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Original Article

Relationship between Platelet Distribution Width (PDW) and GRACE Risk Score to Assess the In-Hospital Outcome in Patients with Acute Coronary Syndrome

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ABSTRACT

Background: Acute coronary syndrome (ACS) is a leading cause of morbidity and in-hospital mortality worldwide, highlighting the need for simple, cost-effective biomarkers for early risk stratification. This study aimed to determine the relationship between platelet distribution width (PDW) and GRACE Risk Score with adverse in-hospital outcomes in patients with ACS. **Methods & Materials:** This cross-sectional observational study was carried out in the Department of Cardiology at Mymensingh Medical College Hospital, Mymensingh, Bangladesh, from January 2024 to December 2024. A purposive sample of 80 patients who were admitted with ACS (STEMI, NSTEMI, and unstable angina) was used. PDW was measured from a routine complete blood count at admission, and GRACE risk scores were calculated. In-hospital adverse events were recorded. Data were entered and analyzed using SPSS version 26. **Results:** The mean age of the participants was 61.8±10.9 years, with the majority being males (72.5%). The most prevalent type of ACS was STEMI (42.5%). Mean PDW was 16.82±2.5 fL, and mean GRACE score was 135.72±24.8 fL. In 35% of the patients, elevated PDW (>17.0 fL) was detected. Adverse events occurred in 30% of patients. High PDW (p=0.004) and elevated GRACE risk (p=0.002) were significantly associated with outcomes. Logistic regression showed PDW (adjusted OR 3.92; p=0.017) and GRACE score (adjusted OR 1.31; p=0.022) independently predicted in-hospital events. **Conclusion:** Platelet distribution width (PDW), an easily obtainable parameter, is associated with adverse in-hospital outcomes in ACS and improves GRACE score–based risk stratification, especially in resource-limited settings.

Keywords: *Platelet distribution width, GRACE risk score, Acute coronary syndrome*

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INTRODUCTION

Both ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI), as well as unstable angina (UA), are classified as acute coronary syndrome (ACS) and a top cause of cardiovascular morbidity and mortality in the world [1]. ACS still remains a significant burden on healthcare systems despite the great development of pharmacological and interventional treatments especially in low- and middle-income countries where resources are limited to deal with advanced diagnostics and early interventions [2]. To make clinical decisions, triage, and resource distribution on ACS patients, risk stratification of ACS patients is necessary. GRACE risk score is an effective risk measure, a well-validated metric that considers the clinical, electrocardiographic, and biochemical parameters to predict short and long-term mortality in patients with ACS [3]. Nevertheless, it involves the calculation of many variables and, logistically, can be difficult in resource-constrained environments, which has led to a desire to seek simpler adjunct biomarkers. The platelets have a key role in the pathophysiology of ACS by mechanisms of plaque rupture, forming thrombus, and inflammatory cascades [4]. Platelet activation and heterogeneity are assessed by the platelet distribution width (PDW), which is an index of platelet volume variability based on the regular complete blood count (CBC). Platelets that are active change their morphology to increase their size variability, which is reflected by an increased value of PDW [5]. PDW is therefore a cheap and universally extinguishable parameter, and without any extra laboratory workup in this instance, when compared to the routine investigations. New data indicate that high PDW correlates with high platelet activation in ischemic heart disease, and it can be used as a surrogate endpoint of disease severity [6]. Several studies have shown that there is a relationship between high PDW and poor clinical outcomes in myocardial infarction patients and other heart-related diseases [7-9]. Though such observations have been made, there is scant data on South Asians, especially Bangladeshis, where the ACS risk factors (including diabetes mellitus, hypertension, and smoking) are still high. Moreover, although both PDW and the GRACE risk score have been independently analyzed in ACS, the concomitant usefulness of PDW and the GRACE score in forecasting adverse outcomes in the hospital has not been well defined [10]. Provided that PDW proves to be a major and independent predictive variable to the extent that it can be most effectively compared or added to the GRACE score, it may significantly simplify the process of risk stratification in an environment where complex scoring is not possible on a routine basis. Some of the recent studies in the neighboring countries have shown that elevated PDW correlates with MACE (major adverse cardiovascular events) and in-hospital events such as heart failure, arrhythmia, and demise among ACS patients [11]. Nevertheless, the results should be confirmed in large, heterogeneous cohorts where the outcome is standardized. The clinical utility of PDW as a supplement to GRACE risk stratification needs more research, especially in the developing country healthcare environment. Considering the latter gaps in evidence, this study was aimed at assessing the association between PDW levels and GRACE risk categories and assessing the individual and aggregate capacity to predict adverse in-hospital outcomes in patients admitted to ACS to a tertiary care facility in Bangladesh.

METHODS & MATERIALS

This is a cross-sectional observational study conducted at Department of Cardiology, at Mymensingh Medical College Hospital, Mymensingh, Bangladesh, from January 2024 to December 2024. 80 patients who were hospitalized with a final diagnosis of acute coronary syndrome (ACS) - STEMI, NSTEMI, and unstable angina - were recruited by consecutive sampling. The study enrolled patients with an established diagnosis of ACS based on clinical presentation, electrocardiographic findings, and cardiac biomarkers; patients who were admitted to the study within 24 hours of the manifestation of the symptoms; and patients who signed informed consent in writing. Patients who had a known hematological disorder that affected platelet indices (e.g., thrombocytopenia, myeloproliferative disorders), had active infections, inflammatory conditions, or malignancies, or received antiplatelet or anticoagulation therapy before admission, or had incomplete data or refused consent were excluded from the study. The independent variables were PDW (fL), which was taken as per the admission complete blood count, and GRACE risk score, which was computed using the usual model of eight variables. Additional variables were also documented in terms of sociodemographic variables (age, sex, residence, income, smoking), clinical variables (ACS type, hypertension, diabetes mellitus, dyslipidemia, family history of IHD, previous IHD, obesity), and baseline investigations (heart rate, blood pressure, serum creatinine, blood glucose, troponin, WEC findings, LVEF, hemoglobin, WBC, platelet count). The dependent variable was adverse in-hospital outcome, which was the incidence of any of the following: acute heart failure, cardiogenic shock, significant arrhythmia, recurring ischemic chest pain, reinfarction, or in-hospital death. The data were typed and processed using SPSS version 26.0. Mean ± standard deviation (SD), frequency, and percentage were the means of representing continuous and categorical variables, respectively. The chi-square test was employed in testing relationships between categorical variables. Binary logistic regression (unadjusted and adjusted) was used to determine the independent predictors of adverse in-hospital outcomes, and the results were in the form of odds ratios (OR) and 95% confidence intervals (CI). The p-value less than 0.05 was regarded as statistically significant. Data collection was preceded by the institutional review board giving ethical approval.

RESULTS

Table I represents the sociodemographic description of 80 ACS patients. The average age was 61.8 ± 10.9 years, with most (35%) of them falling between 60 to 69 years. Males predominated at 72.5%. Over 57.5% were urban. On smoking, 38.8% were currently smoking, and 43.7% had never smoked. The highest-income category had made 20,000-40,000 per month (42.5%).

Table I

Sociodemographic characteristics of the study participants (*n* = 80).

Variable	Category	Frequency (n) /Mean ± SD	Percentage (%)
Age (years)	<50	12	15.0
	50-59	20	25.0
	60-69	28	35.0
	≥70	20	25.0
	Mean ± SD	61.8 ± 10.9 years	-
Sex	Male	58	72.5
	Female	22	27.5
Residence	Urban	46	57.5
	Rural	34	42.5
Smoking status	Current smoker	31	38.8
	Former smoker	14	17.5
	Never smoker	35	43.7
Monthly family income (BDT)	<20,000	18	22.5
	20,000-40,000	34	42.5
	>40,000	28	35.0

The clinical profile of the participants is shown in Table II. STEMI (42.5%), NSTEMI (32.5%), and unstable angina (25%) were the most frequent subtypes of ACS. The most common comorbidity was hypertension (57.5%), diabetes mellitus (38.8%), and dyslipidemia (35%). The family history of IHD was 16.3%, with 22.5% having had a history of IHD and 30% overweight or obese (*Table II*).

Table II

Clinical profile and cardiovascular risk factors of the patients (*n* = 80).

Variable	Category	Frequency (n)	Percentage (%)
Type of ACS	STEMI	34	42.5
	NSTEMI	26	32.5
	Unstable angina	20	25.0
Hypertension	Yes	46	57.5
	No	34	42.5
Diabetes mellitus	Yes	31	38.8
	No	49	61.2
Dyslipidemia	Yes	28	35.0
	No	52	65.0
Family history of IHD	Yes	13	16.3
	No	67	83.7
Previous IHD	Yes	18	22.5
	No	62	77.5
Obesity/overweight	Yes	24	30.0
	No	56	70.0

Table III includes baseline clinical and laboratory parameters. The average heart rate was 88.6 ± 15.2 beats/min, and systolic BP was 129.8 ± 21.4mmHg. Troponin was positive in 75% of the patients. The mean LVEF was 47.2 ± 8.6, the mean PDW was 16.8 ± 2.5 fL, and the mean GRACE risk score was 135.7 ± 24.8, which showed an intermediate-high risk group.

Table III
Admission findings and baseline investigation profile of the patients (*n* = 80).

Variable	Mean ± SD / n (%)
Heart rate (beats/min)	88.6 ± 15.2
Systolic blood pressure (mmHg)	129.8 ± 21.4
Serum creatinine (mg/dL)	1.14 ± 0.33
Random blood glucose (mmol/L)	9.2 ± 3.4
Troponin positive	60 (75.0)
ST-segment deviation on ECG	54 (67.5)
LVEF (%)	47.2 ± 8.6
Hemoglobin (g/dL)	12.4 ± 1.7
Total WBC count (×10⁹/L)	10.9 ± 3.1
Platelet count (×10⁹/L)	244.6 ± 58.3
PDW, fL	16.8 ± 2.5
GRACE risk score	135.7 ± 24.8

Table IV uses PDW and GRACE risk levels to categorize the patients. In most of the patients, it was normal PDW (61.2%), and 35% had increased PDW (>17.0 fL). As to GRACE risk stratification, 45% were intermediate risk, 33.7% high risk, and 21.3% low risk, indicating a high-burden ACS population.

Table IV
Distribution of patients according to PDW level and GRACE risk category (*n* = 80).

Variable	Category	Frequency (n)	Percentage (%)
PDW level (fL)	Low, <9.0	3	3.8
	Normal, 9.0-17.0	49	61.2
	High, >17.0	28	35.0
GRACE risk category	Low risk	17	21.3
	Intermediate risk	36	45.0
	High risk	27	33.7

Table V is a summary of adverse in-hospital events. The most common complication was acute heart failure (17.5%), recurrent ischemic chest pain (13.8%), and significant arrhythmia (12.5%). There were 8.8% cases of cardiogenic shock, 5% cases of reinfarction, and 7.5% cases of in-hospital mortality. In general, one out of every three patients had at least one adverse outcome.

Table V
In-hospital outcomes among the study participants (*n* = 80).

Outcome variable	Frequency (n)	Percentage (%)
Acute heart failure	14	17.5
Cardiogenic shock	7	8.8
Significant arrhythmia	10	12.5
Recurrent ischemic chest pain	11	13.8
Reinfarction	4	5.0
In-hospital death	6	7.5
Any adverse in-hospital outcome	24	30.0

Table VI shows a significant association between both PDW level and GRACE risk category with adverse in-hospital outcome. Patients with high PDW, above 17.0 fL, had the highest proportion of adverse outcomes, 53.6%, compared with 18.4% in the normal PDW group and none in the low PDW group, indicating a statistically significant relationship, p = 0.004. Similarly, adverse outcomes were most frequent in the high GRACE risk group, 55.6%, with a significant association, p = 0.002. Diagnostic analysis showed that both high PDW and high GRACE risk category had moderate sensitivity and good specificity, supporting their usefulness in identifying patients at increased in-hospital risk.

Table VI
Association of PDW level and GRACE risk category with adverse in-hospital outcome, with diagnostic performance for high-risk cut-offs (*n* = 80).

Variable	Adverse outcome present, n (%)	Adverse outcome absent, n (%)
PDW level (fL)	-	-
Low, <9.0	0 (0.0)	3 (100.0)
Normal, 9.0 to 17.0	9 (18.4)	40 (81.6)
High, >17.0	15 (53.6)	13 (46.4)
Diagnostic performance of high PDW (>17.0 fL)	-	-
Sensitivity	62.5%	-
Specificity	76.8%	-

Positive predictive value (PPV)	53.6%	-
Negative predictive value (NPV)	82.7%	-
GRACE risk category	-	-
Low risk	1 (5.9)	16 (94.1)
Intermediate risk	8 (22.2)	28 (77.8)
High risk	15 (55.6)	12 (44.4)
Diagnostic performance of high GRACE risk category	-	-
Sensitivity	62.5%	-
Specificity	78.6%	-
Positive predictive value (PPV)	55.6%	-
Negative predictive value (NPV)	83.0%	-

Sensitivity, specificity, PPV, and NPV were calculated using high PDW (>17.0 fL) and high GRACE risk category as positive test thresholds for prediction of adverse in-hospital outcome.

Binary logistic regression outcomes are demonstrated in *Table VII*. In the case of the unadjusted analysis, high PDW was correlated with a 5.13-fold higher probability of having adverse outcomes (95% CI 1.78 14.81; p = 0.003). This correlation was defined as significant after age and diabetes had been taken into account (adjusted OR 3.92; 95% CI 1.28-11.98; p = 0.017). A 10-point increment in GRACE score was independently linked to a 31% risk of having adverse outcomes (adjusted OR 1.31; 95% CI 1.04-1.66; p = 0.022).

Table VII

Logistic regression analysis for predictors of adverse in-hospital outcome (*n* = 80).

Variable	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
PDW level (High vs Normal)	5.13	1.78-14.81	0.003	3.92	1.28-11.98	0.017
GRACE score (per 10-point increase)	1.41	1.12-1.78	0.003	1.31	1.04-1.66	0.022
Age (Per year Increase)	1.03	0.98-1.09	0.201	1.02	0.96-1.08	0.438
Diabetes (Yes vs No)	1.88	0.71-4.97	0.201	1.49	0.52-4.26	0.451

DISCUSSION

This study assessed the relationship between platelet distribution width (PDW) and GRACE risk score in terms of adverse in-hospital outcomes in patients with acute coronary syndrome (ACS). The study showed that increased PDW (>17.0 fL) and increased risk category of GRACE were significantly correlated with poor in-hospital results and had an independent effect when the results were adjusted to include confounding factors. The chief demographic factors of our cohort were typical of the general ACS population in Bangladesh, with a higher proportion of middle-aged to old men and a high prevalence of cardiovascular risk factors like hypertension, diabetes mellitus, and smoking. This trend is in accordance with Yusuf et al., who showed an increasing level of non-communicable cardiovascular diseases among the low- and middle-income nations [12]. Moreover, the quite high percentage of STEMI presentation is an indication of delayed healthcare-seeking and inaccessibility of early revascularization, which has been reported by Furie (2008) [13]. In our study, the mean PDW was 16.8, which had the value of 2.5 fL, and 35% of the patients exhibited a high PDW. PDW indicates a change in platelet size, which is an indirect measure of platelet activation. Activation of platelets is central in the pathophysiology of ACS because it facilitates the formation of thrombus and microvascular blockage [14]. This biological process helps us to conclude that patients with increased PDW had a high adverse outcome ratio. Moreover, in previous research, high PDW was associated with impaired platelet functions and cardiovascular risks [15]. The relationship between high PDW and adverse in-hospital outcomes was gradient in the sense that in our study, 53.6% of high PDW patients had adverse in-hospital outcomes, as opposed to 18.4% of normal PDW patients (p = 0.004). The findings are also in line with De et al., who showed the prognostic value of PDW [15]. In acute myocardial infarction, an association of high PDW with mortality was found to be significant, which is reported by Pocock et al. [16]. In the same way, other studies carried out in Turkey and China have indicated that high levels of PDW correlate with larger infarct size, less left ventricular ejection fraction, and increased morbidities (heart failure and arrhythmias) [17]. Other investigations have also proven that PDW is related to in-hospital deaths and major adverse cardiac events [18-20]. Our study also revealed that the GRACE risk score, a mature clinical risk stratification tool, was also found to be an independent predictor of unfavorable in-hospital outcomes. A 10-point rise in GRACE score boosted the potential risk of complications by a significant margin, which is in line with the reports of Manea et al. [21]. The high predictive validity of GRACE highlights its sustained level of relevance in the clinical context in a wide range of healthcare facilities. A notable result of this study is that PDW was an independent predictor despite the fact that it was adjusted by using the GRACE score. This indicates that PDW is an extra piece of information to the usual clinical risk models that are used to offer prognostic information. GRACE only takes into consideration the hemodynamic and biochemical variables, but does not explicitly consider platelet activity. Thus, PDW can depict another pathophysiological dimension, i.e., real-time platelet activation, thus supplementing the risk assessment of GRACE. Our total negative in-hospital outcome was 30, and this is quite high in the context of high-income countries but in line with other South Asian studies [22]. This can be explained by the late presentation, a lack of accessibility to advanced cardiac care, and resource shortage. The most common complications experienced included acute heart failure and repeated ischemic chest pains, with an in-hospital mortality rate of 7.5. This information underscores the need to properly and accurately stratify risks at the earliest to inform clinical decision-making and resource allocation. Clinically, PDW is a desirable biomarker because it is not expensive and quick to measure. Compared to the more progressive biomarkers, like NT-proBNP or high-sensitivity troponin tests, PDW is regularly acquired as a part of a complete blood count, and thus, it is especially applied in resource-starved environments [23]. This renders PDW useful in risk assessment at the tertiary and district-level medical institutions. Interestingly, the conventional risk factors like age and diabetes mellitus were not statistically significant in the adjusted regression model. This could be attributed to the fact that the sample is relatively small, and thus it would not have statistical power to establish moderate associations [24]. To sum up, this study demonstrated that PDW is a predictive factor of poor in-hospital outcomes in ACS patients and can be used as an extra

condition to predict outcomes in comparison with the GRACE risk score. The inclusion of PDW into the standard clinical evaluation can also improve risk stratification, especially in resource-limited facilities where not everyone can get access to high-quality diagnostic instruments.

LIMITATIONS

This study is limited by its cross-sectional, single-center design with a modest sample size (n = 80), which may restrict statistical power and generalizability of the findings. Additionally, long-term follow-up outcomes beyond in-hospital stay were not assessed, and interventional procedures (e.g., PCI) were not uniformly captured as potential confounders.

CONCLUSION

This study demonstrates that elevated platelet distribution width (PDW) is a significant and independent predictor of adverse in-hospital outcomes in patients with acute coronary syndrome (ACS), corroborating findings with the GRACE risk score. The majority of our cohort presented with intermediate-to-high GRACE risk and had a 30% rate of in-hospital complications, with elevated PDW strongly correlating with worse outcomes (adjusted OR 3.92). PDW, being a simple and universally available hematological parameter, can meaningfully complement the GRACE score in early risk stratification. Its integration into routine clinical assessment could facilitate timely clinical decision-making, particularly in resource-limited healthcare settings where advanced biomarkers may not be accessible. These findings support the broader adoption of PDW as an adjunct prognostic tool in the management of ACS.

RECOMMENDATIONS

Future multicenter, prospective studies with larger sample sizes and long-term follow-up are warranted to validate the prognostic role of PDW in ACS and to determine optimal PDW cut-off values for clinical use. Studies incorporating PDW alongside other novel platelet indices (e.g., mean platelet volume, platelet-large cell ratio) may further refine risk stratification in ACS patients.

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CONFLICT OF INTEREST

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