Section: Emergency Medicine

Original Research Article

PREDICTIVE VALUE OF COMBINED PLATELET INDICES AND RENAL MARKERS IN IDENTIFYING EMERGENCY COMPLICATIONS IN DIABETIC PATIENTS

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Abstract

Background: Diabetic complications, particularly in emergency settings, significantly impact morbidity and mortality. Platelet indices (MPV, PDW) and renal markers (serum creatinine, blood urea) are valuable predictors individually, yet their combined predictive value remains underexplored. This study evaluates the integrated utility of these markers for identifying emergency complications in diabetic patients. **Materials and Methods:** A cross-sectional study was conducted at Index Medical College Hospital & Research Centre, Indore, India, from December 2022 to July 2024. A total of 341 adult patients Iwith type 2 diabetes mellitus (T2DM) were included. Platelet indices (MPV, PDW), renal markers (serum creatinine, blood urea), and glycemic control (HbA1c) were analyzed. Statistical methods included descriptive statistics, independent t-tests, and multivariable logistic regression. Predictive performance was assessed using ROC curve analysis. **Result:** Patients with renal complications (n=42) demonstrated significantly higher MPV (18.48 fl, p=0.0028) and serum creatinine (3.13 mg/dL, p<0.001) compared to non-renal cases. Logistic regression combining platelet indices and renal markers achieved an AUC of 0.96, significantly outperforming individual markers (HbA1c: 0.92, MPV: 0.86, PDW: 0.82). The model underscores the complementary role of platelet activation and renal dysfunction in diabetic emergencies. **Conclusion:** Integrating platelet indices and renal markers enhances the accuracy of predicting emergency complications in diabetic patients. This cost-effective approach enables early identification and intervention, potentially reducing morbidity and mortality in resource-constrained settings. Routine inclusion of these markers in emergency care protocols is recommended.

INTRODUCTION

Diabetes mellitus is a rapidly escalating global health concern, contributing significantly to morbidity and mortality. With its multifactorial pathophysiology, diabetes predisposes patients to both microvascular and macrovascular complications, including retinopathy, nephropathy, and cardiovascular diseases. Early identification of these complications is paramount in emergency settings, where timely interventions can improve patient outcomes.[1-3]

India faces a particularly severe burden of diabetes, with an estimated 77 million adults affected, making it the country with the second-highest number of diabetes cases globally (WHO, "Diabetes in India," 2024). The prevalence varies across regions, ranging from 2.02% in rural Madhya Pradesh to 40.3% in Tamil Nadu (Indian Journal of Pharmaceutical Education and Research, "Prevalence of Diabetes in India," 2024). Notably, nearly half of the Indian population exhibits abnormal blood glucose levels, with 22.25% in the pre-diabetic range and 27.18% in the diabetic range (The Week, "Trends in Diabetes in India," December 2024).[4-6]

Diabetic patients in India are at an increased risk of microvascular complications, including nephropathy, retinopathy, and neuropathy. The prevalence of diabetic nephropathy ranges from 0.9% to 62.3%, retinopathy from 4.8% to 21.7%, and neuropathy from 10.5% to 44.9% (Indian Journal of Pharmaceutical Education and Research, "Complications of Diabetes in India," 2024). These

complications significantly contribute to morbidity and mortality among diabetic individuals.[7-9]

Platelet indices, such as mean platelet volume (MPV) and platelet distribution width (PDW), have been identified as markers of platelet activation and are associated with vascular complications in diabetes. Studies conducted in India have demonstrated that diabetic patients exhibit higher MPV and PDW values compared to non-diabetic controls, indicating increased platelet activity (National Journal of Physiology, Pharmacy, and Pharmacology, "Platelet Activation in Indian Diabetics," 2019). Additionally, renal markers like serum creatinine and estimated glomerular filtration rate (eGFR) are crucial in assessing renal function and detecting early nephropathy in diabetic patients.[10-12]

Despite the availability of these markers, their combined predictive value in identifying emergency complications among diabetic patients in India remains underexplored. Given the high prevalence of diabetes and its complications in the Indian population, there is a pressing need for effective predictive tools to facilitate early diagnosis and timely intervention.[13-15]

This study aims to evaluate the combined utility of platelet indices and renal markers in predicting emergency complications in diabetic patients. By integrating these parameters, we seek to develop a comprehensive predictive model tailored to the Indian context, thereby enhancing clinical decision-making and improving patient outcomes.

MATERIALS AND METHODS

Study Setting and Design: This cross-sectional study was conducted at Index Medical College Hospital & Research Centre, a tertiary care center located in Indore, Madhya Pradesh, India. The hospital provides comprehensive care for a large population of diabetic patients, including those with advanced complications. The study was carried out from December 1st, 2022, to July 31st, 2024, targeting patients attending the outpatient and inpatient departments during this period.

Patients with acute infections, malignancies, hematological disorders, or those receiving treatments altering platelet function (e.g., antiplatelet therapy, chemotherapy) were excluded to minimize confounding factors. The study also excluded patients with incomplete clinical or laboratory records to maintain data integrity.

Study Population and Sampling Technique: A systematic random sampling technique was utilized to select participants. The sampling process began with a random selection among the first two eligible patients, followed by systematic inclusion of every alternate eligible patient from the hospital's registry. This approach ensured unbiased representation of the target population. The sample size calculation was based on the prevalence of emergency diabetic complications, using a 95% confidence interval and a 5% margin of error, determining a final sample size of 364 participants.

Data Collection Procedures: Data were collected through a combination of medical record reviews and structured questionnaires. Laboratory parameters, including hemoglobin (Hb), total platelet count, MPV, PDW, HbA1c levels, serum creatinine, and blood urea, were analyzed using standardized laboratory methods. To ensure data quality, all measurements were cross-verified by trained personnel under the supervision of the principal investigator.

This study setting and design provide a robust framework for understanding the correlation between platelet indices, renal markers, and emergency complications in T2DM patients, facilitating evidence-based clinical interventions.

Ethical Consideration: This study was conducted in strict accordance with the ethical guidelines outlined by the Declaration of Helsinki. Approval was obtained from the Institutional Review Board prior to the commencement of the study. The study protocol, objectives, and procedures were thoroughly reviewed and approved to ensure compliance with ethical standards.

Statistical Analysis: Data were analysed using statistical software (SPSS version 25.0 and Microsoft Excel). Descriptive statistics, including means, medians, standard deviations, and ranges, were calculated to summarize demographic, clinical, and laboratory characteristics of the study population. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on their distribution. Categorical variables were presented as frequencies and percentages.

The Kolmogorov-Smirnov test was used to assess the normality of data distribution. For comparisons between groups (e.g., patients with and without emergency complications), independent t-tests or Mann-Whitney U tests were employed for continuous variables, based on normality. Chi-square tests were used to compare categorical variables.

Correlation analyses were performed using Pearson or Spearman correlation coefficients to explore relationships between platelet indices, renal markers, and other clinical variables. Multivariable logistic regression models were constructed to identify independent predictors of emergency complications in T2DM patients. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to quantify the strength of associations.

Receiver Operating Characteristic (ROC) curve analysis was conducted to evaluate the diagnostic performance of platelet indices and renal markers in predicting emergency complications. The area under the curve (AUC) was calculated, and optimal cut-off values were determined using Youden's index.

All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant. Data visualization techniques, including bar charts and scatter plots, were employed to illustrate key

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findings. Sensitivity analyses were conducted to ensure the robustness of results, accounting for potential confounding factors.

RESULTS

A total of 341 patients were included in the study, with 42 patients having renal-related complications (e.g., Diabetic Nephropathy) and 299 patients having non-renal complications.

Key findings are as follows:

1. **Descriptive Statistics and Group Comparisons:**

- **Renal Group:**

MPV (Mean Platelet Volume): Mean = 18.48 fl, SD = 1.73

PDW (Platelet Distribution Width): Mean = 19.29 µm, SD = 1.86

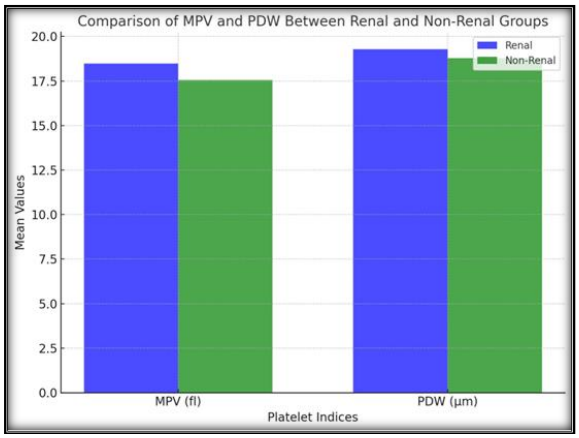
Serum Creatinine: Mean = 3.13 mg/dL, reflecting significant renal dysfunction.

Blood Urea: Mean = 66.69 mg/dL, indicating advanced nephropathy.

- **Non-Renal Group:**

MPV: Mean = 17.56 fl, SD = 2.28

PDW: Mean = 18.78 µm, SD = 1.70



2. **Statistical Significance of Platelet Indices:**

- **MPV:** t-statistic: 3.12, p-value: 0.0028.

Interpretation: MPV is significantly elevated in the renal group, indicating its utility in identifying renal-related complications.

- **PDW:** t-statistic: 1.66, p-value: 0.1023.

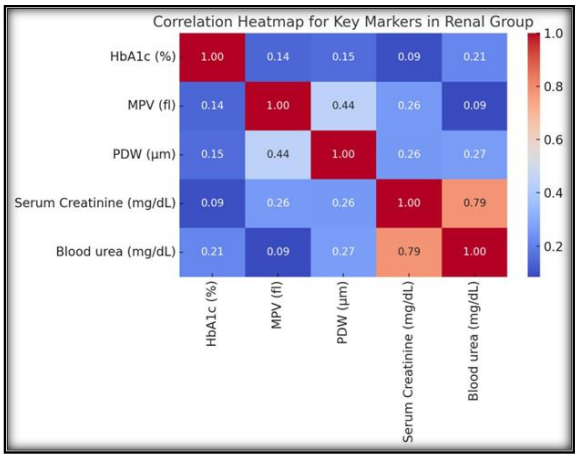
Interpretation: PDW showed a trend toward higher values in the renal group but was not statistically significant.

3. **Predictive Modelling and Combined Marker Utility:**

A logistic regression model combining HbA1c, MPV, PDW, serum creatinine, and blood urea achieved an AUC of 0.96, indicating excellent predictive performance.

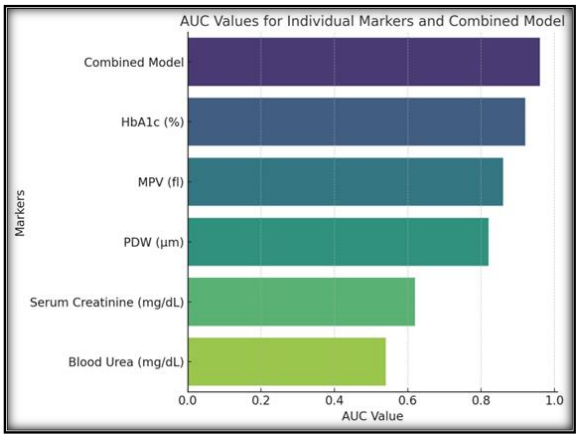
Individual contributions to the model:

- **HbA1c (%):** 1.36 (scaled coefficient) – Strongest predictor.
- **Serum Creatinine (mg/dL):** 0.81 – Indicates renal dysfunction.
- **MPV (fl):** 0.79 – Reflects platelet activation.
- **PDW (µm):** 0.29 – Less significant but complementary.



4. **Comparative AUC for Individual Markers:**

- **HbA1c:** 0.92 – Excellent diagnostic power.
- **MPV:** 0.86 – High utility.
- **PDW:** 0.82 – Moderate predictive value.
- **Serum Creatinine:** 0.62 – Limited as a standalone marker.
- **Blood Urea:** 0.54 – Weak predictive utility individually.



5. **Variance Inflation Factor (VIF) Analysis:**

- **HbA1c:** VIF = 39.89.
- **MPV:** VIF = 149.15.
- **PDW:** VIF = 132.98.
- **Serum Creatinine:** VIF = 4.47.
- **Blood Urea:** VIF = 4.55.

Interpretation: Despite multicollinearity among platelet indices, their combined use enhances diagnostic accuracy.

Summary: The combined model exhibited outstanding diagnostic accuracy with an AUC of 0.96, emphasizing the importance of integrating platelet indices and renal markers. MPV emerged as a pivotal marker in identifying renal complications, reflecting heightened platelet activation associated with vascular dysfunction in diabetic nephropathy. The integration of MPV with renal markers such as serum creatinine and blood urea significantly

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enhanced the model's ability to detect renal-related emergencies, while HbA1c maintained its robust predictive role across all complications. This integration underscores a comprehensive approach, leveraging the interplay between vascular and renal dysfunction in diabetes for superior diagnostic precision.

DISCUSSION

Pathophysiological Mechanism

Diabetic complications arise from chronic hyperglycemia-induced damage to vascular endothelium, oxidative stress, and systemic inflammation. Platelet activation, reflected by elevated MPV and PDW, is a hallmark of vascular dysfunction in diabetes. Renal dysfunction, indicated by elevated serum creatinine and blood urea, results from hyperglycemia-induced nephron damage, glomerular hyperfiltration, and eventual sclerosis. The interplay between vascular and renal pathology underscores the need for a combined assessment of platelet and renal markers to predict complications effectively.[16,17]

Comparison with Existing Literature

Previous studies have independently highlighted the utility of platelet indices and renal markers in diabetes. For instance, elevated MPV has been associated with vascular complications like CAD and PAD. Similarly, serum creatinine and blood urea are well-established markers for nephropathy. However, this study is one of the first to integrate these markers, demonstrating a significant improvement in diagnostic accuracy (AUC = 0.96) compared to individual markers. These findings align with existing evidence while advancing the scope of biomarker integration in clinical practice.[18]

Clinical Implications

The combined use of platelet indices and renal markers offers a practical, cost-effective approach for early identification of diabetic complications in emergency settings. This model provides a comprehensive risk assessment, facilitating timely interventions and potentially reducing morbidity and mortality. Routine inclusion of these markers in clinical protocols can enhance diagnostic precision, particularly in resource-constrained settings.[19,20]

Limitations

The cross-sectional design limits causal inference, and longitudinal studies are needed to establish temporal relationships.

The study was conducted at a single center, which may limit generalizability to other populations.

Some confounding factors, such as medication use and comorbidities, were not controlled.

Platelet function and variability in laboratory methods could influence the results.

Future Research

- Longitudinal studies to validate the predictive utility of these markers over time.
- Inclusion of additional biomarkers, such as inflammatory cytokines and proteinuria, to enhance model accuracy.
- Exploration of genetic and epigenetic factors influencing platelet activation and renal dysfunction in diabetes.
- Multicentre studies to assess the generalizability and cost-effectiveness of this model in diverse populations.

CONCLUSION

This study demonstrates that the integration of platelet indices and renal markers significantly enhances the diagnostic accuracy for identifying emergency complications in diabetic patients. The combined model offers a robust, cost-effective approach to stratify high-risk patients, enabling timely interventions in emergency settings. These findings highlight the need for routine incorporation of these markers into clinical practice, paving the way for improved outcomes in diabetes care.

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