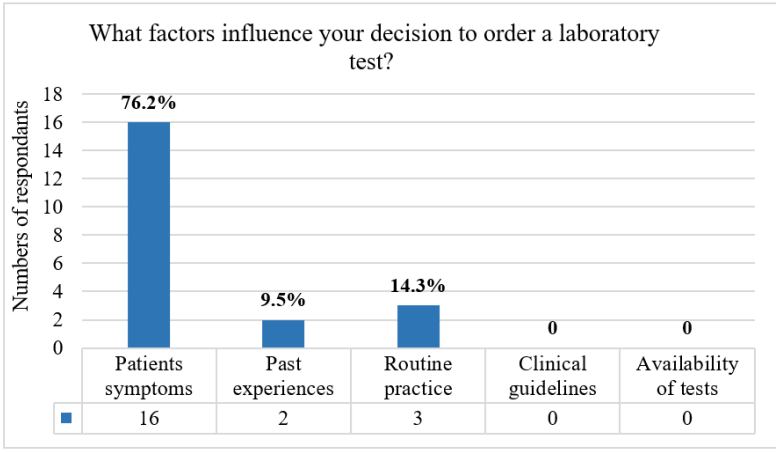

Figure 4: Factors influencing for ordering laboratory tests

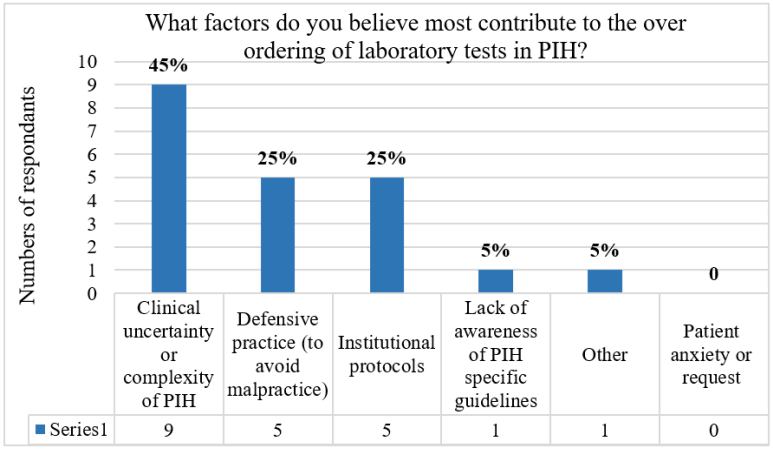

Figure 5: Factors contributing to the over ordering of laboratory tests

Discussion

PIH leading to complications, is a significant cause of maternal and perinatal morbidity and mortality. The current landscape of laboratory tests and their outcomes significantly influence the quality of patient care. The laboratory testing assists consulting physicians in decision-making for the management of PIH [2].

The present study showed that the majority of laboratory test orders complied with FOGSI standards for majority of essential tests, including CBC, LFTs, LDH, and S. Creatinine, with an excellent compliance rate of 100%. For coagulation profile (PT,

Table 2: Distribution of laboratory parameters in mild and severe PIH

Haematological parameters	Mild PIH, N=30 (%)	Severe PIH, N=55 (%)
Total count		
Normal/Low (< 10.0)	09 (30%)	11 (20%)
Abnormal (> 10.0)	21 (70%)	44 (80%)
Haemoglobin		
Normal/High (> 12.0)	06 (20%)	26 (47.27%)
Abnormal (< 12.0)	24 (80%)	29 (52.73%)
Platelet count		
Normal/High (> 100)	25 (83.33%)	47 (85.45%)
Abnormal (< 100)	05 (16.67%)	08 (14.55%)

Table 3: Association of laboratory parameters in cases of mild and severe PIH

Haematological parameters	Mild PIH Mean±SD	Severe PIH Mean±SD	p value
Haemoglobin	11.15±2.86	9.76±2.56	0.02
ALT	17.8±13.11	47.14±83.11	0.05
AST	29.83±14.33	76.27±121.68	0.04
LDH	296.53±152.21	499.52±561.12	0.05

Table 4: Distribution of coagulation parameters in cases of mild and severe PIH

Parameters	Mild PIH, N=30 (%)	Severe PIH, N=55 (%)
PT		
Normal/Low (< 12.68)	27 (90%)	54 (98.18%)
Abnormal (> 12.68)	03 (10%)	01 (1.82%)
APTT		
Normal/Low (< 30.40)	24 (80%)	49 (89.10%)
Abnormal (> 30.40)	06 (20%)	06 (10.90%)
Fibrinogen (Severe n=54)		
Normal/High (> 220.0)	27 (90%)	51 (94.44%)
Abnormal (< 220.0)	05 (10%)	03 (5.56%)

APTT, and Fibrinogen) we found lack of compliance by 85%. As per FOGSI, these tests are recommended only when the platelet count falls below 1,00,000/μL. But in our setup, these tests were ordered more frequently. However as per, Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA), Ministry of Health and Family Welfare (MOHFW) for severe PIH cases, peripheral blood smear and coagulation profile are also included [3].

Contrary to common assumption, our findings demonstrated that majority of PT and APTT remained within normal range even with platelet counts falling below 1,00,000/μL. This challenges the misconception that significant coagulation impairment occurs with low platelets, raising questions about the precise relationship between platelet count and coagulation.

Kodiathodi S. et al included thrombocytopenia (platelet count $< 1,50,000/\mu$L) as an indicator of disease severity with a sensitivity of only 4%. Consequently, they concluded that coagulation screening should not be considered as first-line investigation for women with normal platelet counts in the context of pre-eclampsia [4].

The present study also evaluated all the laboratory parameters with the severity of pre-eclampsia, the results are compared with other studies, as shown in Table 8 below-

A study by Jaiswar S. et al, correlated LDH with severity of PIH. The researcher found that mean LDH levels in 35 cases of mild pre-eclampsia (400.45±45.21) and 36 cases of severe pre-eclampsia (646.95±401.64) with p value of < 0.001 [5]. The findings were comparable with the present study.

The perception survey administered to residents and consultants (Figure 1 to 5), highlighted the need for investigation into why unnecessary tests are being ordered. Interestingly, clinical guidelines and the availability of tests did not influence the decision to order laboratory tests. Clinicians customise testing for each patient individually based on personal judgment or departmental practices rather than strictly adhering to standard guidelines and development of protocols.

Thompson X. et al introduced a quality improvement approach for analyzing the ordering process in the Obstetrics wards in a tertiary care center. The study led to a 39.9% reduction in costs related to blood tests (CAD$7304/month savings), without

Table 5: Distribution of biochemical parameters in cases of mild and severe PIH

Parameters	Mild PIH, N=30 (%)	Severe PIH, N=55 (%)
Alkaline phosphatase (ALP)		
Normal (< 116.0)	06 (20%)	06 (10.90%)
Abnormal (> 116.0)	24 (80%)	49 (89.10%)
Serum Bilirubin		
Normal (< 1.0)	28 (93.33%)	50 (90.90%)
Abnormal (> 1.0)	02 (6.67%)	05 (9.10%)
Serum Protein		
Normal (> 6.4)	10 (33.33%)	12 (21.81%)
Abnormal (< 6.4)	20 (66.67%)	43 (78.19%)
Aspartate transaminase (AST)		
Normal (< 37.0)	24 (80%)	35 (63.64%)
Abnormal (> 37.0)	06 (20%)	20 (36.36%)
Alanine transaminase (ALT)		
Normal (< 59.0)	29 (96.67%)	46 (83.64%)
Abnormal (> 59.0)	01 (3.33%)	09 (16.36%)
Serum Creatinine		
Normal (< 1.0)	28 (93.33%)	48 (87.27%)
Abnormal (> 1.0)	02 (6.67%)	07 (12.72%)
LDH		
Normal (< 234.0)	15 (50%)	11 (20%)
Abnormal (> 234.0)	15 (50%)	44 (80%)
Serum Uric acid		
Normal (< 6.2)	22 (78.57%)	38 (71.70%)
Abnormal (> 6.2)	06 (21.43%)	15 (28.30%)
Serum Sodium (Mild N=30, Severe N=53)		
Normal (> 136.0)	22 (73.33%)	26 (49.05%)
Abnormal (< 136.0)	08 (26.67%)	27 (50.95%)
Serum Potassium (Mild N=30, Severe N=53)		
Normal (> 3.8)	26 (86.67%)	44 (83.02%)
Abnormal (< 3.8)	04 (13.33%)	09 (16.98%)
Serum Chloride (Mild N=30, Severe N=53)		
Normal (> 96.0)	29 (96.67%)	53 (100%)
Abnormal (< 96.0)	01 (3.33%)	0

Table 6: Association of CRP in cases of mild and severe PIH

Parameters	Mild PIH mean±SD (n=3)	Severe PIH mean±SD (n=13)	p value
CRP (< 3.0mg/L)	7.5±3.03	13±42.6	0.25

Table 7: Cost assessment

Laboratory tests	Additional tests performed	Cost per test (Rupees)	Total cost (Rupees)
PT-INR	72	200.0	”14,400.0”
APTT	72	325.0	”23,400.0”
Fibrinogen	71	500.0	”35,500.0”
Serum Sodium	30	175.0	5250.0
Serum Potassium	30	175.0	5250.0
Serum Chloride	30	175.0	5250.0

impacting patients care [5].

At Epsom and St Helier University Hospitals NHS Trust in Carshalton, UK, Gamma-glutamyl transferase (GGT) and serum uric acid tests were not included in the National Institute for Health and Care Excellence (NICE) guidelines or any local guidelines for PIH. On eliminating these tests, it led to significant cost savings and reduced staff burden [6].

Sedrak M. et al study carried out a qualitative analysis among resident doctors to identify the factors leading to unnecessary

testing. The main contributors were routine or habitual practices (90.5%), lack of awareness of costs (86.2%), diagnostic uncertainty (82.8%), and concerns for not having lab results readily available when requested by attending physicians (75.9%) [7].

All of the aforementioned studies show that with the implementation of a carefully structured plan, a considerable reduction in expenses and proper laboratory resource utilization can be achieved without impairing patient care.

In February 2025, an interdepartmental discussion (OBGY and Pathology) and CPC was conducted with involvement of various other departments. Within the OBGYN department, a perception existed that coagulation parameters are altered even with normal platelet counts although all the data were analysed and found no such changes in coagulation.

Recommendations from FOGSI guidelines and PMSMA for PIH patients along with the combination of clinical decision-making, patient-specific factors, and past experiences were taken into consideration as complexity of managing PIH placing clinicians in a dilemma when it comes to adhering to recommended guidelines.

To overcome these challenges, after CPC discussions and considering FOGSI guidelines, an intervention was proposed for both mild and severe PIH cases. Inputs from Obstetrics & Gynaecology and other departments suggested adding a peripheral smear, as the presence of schistocytes indicates haemolysis [14].

Table 8: Comparison of laboratory parameters with various studies

Parameters in PIH	Boddapati, A. et al [8]		Maged, A. et al [9]		Kasraeian, M. et al [10]		Present study	
	Mild Mean±SD (n=33)	Severe Mean±SD (n=40)	Mild Mean±SD (n=90)	Severe Mean±SD (n=90)	Mild Mean±SD (n=180)	Severe Mean±SD (n=270)	Mild Mean±SD (n=30)	Severe Mean±SD (n=55)
Hb g/dl	10.4, ±1.9	10.8, ±2.4	12.3, ±1.3	13.0, ±1.9	11.8, ±1.6	11.78, ±1.8	11.1, ±2.86	9.76, ±2.5
TC $10^3/\mu$L	–	–	6.85, ±1.43	6.96, ±1.82	–	–	12.4, ±5.24	14.8, ± 6.43
Plt $10^3/\mu$L	190, ±90	176, ±84	172, ±57.60	113, ±36.7	191, ±49.06	179, ±56.35	227, ±107	203, ±94.06
PT sec	12.8, ±1.1	13.02±1.53	15.3, ±3.01	20.2, ±6.14	–	–	12.4, ±9.18	10.5, ±1.63
APTT sec	33.0, ±5.2	33.61±6.85	86.1, ±6.12	72.2, ±10.0	–	–	29.3, ±17.8	25.6, ±3.18
S. Bil mg/dl	–	–	0.06, ±0.01	0.06, ±0.03	0.6, ±0.22	0.6, ±0.18	0.47, ±0.41	0.56, ±0.67
ALP u/l	456.7, ±198	502.4, ±228	255.41±73.22	280.2±96.6	333.94±120.6	321.42±147.7	172.2±72.9	191.98±69.11
AST u/l	27.9, ±14	59.22, ±8.35	35.54, ±13.03	45.62, ±14.4	32.45, ±50.8	43.54, ±73.63	29.83, ±14.3	76.27, ±121.6
ALT u/l	20.3, ±10	37.9, ±39.1	38.34, ±13.12	52.24, ±14.8	18.78, ±30.38	32.99, ±54.07	17.8, ±13.1	47.14, ±83.11
Uric Acid mg/dl	4.83, ±1.4	6.11, ±1.99	5.44, ±1.34	6.79, ±1.32	5.43, ±1.2	6.2, ±1.4	4.91, ±1.62	5.53, ±1.59
S. Creat. mg/dl	0.91, ±0.3	0.94, ±0.37	1.09, ±0.39	1.09, ±0.39	0.84, ±0.27	0.9, ±0.26	0.68, ±0.61	0.82, ±0.83
Na^+ mmol/L	–	–	137.11±3.02	135.0±3.52	–	–	135.6±3.10	135.9, ±3.01, (n=53)
K^+ mmol/L	–	–	3.42, ±0.72	2.91, ±0.28	–	–	4.2, ±.59	4.2, ±0.57, (n=53)
Cl^- mmol/L	–	–	–	–	–	–	103.7, ±3.24	103.7, ±2.96, (n=53)

Table 9: Comparison of platelet counts and coagulation parameters with other studies

Study	Platelet count		PT		APTT	
	Mild PIH Mean±SD	Severe PIH Mean±SD	Mild PIH Mean±SD	Severe PIH Mean±SD	Mild PIH Mean±SD	Severe PIH Mean±SD
Chaware S. et al [11]	223, ±36, (n=50)	173, ±56, (n=40)	13.92, ±1.03, (n=50)	14.22, ±1.1, (n=40)	28.5, ±2.52, (n=50)	30.6, ±6.39, (n=40)
Dundy, g. et al [12]	177.5, ±42.25, (n=35)	117.85, ±27.53, (n=28)	13.29, ±1.36, (n=35)	13.95, ±0.99, (n=28)	31.48, ±3.40, (n=35)	35.44, ±3.31, (n=28)
Baig, M. et al [13]	181, ±52, (n=65)	105 , ±63.65, (n=35)	11.8, ±3.2, (n=65)	51.6, ±11.5, (n=35)	19.6, ±5.7, (n=65)	78.7, ±22.7, (n=35)
Present study	227, ±107.1, (n=30)	203, ±94.06, (n=55)	12.4, ±9.18, (n=30)	10.5, ±1.63, (n=55)	29.3, ±17.8, (n=30)	25.6, ±3.18, (n=55)

Conclusion

The present study emphasized a need for an improvement in managing PIH through better adherence to guidelines as the research found a notable inconsistency in following established protocols for laboratory testing that resulted in over-utilization. Based on the perception survey conducted, the majority of participants were found to be ordering laboratory tests unnecessarily and just to be safe. Most of the participants felt the need for additional training for ordering in PIH.

To overcome this, after an interdepartmental discussion and CPC it was agreed that adherence to FOGSI guidelines would be ensured along with addition of peripheral smear for PIH patients.

The association of laboratory parameters, including Haemoglobin, AST, ALT, and LDH levels, with mild and severe PIH groups was found to be statistically significant ($p < 0.05$). However, their effectiveness as a standalone marker for distinguishing between mild and severe cases is limited.

Abbreviations:

- **PIH:** Pregnancy Induced Hypertension
- **SKH:** Shree Krishna Hospital
- **OBGY:** Obstetrics and Gynaecology Department
- **FOGSI:** Federation of Obstetric and Gynaecological Societies of India
- **SBP:** Systolic Blood Pressure

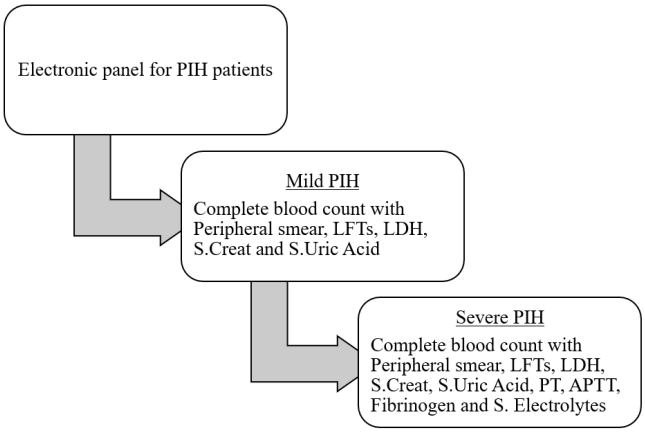

Figure 6: Proposed laboratory ordering for PIH

- **DBP:** Diastolic Blood Pressure
- **PT-INR:** Prothrombin Time-International Normalized Ratio
- **APTT:** Activated Partial Thromboplastin Time
- **LFTs:** Liver Function Tests
- **ALT:** Alanine Transaminase
- **AST:** Aspartate Transaminase
- **LDH:** Lactate Dehydrogenase
- **CRP:** C-reactive Protein
- **LIS:** Laboratory Information System
- **CPC:** Clinico-Pathologic Conference
- **PMSMA:** Pradhan Mantri Surakshit Matritva Abhiyan
- **MOHFW:** Ministry of Health and Family Welfare
- **GGT:** Gamma-glutamyl Transferase
- **NICE:** National Institute for Health and Care Excellence

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Conflicts of Interest: No

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