

Red Cell Distribution Width and Serum Electrolyte Disturbances as Predictors of Length of Hospital Stay in Acute Exacerbation of Chronic Obstructive Pulmonary Disease: A Prospective Observational Study

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ABSTRACT

Introduction: Acute Exacerbation of Chronic Obstructive Pulmonary Disease (AECOPD) is a frequent cause of hospital admission, and early identification of patients likely to have prolonged in-patient stay is clinically useful. Red Cell Distribution Width (RDW) and serum electrolyte disturbances are routinely available at admission, but their combined relationship with length of hospital stay is not consistently described.

Aim: To assess admission RDW and serum electrolyte levels in patients admitted with AECOPD and to examine their association with length of hospital stay.

Materials and Methods: This hospital-based prospective observational study was conducted in the Department of Respiratory Medicine, Adichunchanagiri Institute of Medical Sciences, BG Nagara, Karnataka, India, over three months from June 2025 to August 2025. A total of 50 consecutive patients aged 40 years or older admitted with AECOPD were analysed. RDW and serum electrolyte levels were measured at admission, and length of hospital stay was calculated from admission to discharge. Correlation analysis and multivariate

linear regression were performed using IBM Statistical Package for Social Sciences (SPSS), version 30.0. A p-value<0.05 was considered statistically significant.

Results: The mean age was 65.4±8.2 years, and the mean length of hospital stay was 10.6±2.8 days. Elevated RDW (>14.3%) was present in 41 (82%) patients, while hyponatraemia, hypokalaemia, hypocalcaemia, and hypomagnesaemia were observed in 38 (76%), 32 (64%), 29 (58%), and 18 (36%) patients, respectively. RDW showed a significant positive correlation with length of stay ($r=+0.47$, $p=0.001$). Serum sodium ($r=-0.39$, $p=0.005$) and potassium ($r=-0.31$, $p=0.028$) showed significant inverse correlations. In multivariate analysis, RDW ($\beta=+0.42$, $p=0.001$), serum sodium ($\beta=-0.32$, $p=0.008$), and serum potassium ($\beta=-0.25$, $p=0.038$) remained independent predictors of length of hospital stay.

Conclusion: Higher RDW and lower serum sodium and potassium at admission were independently associated with longer length of hospital stay among patients admitted with AECOPD. These routinely available admission parameters may support early risk stratification and inpatient management planning.

Keywords: Biomarkers, Erythrocyte indices, Hospitalisation, Water-electrolyte imbalance

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) remains a major global health problem, contributing substantially to morbidity, mortality, and healthcare expenditure [1]. Global modelling estimates have shown that COPD continues to affect a large adult population worldwide, with smoking, environmental exposure, and ageing acting as important determinants of disease burden [2]. Acute exacerbations are clinically important events because they accelerate functional decline, increase treatment costs, and frequently require hospital admission.

Length of hospital stay in AECOPD is not uniform. Some patients recover quickly after bronchodilator therapy, corticosteroids, antibiotics, oxygen support, and correction of reversible triggers; others remain admitted for longer because of greater physiological stress, coexisting infection, nutritional compromise, or metabolic instability. Wang et al. reported that several clinical factors may contribute to prolonged hospitalisation after AECOPD, reinforcing the need for simple admission markers that can help anticipate a longer in-patient course [3].

The RDW is reported routinely as part of the complete blood count and reflects heterogeneity in erythrocyte size. Although traditionally used in the assessment of anaemia, RDW has increasingly been

studied as a marker related to inflammation, oxidative stress, and disease severity in COPD [4]. Serum electrolyte disturbances are also common during exacerbations. Deep A et al., observed clinically relevant electrolyte abnormalities among patients presenting with AECOPD, while Ogan N et al., reported that serum electrolyte disturbances and uric acid levels were associated with mortality in this population [5,6].

Recent work has examined RDW as a prognostic marker in AECOPD, including studies linking higher RDW with prognosis, exacerbation severity, and future exacerbation risk [7-9]. However, literature is scarce on assessment of RDW and multiple serum electrolyte levels together in relation to length of hospital stay, especially in Indian tertiary-care settings where these tests are inexpensive, rapidly available, and routinely ordered at admission [9]. The present study was therefore conducted to assess admission RDW and serum electrolyte levels in patients admitted with AECOPD and to evaluate their association with length of hospital stay. It was hypothesised that higher RDW and lower serum sodium and potassium levels would be associated with longer hospitalisation.

MATERIALS AND METHODS

This hospital-based prospective observational study was conducted in the Department of Respiratory Medicine, Adichunchanagiri Institute

of Medical Sciences, Adichunchanagiri University, BG Nagara, Karnataka, India, from June 2025 to August 2025. The study was initiated after approval from the Institutional Ethics Committee of Adichunchanagiri Institute of Medical Sciences (Ref No: AIMS/IEC/208/2025). Written informed consent was obtained from all participants before enrolment.

Inclusion criteria: Patients aged ≥ 40 years who were admitted with a clinical diagnosis of AECOPD were screened consecutively. AECOPD was diagnosed as an acute worsening of respiratory symptoms, such as dyspnoea, cough, and/or sputum, requiring additional therapy in a patient with known COPD, in line with GOLD-based clinical criteria [1]. Patients with previously diagnosed COPD who fulfilled criteria for acute exacerbation requiring inpatient management were included.

Exclusion criteria: Patients with primary haematological disorders, active pulmonary tuberculosis, malignancy, or bronchial asthma were excluded to minimise confounding effects on RDW or electrolyte measurements.

Sample size calculation: Sample size was justified for correlation analysis using Fisher's z transformation. The formula used was

$$n = \{ (Z1 - \alpha/2 + Z1 - \beta) / C \}^2 + 3$$
, where

$C = 0.5 \ln \{ (1+r) / (1-r) \}$. An anticipated moderate correlation coefficient of $r = 0.40$ was used for planning; this was selected as a clinically meaningful moderate effect size, guided by Cohen's conventional approach to effect-size estimation when precise prior estimates are unavailable [10]. Using 95% confidence level and 80% power, the minimum required sample size was 47. The calculated requirement was therefore met by enrolling 50 consecutive eligible patients during the study period. All 50 enrolled participants had admission RDW, serum electrolyte values, and length-of-stay data available for analysis.

Study Procedure

Baseline venous blood samples were obtained at admission before intensive in-patient management. RDW was recorded from the complete blood count. Serum sodium, potassium, calcium, and magnesium were measured using routine biochemical methods. Demographic details, smoking history, presenting symptoms, RDW, serum electrolyte values, and length of hospital stay were recorded. Length of hospital stay was defined as the total number of days from hospital admission to discharge.

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 30.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation, and categorical variables as frequency and percentage. After review of data distribution and scatterplot-based linearity, the Pearson correlation coefficient was used for RDW, serum sodium, serum potassium, serum calcium, and serum magnesium in relation to length of hospital stay. Variables showing significant univariate association with length of stay were entered into a multivariate linear regression model. All statistical tests were two-tailed, and $p < 0.05$ was considered statistically significant.

RESULTS

A total of 50 patients admitted with AECOPD were included and analysed. The mean age was 65.4 $\pm$ 8.2 years. Men constituted 40 (80%) patients and women constituted 10 (20%) patients. Smoking history was present in 39 (78%) patients. Cough was recorded in all 50 (100%) patients, dyspnoea in 47 (94%), and fever in 21 (42%). The mean duration of length of hospital stay was 10.6 $\pm$ 2.8 days. Baseline demographic and clinical characteristics are shown in [Table/Fig-1].

Variables	n (%)
Age (years), (Mean $\pm$ SD)	65.4 $\pm$ 8.2
Gender	
Male	40 (80)
Female	10 (20)
Characteristics	
Smoking history	39 (78)
Cough	50 (100)
Dyspnoea	47 (94)
Fever	21 (42)
Length of hospital stay (days), (Mean $\pm$ SD)	10.6 $\pm$ 2.8

[Table/Fig-1]: Baseline demographic and clinical characteristics of the study cohort (N=50). Values are expressed as mean $\pm$ standard deviation or number (percentage), as appropriate

At admission, the mean RDW was 16.9 $\pm$ 2.8%, and elevated RDW ($>14.3\%$) [4] was present in 41 (82%) patients. The mean serum sodium level was 131.2 $\pm$ 4.5 mmol/L, with hyponatraemia observed in 38 (76%) patients. Mean potassium was 3.3 $\pm$ 0.6 mmol/L, with hypokalaemia in 32 (64%) patients. Mean calcium was 8.1 $\pm$ 0.4 mg/dL and mean magnesium was 1.76 $\pm$ 0.2 mg/dL; hypocalcaemia and hypomagnesaemia were present in 29 (58%) and 18 (36%) patients, respectively. The admission RDW and electrolyte profile are shown in [Table/Fig-2].

Parameters	Mean $\pm$ SD	Patients with abnormal values, n (%)
RDW (%)	16.9 $\pm$ 2.8	41 (82)
Serum sodium (mmol/L)	131.2 $\pm$ 4.5	38 (76)
Serum potassium (mmol/L)	3.3 $\pm$ 0.6	32 (64)
Serum calcium (mg/dL)	8.1 $\pm$ 0.4	29 (58)
Serum magnesium (mg/dL)	1.76 $\pm$ 0.20	18 (36)

[Table/Fig-2]: Admission RDW and serum electrolyte profile of the study cohort (N=50). RDW: Red cell distribution width; Thresholds indicate abnormal category classification; the RDW cut-off of $>14.3\%$ was cited from prior COPD-RDW literature [4], while electrolyte cut-offs represent the laboratory reference limits used for clinical categorisation

Correlation analysis using the Pearson's correlation coefficient showed that RDW had a significant positive association with length of hospital stay ($r = +0.47$, $p = 0.001$). Serum sodium ($r = -0.39$, $p = 0.005$) and serum potassium ($r = -0.31$, $p = 0.028$) showed significant inverse correlations with length of hospital stay. Serum calcium ($r = -0.21$, $p = 0.143$) and serum magnesium ($r = -0.13$, $p = 0.369$) showed weaker, statistically non significant inverse correlations. These results are presented in [Table/Fig-3].

Variables	r-value	p-value	Interpretation
RDW (%)	+0.47	0.001	Significant positive correlation
Serum sodium (mmol/L)	-0.39	0.005	Significant inverse correlation
Serum potassium (mmol/L)	-0.31	0.028	Significant inverse correlation
Serum calcium (mg/dL)	-0.21	0.143	Not significant
Serum magnesium (mg/dL)	-0.13	0.369	Not significant

[Table/Fig-3]: Correlation between admission parameters and length of hospital stay. RDW: Red cell distribution width; Pearson correlation coefficients are shown. Negative r values indicate an inverse association with the length of hospital stay

In the multivariate linear regression model, RDW, serum sodium, and serum potassium remained independent predictors of length of hospital stay. RDW had a positive standardised beta coefficient ($\beta = +0.42$, $p = 0.001$), while serum sodium ($\beta = -0.32$, $p = 0.008$) and serum potassium ($\beta = -0.25$, $p = 0.038$) retained inverse associations. The model explained 39.6% of the variation in length of hospital stay ($R^2 = 0.396$; adjusted $R^2 = 0.357$), as shown in [Table/Fig-4].

Variables	Standardised beta	95% CI for B	p-value	Inference
RDW (%)	+0.42	0.185 to 0.648	0.001	Independent predictor
Serum sodium (mmol/L)	-0.32	-0.344 to -0.054	0.008	Independent predictor
Serum potassium (mmol/L)	-0.25	-2.238 to -0.064	0.038	Independent predictor
Overall model	—	R ² =0.396; adjusted R ² =0.357	<0.001	Statistically significant

[Table/Fig-4]: Multivariate linear regression model for predictors of length of hospital stay.

RDW: Red cell distribution width; Multivariate linear regression with length of hospital stay as the dependent variable. Model R²=0.396 and adjusted R²=0.357. Values under 95% CI represent confidence intervals for the unstandardised B coefficients; standardised beta values are shown separately for comparability with the originally reported effect estimates

DISCUSSION

The present study showed that RDW, serum sodium, and serum potassium measured at admission were significantly associated with length of hospital stay in patients admitted with AECOPD. The cohort had a mean length of hospital stay of 10.6±2.8 days. RDW showed a significant positive correlation with stay duration ($r=+0.47$, $p=0.001$), whereas serum sodium ($r=-0.39$, $p=0.005$) and serum potassium ($r=-0.31$, $p=0.028$) showed inverse correlations. These findings suggest that both haematological stress and electrolyte imbalance may contribute to identifying patients likely to require a longer in-patient course.

The RDW finding is consistent with earlier literature showing a relationship between haematological indices and COPD severity. Kalemci S et al., reported that haematological parameters varied with the severity level of COPD, supporting the biological link between systemic illness burden and blood indices [11]. The present study extends this idea in an admission-based AECOPD cohort, where elevated RDW was common, being present in 41 (82%) patients, and was independently associated with length of hospital stay in multivariable analysis.

The RDW has been examined in relation to several clinically relevant outcomes in AECOPD. Zhu M et al., reported that a dynamic increase in RDW predicted a higher risk of 30-day readmission among patients with AECOPD [12]. Epstein D et al., described increased RDW as a predictor of adverse outcome in patients hospitalised due to AECOPD [13]. In the present study, the focus was not mortality or readmission, but length of hospital stay; nevertheless, the direction of association was similar, suggesting that RDW may reflect a broader inflammatory and physiological burden at admission.

Electrolyte abnormalities were also frequent. Hyponatraemia was observed in 38 (76%) patients and hypokalaemia in 32 (64%) patients. These results are clinically relevant because sodium and potassium remained independent predictors in the multivariate model. Deep A et al., documented electrolyte abnormalities in patients presenting with AECOPD, and Ogan N et al., reported that electrolyte disturbances were associated with mortality in AECOPD [5,6]. In comparison, the present study used length of hospital stay as the outcome and found that lower sodium and potassium were associated with longer admission duration.

Calcium and magnesium abnormalities were present, with hypocalcaemia in 29 (58%) and hypomagnesaemia in 18 (36%) patients. However, their correlations with length of hospital stay were not statistically significant (calcium: $r=-0.21$, $p=0.143$; magnesium: $r=-0.13$, $p=0.369$). This does not rule out clinical relevance, because both parameters may influence respiratory muscle performance or overall physiological stability. It only indicates that, in the present study cohort of 50 patients, their direct relationship with length of hospital stay was weaker than that observed for RDW, sodium, and potassium.

The multivariate findings provide a more focused interpretation. RDW ($\beta=+0.42$, $p=0.001$), serum sodium ($\beta=-0.32$, $p=0.008$),

and serum potassium ($\beta=-0.25$, $p=0.038$) remained independent predictors of length of hospital stay. Nutritional and systemic factors may partly explain this pattern. Yuan FZ et al., reported that prognostic nutritional indexes were related to clinical outcomes in AECOPD [14]. More recent population-based evidence has also linked RDW-related indices with mortality in COPD [15], and Long Z et al., reported that the RDW/haematocrit ratio independently predicted 28-day mortality among ICU patients with AECOPD [16]. The present findings therefore fit within a wider literature suggesting that RDW captures more than simple erythrocyte variation.

These findings have practical implications in Indian tertiary-care hospitals. RDW and serum electrolytes are inexpensive, routinely available, and measured early during admission. A patient admitted with elevated RDW and low sodium or potassium may require closer monitoring, timely correction of reversible metabolic abnormalities, and more realistic planning for bed occupancy. These parameters should not replace clinical assessment, arterial blood gas interpretation, radiological evaluation, or comorbidity assessment. Rather, they may serve as adjunctive markers that sharpen early risk stratification.

Limitation(s)

The present study was a single-centre study with 50 participants, and therefore the precision and generalisability of the findings are limited. The study analysed admission values only; serial RDW and electrolyte trends during treatment were not assessed. Arterial blood gas severity, nutritional indices, and detailed co-morbidity burden were not incorporated into the final model. The findings should therefore be interpreted as associations rather than causal effects.

Future multicentre studies should validate a combined RDW-electrolyte risk model in larger AECOPD cohorts, incorporate arterial blood gas severity, comorbidity burden, inflammatory and nutritional markers, and examine whether serial correction of sodium and potassium abnormalities shortens length of hospital stay. Current large-database COPD studies have also emphasised the need to test RDW-based markers against clinically meaningful outcomes such as in-hospital mortality, ICU mortality, readmission, and external validation across heterogeneous hospital settings [16,17].

CONCLUSION(S)

Admission RDW, serum sodium, and serum potassium were independently associated with length of hospital stay in patients admitted with AECOPD. Elevated RDW and lower sodium and potassium levels may help identify patients likely to have a prolonged inpatient course. These routinely available parameters may be used as adjuncts to clinical assessment for early risk stratification and management planning.

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