

Correlation analysis of peripheral blood composite inflammatory indices in differentiating SARS-CoV-2 infected patients with and without pneumonia.

Wei-Shan Liao¹、Hueng-Chuen Fan²

¹Department of Clinical Pathology, Tungs' Taichung MetroHarbor Hospital,Taiwan

²Department of Children's Medicine, Tungs' Taichung MetroHarbor Hospital,Taiwan

BACKGROUND

With the emergence of various SARS-CoV-2 variants, the clinical manifestations of COVID-19 have become increasingly diverse. This study aimed to investigate whether peripheral blood composite inflammatory indices—namely the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR), C-reactive protein-to-lymphocyte ratio (CLR), eosinophil-to-lymphocyte ratio (ELR), systemic inflammation response index (SII), systemic inflammation response index (SIRI), aggregate index of systemic inflammation (AISi), and multi-inflammatory index (MII)—can distinguish between patients with and without pneumonia in confirmed COVID-19 cases.

METHODS

This retrospective study enrolled hospitalized COVID-19 patients diagnosed via positive RT-PCR from nasopharyngeal swabs in the emergency department between January 1 and June 30, 2022. Laboratory data were used to calculate blood composite inflammatory indices including NLR, PLR, MLR, CLR, ELR, SII, SIRI, AISi, and MII, derived from complete blood count parameters. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the ability of each index to discriminate between pneumonic and non-pneumonic cases.

RESULTS

A total of 287 patients were enrolled in this study, among whom 162 (56.4%) were diagnosed with pneumonia based on chest radiography and computed tomography findings. Compared to the non-pneumonic group, the pneumonic group had significantly higher levels of NLR, PLR, MLR, CLR, SII, SIRI, AISi, and MII ($P < 0.05$, Table 1). ROC curve analysis revealed that NLR (AUC = 0.710, sensitivity = 85.8%, specificity = 50.4%), SIRI (AUC = 0.705, sensitivity = 73.5%, specificity = 64.0%), CLR (AUC = 0.702, sensitivity = 85.8%, specificity = 46.4%), SII (AUC = 0.701, sensitivity = 70.4%, specificity = 64.8%), and MII (AUC = 0.701, sensitivity = 72.8%, specificity = 57.6%) were effective in differentiating patients with pneumonia from those without (Fig 1, Table 2).

| Laboratory examinations | Pneumonic N=162 | Non-pneumonic N=125 | <i>P</i> ^a value |
|-----------------------------------|-------------------------|------------------------|-----------------------------|
| Age | 82(72-89) | 67(29-83) | <0.001 |
| Gender, male/female | 99/63 | 74/51 | 0.79 ^b |
| WBC(×10 ³ /μL) | 8(6.03-10.8) | 7(5-9.9) | 0.016 |
| Neutrophil(×10 ³ /μL) | 5.9(4.2-8.96) | 4.48(3.06-6.83) | <0.001 |
| Lymphocyte(×10 ³ /μL) | 1.04(0.68-1.58) | 1.5(0.91-2.17) | <0.001 |
| Monocyte(×10 ³ /μL) | 0.48(0.34-0.65) | 0.49(0.37-0.59) | 0.739 |
| Platelet(×10 ³ /μL) | 201(144.25-275.5) | 205(159-280) | 0.234 |
| Eosinophil(×10 ³ /μL) | 0.07(0.01-0.15) | 0.07(0.02-0.19) | 0.326 |
| NLR | 5.32(3.18-9.44) | 3.21(1.81-6.99) | <0.001 |
| PLR | 184(132.86-299.03) | 151.09(93.57-220.27) | 0.001 |
| MLR | 0.43(0.29-0.73) | 0.36(0.187-0.59) | 0.011 |
| ELR | 0.05(0.02-0.14) | 0.05(0.02-0.12) | 0.326 |
| CLR | 3.21(0.73-10.79) | 0.76(0.11-4.92) | <0.001 |
| SII | 1062.86(609.81-2205.28) | 694.4(358.5-1426.82) | <0.001 |
| SIRI | 2.68(1.39-5.35) | 1.53(0.82-4.44) | 0.001 |
| MI | 16.92(3.48-68.26) | 3.97(0.41-24.27) | <0.001 |
| AISi | 562.3(261.12-1397.16) | 328.16(161.33-973.33) | 0.005 |
| CRP(mg/dL) | 2.85(0.76-11.08) | 0.93(0.2-5.35) | <0.001 |
| PCT(ng/mL) | 2.36(0.29-5.71) | 0.69(0.1-1.66) | <0.001 |

Table 1. Demographic characteristics and laboratory results of patients with COVID-19.

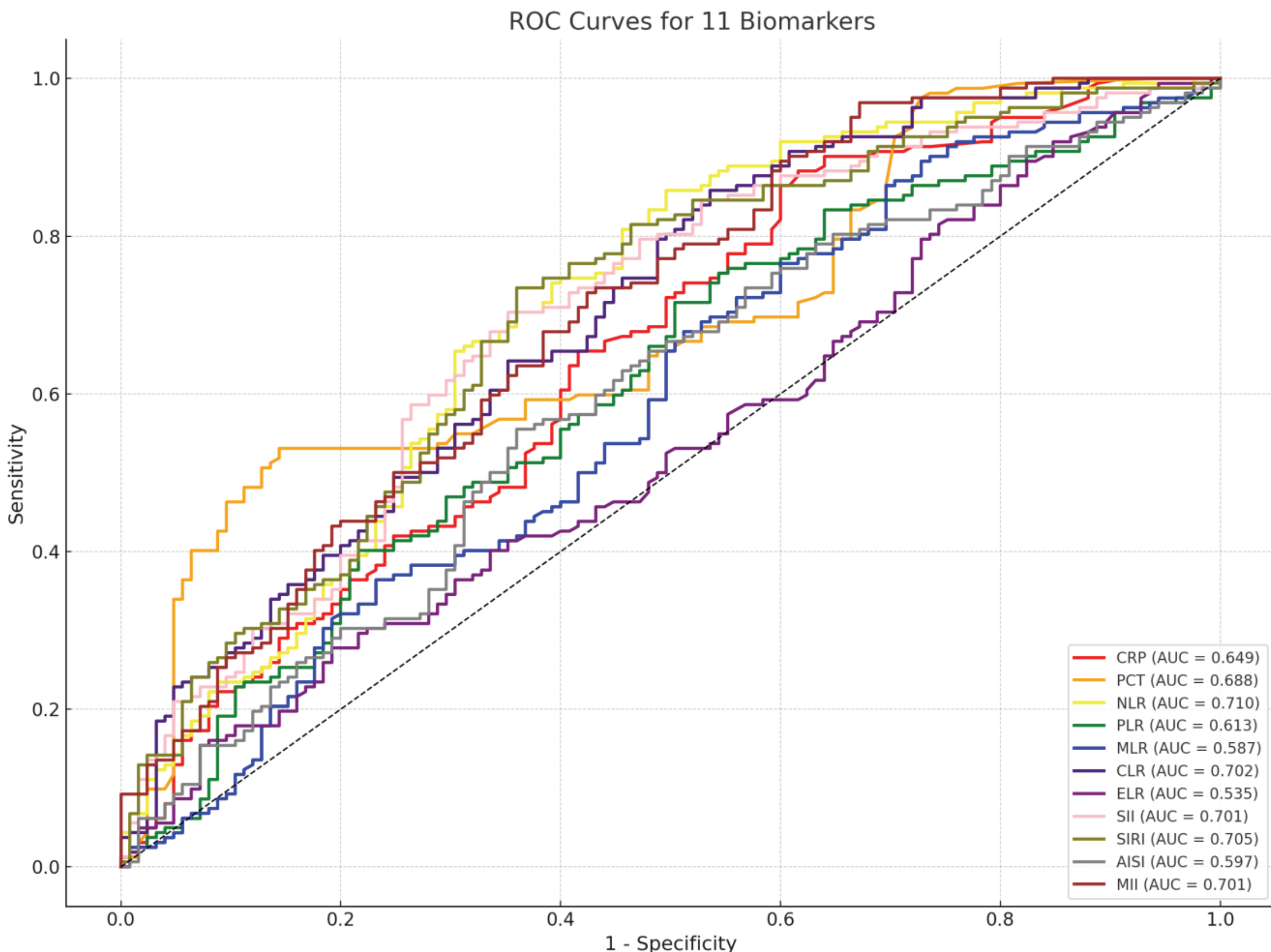


Figure 1. ROC curves of the derived peripheral blood composite inflammatory indices for predicting COVID-19 pneumonia.

Continuous variables were expressed as median (interquartile range), and categorical variables as percentages. The Chi-square test was applied to assess differences in categorical data. A p -value < 0.05 was considered statistically significant. P^a value : Mann–Whitney U test ; P^b value : Chi-Square test.
NLR (Neutrophil to lymphocyte ratio) = Neutrophil count / lymphocyte count
PLR (Platelet to lymphocyte ratio) = Platelet count / lymphocyte count
MLR (Monocyte to lymphocyte ratio) = Monocyte count / lymphocyte count
ELR (Eosinophil to lymphocyte ratio) = Eosinophil count / lymphocyte count
CLR (C-reactive protein to lymphocytes ratio) = C-reactive protein (CRP) / lymphocyte count
SII (Systemic inflammatory index) = Neutrophil count × PLR
SIRI (Systemic inflammation response index)=Neutrophil count × monocyte count / lymphocyte count
MI (Multi-inflammatory index) = NLR × CRP
AISi (Aggregate index of systemic inflammation) =Neutrophil count × monocyte count × platelet count / lymphocyte count

CONCLUSION

Due to the cost-effectiveness, accessibility, and rapid availability of complete blood count testing, peripheral blood composite inflammatory indices have been increasingly explored in the context of COVID-19 diagnosis. Our findings suggest that NLR, CLR, SIRI, SII, and MII can effectively discriminate between pneumonic and non-pneumonic COVID-19 patients. These markers may serve as useful tools in the emergency department for triaging and managing patients, identifying those requiring intensive care, and optimizing resource utilization.

| Biomarker | Cut-off | Sensitivity (%) | Specificity (%) | AUC | 95% CI | p-value | Youden's Index | Odds Ratio |
|-----------|---------|-----------------|-----------------|-------|-------------|---------|----------------|------------|
| CRP | 0.46 | 88.3 | 38.4 | 0.649 | 0.586–0.711 | <0.001 | 0.267 | 4.69 |
| PCT | 2.11 | 53.1 | 85.6 | 0.688 | 0.623–0.748 | <0.001 | 0.387 | 6.73 |
| NLR | 3.228 | 85.8 | 50.4 | 0.71 | 0.650–0.768 | <0.001 | 0.362 | 6.14 |
| PLR | 142.31 | 71.6 | 49.6 | 0.613 | 0.550–0.675 | <0.001 | 0.212 | 2.48 |
| CLR | 0.501 | 85.8 | 46.4 | 0.702 | 0.644–0.759 | <0.001 | 0.322 | 5.23 |
| MLR | 0.215 | 86.4 | 30.4 | 0.587 | 0.521–0.650 | <0.001 | 0.168 | 2.78 |
| ELR | 0.132 | 27.8 | 80.8 | 0.535 | 0.469–0.597 | 0.0968 | 0.086 | 1.62 |
| SII | 901.24 | 70.4 | 64.8 | 0.701 | 0.638–0.760 | <0.001 | 0.352 | 4.37 |
| SIRI | 2.318 | 73.5 | 64 | 0.705 | 0.643–0.765 | <0.001 | 0.375 | 4.92 |
| MI | 5.903 | 72.8 | 57.6 | 0.701 | 0.642–0.758 | <0.001 | 0.304 | 3.64 |
| AISi | 485.72 | 55.6 | 64 | 0.597 | 0.528–0.662 | 0.001 | 0.196 | 2.22 |

Table 2. ROC analysis of derived blood composite inflammatory indices.

