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ROLE OF RED CELL DISTRIBUTION WIDTH AS A PREDICTOR OF DISEASE SEVERITY AMONG HOSPITALIZED PATIENTS IN A TERTIARY CARE HOSPITAL IN NORTH INDIA: A CROSS-SECTIONAL OBSERVATIONAL STUDY

Dr. Neeta Binwani

Assistant Professor, Department of Pathology, Era's Lucknow Medical College and Hospital, Sarfarazganj, Lucknow, Uttar Pradesh, India neetabinwani513@gmail.com

Corresponding Author: Dr. Neeta Binwani

Address: Department of Pathology, Era's Lucknow Medical College and Hospital, Sarfarazganj, Lucknow, Uttar Pradesh, India

ABSTRACT

Background: Red cell distribution width (RDW) is a routinely reported hematological parameter that reflects variability in erythrocyte size. Recent studies have suggested its potential role as a prognostic marker in various clinical conditions. Given its widespread availability and low cost, RDW may serve as a useful indicator of disease severity among hospitalized patients.

Objectives: To assess the association between RDW and disease severity among hospitalized patients and to evaluate its usefulness as a predictor of severe disease in a tertiary care hospital in North India.

Methods: A hospital-based observational cross-sectional analytical study was conducted in the Department of Medicine of a tertiary care hospital in North India from March 2013 to July 2013. A total of 46 adult patients meeting the eligibility criteria were enrolled using consecutive sampling. Demographic, clinical, and laboratory data were collected at admission. RDW was measured as part of the complete blood count using an automated hematology analyzer. Patients were categorized into mild/moderate disease and severe disease groups based on predefined clinical criteria. Statistical analysis was performed using SPSS version 20.0. Continuous variables were compared using appropriate parametric or non-parametric tests, while categorical variables were analyzed using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Results: Of the 46 study participants, 28 (60.9%) had mild to moderate disease and 18 (39.1%) had severe disease. Patients with severe disease had significantly higher RDW values than those with mild/moderate disease (15.2 ±1.6% vs. 13.6 ±1.1%; $p<0.001$). Elevated RDW (>14%) showed a significant association with severe disease ($p=0.001$). RDW demonstrated a positive correlation with total leukocyte count ($r=0.42$, $p=0.004$) and a weak negative correlation with hemoglobin concentration ($r=-0.31$, $p=0.04$). An RDW threshold of >14% showed a sensitivity of 83.3%, specificity of 67.9%, positive predictive value of 62.5%, negative predictive value of 86.4%, and overall accuracy of 73.9% for identifying severe disease.

Conclusion: Elevated RDW is significantly associated with increased disease severity among hospitalized patients. As an inexpensive and routinely available laboratory parameter, RDW may serve as a useful adjunctive marker for early risk stratification and prognostic assessment in clinical practice.

Keywords: Red cell distribution width; RDW; Disease severity; Prognostic marker; Hospitalized patients; Inflammation; Risk stratification.

INTRODUCTION

Red cell distribution width (RDW) is a routinely reported parameter in the complete blood count that reflects the degree of variability in circulating erythrocyte size. Traditionally, RDW has been used primarily in the differential diagnosis of anemia and related hematological disorders. However, over the last decade, growing evidence has suggested that RDW may serve as a useful biomarker beyond hematological diseases, particularly in predicting adverse clinical outcomes and disease severity across a wide range of medical conditions [1]. Because RDW is inexpensive, readily available, and universally measured in hospitalized patients, its potential utility as a prognostic indicator has attracted considerable attention among clinicians and researchers.

Several studies have demonstrated a significant association between elevated RDW and increased morbidity and mortality in cardiovascular diseases, including heart failure, coronary artery disease, and peripheral vascular disease [2,3]. RDW has also emerged as a predictor of poor outcomes in critically ill patients admitted to intensive care units, where higher values have been linked with increased hospital mortality and prolonged hospitalization [4,5]. These observations suggest that RDW may reflect underlying pathophysiological processes that extend beyond abnormalities of erythropoiesis.

The biological mechanisms underlying the association between elevated RDW and disease severity are not fully understood. Chronic inflammation, oxidative stress, nutritional deficiencies, impaired iron metabolism, renal dysfunction, and bone marrow suppression have all been proposed as contributing factors [6]. Inflammatory cytokines may interfere with erythrocyte maturation and survival, resulting in greater heterogeneity of red blood cell size and consequently increased RDW values. Since inflammation and oxidative stress are common pathways involved in the progression of many acute and chronic illnesses, RDW may act as an indirect marker of overall disease burden [7].

In recent years, studies conducted in different populations have reported that elevated RDW is associated with worse outcomes in conditions such as sepsis, pneumonia, acute cardiovascular events, chronic kidney disease, and critical illness [4,5,8]. These findings have generated interest in evaluating RDW as a simple prognostic tool that could complement established clinical scoring systems and laboratory markers. Compared with specialized biomarkers, RDW has the advantage of being inexpensive and immediately available at the time of patient presentation, making it particularly relevant in resource-constrained healthcare settings.

In India, where healthcare facilities frequently encounter a large burden of acute and chronic diseases, the identification of cost-effective prognostic markers remains an important clinical priority. Tertiary care hospitals in North India manage a diverse spectrum of patients with varying disease severity, often requiring rapid risk stratification to guide treatment decisions and resource allocation. Despite the increasing international literature on RDW, data from Indian hospital settings evaluating its role as a predictor of disease severity remain limited [9].

Furthermore, most available studies have focused on specific disease categories or mortality outcomes, while fewer investigations have explored the relationship between RDW and overall disease severity among hospitalized patients in routine clinical practice [10]. Variations in patient demographics, nutritional status, disease spectrum, and healthcare delivery systems may influence

the prognostic performance of RDW across different populations. Therefore, locally generated evidence is necessary before RDW can be routinely incorporated into clinical decision-making. Considering the widespread availability of RDW and the need for simple prognostic indicators in tertiary care settings, evaluating its association with disease severity may provide valuable clinical insights. The present study was undertaken in a tertiary care hospital in North India to assess the role of RDW in predicting disease severity among hospitalized patients. The specific objective was to determine the association between RDW values and disease severity and to evaluate its usefulness as a readily available prognostic marker in routine clinical practice.

METHODOLOGY

Study Design: This was a hospital-based observational cross-sectional analytical study conducted to evaluate the role of red cell distribution width (RDW) in predicting disease severity among hospitalized patients.

Study Setting: The study was conducted in the Department of Medicine of a tertiary care teaching hospital in North India. Patients admitted to medical wards and evaluated for various acute and chronic illnesses during the study period were considered for inclusion.

Study Duration: The study was conducted over a period of five months from March 2013 to July 2013.

Study Population: The study population comprised adult patients admitted to the Department of Medicine during the study period who underwent routine hematological investigations, including complete blood count with RDW estimation, at the time of hospital admission.

Inclusion Criteria

Patients aged 18 years and above.
Patients admitted to the Department of Medicine during the study period.
Patients in whom complete blood count including RDW measurement was available at admission.
Patients willing to provide informed written consent for participation.

Exclusion Criteria

Patients with known hematological malignancies.
Patients with recent blood transfusion within the preceding three months.
Patients receiving chemotherapy or radiotherapy.
Patients with documented hemoglobinopathies.
Pregnant women.
Patients with incomplete clinical or laboratory records.
Patients unwilling to provide informed consent.

Sample Size: The sample size was determined based on the expected prevalence of elevated RDW among hospitalized patients and the feasibility of recruitment during the study period.
The sample size was calculated using the formula:
$n = Z^2 \times p \times q / d^2$
Where:

n = required sample size
Z = 1.96 at 95% confidence level

p = anticipated prevalence (50%, used in the absence of reliable local estimates to obtain maximum sample size)
q = 1 − p
d = allowable error

Considering the limited study duration and feasibility constraints, a minimum sample of approximately 45 patients was considered adequate for exploratory assessment. During the study period, 46 eligible patients satisfying the selection criteria were enrolled and included in the final analysis.

Sampling Technique: A consecutive sampling technique was employed. All eligible patients admitted during the study period who fulfilled the inclusion criteria and provided informed consent were recruited consecutively until the desired sample size was achieved.

Data Collection Tools and Procedure: After obtaining informed consent, demographic details, relevant clinical history, presenting complaints, physical examination findings, and final clinical diagnosis were recorded using a predesigned case record form. Venous blood samples were collected at admission as part of routine clinical evaluation. Complete blood count parameters, including hemoglobin concentration, total leukocyte count, platelet count, mean corpuscular volume, and RDW, were measured using an automated hematology analyzer available in the central laboratory. Disease severity was assessed using predefined clinical and laboratory criteria based on the underlying diagnosis and treating physician assessment. Patients were categorized into mild/moderate and severe disease groups for analytical comparison. All data were entered into a structured database and checked for completeness before analysis.

Study Variables: The primary independent variable was RDW measured at hospital admission and expressed as a percentage. Additional independent variables included age, sex, hemoglobin concentration, total leukocyte count, platelet count, and underlying clinical diagnosis. The dependent variable was disease severity, categorized according to established clinical criteria and overall patient status during hospitalization. The association between RDW levels and disease severity constituted the primary outcome measure of the study.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 20.0. Continuous variables were summarized as mean ±standard deviation or median with interquartile range, depending on data distribution. Categorical variables were expressed as frequencies and percentages. Comparisons between severity groups were performed using Student's t-test or Mann–Whitney U test for continuous variables and Chi-square test or Fisher's exact test for categorical variables, as appropriate. Correlation analysis was performed to evaluate the relationship between RDW and disease severity indicators. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: Written informed consent was obtained from all participants before enrollment. Confidentiality and anonymity of patient information were maintained throughout the study. Participation was voluntary, and patients were free to withdraw at any stage without affecting their treatment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and applicable institutional guidelines governing biomedical research involving human participants.

RESULTS

A total of 46 patients were included in the study, of whom 28 (60.9%) were categorized as having mild to moderate disease severity and 18 (39.1%) were classified as having severe disease. Patients with severe disease were significantly older and had higher total leukocyte counts compared with those in the mild/moderate disease group (Table 1).

Table 1. Baseline demographic and clinical characteristics of study participants (N = 46)

Variable	Mild/Moderate Disease (n=28)	Severe Disease (n=18)	Total (N=46)	p-value
Age (years), Mean ± SD	48.6 ± 13.2	57.8 ± 14.1	52.2 ± 14.1	0.03
Male, n (%)	17 (60.7)	12 (66.7)	29 (63.0)	0.68
Female, n (%)	11 (39.3)	6 (33.3)	17 (37.0)	—
Hemoglobin (g/dL), Mean ± SD	11.8 ± 1.9	10.9 ± 2.1	11.4 ± 2.0	0.14
Total Leukocyte Count (×10⁹/L), Mean ± SD	9.4 ± 3.1	12.1 ± 4.5	10.5 ± 3.9	0.02

RDW values were significantly higher among patients with severe disease. The proportion of patients with RDW values greater than 15% was substantially higher in the severe disease group, indicating a positive relationship between increasing RDW and disease severity (Table 2)

Table 2. Comparison of RDW values according to disease severity

RDW Parameter	Mild/Moderate Disease (n=28)	Severe Disease (n=18)	p-value
RDW (%), Mean ± SD	13.6 ± 1.1	15.2 ± 1.6	<0.001
RDW <14%, n (%)	19 (67.9)	3 (16.7)	—
RDW 14–15%, n (%)	7 (25.0)	6 (33.3)	—
RDW >15%, n (%)	2 (7.1)	9 (50.0)	0.001

A statistically significant association was observed between elevated RDW (>14%) and severe disease status. Patients with elevated RDW demonstrated a markedly greater likelihood of belonging to the severe disease category compared with patients having normal RDW values (Table 3).

Table 3. Association between elevated RDW and disease severity

RDW Category	Mild/Moderate Disease n (%)	Severe Disease n (%)	Total
≤14% (n=22)	19 (86.4)	3 (13.6)	22
>14% (n=24)	9 (37.5)	15 (62.5)	24

Correlation analysis revealed a moderate positive correlation between RDW and total leukocyte count, while a weak negative correlation was observed between RDW and hemoglobin concentration. Increasing age also showed a weak positive correlation with RDW (Table 4).

Table 4. Correlation of RDW with selected laboratory parameters

Variable	Correlation Coefficient (r)	p-value
Hemoglobin (g/dL)	-0.31	0.04
Total Leukocyte Count (×10⁹/L)	0.42	0.004
Age (years)	0.29	0.05

Evaluation of diagnostic performance demonstrated that an RDW threshold of >14% showed good sensitivity and negative predictive value for identifying severe disease, suggesting its potential utility as a screening and prognostic marker in hospitalized patients (Table 5)

Table 5. Diagnostic performance of elevated RDW (>14%) in identifying severe disease

Parameter	Value (%)
Sensitivity	83.3
Specificity	67.9
Positive Predictive Value	62.5
Negative Predictive Value	86.4
Overall Accuracy	73.9

DISCUSSION

The present hospital-based observational study evaluated the role of red cell distribution width (RDW) in predicting disease severity among hospitalized patients in a tertiary care center in North India. The study demonstrated that patients with severe disease had significantly higher RDW values compared with those having mild to moderate disease severity. Elevated RDW was significantly associated with severe disease status, and higher RDW values showed a positive correlation with markers suggestive of systemic illness burden, particularly total leukocyte count. These findings support the potential utility of RDW as a readily available and inexpensive prognostic marker in routine clinical practice.

RDW has traditionally been used as a hematological parameter for the differential diagnosis of anemia. However, accumulating evidence before and during the study period suggested that RDW may also serve as a marker of disease severity and adverse clinical outcomes in diverse patient populations [1,2]. The significantly higher mean RDW observed among patients with severe disease in the present study is consistent with previous investigations that reported an association between anisocytosis and worsening clinical status [4,5].

Felker et al. reported that elevated RDW was independently associated with adverse outcomes in patients with heart failure, suggesting that RDW reflects underlying pathophysiological disturbances beyond erythrocyte morphology alone [2]. Similarly, Allen et al. demonstrated that increased RDW

was associated with disease progression and poorer prognosis in cardiovascular disorders [6]. Although the present study included a heterogeneous hospitalized population rather than a disease-specific cohort, the observed relationship between RDW and disease severity supports the broader applicability of these findings.

The significant association between elevated RDW and severe disease observed in this study is also in agreement with findings reported by Braun et al., who demonstrated that hospitalized patients with higher RDW values experienced worse clinical outcomes and increased mortality risk [4]. Likewise, Hunziker et al. found that RDW improved risk stratification among critically ill patients and provided prognostic information beyond conventional severity assessment tools [5]. The consistency of these observations across different patient populations suggests that RDW may represent a generalized marker of physiological stress and systemic dysfunction.

Several biological mechanisms may explain the association between elevated RDW and disease severity. Chronic inflammation is considered one of the most important contributing factors. Pro-inflammatory cytokines may impair erythrocyte maturation, alter iron metabolism, and shorten red blood cell survival, resulting in increased variability in erythrocyte size [7]. In addition, oxidative stress, nutritional deficiencies, renal impairment, and neurohormonal activation may contribute to ineffective erythropoiesis and anisocytosis [6]. Because these mechanisms are frequently encountered in severe acute and chronic illnesses, RDW may indirectly reflect the cumulative burden of disease.

In the present study, RDW demonstrated a positive correlation with total leukocyte count. This observation supports the hypothesis that inflammation contributes to elevated RDW values. Increased leukocyte counts are commonly regarded as indicators of systemic inflammatory response, and the concurrent rise in RDW may reflect shared underlying inflammatory pathways. Similar associations between RDW and inflammatory markers have been reported in previous studies [7,8].

A weak negative correlation between RDW and hemoglobin concentration was also observed. This finding is biologically plausible because greater heterogeneity in erythrocyte size may accompany disturbances in erythropoiesis and anemia. However, the magnitude of the correlation was modest, suggesting that the prognostic value of RDW cannot be explained solely by hemoglobin levels and may represent additional pathophysiological processes.

The diagnostic performance analysis showed relatively high sensitivity and negative predictive value for elevated RDW in identifying severe disease. These findings suggest that RDW may be particularly useful as an initial screening parameter for identifying patients who require closer clinical monitoring. Since RDW is routinely reported as part of a complete blood count, its incorporation into clinical assessment would not incur additional costs, an important consideration in resource-limited healthcare settings.

From a public health perspective, early recognition of patients at risk for severe disease may facilitate timely intervention, optimized resource utilization, and improved patient outcomes. In tertiary care hospitals with heavy patient loads, simple laboratory markers that assist in risk stratification can provide valuable support to clinical decision-making. RDW may therefore serve as a practical adjunct to established clinical and laboratory assessment methods.
The present study has several strengths. First, it evaluated RDW using routinely available laboratory data, thereby reflecting real-world clinical practice. Second, all patients were assessed within a uniform hospital setting using standardized laboratory methods. Third, the study addressed an area with limited data from North Indian tertiary care institutions.

Certain limitations should also be acknowledged. The study was conducted at a single center and included a relatively small sample size, which may limit the generalizability of the findings. The cross-sectional design precluded assessment of temporal relationships and long-term outcomes. In addition, disease severity was evaluated across a heterogeneous patient population, which may have introduced variability related to underlying diagnoses. Larger prospective studies involving diverse clinical settings are required to further validate the prognostic utility of RDW and establish clinically meaningful cut-off values for risk prediction.

Overall, the findings of the present study are consistent with existing literature indicating that elevated RDW is associated with increased disease severity. The results support the growing evidence that RDW may function as a simple and cost-effective biomarker for risk stratification among hospitalized patients.

CONCLUSION

The present study demonstrated a significant association between elevated red cell distribution width (RDW) and increased disease severity among hospitalized patients in a tertiary care hospital setting. Patients with severe disease exhibited higher RDW values compared with those having mild to moderate disease severity. Elevated RDW was also associated with higher leukocyte counts, supporting its relationship with systemic inflammatory burden and overall physiological stress.
As RDW is routinely available through standard complete blood count testing, it represents a simple, inexpensive, and readily accessible laboratory parameter that may aid in early risk stratification of hospitalized patients. The observed sensitivity and negative predictive value suggest that RDW may be useful in identifying patients who are less likely to have severe disease while helping clinicians recognize individuals who may require closer monitoring and more intensive management.Although the findings are encouraging, larger multicenter prospective studies are needed to validate these observations and establish standardized RDW thresholds for clinical application. Incorporation of RDW into routine clinical assessment may improve prognostic evaluation and support evidence-based decision-making in resource-constrained healthcare settings.

DECLARATIONS

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Conflict of Interest: The authors declare that there is no conflict of interest.
Informed Consent: Written informed consent was obtained from all participants before enrollment in the study.
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