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ORIGINAL RESEARCH

Predictive Value of NLR, PLR, RDW and PDW in the Adverse Prognosis of Neonatal Pneumonia

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Objective: Neutrophil-to-lymphocyte ratio (NLR), Platelet-to-lymphocyte ratio (PLR), Red-cell-distribution width (RDW) and Platelet-distribution width(PDW) have been proved to be related to the severity of a variety of diseases and poor prognosis. But their predictive value in neonatal pneumonia is still unknown. Therefore, this study explored the predictive value of NLR, PLR, RDW and PDW in the adverse prognosis of neonatal pneumonia.

Methods: We retrospectively analyzed 132 neonates with pneumonia treated in our hospital from April 2022 to October 2024. At the same time, 50 healthy newborns delivered in our hospital during the same period were selected as the control group. The levels of NLR, PLR, RDW and PDW in children with different disease severity and prognosis were analyzed; The correlation between NLR, PLR, RDW, PDW levels and disease severity was analyzed, and the predictive value for the adverse prognosis of neonatal pneumonia.

Results: Among 132 children, 65 were mild, 44 moderate and 23 severe; 26 cases had poor prognosis. The levels of NLR, PLR, RDW and PDW in children with different disease severity were significantly different ($P<0.05$). Spearman test showed that NLR, PLR, RDW, PDW were significantly positively correlated with the severity of neonatal pneumonia ($P<0.05$). Multivariate logistic regression analysis showed that NLR, PLR, RDW and PDW were the related factors influencing the poor prognosis of neonatal pneumonia ($p<0.05$). ROC curve analysis showed that the value of combined prediction of four indicators for poor prognosis of neonatal pneumonia was higher than that of single indicators, and the sensitivity of combined prediction was 100%, and the specificity was 94.9%.

Conclusion: NLR, PLR, RDW, PDW were positively correlated with the severity of neonatal pneumonia, and the value of combined prediction of poor prognosis was higher.

Keywords: Neutrophil-to-lymphocyte ratio, Platelet-to-lymphocyte ratio, Red-cell-distribution width, Platelet-distribution width, neonatal pneumonia

Introduction

Neonatal pneumonia is mainly the inflammatory pathological changes of lung tissue caused by neonatal inhalation of foreign bodies such as amniotic fluid and meconium or infection with viruses and bacteria during intrauterine or delivery and after birth.[1,2] Because the organs and immune system of newborns are not fully developed, dyspnea, expectoration and cough caused by pulmonary infection pose a great threat to the health of newborns.[2,3] However, accurate diagnosis and evaluation of the disease can guide the clinical implementation of targeted treatment, and help to ensure the significance of disease prognosis.[1–3]

Currently, neonatal pneumonia is most diagnosed through etiology and X-ray examination in clinical practice.[4,5] However, the former takes a long time to culture, while the latter has low specificity and has limitations in clinical application.[4] Hematological inflammatory parameters have the advantages of high timeliness and simple operation, so they have gradually become a new trend in diagnosis and treatment of pulmonary infections.[6] NLR and PLR are common clinical indicators of inflammation. The level will increase significantly in the later stage of infection and is positively correlated with the degree of inflammatory response.[7,8] In addition, it has been clinically found that infectious diseases

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can cause decreased platelet and red blood cell production and morphological changes, leading to abnormalities in RDW and PDW. This in turn affects the body's coagulation and immune functions, and has an impact on disease prognosis.[9,10]

Growing evidence indicates that NLR, PLR, RDW, and PDW are associated with disease severity and adverse outcomes across inflammatory conditions in adults (eg, COVID-19, COPD, cardiovascular disease),[7–11] with similar observations reported in pediatric infectious and critical illnesses.[12–16] Whether these readily available hematologic indices can predict adverse prognosis in neonatal pneumonia, however, remains insufficiently studied. Therefore, we aimed to evaluate the prognostic value of NLR, PLR, RDW, and PDW for adverse outcomes in neonatal pneumonia (eg, treatment failure, death, mechanical ventilation or ICU admission, referral due to deterioration, or treatment abandonment). To our knowledge, this is the first study to assess these indices for prognostication in neonatal pneumonia.

Materials and Methods

Patients

This is a retrospective study based on data from the electronic medical record system. We retrospectively analyzed 132 neonatal pneumonia treated in our hospital from April 2022 to October 2024. Inclusion criteria: 1) All delivered in our hospital;2) met the diagnostic criteria for neonatal pneumonia;[13]) confirmed diagnosis through clinical examination;4) birth age <28 days;5) accompanied by varying degrees of groan, cyanosis or refractory apnea, etc.;6) Suction frequency>60 times/min;7) X-ray examination showed that there were infiltration shadows of different sizes in the lungs;8) Pathogen bacteria were cultured in the secretions of the lower respiratory tract. Exclusion criteria: 1) neonatal chromosomal abnormalities;2) incomplete clinical data;3) congenital abnormalities of the respiratory tract;4) congenital heart disease;5) congenital metabolic and genetic diseases. Fifty healthy neonates delivered at our hospital during the study period were included as controls. The control sample size reflected feasibility: only infants who underwent clinically indicated routine blood testing were eligible; for ethical reasons, no additional phlebotomy was performed solely for research. Individual matching was not undertaken; instead, group comparability was evaluated using baseline demographics (sex, gestational age, birth weight, and delivery mode), which showed no significant differences between the pneumonia and control groups (Table 1). The control group provided baseline distributions for NLR, PLR, RDW, and PDW in uninfected neonates, enabling comparison with diseased infants and clarifying the stepwise increases of these indices from healthy to mild, moderate, and severe cases—supporting that observed elevations were disease-related rather than normal neonatal variation.

Definition of Disease Severity

Mild: General status is good, no high-risk factors, vital signs are stable, and no obvious abnormalities in organ functions. Moderate: with obvious clinical symptoms, mechanical ventilation ≤ 4 days. Severe: disturbance of consciousness, respiratory rate > 30 beats/min, arterial partial pressure of oxygen (PaO2) < 60 mmHg, PaO2/fraction of oxygen

Table 1 Comparison of Demographic Characteristics Between Pneumonia Group and Control Group

Variables	Pneumonia Group (n=132)	Control Group (n=50)	t/χ^2	P
Date of birth (days), M(IQR)	15 (12.5, 18.5)	15 (11, 17)	−1.193	0.233
Male (yes), n (%)	78 (59.1)	31 (60.8)	0.044	0.834
Birth weight (kg), Mean±SD	2.90±0.60	3.06±0.65	−1.522	0.13
Geothermal age (weeks), M(IQR)	39 (37, 39)	39 (38, 40)	−1.544	0.122
Method of delivery, n (%)			0.888	0346
Natural labor	85 (64.4)	29 (56.9)		
Cesarean section	47 (35.6)	22 (43.1)		
Degree of disease, n (%)				
Mild	65 (49.2)	/	/	/
Moderate	44 (33.3)	/	/	/
Severe	23 (17.4)	/	/	/
Poor prognosis (yes), n (%)	26 (19.7)	/	/	/

concentration in inhaled air (FiO2) < 300 mmHg, requiring mechanical ventilation treatment, or even entering the intensive care unit (ICU) for treatment.

Collect Data

Collect demographic characteristics of children, including birth age, gender, birth weight, gestational age and delivery method. 2) Biomarkers, including NLR, PLR, RDW, PDW levels. Test method: A vacuum blood collection tube containing ethylenediamine tetraacetic acid was used to collect a blood sample of 3mL on the morning of the second day after admission. Blood analysis was performed using the AU5800 automatic biochemical analyzer (Beckman, USA) to measure RDW, PDW, platelet count, lymphocyte count, and neutrophil count; NLR= neutrophil to lymphocyte ratio; PLR= platelet to lymphocyte ratio. 3) Poor prognosis of neonatal pneumonia: i. Treatment failed and vital signs disappeared; ii. Clinical death was declared; Referral and transfer for treatment due to worsening disease progression; iii. Unstable vital signs, concomitant with other diseases or complications, and poor treatment results in abandonment of treatment. Good prognosis: normal body temperature, normal appetite, improved spirit, ability to breathe spontaneously, disappearance of pulmonary rales, and no shadows or nodules on chest X-ray. He was cured and discharged; the condition was reduced or improved compared with before admission.

Treatment Methods

All children were given targeted antibiotic treatment based on the type of bacteria detected. Children with mild pneumonia were given oxygen inhalation through nasal catheter. Severe children with severe hypoxemia or NRDS were given invasive or non-invasive mechanical ventilation combined with pulmonary surfactants. Control blood oxygen within the normal range. While anti-infective treatment, correct water, electrolytes and acid-base balance disorders to ensure adequate energy and nutritional support.

Statistical Methods

Statistical analysis was completed by SPSS software version 26.0 (SPSS, Chicago, IL, USA). For qualitative variables, significant differences between groups were tested by chi-square. To test the normality of the distribution of metric data, we used the Shapiro–Wilk test. The measurement data all conform to a normal distribution and have uniform variances, and are expressed as mean and standard deviation (SD). The comparison between the two groups uses *t*-test, the comparison between multiple groups uses one-way analysis of variance (ANOVA), and the multiple comparisons uses LSD-*t* test. For non-normal measurement data, the median and interquartile range (IQR) are used to express the comparison between the two groups using the Mann–Whitney *U*-test, the comparison between multiple groups using the Kruskal–Wallis *H*-test, and the pairwise comparison using the Nemenyi test. Spearman test was used for the correlation between biomarker levels and different disease degrees. A logistic regression model was performed on the biomarkers, and the outcome was poor prognosis of neonatal pneumonia. Predictions from the logistic regression model were used to test the predictive performance of biomarkers on poor prognosis using receiver operating characteristics (ROC) analysis. Significance was considered when P values were <0.05.

Results

Demographic Characteristics

In this retrospective analysis, we included 132 neonatal pneumonia. Among them, 78 were males and 54 were females; 65 were mild pneumonia, 44 were moderate pneumonia, and 23 were severe pneumonia. 26 cases had poor prognosis. During the same period, 50 healthy newborns were selected as the control group. There was no statistical significance between the pneumonia group and the control group in demographic characteristics such as birth age, gender, birth weight, gestational age and delivery method (P>0.05) (Table 1).

Comparison of NLR, PLR, RDW, PDW Between Pneumonia Group and Control Group

There were significant differences in NLR, PLR, RDW, and PDW in patients with different disease degrees in the pneumonia group, and the levels in severe children were the highest, followed by moderate children, and the third was mild, and all were higher than that in the comparison group (P<0.05) (Table 2).

Correlation Analysis Between NLR, PLR, RDW, PDW and Severity of Disease

Spearman test results showed that there was a significant positive correlation between the levels of NLR, PLR, RDW, and PDW and the severity of neonatal pneumonia (P<0.05) (Table 3).

Comparison of NLR, PLR, RDW and PDW in Neonatal Pneumonia with Different Prognosis

Among the 132 children in the pneumonia group, 106 had good prognosis and 26 had poor prognosis. The levels of NLR, PLR, RDW, and PDW in patients with poor prognosis were significantly higher than those with good prognosis (P<0.05) (Table 4).

Table 2 Comparison of NLR, PLR, RDW, PDW Between Pneumonia Group and Control Group

Group	NLR, M(IQR)	PLR, M(IQR)	RDW (%), M(IQR)	PDW (%), Mean±SD
Control group (n=50)	1.77 (1.49, 2.55)	51.0 (38.0, 60.0)	12.2 (10.8, 12.8)	12.4±1.7
Mild (n=65)	3.56 (2.64, 4.68)[a]	79.6 (68.5, 92.9)[a]	12.6 (11.5, 14.5)[a]	13.7±2.1[a]
Moderate (n=44)	4.88 (4.33, 5.84)[ab]	99.7 (85.7, 116.45)[ab]	14.4 (12.7, 15.85)[ab]	14.7±1.8[ab]
Severe (n=23)	7.34 (6.59, 8.11)[abc]	141.3 (126.6, 154)[abc]	16.3 (14.6, 17.9)[abc]	16.6±1.6[abc]
H/F	115.448	129.633	60.386	30.446
P	<0.001	<0.001	<0.001	<0.001

Note: Compared with the control group, [a]P<0.05; Compared with mild, [b]P<0.05; Compared with moderate, [c]P<0.05.
Abbreviations: NLR, Neutrophil-to-lymphocyte ratio; PLR, Platelet-to-lymphocyte ratio; RDW, Red-cell-distribution width; PDW, Platelet-distribution width; SD, standard deviation; M(IQR), Median and interquartile range.

Table 3 Correlation Analysis Between NLR, PLR, RDW, PDW and Severity of Disease

Variables		NLR	PLR	RDW	PDW
Severity of disease	*r*	0.662	0.663	0.474	0.465
	P	<0.001	<0.001	<0.001	<0.001

Abbreviations: NLR, Neutrophil-to-lymphocyte ratio; PLR, Platelet-to-lymphocyte ratio; RDW, Red-cell-distribution width; PDW, Platelet-distribution width.

Table 4 Comparison of NLR, PLR, RDW, and PDW in Neonatal Pneumonia with Different Prognosis

Group	NLR, M(IQR)	PLR, M(IQR)	RDW (%), M(IQR)	PDW (%), Mean±SD
Poor prognosis (n=26)	4.53 (3.41, 5.68)	89.25 (76.5, 109.5)	13.5 (12.3, 15.5)	17.2±1.4
Good prognosis (n=106)	7.23 (6.85, 8.54)	148.55 (141.3, 155.2)	16.85 (14.8, 18.5)	14.2±2.0
Z/t	−5.258	−5.728	−3.825	−5.468
P	<0.001	<0.001	<0.001	<0.001

Abbreviations: NLR, Neutrophil-to-lymphocyte ratio; PLR, Platelet-to-lymphocyte ratio; RDW, Red-cell-distribution width; PDW, Platelet-distribution width.

Multivariate Logistic Regression Analysis of Poor Prognosis of Neonatal Pneumonia

Multivariate logistic regression analysis showed that NLR (OR: 5.219, 95% CI: 1.011–26.939), PLR (1.171, 1.031–1.330), RDW (3.066, 1.040–9.042) and PDW (2.622, 1.027–6.693) were all independent risk factors for poor prognosis of neonatal pneumonia (P<0.05) (Table 5).

ROC curve analysis of NLR, PLR, RDW, PDW and their combination in predicting poor prognosis of neonatal pneumonia

The results of ROC curve analysis showed that NLR, PLR, RDW, and PDW were of high value in the poor prognosis of neonatal pneumonia (P<0.001). Among them, the best cutoff value for NLR is 6.285, AUC is 0.931, sensitivity is 100%, and specificity is 83.1%; the best cutoff value for PLR is 125.55, AUC is 0.969, sensitivity is 92.9%, and specificity is 89.0%; the best cutoff value for RDW is 17.25, AUC is 0.813, sensitivity is 50.0%, and specificity is 95.8%; The best cutoff for PDW was 15.75, AUC was 0.886, sensitivity was 92.9%, and specificity was 74.6%. The value of the four factors in the combined diagnosis of neonatal pneumonia was higher than that of individual indicators. The AUC was 0.993, the sensitivity was 100%, and the specificity was 94.9% (P<0.001) (Table 6 and Figure 1).

Discussion

This study evaluated the predictive value of NLR, PLR, RDW, and PDW in poor prognosis of neonatal pneumonia. The results showed that the levels of NLR, PLR, RDW, and PDW were positively correlated with the degree of neonatal disease. The combined value of NLR, PLR, RDW, and PDW in predicting poor prognosis of neonatal pneumonia is higher than the predictive value of each individual indicator. This is consistent with previous research results. Pujani et al[12] found that NLR, PLR, RDW and PDW levels are associated with the severity of COVID-19 and poor prognosis. At the same time, Şahin et al[13] also found that NLR, PLR, and RDW can be used as simple and cost-effective markers to assess the severity of exacerbations and predict hospitalization and further exacerbations in COPD patients. However,

Table 5 Multivariate Logistic Regression Analysis of Poor Prognosis of Neonatal Pneumonia

Variables	B	SE	Wald	P	OR	95% CI
NLR	1.652	0.837	3.893	0.048	5.219	1.011–26.939
PLR	0.158	0.065	5.911	0.015	1.171	1.031–1.330
RDW	1.121	0.552	4.125	0.042	3.066	1.040–9.042
PDW	0.964	0.478	4.064	0.044	2.622	1.027–6.693

Note: B indicates partial regression system; *S.E.* indicates standard error; *Wald* χ^2=(B/*S.E.*)$^{2;}$ *OR* is odds ratio; *95% CI* is the confidence interval of *OR.*

Abbreviations: NLR, Neutrophil-to-lymphocyte ratio; PLR, Platelet-to-lymphocyte ratio; RDW, Red-cell-distribution width; PDW, Platelet-distribution width.

Table 6 Value of NLR, PLR, RDW, PDW and Their Combination in Predicting Poor Prognosis in Neonatal Pneumonia

Variables	Cut-off	ROC	Sensitivity (%)	Specificity (%)	95% CI	P
NLR	6.285	0.931	100%	83.1%	0.886–0.975	<0.001
PLR	125.55	0.969	92.9%	89.0%	0.936–1.000	<0.001
RDW	17.25	0.813	50.0%	95.8%	0.697–0.929	<0.001
PDW	15.75	0.886	92.9%	74.6%	0.818–0.954	<0.001
Joint prediction		0.993	100%	94.9%	0.982–1.000	<0.001

Note: *95% CI* is the confidence interval of *OR.*

Abbreviations: NLR, Neutrophil-to-lymphocyte ratio; PLR, Platelet-to-lymphocyte ratio; RDW, Red-cell-distribution width; PDW, Platelet-distribution width; ROC, Receiver operating characteristic.

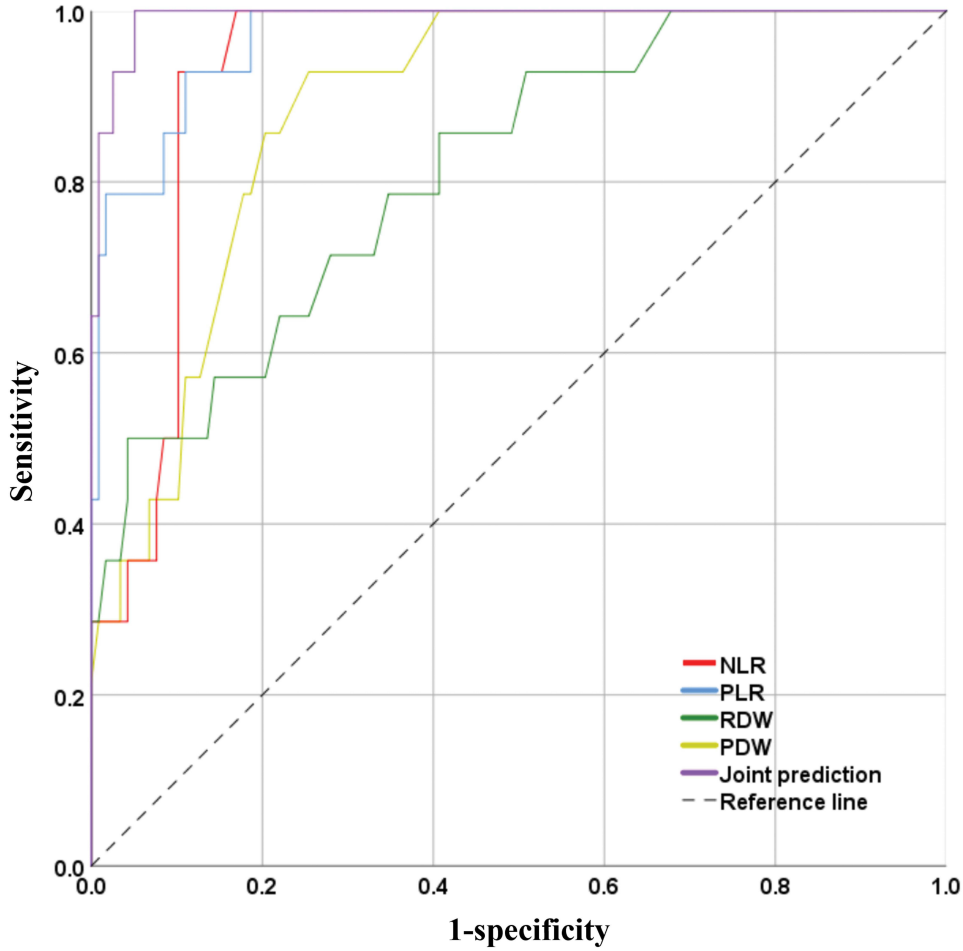

Figure 1 Effectiveness of NLR, PLR, RDW, PDW and their combination in predicting poor prognosis of neonatal pneumonia.

this study confirms the high predictive value of NLR, PLR, RDW, and PDW in different disease severity and poor prognosis in neonatal pneumonia.

Neonatal pneumonia is a common and serious disease in the neonatal period. Early and accurate diagnosis and disease assessment are crucial to improving the prognosis of children.[12–15] This study found that NLR, PLR, RDW, and PDW in the pneumonia group were higher than those in the control group. This is consistent with the research results of Liao et al[14] and Liu et al.[15] They all found significant differences in NLR levels in neonatal pneumonia compared with healthy people.[14,15] This is mainly due to lung infection leading to local and systemic blood circulation disorders. Lung inflammation can affect oxygen exchange and lead to tissue hypoxia. The hypoxia signal will be fed back to hematopoietic organs such as bone marrow, affecting the production and function of blood cells. During infection, pathogens or immune complexes in the blood can interact directly with blood cells, change blood cell characteristics, and cause changes in NLR, PLR, RDW, PDW, etc.[14–16] Spearman test results showed that the levels of NLR, PLR, RDW, and PDW were positively correlated with the severity of different diseases. This shows that these indicators can reflect the severity of neonatal pneumonia. As the condition worsens, the inflammatory reaction becomes stronger and the impact on the blood system becomes more significant, leading to the gradual increase of these indicators.[15,16] For example, in severe infection, the body mobilizes a large number of immune cells in order to fight the infection, further increases neutrophils and further decreases lymphocytes, resulting in a significant increase in NLR.[13,14,16] At the same time, Moreno et al[17] also pointed out that the changes in platelet production and function in children with severe lung infections are more obvious, with increased PLR and PDW, intensified red cell metabolism disorders, and increased RDW. Therefore, we believe that the severity of the child's condition can be preliminarily judged based on the changing trends of these

indicators. Especially when some symptoms are atypical or imaging examinations are difficult to diagnose clearly, abnormal changes in these blood indicators can help identify neonatal pneumonia. Disease severity.[15–17]

Our findings are further supported by recent studies. For instance, Ricci et al[18] demonstrated that advanced hematological ratios are valuable prognostic tools for assessing pneumonia severity in pediatric intensive care, which is consistent with our observations on NLR, PLR, RDW, and PDW in neonatal pneumonia. In addition, Chen et al[19] reported that the lactate/albumin ratio has significant prognostic value in pediatric nosocomial infections, suggesting that other biomarker ratios may also provide complementary information. Together, these studies highlight that diverse biomarker ratios can be integrated into clinical decision-making, and our work contributes neonatal-specific evidence to this evolving field.

In recent years, hematological indicators such as NLR, PLR, RDW and PDW have played an important role in predicting poor prognosis in a variety of diseases.[17,18] Multivariate logistic regression analysis results in this study showed that NLR (OR: 5.219, 95% CI: 1.011–26.939), PLR (1.171, 1.031–1.330), RDW (3.066, 1.040–9.042) and PDW (2.622, 1.027–6.693) were all independent risk factors for poor prognosis of neonatal pneumonia. In clinical practice, the ROC-derived cut-offs reported in Table 6 (eg, NLR 6.285, PLR 125.55, RDW 17.25%, PDW 15.75%) can support early risk stratification in neonatal pneumonia. Values above these thresholds indicate an elevated risk of adverse prognosis and may warrant (i) closer monitoring of vital signs and oxygenation, (ii) early repeat complete blood counts to confirm trajectory, and (iii) timely escalation of supportive care (eg, NICU observation, readiness for respiratory support) according to the overall clinical picture. Conversely, values below the thresholds suggest a lower-risk profile and may support standard management with routine follow-up. Early identification of high-risk infants can also inform resource allocation by prioritizing intensified surveillance where it is most needed. These thresholds are intended to complement —not replace clinical judgment and existing guidelines and should undergo external validation in larger, multicenter cohorts before adoption as formal decision rules. Further ROC curve analysis showed that NLR, PLR, RDW, and PDW were of high value in the poor prognosis of neonatal pneumonia. The value of the four factors in the combined diagnosis of neonatal pneumonia was higher than that of individual indicators, with AUC of 0.993, sensitivity of 100%, and specificity of 94.9%. This is mainly because neutrophils and lymphocytes also help amplify inflammatory signals through cytokines and chemokines.[16–18] An increase in NLR and PLR levels suggests a decrease in the number of lymphocytes; the immune analysis of the body is affected, which is not conducive to recovery of the disease.[20] Elevated RDW suggests an infection-induced disorder of erythroid hematopoietic function in the bone marrow, which may be accompanied by anemia (such as chronic disease anemia), and is associated with the severity and poor prognosis of neonatal pneumonia (such as hypoxemia, worsening tissue hypoxia).[14,21] Increased PDW suggests active platelet production but abnormal function, and is related to vascular endothelial damage, microthrombosis and organ hypoperfusion, which in turn affects prognosis.[22,23] Cai et al[22] pointed out that increases in NLR and PLR levels can be used to diagnose and evaluate acute exacerbations in COPD patients. Lv et al[23] also showed that NLR, PLR, RDW, and PDW are associated with poor prognosis. It can be seen that this study clarified the predictive value of NLR, PLR, RDW, and PDW in poor prognosis of neonatal pneumonia. This also provides a reference for early clinical prediction of the prognosis of children with neonatal pneumonia, helps to adjust treatment strategies in a timely manner and improve the prognosis of children.[22–24]

This study has several limitations. First, its single-center, retrospective design and the modest number of adverse events limit generalizability, introduce risks of selection bias and missing data, and preclude causal inference. No a priori power calculation was performed; the sample of 132 neonates is appropriate for exploratory analysis but underpowered compared with multicenter prospective cohorts. Second, biomarkers were assessed at a single time point; future studies should incorporate longitudinal (serial) measurements during early hospitalization and analyze trajectories using mixed-effects models and time-dependent ROC/C-index. Third, we did not examine heterogeneity across pathogen categories, and variability in biomarker profiles may affect performance. Fourth, model development could be strengthened by integrating NLR, PLR, RDW, and PDW with additional inflammatory or metabolic biomarkers and by reporting internal validation (eg, bootstrap), calibration (calibration plots, Brier score), net reclassification metrics, and decision-curve analysis, followed by external validation in independent cohorts. Finally, larger multicenter, prospective studies with predefined endpoints, standardized sampling/measurement protocols, and a priori sample-size/power calculations (based

on expected AUC or odds-ratio and anticipated event rates) are needed to confirm these findings; such studies may also conduct direct statistical comparisons of AUCs among biomarkers to clarify their relative prognostic performance.

Conclusion

NLR, PLR, RDW, and PDW are positively correlated with the severity of neonatal pneumonia and show substantial prognostic value; a combined panel outperforms any single index. Operationally, incorporating these indices into a simple admission screen—and, pending external validation, embedding them in EMR-based decision support—may help identify high-risk neonates who warrant intensified observation and earlier escalation of care, while supporting routine management for lower-risk cases. Multicenter, prospective studies with predefined endpoints should validate thresholds, assess integration with additional biomarkers, and confirm clinical impact.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Statement

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee, and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Our study was approved by the Ethics Review Board of the Hebei Provincial Hospital of Chinese Medicine (No.2023KS231).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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