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Original Research Article

PROSPECTIVE ASSESSMENT OF THE NEUTROPHIL-TO LYMPHOCYTE RATIO AS A PREDICTOR OF DISEASE SEVERITY AND CLINICAL OUTCOMES IN COMMUNITY ACQUIRED PNEUMONIA

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ABSTRACT

Background: Community-acquired pneumonia (CAP) is a major cause of hospitalization and mortality worldwide. Early identification of disease severity is essential for appropriate clinical management. The neutrophil-to-lymphocyte ratio (NLR) is an inexpensive and readily available inflammatory biomarker with potential prognostic significance in CAP. **Aim:** To evaluate admission NLR as a predictor of disease severity and clinical outcomes in patients with community-acquired pneumonia.

Materials and Methods: This prospective observational study included 116 patients with CAP, categorized into non-severe (n=72) and severe (n=44) groups. Admission NLR, clinical characteristics, laboratory parameters, CURB-65 scores, and Pneumonia Severity Index (PSI) were assessed. Associations with ICU admission, ventilatory support, hospital stay, and in-hospital mortality were evaluated using multivariable logistic regression and receiver operating characteristic (ROC) curve analysis.

Results: Patients with severe CAP were significantly older than those with non-severe CAP (66.48 ± 12.09 versus 54.61 ± 13.14 years; $p<0.001$). Median NLR was significantly higher in severe CAP (7.27 versus 4.45; $p<0.001$) and increased progressively with CURB-65 and PSI categories. Higher NLR (≥4.768) was associated with increased ICU admission (48.53% versus 18.75%; $p=0.001$) and in-hospital mortality (19.12% versus 6.25%; $p=0.048$). Admission NLR independently predicted severe CAP (aOR=2.420; $p<0.001$). ROC analysis demonstrated good discriminatory performance for severe CAP (AUC=0.891), with 95.45% sensitivity and 63.89% specificity at a cut-off of 4.768. However, NLR was not an independent predictor of mortality ($p=0.053$).

Conclusion: Admission NLR is a simple, cost-effective biomarker associated with CAP severity and adverse clinical outcomes. It may complement established severity scoring systems for early risk stratification, although its independent mortality prediction requires further validation.

Keywords: Community-acquired pneumonia; Neutrophil-to-lymphocyte ratio; Disease severity; CURB-65; In-hospital mortality.

INTRODUCTION

Community-acquired pneumonia (CAP) is an acute infection of the pulmonary parenchyma acquired outside healthcare facilities and remains a major cause of illness, hospitalization, and preventable death worldwide. Its burden spans different age groups and health systems, with particularly serious consequences for older adults and people with limited physiological reserve. Although effective antimicrobial therapy, vaccination, and supportive care have improved management, CAP continues to challenge clinicians because its presentation and subsequent course vary substantially. The continuing

burden of lower respiratory infections emphasizes the need for accessible methods that identify patients likely to deteriorate and allow timely allocation of healthcare resources.[1] CAP may be caused by bacteria, respiratory viruses, or mixed infections, and a specific pathogen is not always identified despite appropriate investigation. Patients commonly present with cough, fever, sputum production, pleuritic discomfort, and dyspnoea, but these manifestations may be nonspecific, especially among elderly or immunocompromised individuals. The clinical spectrum extends from uncomplicated infection managed outside hospital to progressive respiratory failure and systemic complications. Age, pre-existing pulmonary disease, metabolic disorders, cardiovascular comorbidities, and altered host immunity can influence clinical presentation and recovery. Consequently, an accurate assessment must consider the patient's overall condition rather than isolated symptoms or radiological abnormalities.[2] Severe CAP represents a particularly important clinical challenge because pulmonary infection may trigger profound hypoxaemia, sepsis, circulatory instability, and multiorgan dysfunction. Patients with rapidly progressive illness can require supplemental oxygen, non-invasive or invasive ventilatory support, vasopressors, and intensive care. Recognition of impending deterioration at the time of hospital admission is therefore essential for selecting appropriate monitoring intensity and initiating timely interventions. Contemporary international guidance emphasizes comprehensive clinical assessment, microbiological investigation where indicated, prompt antimicrobial treatment, and individualized supportive care. However, no single physiological measurement or laboratory test adequately captures the complexity of pneumonia severity.[3] Several clinical prediction systems assist risk stratification in CAP, particularly the Pneumonia Severity Index (PSI) and CURB-65 score, which incorporates confusion, blood urea, respiratory rate, blood pressure, and age. These tools organize clinical information to support decisions about hospitalization and treatment intensity. Nevertheless, scoring systems can be influenced by age and comorbid disease, require multiple variables, and may not completely reflect dynamic changes in inflammation or organ dysfunction. Biomarkers such as C-reactive protein and procalcitonin may provide supplementary information, although they have limitations related to timing, specificity, cost, and availability. There remains a clinical need for rapid, inexpensive adjunctive indicators of risk.[4] The neutrophil-to-lymphocyte ratio (NLR), calculated by dividing the absolute neutrophil count by the absolute lymphocyte count, has attracted attention as a readily available indicator of systemic inflammation. Neutrophils are prominent mediators of the innate immune response and participate in pathogen elimination through migration, phagocytosis, and inflammatory signalling. Lymphocytes contribute to coordinated adaptive immunity and immune regulation. During severe infection, increased neutrophil production and recruitment may coexist with stress-related lymphocyte redistribution or depletion. NLR therefore integrates two interconnected immune responses within one measure, potentially reflecting inflammatory intensity more comprehensively than either cell count considered independently.[5] An important practical advantage of NLR is that it can be calculated from a routine complete blood count without requiring additional specialized testing. This may be particularly useful in emergency departments, peripheral hospitals, and healthcare settings where rapid biochemical assays are not consistently available. Interest in NLR as a prognostic marker in CAP has increased because inflammation and immune dysregulation contribute to respiratory deterioration, organ-support requirements, and death. Nevertheless, NLR is not specific to pneumonia and may be altered by corticosteroid exposure, haematological disorders, chronic inflammatory conditions, and concurrent infections. Its interpretation should therefore remain contextual and complement, rather than replace, clinical examination and validated severity scores.[6]

MATERIALS AND METHODS

The present study was designed as a hospital-based prospective observational study to evaluate the neutrophil-to-lymphocyte ratio (NLR) as a predictor of disease severity and clinical outcomes among patients diagnosed with community-acquired pneumonia (CAP). The study aimed to determine the association between NLR levels, clinical severity scores, inflammatory markers, requirement for intensive care, duration of hospitalization, and in-hospital mortality. The study was conducted at a tertiary care hospital in the Department of General Medicine. Patients presenting to the emergency department or admitted to medical wards with a diagnosis of community-acquired pneumonia were evaluated for eligibility. A total of 116 patients diagnosed with community-acquired pneumonia were included in the study. Participants were recruited using a consecutive sampling technique based on predefined inclusion and exclusion criteria. All eligible patients underwent detailed clinical evaluation, laboratory investigations, radiological assessment, and prospective monitoring of clinical outcomes.

Inclusion Criteria

Patients aged 18 years and above with a clinical and radiological diagnosis of community-acquired pneumonia were included. CAP was defined by the presence of a new pulmonary infiltrate on chest radiography accompanied by at least one compatible clinical feature, including fever, cough, sputum production, dyspnoea, pleuritic chest pain, or abnormal respiratory examination findings. Patients admitted directly from the community or developing

symptoms before hospitalization were considered eligible.

Exclusion Criteria

Patients with hospital-acquired pneumonia, ventilator-associated pneumonia, active pulmonary tuberculosis, known haematological malignancies, or disorders significantly affecting leukocyte counts were excluded. Patients receiving chemotherapy, long-term systemic corticosteroids, or other major immunosuppressive treatments were also excluded. Individuals with incomplete baseline haematological investigations or insufficient clinical information for severity assessment were not included.

Clinical Assessment and Data Collection

Detailed demographic and clinical information was recorded using a structured case record form. Parameters included age, gender, body mass index, smoking history, alcohol consumption, presenting symptoms, symptom duration, and associated comorbidities such as diabetes mellitus, hypertension, chronic obstructive pulmonary disease, cardiovascular disease, and chronic kidney disease. Vital parameters, including body temperature, heart rate, respiratory rate, systolic and diastolic blood pressure, oxygen saturation (SpO_2), and Glasgow Coma Scale score, were documented at admission.

Laboratory Investigations and NLR Calculation

Venous blood samples were collected within 24 hours of admission, preferably before initiation of antibiotic or corticosteroid therapy. Complete blood counts were performed using an automated haematology analyser. Haematological parameters included total leukocyte count, absolute neutrophil count, absolute lymphocyte count, haemoglobin concentration, and platelet count. NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. Additional investigations included serum C-reactive protein, procalcitonin where available, blood urea, serum creatinine, serum electrolytes, liver function tests, and arterial blood gas analysis when clinically indicated. Microbiological investigations, including sputum examination and blood cultures, were performed according to clinical requirements.

Assessment of Pneumonia Severity

Disease severity was assessed using the CURB-65 scoring system, incorporating confusion, blood urea nitrogen, respiratory rate, blood pressure, and age ≥65 years. Patients were classified into low-risk (0–1), intermediate-risk (2), and high-risk (3–5) categories. The Pneumonia Severity Index (PSI) was also calculated using demographic characteristics, comorbidities, clinical findings, and laboratory parameters. Severe CAP was identified according to American Thoracic Society/Infectious Diseases Society of America criteria, based on the presence of one major or at least three minor severity criteria.

Assessment of Clinical Outcomes

All enrolled patients were monitored prospectively throughout hospitalization. Primary outcomes included the association of admission NLR with pneumonia severity and in-hospital mortality. Secondary outcomes included intensive care unit admission, requirement for supplemental oxygen, non-invasive or invasive mechanical ventilation, development of septic shock, length of hospital stay, and clinical recovery. Time to clinical stability was assessed using improvement in vital parameters, oxygenation, mental status, and ability to maintain oral intake. Patients were categorized according to survival status and the presence or absence of major adverse clinical outcomes.

Correlation of NLR With Disease Severity

Admission NLR values were compared across CURB-65 risk categories, PSI classes, and severe versus non-severe CAP groups. Associations between NLR and inflammatory markers, oxygen saturation, respiratory rate, and hospitalization duration were examined. Receiver operating characteristic (ROC) curve analysis was performed to determine the discriminatory ability of NLR for predicting severe pneumonia and in-hospital mortality. The optimal NLR cut-off value was identified using the Youden index.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using **IBM SPSS Statistics version 27.0**. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution, while categorical variables were presented as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Comparisons were performed using the independent Student's t-test or Mann–Whitney U test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables. Analysis of variance or the Kruskal–Wallis test was applied for multiple-group comparisons. Pearson's or Spearman's correlation analysis was used to assess relationships between NLR and clinical parameters. Multivariable logistic regression was performed to evaluate the independent predictive value of NLR after adjustment for relevant confounding variables. ROC analysis was used to calculate the area under the curve (AUC), sensitivity, specificity, and optimal cut-off values with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Comparison of Baseline Demographic and Clinical Characteristics Between Non-Severe and Severe Community-Acquired Pneumonia Patients (N=116)

A total of 116 patients with community-acquired pneumonia were included in the study, comprising 72 patients with non-severe CAP and 44 patients with severe CAP. The mean age was significantly higher among patients with severe CAP (66.48 ± 12.09 years) compared to those with non-severe CAP (54.61 ± 13.14 years; $p<0.001$). Males constituted 62.93% of the study population, although gender

distribution did not differ significantly between the groups (p=0.360). Hypertension was significantly more prevalent in severe CAP patients (54.55%) than in non-severe CAP patients (25.00%; p=0.001), whereas differences in diabetes mellitus, COPD, smoking history, and chronic kidney disease were statistically insignificant. Dyspnoea was significantly more frequent in the severe CAP group (90.91% vs. 75.00%; p=0.034), while fever, cough, and productive sputum showed no significant differences. Additionally, the mean duration of symptoms was significantly longer in severe CAP patients (5.64 ± 1.51 days) compared with non-severe CAP patients (4.58 ± 1.98 days; p=0.002).

Table 2: Comparison of Admission Clinical, Haematological and Biochemical Parameters Between Non-Severe and Severe CAP Patients (N=116)

Significant differences were observed in clinical, haematological, and biochemical parameters between patients with non-severe and severe community-acquired pneumonia. Patients with severe CAP demonstrated significantly lower oxygen saturation (87.18 ± 2.38% vs. 94.75 ± 2.53%) and systolic blood pressure (104.23 ± 15.29 vs. 120.63 ± 16.09 mmHg), along with a higher respiratory rate (29.48 ± 3.14 vs. 20.29 ± 2.69 breaths/min; all p<0.001). Total leukocyte count and absolute neutrophil count were significantly elevated in severe CAP patients, whereas the absolute lymphocyte count was significantly reduced (p<0.001). The median neutrophil-to-lymphocyte ratio was markedly higher in severe CAP patients (7.27; IQR: 5.95–10.46) compared with non-severe CAP patients (4.45; IQR: 3.72–5.49; p<0.001). Similarly, serum C-reactive protein and procalcitonin levels were significantly elevated in the severe CAP group, indicating greater systemic inflammatory activity (p<0.001). Blood urea and serum creatinine concentrations were also significantly higher among patients with severe CAP (p<0.001), suggesting greater renal dysfunction or physiological stress associated with disease severity.

Table 3: Association of Neutrophil-to-Lymphocyte Ratio with CURB-65 Score, Pneumonia Severity Index and Clinical Severity (N=116)

A significant association was observed between increasing neutrophil-to-lymphocyte ratio and established pneumonia severity scoring systems. According to the CURB-65 classification, the median NLR progressively increased from 4.60 in low-risk patients to 6.14 in moderate-risk patients and 8.48 in high-risk patients, demonstrating a statistically significant difference across risk categories (p<0.001). Similarly, NLR increased across Pneumonia Severity Index categories, with median values of 4.47, 4.67, 6.28, and 10.21 in PSI classes I–II, III, IV, and V, respectively (p<0.001). Patients classified as having severe CAP showed a significantly higher median NLR (7.27) compared with those having non-severe CAP (4.45; p<0.001). Among the 116 patients, 100 (86.21%) survived, while 16 (13.79%) died during hospitalization. The median NLR was significantly higher among non-survivors (7.35; IQR: 5.79–10.46) than survivors (4.85; IQR: 4.22–6.57; p=0.003), indicating an association between elevated admission NLR and adverse clinical outcomes.

Table 4: Association of Admission Neutrophil-to-Lymphocyte Ratio with Disease Severity and Clinical Outcomes Among CAP Patients (N=116)

Patients were categorized into lower NLR (<4.768; n=48) and higher NLR (≥4.768; n=68) groups to evaluate the relationship between admission NLR and subsequent clinical outcomes. Severe community-acquired pneumonia was significantly more frequent in the higher NLR group (61.76%) compared with the lower NLR group (4.17%; p<0.001). The requirement for supplemental oxygen (72.06% vs. 50.00%; p=0.015) and ICU admission (48.53% vs. 18.75%; p=0.001) were also significantly greater among patients with higher NLR values. Similarly, non-invasive mechanical ventilation (30.88% vs. 8.33%; p=0.004), invasive mechanical ventilation (22.06% vs. 4.17%; p=0.007), and septic shock (16.18% vs. 2.08%; p=0.014) occurred more frequently in the higher NLR group. In-hospital mortality was significantly higher among patients with elevated NLR (19.12%) than among those with lower NLR (6.25%; p=0.048). Furthermore, patients with higher NLR experienced a significantly longer median hospital stay (8.00 vs. 6.00 days; p=0.002) and delayed clinical stability (4.50 vs. 3.00 days; p<0.001).

Table 5: Multivariable Logistic Regression Analysis of Predictors of Severe Community-Acquired Pneumonia and In-Hospital Mortality (N=116)

Multivariable logistic regression analysis was performed to identify factors independently associated with severe community-acquired pneumonia and in-hospital mortality. Admission NLR demonstrated a statistically significant association with severe CAP, with each unit increase in NLR associated with 2.420 times higher adjusted odds of severe disease (aOR=2.420; 95% CI: 1.641–3.570; p<0.001). Increasing age was also significantly associated with severe CAP (aOR=1.042; 95% CI: 1.000–1.086; p=0.048), indicating approximately 4.20% higher adjusted odds of severe disease per additional year of age. Hypertension was another significant independent factor, with hypertensive patients demonstrating approximately fourfold higher adjusted odds of severe CAP (aOR=4.033; 95% CI: 1.301–12.501; p=0.016). In the mortality model, admission NLR showed a positive association with in-hospital mortality (aOR=1.182; 95% CI: 0.998–1.401), but this association did not reach statistical significance (p=0.053). Similarly, increasing age was not independently associated with mortality (aOR=1.027; 95% CI: 0.982–1.073; p=0.244), suggesting that the evidence for independent

mortality prediction was less conclusive than that for predicting severe CAP.

Table 6: Receiver Operating Characteristic Curve Analysis of Admission NLR for Predicting Severe CAP and Adverse Clinical Outcomes (N=116)

Receiver operating characteristic curve analysis was performed to assess the discriminatory performance of admission neutrophil-to-lymphocyte ratio in predicting severe CAP, ICU admission, and in-hospital mortality. For predicting severe CAP, NLR demonstrated good discriminatory ability, with an area under the curve (AUC) of 0.891 (95% CI: 0.828–0.941; p<0.001). An optimal NLR cut-off value of 4.768 provided a sensitivity of 95.45% and specificity of 63.89% for identifying severe community-acquired pneumonia. For predicting ICU admission, the AUC was 0.761 (95% CI: 0.661–0.854; p<0.001), with an optimal cut-off value of 7.168, yielding 52.38% sensitivity and 94.59% specificity. Similarly, NLR demonstrated moderate discriminatory ability for predicting in-hospital mortality, with an AUC of 0.736 (95% CI: 0.584–0.869; p=0.003). At an optimal cut-off value of 7.267, sensitivity and specificity for mortality prediction were 62.50% and 87.00%, respectively, suggesting that admission NLR may be more useful for identifying severe pneumonia than for independently predicting mortality.

Table 1: Comparison of Baseline Demographic and Clinical Characteristics Between Non-Severe and Severe Community-Acquired Pneumonia Patients (N=116)

Parameters	Total (N=116)	Non-Severe CAP (n=72)	Severe CAP (n=44)	p-value
Age (years), mean ± SD	59.11 ± 13.95	54.61 ± 13.14	66.48 ± 12.09	<0.001
Male	73 (62.93%)	43 (59.72%)	30 (68.18%)	0.360
Female	43 (37.07%)	29 (40.28%)	14 (31.82%)	0.360
BMI (kg/m²), mean ± SD	24.81 ± 3.74	25.12 ± 3.34	24.32 ± 4.32	0.297
Smoking history	41 (35.34%)	25 (34.72%)	16 (36.36%)	0.858
Diabetes mellitus	37 (31.90%)	19 (26.39%)	18 (40.91%)	0.104
Hypertension	42 (36.21%)	18 (25.00%)	24 (54.55%)	0.001
Chronic obstructive pulmonary disease	34 (29.31%)	19 (26.39%)	15 (34.09%)	0.377
Chronic kidney disease	9 (7.76%)	6 (8.33%)	3 (6.82%)	1.000
Fever	88 (75.86%)	52 (72.22%)	36 (81.82%)	0.241
Cough	109 (93.97%)	66 (91.67%)	43 (97.73%)	0.250
Dyspnoea	94 (81.03%)	54 (75.00%)	40 (90.91%)	0.034
Productive sputum	76 (65.52%)	43 (59.72%)	33 (75.00%)	0.093
Duration of symptoms (days), mean ± SD	4.98 ± 1.88	4.58 ± 1.98	5.64 ± 1.51	0.002

Table 2: Comparison of Admission Clinical, Haematological and Biochemical Parameters Between Non-Severe and Severe CAP Patients (N=116)

Parameters	Non-Severe CAP (n=72)	Severe CAP (n=44)	p-value
Oxygen saturation (SpO_2 , %), mean ± SD	94.75 ± 2.53	87.18 ± 2.38	<0.001
Respiratory rate (breaths/min), mean ± SD	20.29 ± 2.69	29.48 ± 3.14	<0.001
Systolic blood pressure (mmHg), mean ± SD	120.63 ± 16.09	104.23 ± 15.29	<0.001
Total leukocyte count (×10³/µL), mean ± SD	10.12 ± 2.02	11.98 ± 1.81	<0.001
Absolute neutrophil count (×10³/µL), mean ± SD	7.39 ± 1.70	9.67 ± 1.70	<0.001
Absolute lymphocyte count (×10³/µL), mean ± SD	1.69 ± 0.43	1.29 ± 0.39	<0.001
Neutrophil-to-lymphocyte ratio, median (IQR)	4.45 (3.72–5.49)	7.27 (5.95–10.46)	<0.001
C-reactive protein (mg/L), median (IQR)	40.06 (26.02–55.98)	105.70 (84.22–130.13)	<0.001
Procalcitonin (ng/mL), median (IQR)	0.67 (0.45–0.85)	1.49 (0.91–1.86)	<0.001
Blood urea (mg/dL), mean ± SD	31.39 ± 11.14	43.03 ± 10.30	<0.001
Serum creatinine (mg/dL), mean ± SD	1.01 ± 0.25	1.29 ± 0.25	<0.001

Table 3: Association of Neutrophil-to-Lymphocyte Ratio with CURB-65 Score, Pneumonia Severity Index and Clinical Severity (N=116)

Severity Parameters	Number of Patients n (%)	NLR, Median (IQR)	p-value
CURB-65 score			<0.001
Low risk (0–1)	76 (65.52%)	4.60 (3.97–5.81)	
Moderate risk (2)	20 (17.24%)	6.14 (4.65–7.34)	
High risk (3–5)	20 (17.24%)	8.48 (6.43–10.50)	
Pneumonia Severity Index			<0.001
PSI Class I–II	50 (43.10%)	4.47 (3.91–5.71)	
PSI Class III	22 (18.97%)	4.67 (3.72–5.45)	
PSI Class IV	30 (25.86%)	6.28 (4.85–7.91)	
PSI Class V	14 (12.07%)	10.21 (7.19–11.59)	
CAP severity			<0.001
Non-severe CAP	72 (62.07%)	4.45 (3.72–5.49)	
Severe CAP	44 (37.93%)	7.27 (5.95–10.46)	
Survival status			0.003
Survivors	100 (86.21%)	4.85 (4.22–6.57)	
Non-survivors	16 (13.79%)	7.35 (5.79–10.46)	

Table 4: Association of Admission Neutrophil-to-Lymphocyte Ratio with Disease Severity and Clinical Outcomes Among CAP Patients (N=116)

Clinical Outcomes	Total (N=116)	Lower NLR (<4.768) (n=48)	Higher NLR (≥4.768) (n=68)	p-value
Severe community-acquired pneumonia	44 (37.93%)	2 (4.17%)	42 (61.76%)	<0.001
Requirement for supplemental oxygen	73 (62.93%)	24 (50.00%)	49 (72.06%)	0.015
ICU admission	42 (36.21%)	9 (18.75%)	33 (48.53%)	0.001
Non-invasive mechanical ventilation	25 (21.55%)	4 (8.33%)	21 (30.88%)	0.004
Invasive mechanical ventilation	17 (14.66%)	2 (4.17%)	15 (22.06%)	0.007
Septic shock	12 (10.34%)	1 (2.08%)	11 (16.18%)	0.014
In-hospital mortality	16 (13.79%)	3 (6.25%)	13 (19.12%)	0.048
Length of hospital stay (days), median (IQR)	7.00 (5.00–9.00)	6.00 (4.00–8.00)	8.00 (5.00–10.00)	0.002
Time to clinical stability (days), median (IQR)	4.00 (3.00–5.00)	3.00 (2.00–4.00)	4.50 (3.00–5.00)	<0.001

Table 5: Multivariable Logistic Regression Analysis of Predictors of Severe Community-Acquired Pneumonia and In-Hospital Mortality (N=116)

Predictive Parameters	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Outcome: Severe CAP (n=44)			
Admission NLR (per unit increase)	2.420	1.641–3.570	<0.001
Age (per year increase)	1.042	1.000–1.086	0.048
Hypertension (present vs absent)	4.033	1.301–12.501	0.016
Outcome: In-hospital mortality (n=16)			
Admission NLR (per unit increase)	1.182	0.998–1.401	0.053
Age (per year increase)	1.027	0.982–1.073	0.244

Table 6: Receiver Operating Characteristic Curve Analysis of Admission NLR for Predicting Severe CAP and Adverse Clinical Outcomes (N=116)

Predictive Outcomes	AUC	95% CI	Optimal NLR Cut-off	Sensitivity (%)	Specificity (%)	p-value
Severe CAP	0.891	0.828–0.941	4.768	95.45	63.89	<0.001
ICU admission	0.761	0.661–0.854	7.168	52.38	94.59	<0.001
In-hospital mortality	0.736	0.584–0.869	7.267	62.50	87.00	0.003

DISCUSSION

The present study evaluated the prognostic significance of admission neutrophil-to-lymphocyte ratio (NLR) among 116 patients with community-acquired pneumonia (CAP), including 72 patients with non-severe CAP and 44 with severe CAP. Patients with severe CAP were significantly older than those with non-severe CAP (66.48 ± 12.09 versus 54.61 ± 13.14 years; p<0.001), suggesting that advancing age contributes to increased disease severity. Hypertension was significantly more prevalent among patients with severe CAP (54.55% versus 25.00%; p=0.001), while diabetes mellitus, COPD, smoking history, and chronic kidney disease showed no statistically significant differences. Dyspnoea was more frequent in severe CAP (90.91% versus 75.00%; p=0.034), and the duration of symptoms was significantly longer (5.64 ± 1.51 versus 4.58 ± 1.98 days; p=0.002). Similar findings were reported by Wang et al. (2022), who evaluated 172 patients with CAP, including 48 severe and 124 non-severe cases. Their study demonstrated a median age of 74 years, a median symptom duration of 5 days, and hypertension in 33.70% of patients. Multivariable analysis identified hypertension as an independent risk factor for severe CAP (OR=3.749; 95% CI: 1.411–9.962), closely resembling the present study's adjusted OR of 4.033 (95% CI: 1.301–12.501). The findings support the importance of advanced age, underlying cardiovascular comorbidity, and delayed presentation in identifying patients at increased risk of severe pneumonia.[7]

The present study demonstrated substantial differences in clinical, haematological, and biochemical parameters between patients with severe and non-severe CAP. Severe CAP patients had significantly lower oxygen saturation (87.18 ± 2.38% versus 94.75 ± 2.53%) and systolic blood pressure (104.23 ± 15.29 versus 120.63 ± 16.09 mmHg), together with a significantly higher respiratory rate (29.48 ± 3.14 versus 20.29 ± 2.69 breaths/min; all p<0.001). Severe CAP was also associated with increased total leukocyte and absolute neutrophil counts, reduced absolute lymphocyte counts, and elevated CRP, procalcitonin, blood urea, and serum creatinine concentrations. The median NLR was significantly higher in severe CAP (7.27; IQR: 5.95–10.46) than non-severe CAP (4.45; IQR: 3.72–5.49; p<0.001). These observations are comparable to the findings of Ghosh et al. (2025), who prospectively evaluated 162 hospitalized CAP patients in Northeast India. Their study reported a significantly higher mean NLR among patients with CURB-65 scores ≥3 compared with those scoring below 3 (14.21 ± 6.73 versus 8.07 ± 4.52; p<0.001). Severe cases also showed higher total leukocyte counts (17.92 ± 7.11 versus 14.64 ± 6.18 $\times 10^3/\mu L$; p=0.047), increased absolute neutrophil counts (15.28 ± 6.78 versus 12.11 ± 5.93 $\times 10^3/\mu L$; p=0.041), reduced lymphocyte counts (1.28 ± 0.58 versus 1.72 ± 0.65 $\times 10^3/\mu L$;

p=0.026), and elevated serum creatinine (1.71 ± 0.84 versus 1.18 ± 0.62 mg/dL; p=0.009). Although the NLR values were higher in their population and were expressed as means rather than medians, both investigations demonstrate that increasing neutrophilia, lymphopenia, and renal dysfunction accompany greater pneumonia severity.[8]

A significant relationship was observed between admission NLR and established pneumonia severity scoring systems in the present study. Median NLR increased progressively across CURB-65 risk categories, from 4.60 in low-risk patients to 6.14 in moderate-risk patients and 8.48 in high-risk patients (p<0.001). Similarly, median NLR increased from 4.47 in PSI classes I–II to 4.67 in class III, 6.28 in class IV, and 10.21 in class V (p<0.001). The relationship between NLR and increasing clinical severity was consistent with the findings of de Jager et al. (2012), who prospectively investigated 395 patients with CAP. Their study reported a mean age of 63.4 ± 16.0 years, ICU admission in 7.80% of patients, and mortality in 5.80%. NLR increased consistently with advancing CURB-65 scores, demonstrating its relationship with disease severity. Furthermore, mean NLR was significantly higher among non-survivors than survivors (23.3 ± 16.8 versus 13.0 ± 11.4). The AUC for NLR in predicting mortality was 0.701, exceeding the discriminatory performance of neutrophil count (0.681), total leukocyte count (0.672), lymphocyte count (0.630), and CRP (0.565). In comparison, the present study demonstrated an AUC of 0.736 for in-hospital mortality prediction and 0.891 for severe CAP identification. These findings suggest that admission NLR reflects the systemic inflammatory response associated with increasing pneumonia severity and may provide useful supplementary information alongside conventional scoring systems.[9]

The relationship between admission NLR, pneumonia severity scores, and clinical outcomes was further demonstrated in the present investigation. NLR increased progressively across PSI categories, reaching a median of 10.21 in PSI class V, compared with 4.47 in classes I–II (p<0.001). Furthermore, in-hospital mortality occurred in 16 of the 116 patients (13.79%), and the median NLR was significantly higher among non-survivors (7.35; IQR: 5.79–10.46) than survivors (4.85; IQR: 4.22–6.57; p=0.003). Comparable findings were described by Calis et al. (2025), who conducted a multicentre observational study involving 343 hospitalized CAP patients. Their study population had a mean age of 74 ± 11.8 years, and 51 patients (14.87%) experienced in-hospital mortality, a proportion comparable to the present study. The mean NLR was 13.1 ± 14.9, and significantly higher NLR values were observed among non-survivors (p=0.009). The investigators also demonstrated positive associations between NLR and CURB-65, PSI, and qSOFA scores. However, the conventional scoring systems showed stronger mortality discrimination, with AUC values of 0.83 for CURB-65 and 0.82 for PSI, whereas an NLR threshold of 10.02 provided 58.80% sensitivity and 60.80% specificity for mortality prediction. These findings support the observed association between NLR and increasing disease severity while emphasizing that NLR should complement rather than replace established clinical severity scoring systems.[10]

The association between elevated admission NLR and mortality represents an important observation of the present study. Among 116 CAP patients, 100 (86.21%) survived and 16 (13.79%) died during hospitalization. Non-survivors demonstrated a significantly higher median NLR of 7.35 compared with 4.85 among survivors (p=0.003). Furthermore, patients with NLR ≥4.768 experienced significantly higher in-hospital mortality than those with NLR below 4.768 (19.12% versus 6.25%; p=0.048). Similar findings were reported by Cataudella et al. (2017), who prospectively evaluated 195 elderly patients hospitalized with CAP and investigated the ability of NLR to predict 30-day mortality. Their study demonstrated that NLR significantly predicted mortality (p<0.001) and performed better than PSI, CURB-65, CRP, and total leukocyte count in their cohort. No deaths occurred among patients with NLR below 11.12, whereas 30-day mortality increased to 30% among patients with NLR between 11.12 and 13.4 and 50% among those with values between 13.4 and 28.3. All patients with NLR greater than 28.3 died within 30 days. Although the NLR thresholds were substantially higher than those observed in the present study, both investigations demonstrated increasing mortality with elevated NLR. Differences in age distribution, disease severity, patient selection, and duration of mortality follow-up may explain the variation in prognostic thresholds.[11]

The present study demonstrated significant associations between elevated admission NLR and the requirement for intensive care and organ support. Severe CAP was observed in 61.76% of patients with NLR ≥4.768 compared with only 4.17% of those with lower NLR (p<0.001). Patients with higher NLR also demonstrated significantly greater requirements for supplemental oxygen (72.06% versus 50.00%; p=0.015), ICU admission (48.53% versus 18.75%; p=0.001), non-invasive mechanical ventilation (30.88% versus 8.33%; p=0.004), and invasive mechanical ventilation (22.06% versus 4.17%; p=0.007). Septic shock was also more frequent in the elevated NLR group (16.18% versus 2.08%; p=0.014). Comparable findings were reported by Tekin et al. (2024), who evaluated 4,039 hospitalized CAP patients in a retrospective cohort study. In their investigation, ICU admission occurred in 46.50% of patients with NLR greater than 12 compared with 34.60% of those with NLR ≤12. After adjustment for PSI, elevated NLR remained significantly associated with ICU admission (adjusted OR=1.405; 95% CI: 1.216–1.624; p<0.001). Invasive mechanical ventilation was required in 19.50% of patients with higher NLR compared with 16.20% of those with lower NLR. However, NLR was not independently

associated with hospital mortality after adjustment (OR=1.115; 95% CI: 0.774–1.606; p=0.559). These observations are consistent with the present study in demonstrating an association between elevated NLR and increased ICU requirements, while suggesting that its independent ability to predict mortality may be less reliable.[12]

The present study also demonstrated that elevated NLR was associated with prolonged hospitalization and delayed recovery. Patients with admission NLR ≥4.768 had a significantly longer median hospital stay than those with lower NLR (8.00 versus 6.00 days; p=0.002). Similarly, the median time required to achieve clinical stability was significantly prolonged (4.50 versus 3.00 days; p<0.001). Furthermore, ICU admission and in-hospital mortality were higher in patients with elevated NLR (48.53% versus 18.75% and 19.12% versus 6.25%, respectively). These findings are comparable with the large observational study conducted by Sharma et al. (2025), which included 7,862 patients hospitalized with CAP at two Australian hospitals. Their study reported a mean age of 75.1 years, with 54.60% male patients and a mean NLR of 12.6. A total of 2,877 patients (36.60%) had NLR greater than 12. After multivariable adjustment, higher NLR was independently associated with prolonged hospital stay (incidence rate ratio=1.11; 95% CI: 1.08–1.13; p<0.001), ICU admission (aOR=1.41; 95% CI: 1.06–1.88; p=0.019), and in-hospital mortality (aOR=1.27; 95% CI: 1.06–1.53; p=0.009). Although the mortality association remained statistically significant in their larger cohort, the present study demonstrated only a borderline independent association with mortality (aOR=1.182; p=0.053). Differences in sample size, population characteristics, and statistical power may contribute to these variations. Both studies nevertheless suggest that elevated admission NLR is associated with prolonged hospitalization and increased clinical resource requirements.[13]

Multivariable logistic regression analysis in the present study identified admission NLR as an independent factor associated with severe CAP. Each unit increase in NLR was associated with a 2.420-fold increase in the adjusted odds of severe disease (95% CI: 1.641–3.570; p<0.001). Increasing age (aOR=1.042; 95% CI: 1.000–1.086; p=0.048) and hypertension (aOR=4.033; 95% CI: 1.301–12.501; p=0.016) were additional independent factors. In contrast, admission NLR demonstrated a weaker association with in-hospital mortality (aOR=1.182; 95% CI: 0.998–1.401; p=0.053), which did not reach conventional statistical significance. Similar findings regarding the prognostic relevance of NLR were reported by Enersen et al. (2023), who conducted a derivation-validation cohort study involving 831 patients in a Danish multicentre derivation cohort and 2,463 patients in a European multicentre validation cohort. Their investigation demonstrated that increasing NLR was associated with 90-day mortality in both cohorts. In the derivation cohort, the adjusted hazard ratio for mortality associated with NLR was 1.016 (95% CI: 1.001–1.032; p=0.038), after accounting for relevant clinical factors. However, incorporating NLR into CURB-65 did not improve the scoring system's overall predictive performance. The present findings similarly suggest that NLR provides important information regarding clinical severity, although its independent association with mortality requires cautious interpretation. The different effect measures and mortality follow-up periods prevent direct numerical comparison of the regression estimates.[14]

Receiver operating characteristic analysis in the present study demonstrated that admission NLR had good discriminatory ability for severe CAP, with an AUC of 0.891 (95% CI: 0.828–0.941; p<0.001). An optimal threshold of 4.768 provided 95.45% sensitivity and 63.89% specificity for identifying severe pneumonia. For ICU admission, NLR demonstrated an AUC of 0.761 (95% CI: 0.661–0.854), with a threshold of 7.168 yielding 52.38% sensitivity and 94.59% specificity. Mortality prediction was comparatively less accurate, with an AUC of 0.736 (95% CI: 0.584–0.869; p=0.003); a threshold of 7.267 provided 62.50% sensitivity and 87.00% specificity. Comparable findings were reported by Ge et al. (2019), who retrospectively evaluated 150 adult CAP patients to investigate the association between NLR and unfavourable clinical outcomes, including ICU admission and 30-day mortality. Their multivariable analysis demonstrated that both NLR and CURB-65 were independent predictors of unfavourable outcomes (p<0.05). ROC analysis revealed an NLR AUC of 0.81 (95% CI: 0.73–0.89), with 81.00% sensitivity and 72.80% specificity. The combination of NLR and CURB-65 further improved the reported predictive sensitivity and specificity to 89.40% and 91.30%, respectively. Although their outcome definition differed from the individual endpoints evaluated in the present study, both investigations indicate that admission NLR can contribute to early identification of patients at increased risk of complications. Overall, the present findings suggest that NLR is particularly useful for identifying severe CAP, whereas its ability to predict ICU admission and mortality is more moderate. Its routine availability, low cost, and ease of calculation support its potential role as an adjunct to established pneumonia severity assessments, although the identified thresholds require external validation before routine clinical application.[15]

CONCLUSION

The present study concluded that admission neutrophil-to-lymphocyte ratio (NLR) is a useful, inexpensive, and readily available biomarker for assessing disease severity and clinical outcomes in patients with community-acquired pneumonia. Elevated NLR was significantly associated with severe pneumonia, higher CURB-65 and PSI scores, increased ICU admission, greater ventilatory support

requirements, and prolonged hospitalization. NLR demonstrated good discriminatory ability for predicting severe CAP (AUC=0.891), with an optimal cut-off value of 4.768. Although elevated NLR was associated with increased in-hospital mortality, its independent predictive significance for mortality was not established. Therefore, admission NLR may serve as a valuable adjunct to established clinical severity scoring systems for early risk stratification and patient management.

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