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Original Article

Baseline Neutrophil-To-Lymphocyte Ratio Versus NT-ProBNP for Predicting Mortality in Severe Pneumonia

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ABSTRACT

Background: Severe pneumonia is associated with substantial short-term mortality, and early identification of high-risk patients remains essential, particularly in settings where rapid access to complex prognostic tools is limited. Objective: To compare the performance of baseline neutrophil-to-lymphocyte ratio and N-terminal pro-B-type natriuretic peptide for predicting all-cause 30-day mortality in adults hospitalized with severe pneumonia, and to evaluate whether their combined use improves prognostic accuracy. Methods: This prospective observational study was conducted at the Department of Medicine, Pak Emirates Military Hospital, Rawalpindi, Pakistan, from July 2023 to June 2024. A total of 130 adults meeting IDSA/ATS 2007 criteria for severe pneumonia were enrolled. Blood samples were obtained within six hours of admission for calculation of neutrophil-to-lymphocyte ratio and measurement of NT-proBNP. Receiver operating characteristic curve analysis, DeLong comparison, and binary logistic regression were performed. Results: Thirty-eight of 130 patients (29.2%) died within 30 days. Non-survivors had higher median neutrophil-to-lymphocyte ratio (19.4 vs 9.1; p<0.001) and NT-proBNP (4,820 vs 1,240 pg/mL; p<0.001). Neutrophil-to-lymphocyte ratio showed an AUC of 0.812 (95% CI 0.736-0.888), while NT-proBNP showed an AUC of 0.779 (95% CI 0.697-0.861), with no significant difference between them (p=0.38). The combined model improved AUC to 0.856 (95% CI 0.789-0.923). On multivariable analysis, both biomarkers independently predicted mortality. Conclusion: Both neutrophil-to-lymphocyte ratio and NT-proBNP are effective admission biomarkers for mortality risk stratification in severe pneumonia, with neutrophil-to-lymphocyte ratio offering particular practical value in resource-limited settings; combined assessment may further improve prognostic performance. Keywords: Mortality, NT-proBNP, neutrophil-to-lymphocyte ratio, pneumonia, prognosis, severe pneumonia.

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INTRODUCTION

Severe pneumonia, whether community acquired or hospital associated, remains one of the leading infectious causes of hospital admission, intensive care utilization, and short-term mortality worldwide. Despite improvements in antimicrobial therapy, organ support, and critical care protocols, early mortality remains substantial, particularly among patients presenting with respiratory compromise, sepsis, or multiorgan dysfunction (1-3). In low- and middle-income settings, this burden is amplified by delayed presentation, limited access to advanced diagnostics, and variable availability of validated severity assessment tools. In Pakistan and comparable healthcare environments, severe pneumonia continues to contribute considerably to in-hospital mortality and resource strain, especially in high-dependency and intensive care settings, underscoring the need for reliable and rapidly obtainable prognostic markers that can support early clinical decision-making (1-3).

Several clinical prediction models, including the Pneumonia Severity Index, CURB-65, and APACHE II, have been used to estimate severity and mortality risk in pneumonia, and their prognostic value has been demonstrated across diverse populations (4,5). However, these scoring systems require multiple clinical, biochemical, and radiographic inputs, some of which may not be immediately available in emergency or resource-constrained environments. In addition, although these instruments are useful for severity stratification, they were not specifically developed as rapid biomarker-based tools for bedside

prognostication. This creates an important practical gap in settings where clinicians must make early triage and monitoring decisions before complete diagnostic workup is available. A simple, inexpensive, and reproducible biomarker that performs comparably to more specialized assays would therefore have substantial clinical relevance, particularly in hospitals with constrained laboratory infrastructure (3-5).

Among the candidate biomarkers, the neutrophil-to-lymphocyte ratio has received increasing attention as a readily accessible indicator of systemic inflammatory stress. Derived from a routine complete blood count, NLR reflects the balance between neutrophil-driven innate inflammatory activation and lymphocyte suppression associated with physiological stress, infection severity, and immune dysregulation. Elevated admission NLR has been associated with poor outcomes in sepsis, respiratory infections, and critically ill populations, and previous studies in severe pneumonia have reported fair-to-good discriminatory ability for short-term mortality prediction, with area under the receiver operating characteristic curve values generally ranging from approximately 0.72 to 0.83 (6-8). Because it is inexpensive, universally available, and rapidly calculated without additional laboratory burden, NLR is particularly attractive for clinical environments where more advanced biomarker testing may be limited.

N-terminal pro-B-type natriuretic peptide represents another potentially valuable prognostic biomarker in severe pneumonia. Although most commonly used in the assessment of cardiac failure, NT-proBNP may also rise in severe pulmonary infection due to inflammatory myocardial depression, hypoxaemia-induced ventricular strain, sepsis-related haemodynamic stress, and endotoxin-mediated cardiac dysfunction, even in patients without previously established structural heart disease (9,10). Prior studies have demonstrated that elevated NT-proBNP levels are associated with worse short-term outcomes in patients with severe pneumonia, including those requiring intensive care, suggesting that this biomarker may capture a cardiopulmonary dimension of disease severity not fully reflected by conventional inflammatory indices (9,10). However, NT-proBNP testing is more costly and less accessible than a standard blood count, which may limit its routine use in lower-resource settings.

Although both NLR and NT-proBNP have individually shown prognostic utility in pneumonia, the available literature has largely examined them in isolation, and direct head-to-head comparison within the same severe pneumonia cohort remains limited, particularly in South Asian populations. This knowledge gap is clinically important because determining whether a low-cost, routinely available inflammatory marker can provide prognostic performance comparable to a more specialized cardiac biomarker would directly inform bedside risk stratification strategies in resource-limited healthcare systems. Furthermore, examining whether the combined use of these biomarkers improves mortality prediction may help identify a more comprehensive yet still pragmatic prognostic approach. Therefore, this study was undertaken to compare the ability of baseline NLR and NT-proBNP to predict all-cause 30-day mortality in adults hospitalized with severe pneumonia and to assess whether their combined use offers incremental prognostic value. We hypothesized that admission NLR would demonstrate prognostic performance comparable to NT-proBNP for 30-day mortality prediction and that combining both biomarkers would improve discriminatory accuracy (4,6-10).

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Medicine, Pak Emirates Military Hospital, Rawalpindi, Pakistan, over a one-year period from 1 July 2023 to 30 June 2024. The study was designed to compare the prognostic performance of two admission biomarkers, neutrophil-to-lymphocyte ratio and N-terminal pro-B-type natriuretic peptide, for predicting all-cause 30-day mortality among adults admitted with severe pneumonia. A prospective design was selected to ensure temporal alignment between baseline biomarker measurement and subsequent outcome assessment, to reduce recall bias, and to permit standardized data collection at the time of presentation. Ethical approval was granted by the Institutional Ethical Review Committee of the hospital under reference

A/28/ERC/10/3/23, dated 1 February 2023, and the study was conducted in accordance with the Declaration of Helsinki, revised in 2013 (4,11,12).

Eligible participants were adults aged 18 years or older presenting with a primary diagnosis of severe pneumonia who fulfilled the 2007 Infectious Diseases Society of America/American Thoracic Society criteria, defined by the presence of at least one major criterion or three or more minor criteria, and in whom blood sampling could be performed within six hours of hospital admission (4). Participants were recruited consecutively from patients presenting through the emergency department or admitted directly to the medical wards during the study period, thereby reducing discretionary selection and improving representativeness of the source population. Written informed consent was obtained from each participant before enrolment; where the clinical condition impaired decision-making capacity, consent was obtained from the legally authorized representative in accordance with institutional ethical procedures.

Patients were excluded if they had conditions likely to substantially distort either biomarker independent of pneumonia severity. These exclusions included pre-existing congestive cardiac failure with an ejection fraction below 40% or prior hospitalization for heart failure, chronic kidney disease with estimated glomerular filtration rate below 30 mL/min/1.73 m^2, haematological malignancy or active solid-organ malignancy, current treatment with systemic corticosteroids, immunosuppressive agents, or biologic therapies, antibiotic use for more than 48 hours before presentation, readmission within 30 days of a previous pneumonia episode, or missing baseline biomarker data. These criteria were applied to improve internal validity by minimizing major confounding from chronic cardiac dysfunction, advanced renal impairment, malignancy-related inflammatory alterations, immunosuppression, and partially treated infection. Cases with incomplete baseline biomarker measurements were excluded from the analytic dataset, and no statistical imputation was performed because the primary predictor variables were unavailable for valid model construction.

A predesigned structured proforma was used to collect baseline demographic, clinical, and laboratory information at admission. Demographic variables included age and sex. Clinical variables included respiratory rate, room-air oxygen saturation, systolic blood pressure, Glasgow Coma Scale score, intensive care unit admission status, chest radiographic findings, and relevant comorbidities including diabetes mellitus, hypertension, and chronic obstructive pulmonary disease. CURB-65 score was also recorded as an established clinical severity index for pneumonia (5). Laboratory variables included total white blood cell count, absolute neutrophil count, absolute lymphocyte count, C-reactive protein, serum creatinine, and albumin. The neutrophil-to-lymphocyte ratio was operationally defined as the absolute neutrophil count divided by the absolute lymphocyte count from the first complete blood count performed within six hours of admission. NT-proBNP was defined as the plasma concentration measured from the same admission blood sampling window, before outcome occurrence. The primary outcome was all-cause mortality within 30 days of admission, determined using hospital records for inpatients and telephone follow-up for patients discharged before day 30. Outcome status was recorded using a predefined outcome ascertainment process to ensure uniform follow-up for all enrolled participants.

Venous blood samples were collected within six hours of admission under routine aseptic technique and processed in the hospital's central laboratory according to standardized departmental procedures. Complete blood count parameters were generated using the automated haematology analyzer in routine use at the institution, and NLR was calculated from the absolute neutrophil and lymphocyte counts. NT-proBNP was measured by electrochemiluminescence immunoassay on the Roche Cobas e411 platform (Roche Diagnostics, Mannheim, Germany). All laboratory assays were performed by trained technicians who were unaware of the subsequent clinical outcomes, thereby reducing measurement bias in biomarker assessment. Clinical management decisions were made by the treating teams according to standard departmental protocols and were not influenced by the study investigators, preserving the observational nature of the study.

The required sample size was estimated using the Hanley and McNeil approach for comparison of two correlated receiver operating characteristic curves, implemented in MedCalc version 22.0 (11,12). Based on previously reported area under the curve estimates of 0.791 for NLR and 0.715 for NT-proBNP in severe pneumonia, with a two-sided alpha of 0.05, statistical power of 80%, and an expected survivor to non-survivor ratio of 2.3:1 corresponding to an approximate mortality rate of 30%, the minimum required sample was calculated as 117 participants. To accommodate potential attrition or incomplete observations, the target enrolment was increased by approximately 10%, resulting in a final planned sample of 130 patients.

Several steps were taken to address bias and improve data integrity. Consecutive enrolment minimized selective recruitment; standardized eligibility criteria reduced misclassification of severe pneumonia; biomarker sampling within a fixed six-hour window improved temporal consistency; use of a structured proforma reduced information variability; and laboratory staff were blinded to patient outcomes. Exclusion of patients with major cardiac and renal disease was intended to limit confounding in NT-proBNP interpretation, while multivariable modelling was used to account for additional clinically relevant covariates associated with mortality risk. Source documents were cross-checked against the case record form before data entry, and the final database was reviewed for completeness and internal consistency before analysis. Data were entered in coded form and analyzed using IBM SPSS Statistics version 24.0.

Statistical analysis was performed according to variable type and distribution. Continuous variables were summarized as mean with standard deviation when normally distributed and as median with interquartile range when skewed. Categorical variables were summarized as frequencies and percentages. Between-group comparisons for survivors and non-survivors were conducted using the independent-samples t-test for normally distributed continuous variables, the Mann-Whitney U test for skewed continuous variables, and the chi-square test or Fisher's exact test for categorical variables, as appropriate. Discriminatory performance for 30-day mortality was assessed using receiver operating characteristic curve analysis, with calculation of the area under the curve and corresponding 95% confidence intervals. The DeLong method was used to compare the correlated AUC values of NLR and NT-proBNP directly, and optimal biomarker thresholds were identified using the maximum Youden index (13,14). To evaluate independent predictors of mortality, binary logistic regression analysis was performed using clinically plausible covariates and variables demonstrating prognostic relevance on baseline analysis, including age, ICU admission, CURB-65 category, albumin level, NLR threshold status, and NT-proBNP threshold status. Adjusted odds ratios with 95% confidence intervals were reported. All hypothesis tests were two sided, and a p-value below 0.05 was considered statistically significant (13,14).

RESULTS

A total of 148 patients were screened during the study period, of whom 130 fulfilled eligibility criteria and were included in the final analysis. Eighteen patients were excluded, including nine with known cardiac failure, five with stage 5 chronic kidney disease, and four with incomplete baseline biomarker data. Among the included participants, the mean age was 57.3 ± 14.6 years, 82 patients (63.1%) were male, and 38 died within 30 days, yielding an all-cause 30-day mortality rate of 29.2%. Non-survivors were significantly older than survivors, whereas sex distribution and major baseline comorbidities did not differ significantly between groups. Markers of illness severity were consistently worse among non-survivors, including higher CURB-65 scores, greater ICU admission frequency, higher inflammatory burden, worse renal indices, and lower albumin levels, indicating a more severe systemic and physiological profile at presentation.

Non-survivors demonstrated markedly worse inflammatory and organ stress profiles at admission. Median white blood cell count was 15.7 $\times 10^9$/L in non-survivors versus 11.4 $\times 10^9$/L in survivors, while median neutrophil count was 13.6 versus 8.9 $\times 10^9$/L and median lymphocyte count was 0.71 versus 1.04

$\times 10^9$/L, all supporting substantially greater inflammatory dysregulation in those who died. CRP was almost doubled in non-survivors, with a median of 164 mg/L compared with 87 mg/L in survivors. Serum albumin was 0.5 g/dL lower in non-survivors, and ICU admission was more than twice as frequent in those who died, occurring in 78.9% of non-survivors compared with 30.4% of survivors. These findings support a clinically coherent pattern in which mortality clustered in older, more severely ill patients with greater systemic inflammation, poorer physiological reserve, and more frequent critical care requirement.

Table 1. Baseline demographic, clinical, and laboratory characteristics according to 30-day survival status

Variable	Survivors (n=92)	Non-survivors (n=38)	Effect estimate*	p-value
Age (years), mean ± SD	54.8 ± 14.1	63.7 ± 13.2	Mean difference 8.9 years	0.002
Male sex, n (%)	58 (63.0)	24 (63.2)	OR 1.01	0.991
Diabetes mellitus, n (%)	31 (33.7)	16 (42.1)	OR 1.43	0.361
Hypertension, n (%)	38 (41.3)	19 (50.0)	OR 1.42	0.371
COPD, n (%)	14 (15.2)	9 (23.7)	OR 1.73	0.237
CURB-65, median (IQR)	2 (1–3)	3 (2–4)	Median difference 1 point	<0.001
ICU admission, n (%)	28 (30.4)	30 (78.9)	OR 8.57	<0.001
WBC ($\times 10^9$/L), median (IQR)	11.4 (8.2–15.8)	15.7 (11.9–21.3)	Median difference 4.3	0.001
Neutrophils ($\times 10^9$/L), median (IQR)	8.9 (6.1–12.4)	13.6 (10.2–18.7)	Median difference 4.7	<0.001
Lymphocytes ($\times 10^9$/L), median (IQR)	1.04 (0.72–1.41)	0.71 (0.42–1.02)	Median difference −0.33	<0.001
CRP (mg/L), median (IQR)	87 (54–142)	164 (112–238)	Median difference 77	<0.001
Creatinine (µmol/L), mean ± SD	102 ± 38	131 ± 54	Mean difference 29	0.003
Albumin (g/dL), mean ± SD	3.4 ± 0.5	2.9 ± 0.5	Mean difference −0.5	<0.001

*Effect estimates are descriptive between-group contrasts derived from reported aggregate data; odds ratios for categorical variables are approximate unadjusted contrasts based on the observed counts. Source data from manuscript table.

Both index biomarkers were significantly elevated among non-survivors. Median NLR in non-survivors was 19.4 (IQR 14.2–27.1), compared with 9.1 (IQR 6.0–13.4) in survivors, representing an absolute median difference of 10.3. NT-proBNP showed a similarly strong separation, with a median of 4,820 pg/mL (IQR 2,980–8,640) in non-survivors versus 1,240 pg/mL (IQR 680–2,310) in survivors, an absolute median difference of 3,580 pg/mL. Both contrasts were highly statistically significant, indicating that greater inflammatory imbalance and greater cardiopulmonary stress at admission were each strongly associated with subsequent 30-day death.

Table 2. Diagnostic performance of admission biomarkers for prediction of 30-day mortality

Parameter	AUC (95% CI)	Optimal cut-off	Sensitivity (%)	Specificity (%)	DeLong comparison p-value	p-value vs AUC 0.5
NLR	0.812 (0.736–0.888)	≥14.5	76.3	79.1	0.38†	<0.001
NT-proBNP	0.779 (0.697–0.861)	≥2800 pg/mL	73.7	75.8	0.38†	<0.001
NLR + NT-proBNP	0.856 (0.789–0.923)	—	81.6	83.7	—	<0.001

†DeLong test comparing NLR and NT-proBNP AUCs. Combined model derived from joint biomarker model reported in the manuscript.

Receiver operating characteristic analysis demonstrated good discrimination for both biomarkers. NLR achieved an AUC of 0.812 (95% CI 0.736–0.888), while NT-proBNP achieved an AUC of 0.779 (95% CI 0.697–0.861). Although the point estimate for NLR was numerically higher, the DeLong comparison showed that this difference was not statistically significant (p=0.38), indicating broadly comparable prognostic performance between the two admission markers. At the optimal threshold of 14.5, NLR yielded 76.3% sensitivity and 79.1% specificity. NT-proBNP, using a threshold of 2,800 pg/mL, yielded 73.7% sensitivity and 75.8% specificity. When both biomarkers were combined, the AUC increased to 0.856 (95% CI 0.789–0.923), with sensitivity rising to 81.6% and specificity to 83.7%, suggesting improved overall classification when inflammatory and cardiopulmonary stress information were integrated.

Table 3. Multivariable logistic regression for independent predictors of 30-day mortality

Variable	Adjusted OR	95% CI	p-value
NLR ≥14.5	4.71	2.04–10.88	<0.001
NT-proBNP ≥2800 pg/mL	3.96	1.72–9.11	0.001
Age ≥60 years	2.81	1.24–6.41	0.014
ICU admission	6.34	2.47–16.27	<0.001
CURB-65 ≥3	2.19	0.93–5.17	0.073
Albumin <3.0 g/dL	2.44	1.02–5.84	0.046

Reference categories: NLR <14.5, NT-proBNP <2800 pg/mL, age <60 years, no ICU admission, CURB-65 <3, albumin ≥3.0 g/dL.

In multivariable analysis, both biomarkers remained independently associated with mortality after adjustment for clinical severity indicators and relevant baseline factors. NLR ≥14.5 was associated with a 4.71-fold increase in the odds of 30-day mortality (95% CI 2.04–10.88; p<0.001), while NT-proBNP ≥2,800 pg/mL was associated with a 3.96-fold increase (95% CI 1.72–9.11; p=0.001). ICU admission emerged as the strongest independent predictor overall, with an adjusted odds ratio of 6.34 (95% CI 2.47–16.27; p<0.001), reflecting the heavy mortality burden among critically ill patients. Age ≥60 years and hypoalbuminaemia also retained statistical significance, whereas CURB-65 ≥3 showed a positive but non-significant adjusted association. Collectively, these findings indicate that both NLR and NT-proBNP provide prognostic information beyond conventional bedside severity indicators and basic clinical risk variables.

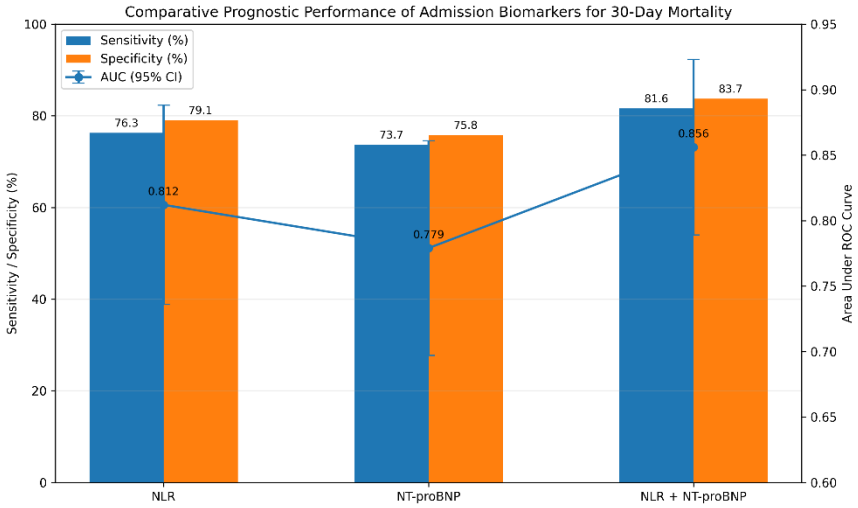

Figure 1 Consistent gradient in prognostic performance across the three models

This integrated figure shows a consistent gradient in prognostic performance across the three models, with the combined NLR plus NT-proBNP model achieving the highest discriminatory profile, including an AUC of 0.856 (95% CI 0.789–0.923), sensitivity of 81.6%, and specificity of 83.7%, compared with NLR alone at 0.812, 76.3%, and 79.1%, and NT-proBNP alone at 0.779, 73.7%, and 75.8%, respectively. The visual separation indicates that although NLR and NT-proBNP perform similarly as single admission biomarkers, combining inflammatory and cardiopulmonary stress signals yields a measurable improvement in both detection of eventual non-survivors and correct classification of survivors, supporting the clinical value of dual-marker risk stratification in severe pneumonia.

DISCUSSION

In this prospective observational study of adults hospitalized with severe pneumonia, both admission neutrophil-to-lymphocyte ratio and NT-proBNP demonstrated good ability to predict all-cause 30-day mortality, and their discriminative performance was statistically comparable. The observed mortality rate of 29.2% is consistent with previously reported outcomes in severe pneumonia cohorts from tertiary and critical care settings, where short-term mortality commonly remains high despite improvements in

antimicrobial therapy and supportive care (3,15). This supports the clinical relevance of early prognostic assessment in this patient population and reinforces the need for practical biomarkers that can be obtained at the time of presentation.

The prognostic performance of NLR in the present study was robust, with an AUC of 0.812 and an optimal threshold of 14.5. This finding is closely aligned with earlier reports in severe pneumonia, including studies showing AUC values around 0.79 and cut-off values near 14.9 for short-term mortality prediction, suggesting reasonable external coherence of the observed signal across populations (7,8). From a biological perspective, this relationship is plausible because severe pneumonia is characterized by exaggerated innate inflammatory activation, neutrophilia, and stress-related lymphopenia, leading to elevation of NLR as a composite indicator of both inflammatory burden and impaired immune regulation (6,16). The marked between-group difference observed in this cohort, with median NLR of 19.4 in non-survivors compared with 9.1 in survivors, further supports its role as a clinically meaningful indicator of adverse prognosis.

NT-proBNP also performed well, with an AUC of 0.779 and an optimal cut-off of 2,800 pg/mL. Its prognostic utility is consistent with prior work showing that elevated natriuretic peptide levels in pneumonia are associated with worse outcomes even in the absence of overt heart failure, likely because they reflect a broader syndrome of cardiopulmonary stress, inflammatory myocardial dysfunction, hypoxaemia-related ventricular strain, and sepsis-associated haemodynamic compromise (9,10,17). In the present study, median NT-proBNP levels were almost fourfold higher in non-survivors than survivors, supporting the view that mortality risk in severe pneumonia is not driven by inflammation alone, but by the interaction of infection, organ stress, and systemic physiological decompensation.

A central finding of this study is that the difference between the AUCs of NLR and NT-proBNP was not statistically significant on DeLong testing. This suggests that, within this cohort, the low-cost and widely available inflammatory marker performed comparably to the more specialized and resource-intensive cardiac biomarker. This has important practical implications for healthcare systems where access to advanced biochemical testing is limited. Because NLR is derived from a routine complete blood count and does not require additional assay cost or laboratory infrastructure, it may serve as an effective first-line risk stratification tool in district hospitals, emergency units, and other resource-constrained clinical settings (18,19). From an implementation standpoint, an admission NLR threshold of 14.5 could be used to identify patients requiring closer monitoring, earlier escalation of care, or prompt senior review, particularly where comprehensive severity scoring or NT-proBNP measurement is not immediately feasible.

At the same time, the combined biomarker model demonstrated the highest overall discrimination, with an AUC of 0.856, sensitivity of 81.6%, and specificity of 83.7%. These findings should be interpreted as evidence of improved predictive performance within the present cohort rather than definitive proof of broader superiority, because the model has not yet undergone external validation. Nevertheless, the observed increase in AUC is clinically plausible and likely reflects complementary pathophysiological information captured by the two markers. NLR primarily reflects the magnitude of inflammatory and immune dysregulation, whereas NT-proBNP reflects cardiovascular stress and haemodynamic burden. Their joint use therefore offers a broader representation of severe pneumonia pathobiology than either marker alone (9,16,20). In practice, this suggests a potentially useful tiered approach in which NLR may function as the initial screening biomarker and NT-proBNP may add value where available, especially in patients with borderline clinical severity or uncertain triage needs.

The multivariable findings further strengthen the clinical relevance of these biomarkers. After adjustment for age, ICU admission, CURB-65 score, and albumin, NLR at or above 14.5 remained associated with a 4.71-fold increase in the odds of 30-day mortality, while NT-proBNP at or above 2,800 pg/mL remained associated with a 3.96-fold increase. These associations indicate that both markers retain independent prognostic value beyond conventional bedside risk indicators. ICU admission showed

the strongest adjusted association with mortality, which is expected because it reflects a high level of clinical severity at presentation. Age 60 years or older and hypoalbuminaemia also remained significant, consistent with prior literature linking advancing age, frailty, poor nutritional reserve, and systemic illness burden to worse pneumonia outcomes (20-22). Although CURB-65 of 3 or more showed a positive association, it did not reach statistical significance in the adjusted model, which may indicate overlap between score-derived severity information and the physiological burden already captured by biomarker elevations.

These findings also have interpretive importance for bedside prognostication. Traditional severity scores remain useful and should not be replaced solely on the basis of a single-center biomarker study. However, where full score calculation is delayed, incomplete, or logistically difficult, biomarkers such as NLR may offer immediate and objective supplementary risk information. In this context, the present results support the use of NLR as a pragmatic triage adjunct rather than a standalone substitute for comprehensive clinical assessment. The combination of age, ICU requirement, albumin status, and elevated biomarkers may help clinicians identify a particularly high-risk phenotype early in the admission course, thereby facilitating timely escalation and more targeted surveillance.

The study has several methodological strengths. Its prospective design reduced recall bias and ensured that biomarker measurement preceded outcome ascertainment. Severe pneumonia was defined using recognized IDSA/ATS criteria, blood sampling was standardized within six hours of admission, laboratory measurements were performed using consistent protocols, and complete 30-day follow-up was achieved for all included participants. The exclusion of patients with major cardiac failure and severe renal impairment also improved interpretability of NT-proBNP by reducing major non-pneumonic causes of biomarker elevation.

Nevertheless, the findings should be interpreted in light of important limitations. The study was conducted at a single tertiary military hospital, which may limit generalizability to civilian hospitals, rural facilities, and more heterogeneous healthcare populations. The sample size, although adequate for the primary AUC comparison, was insufficient for more detailed subgroup analyses by pathogen type, microbiological confirmation, or comorbidity strata. Biomarkers were measured only at baseline, so dynamic changes over the first 48 to 72 hours could not be evaluated. Microbiological etiology was not established in all cases, introducing potential residual confounding because bacterial, viral, and atypical infections may produce different inflammatory and cardiocirculatory profiles. In addition, although advanced renal impairment was excluded, lesser degrees of subclinical renal dysfunction may still have influenced NT-proBNP values. Finally, the combined model was evaluated internally only, and its apparent performance gain should therefore be validated in larger multicenter cohorts before broader clinical adoption.

Overall, the present findings indicate that both NLR and NT-proBNP are clinically informative for early mortality risk assessment in severe pneumonia, with NLR offering particular value as a simple, inexpensive, and widely accessible biomarker. The results support a pragmatic risk stratification framework in which NLR can be used at first presentation and NT-proBNP can provide incremental value where laboratory capacity permits. Future multicenter studies should assess external validity, evaluate serial biomarker measurement, and determine whether integrating these markers into clinical risk pathways improves outcomes through earlier escalation and more tailored monitoring (7,9,20).

CONCLUSION

Baseline neutrophil-to-lymphocyte ratio and NT-proBNP are both effective predictors of all-cause 30-day mortality in adults hospitalized with severe pneumonia, with no statistically significant difference in their individual discriminative performance in this cohort. Because NLR is inexpensive, rapidly available, and derived from a routine complete blood count, it represents a particularly practical bedside prognostic marker for resource-limited settings. The combined use of NLR and NT-proBNP showed

improved predictive performance within the present dataset and may offer a broader assessment of inflammatory and cardiopulmonary stress, although this combined approach requires external validation before routine adoption. These findings support the use of admission biomarkers as adjuncts to clinical judgment and conventional severity assessment in the early risk stratification of severe pneumonia.

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