



Diagnostic value of blood parameters for community-acquired pneumonia

Yukai Huang^{a,b}, Aihua Liu^c, Ling Liang^d, Jiawei Jiang^b, Haihua Luo^a, Weiming Deng^b,
Guohui Lin^b, Maosheng Wu^b, Tianwang Li^{b,*}, Yong Jiang^{a,*}

^a Guangdong Provincial Key Laboratory of Proteomics, State Key Laboratory of Organ Failure Research, Southern Medical University, Guangzhou 510515, China

^b Guangdong Second Provincial General Hospital, Guangzhou 510317, China

^c Department of Respiration, Nanfang Hospital of Southern Medical University, Guangzhou 510515, China

^d The Second Affiliated Hospital of Guangzhou Medical University, Guangzhou 510260, China

ARTICLE INFO

Keywords:

Monocyte
Neutrophil-to-lymphocyte ratio
Monocyte-to-lymphocyte ratio
Community-acquired pneumonia
Diagnostic value

ABSTRACT

Background: Community-acquired pneumonia (CAP) has a high rate of morbidity and mortality. Blood parameters, including neutrophil, platelet, lymphocyte, monocyte, neutrophil to lymphocyte ratio (NLR), platelet to lymphocyte ratio (PLR), and monocyte to lymphocyte ratio (MLR), have been proposed as indicators of systemic inflammation and infection. However, few studies have focused on the diagnostic value of blood parameters for CAP.

Objective: The study aims to determine the diagnostic value of blood parameters for CAP and to investigate their relationship with disease severity.

Methods: CAP patients who fulfilled the inclusion criteria were enrolled in this study. Healthy age- and gender-matched subjects were also enrolled as a control group. Blood parameters, blood biochemistry, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), procalcitonin (PCT), days in hospital, body temperature, pneumonia severity index (PSI), and CURB-65 were recorded. The area under the curve (AUC) values was determined using the receiver-operating characteristic (ROC) curve. The correlation between the variables was tested with Pearson correlation analysis.

Results: The study included 80 CAP patients and 49 healthy subjects. White blood cell (WBC), neutrophil, monocyte, MLR, PLR, and NLR levels in the CAP group were higher than that of control group, while lymphocyte and hemoglobin (HGB) levels were lower ($P < 0.05$). The ROC curve result showed that NLR and MLR yielded higher AUC values than other variables. Monocyte was positively correlated with ESR and negatively with body temperature, aspartate aminotransferase (AST), and creatinine (CREA). NLR was positively correlated with CRP, PCT, days in hospital, alanine aminotransferase (ALT), AST, and PSI. MLR was positively correlated with CRP, PCT, and body temperature. An increase in ALT or AST of > 2 times of normal was defined as liver injury, and CAP patients were divided into the liver normal group and liver injury group. Sixty-nine patients belonged to the liver normal group, and 11 patients belonged to the liver injury group. Blood parameters, ESR, CRP, PCT, PSI, and CURB-65 were compared between the two groups. The results demonstrated that the monocyte level in the liver injury group was lower than that of the liver normal group ($P < 0.05$). The ROC curve result showed that the AUC value of monocyte for liver injury was 0.838 (95% confidence interval: 0.733–0.943), which was higher than other variables.

Conclusions: NLR and MLR were elevated in CAP patients, resulting in a higher diagnostic value for CAP. NLR showed a significant correlation to PSI, indicating the disease severity of CAP. Monocyte had a higher diagnostic value for liver injury in CAP patients.

1. Introduction

Community-acquired pneumonia (CAP) is a very common type of respiratory infection with high morbidity and mortality [1]. Despite the rapid development of new treatments, CAP continues to cause a high

rate of complications and death [2]. It is reported that there were 120 million episodes of pneumonia (14 million of which progressed to severe episodes) in children younger than 5 years old in 2010 [3]. The incidence of CAP requiring hospitalization was 20.6 cases per 10,000 each year in adults [4]. The most challenging task for a physician is the

* Corresponding authors.

E-mail addresses: 13710874687@163.com (T. Li), jiang48231@163.com (Y. Jiang).

<https://doi.org/10.1016/j.intimp.2018.08.022>

Received 6 May 2018; Received in revised form 16 August 2018; Accepted 17 August 2018

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risk stratification of patients with CAP, therefore, earlier diagnosis is urgently required to reduce mortality.

Currently, chest radiography has been widely used to determine the significance and prognosis of CAP. Biochemical markers such as procalcitonin (PCT), C-reactive protein (CRP), tumor necrosis factor (TNF), and interleukin-6 (IL-6) in combination with chest radiography help to specify patients at risk as well as to determine appropriate antibiotic usage [5,6]. However, their sensitivity and specificity for prediction of CAP severity are variable and largely insufficient. Thus, additional biomarkers are urgently required to assess disease severity and simplify the diagnosis process.

Blood parameters, including neutrophil, platelet, lymphocyte, monocyte, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and monocyte-to-lymphocyte ratio (MLR), have been proposed as indicators of systemic inflammation and infection [7,8]. NLR has been recommended as a promising candidate predictor of mortality for CAP patients [9]. MLR has also been demonstrated as a new indicator of disease severity in many diseases, such as rheumatic diseases and cancer [10–12]. However, few studies have focused on the diagnostic value of blood parameters for CAP.

Therefore, this study retrospectively examined neutrophil, lymphocyte, platelet, monocyte, MLR, NLR, and PLR in CAP patients and determined their diagnostic value for CAP and their relationship with disease severity.

2. Materials and methods

2.1. Participant characteristics

A total of 80 CAP patients and 49 healthy subjects from our hospital were enrolled in the study between July 2015 and March 2018. CAP was defined by the following criteria [13]:

1. Chest radiograph showing a new patchy infiltrate, leaf or segment consolidation, ground-glass opacity, or interstitial change.
2. At least one of the following signs:
 - a. Presence of cough, sputum production, or dyspnea;
 - b. Core body temperature $> 38.0^{\circ}\text{C}$;
 - c. Auscultatory findings of abnormal breath sounds and rales;
 - d. Peripheral white blood cell (WBC) count $> 10 \times 10^9/\text{L}$ or $< 4 \times 10^9/\text{L}$.
3. Symptom onset that began in the community, rather than in a health care setting.

Those who had other kinds of diseases, such as malignancy, active infection, diabetes mellitus, hypertension, renal failure, or rheumatic disease, were excluded from the study. This study was approved by the Ethics Committee of Guangdong Second Provincial General Hospital (2018-FSKWZ-002).

2.2. Clinical and laboratory assessments

Patient age, gender, clinical features, WBC, neutrophil, monocyte, platelet, lymphocyte, hemoglobin (HGB), CRP, erythrocyte sedimentation rate (ESR), PCT, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine (CREA), creatine kinase isoenzyme (CKMB), days in hospital, body temperature, Pneumonia Severity Index (PSI), and CURB-65 were recorded. MLR, NLR, and PLR were calculated.

2.3. Statistical analysis

Database management and statistical analysis were performed with SPSS 13.0. Continuous variables were presented as mean \pm standard deviation (SD), and categorical variables were indicated as number (n) and percent (%). Comparisons of the study parameters were performed

using Student's t -tests, while qualitative variables were assessed with chi-square tests. The area under curve (AUC) value, optimal cutoff value, sensitivity, and specificity were determined using receiver-operating characteristic (ROC) curve. Pearson correlation analysis was carried out to test the correlation of the data. A P value < 0.05 was accepted as significant.

3. Results

3.1. Basic characteristics of CAP patients and healthy subjects

Our study included 80 CAP patients and 49 healthy subjects. WBC, neutrophil, and monocyte levels in the CAP group were higher than that of the control group, whereas lymphocyte and HGB levels were lower ($P < 0.05$). The MLR, PLR, and NLR values were 0.19 ± 0.08 , 119.80 ± 33.02 , and 1.62 ± 0.53 in the control group, which were significantly lower than that in CAP patients (0.56 ± 0.33 , 240.39 ± 170.16 , and 7.00 ± 7.13 , respectively; $P < 0.05$). The ESR was 47.48 ± 31.57 mm/h, CRP was 54.92 ± 44.08 mg/L, and PCT was 2.30 ± 9.44 . The number of days spent in the hospital was 7.84 ± 4.52 , body temperature was $38.08 \pm 1.33^{\circ}\text{C}$, ALT was 44.20 ± 64.30 U/L, AST was 45.00 ± 67.74 U/L, CREA was 86.74 ± 28.36 $\mu\text{mol/L}$, CKMB was 7.36 ± 4.57 ng/mL, PSI was 51.61 ± 25.62 , and CURB-65 was 0.30 ± 0.62 in CAP patients (Table 1).

3.2. NLR and MLR have high diagnostic value for CAP

The ROC curve was used to evaluate the diagnostic value of blood parameters for CAP. For patients with CAP, the AUCs were as follows: neutrophil, 0.836 (confidence interval [CI] 95%: 0.768–0.904); monocyte, 0.698 (CI95%: 0.609–0.787); platelet, 0.595 (CI95%: 0.498–0.691); lymphocyte, 0.853 (CI95%: 0.691–0.928); MLR, 0.904 (CI95%: 0.854–0.955); NLR, 0.938 (CI95%: 0.897–0.978); and PLR, 0.820 (CI95%: 0.748–0.892). NLR and MLR yielded higher AUC values than neutrophil, monocyte, platelet, lymphocyte, and PLR. In addition, the optimal cutoff value of NLR for CAP was 2.20, with a specificity of 89.8% and sensitivity of 88.8%. The optimal cutoff value of MLR for CAP was 0.225, with a specificity of 81.6% and sensitivity of 82.5% (Fig. 1 and Table 2).

Table 1
Demographic features and laboratory findings of the participants.

	Control (n = 49)	CAP (n = 80)	P
Age (years)	40.78 \pm 11.53	44.13 \pm 17.81	0.197
Gender (male/female)	24/25	44/36	0.587
WBC ($\times 10^9/\text{L}$)	6.24 \pm 1.28	8.01 \pm 3.14	< 0.001
Neutrophil ($\times 10^9/\text{L}$)	3.41 \pm 0.74	6.07 \pm 2.86	< 0.001
Lymphocyte ($\times 10^9/\text{L}$)	2.24 \pm 0.68	1.27 \pm 0.67	< 0.001
Monocyte ($\times 10^9/\text{L}$)	0.40 \pm 0.16	0.58 \pm 0.28	< 0.001
Platelet ($\times 10^9/\text{L}$)	252.39 \pm 47.83	236.67 \pm 94.32	0.214
Hemoglobin (g/dL)	142.31 \pm 14.50	129.11 \pm 21.50	< 0.001
NLR	1.62 \pm 0.53	7.00 \pm 7.13	< 0.001
PLR	119.80 \pm 33.02	240.39 \pm 170.16	< 0.001
MLR	0.19 \pm 0.08	0.56 \pm 0.33	< 0.001
ESR (mm/h)		47.48 \pm 31.57	
CRP (mg/L)		54.92 \pm 44.08	
PCT (ng/mL)		2.30 \pm 9.44	
Body temperature ($^{\circ}\text{C}$)		38.08 \pm 1.33	
Days in hospital		7.84 \pm 4.52	
ALT (U/L)		44.20 \pm 64.30	
AST (U/L)		45.00 \pm 67.74	
CREA ($\mu\text{mol/L}$)		86.74 \pm 28.36	
CKMB (ng/mL)		7.36 \pm 4.57	
PSI		51.61 \pm 25.62	
CURB-65		0.30 \pm 0.62	

Bold data indicates significant at $p < 0.05$.

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