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*Research Article*

# The Diagnostic Utility of Mean Platelet Volume (MPV) and Neutrophil-to-Lymphocyte Ratio (NLR) for Detection of SBP in Cirrhotic Patients: A Retrospective Analysis

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Background: Spontaneous bacterial peritonitis (SBP) is a serious complication of liver cirrhosis that manifests as infection of ascitic fluid. Early diagnosis requires an invasive procedure known as diagnostic paracentesis. A non-invasive alternative is the use of systemic inflammatory biomarkers, Neutrophil-to-Lymphocyte Ratio (NLR) and Mean Platelet Volume (MPV). Objective: The study's aim was to determine the diagnostic accuracy, sensitivity, and specificity of MPV and NLR for diagnosing SBP among cirrhotic patients with ascites. Methods: This is a retrospective case series study conducted at a tertiary care hospital over a 2-year period. The study included 325 patients with liver cirrhosis who underwent diagnostic paracentesis. There were 75 patients with positive SBP and 250 patients with negative SBP. Results: NLR had a sensitivity of 81.33%, a specificity of 84.40%, a positive predictive value (PPV) of 61%, and a negative predictive value (NPV) of 93.78% at a cutoff of 5.6. In addition, NLR had an overall diagnostic accuracy of 83.69%. Meanwhile, MPV at a cutoff of 8.9 fL had a sensitivity of 69.33%, a specificity of 80.80%, a PPV of 52%, and an NPV of 89.78%, with an overall diagnostic accuracy of 78.15%. The area under the ROC curve of NLR was greater than that of MPV. Conclusion: NLR and MPV are easily obtainable biomarkers of acute inflammation with diagnostic accuracy for SBP. NLR has a better negative predictive value than MPV at the cutoff of 5.6 and, thus, can be considered an efficient screening tool for the early diagnosis of SBP to allow timely antibiotic administration.

**Keywords:** Spontaneous Bacterial Peritonitis, Cirrhosis, Neutrophil-to-Lymphocyte Ratio, Mean Platelet Volume, Ascitic Fluid

## INTRODUCTION

Liver cirrhosis is the end-result of chronic liver disease characterized by extensive hepatic fibrosis and structural distortion. Patients with cirrhosis and decompensation frequently experience complications such as ascites. Ascites may lead to secondary complications such as spontaneous bacterial peritonitis (SBP), one of the most prevalent and dangerous bacterial infections in hepatology. [1] SBP is an acute bacterial infection of ascitic fluid without an underlying anatomical source of infection, occurring in up to 30% of hospitalized cirrhotic patients with ascites, and has a significant mortality risk if left untreated.[2] The pathophysiology of SBP is largely governed by bacterial translocation; advanced cirrhosis leads to alterations in the intestinal microflora, increased mucosal permeability, and reduced reticuloendothelial clearance, allowing viable bacteria to enter the systemic circulation. With very little resistance, these bacteria may colonize in the immunodeficient ascitic fluid, which may leads to an infection. [3,4] The gold-standard diagnostic test for SBP is paracentesis with ascitic fluid analysis that demonstrates polymorphonuclear (PMN) leukocyte count of ≥250 cells/mm3. However, this procedure is associated with considerable logistic limitations. Firstly, timely paracentesis may not be performed if the patient's condition prevents it, such as in severe coagulopathy or superimposed infections. Secondly, routine bacterial cultures of ascitic fluid often prove to be unrevealing.

[5,6] Due to the crucial role of timely antibiotic administration to improve prognosis in cases of SBP, novel studies strive to detect early and easily accessible biomarkers of the infection.

Systemic inflammatory markers originating from routinely available complete blood counts (CBCs) have gained increasing attention in the literature. Neutrophil-to-Lymphocyte Ratio (NLR) reflects the host's immunological response to infection; endotoxin exposure causes neutrophil demargination, resulting in neutrophilia, while concurrent stress-induced lymphopenia. NLR has been shown to be a sensitive and specific predictor of bacterial infections in decompensated cirrhosis. [7,8] Mean Platelet Volume (MPV) indirectly estimates platelet reactivity. Platelets are key regulators of the immune response; they are activated and consumed during severe systemic inflammation, which leads to the production of younger, larger platelets in the bone marrow, increasing the MPV. [9-12]

While promising, the exact diagnostic cut-off thresholds and the relative predictive power of these markers are still debated in the literature. This study was done to analyze and compare the performance of MPV and NLR in diagnosing spontaneous bacterial peritonitis (SBP) in the cirrhotic patients.

## MATERIALS AND METHODS

### Study Design and Setting

The current study was observational retrospective cohort study conducted at the Department of Pathology of a tertiary care hospital. The study includes the patient's data collected during two-year's work there. The results of blood chemistry analysis were related to the diagnostic outcome of spontaneous bacterial peritonitis fluid examination. The study was approved by the Institutional Ethics Committee on the basis of Declaration of Helsinki principles for clinical research studies, which involved only indirect patient's influence. All materials used for the study were obtained as a result of routine institutional patient care.

### Patient Population

A total of 325 adult patients with a clinical, radiological, or histological diagnosis of cirrhosis complicated by ascites were included in the study. All the patients underwent diagnostic abdominal paracentesis within 24 hours of admission. In the final trial, 75 patients with positive SBP diagnosis and 250 patients comprising the non-SBP control group were enrolled.

### Inclusion and Exclusion Criteria

To determine the study population, the following inclusion criteria were considered:

1. Age: more than 18 years.
2. Diagnosis of liver cirrhosis with ascites.
3. History of diagnostic paracentesis with a complete analysis of ascitic fluid at the time of admission.
4. Availability of a routine complete blood count (CBC) with differential within two hours of paracentesis.

Exclusion criteria were:

1. Patients with secondary bacterial peritonitis (secondary peritonitis due to hollow viscus perforation, appendicitis).
2. Secondary acute bacterial, viral, or severe fungal infections.
3. Hepatocellular carcinoma or disseminated malignancies.
4. Acute upper gastrointestinal bleeding within 72 hours of admission.
5. Empirical broad-spectrum antibiotics received before admission during the previous two weeks.
6. Intrinsic hematologic disorders of the leukocyte or platelet lineage.
7. Tuberculous peritonitis or peritoneal carcinomatosis.

### Data Collection and Laboratory Analysis

Demographic variables, clinical history, and complete blood count (CBC) parameters were extracted from electronic health records. CBCs were analyzed using an automated hematology analyzer. The neutrophil lymphocyte ratio (NLR) was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. The mean platelet volume (MPV) in fL was obtained directly from the analyzer.

Diagnostic paracentesis was simultaneously performed under strict aseptic conditions. Total leukocyte and polymorphonuclear cell count of ascitic fluid were obtained. The diagnosis of spontaneous bacterial peritonitis (SBP) was made based on the presence of an ascitic fluid polymorphonuclear cell count of ≥250

cells/mm3 according to international consensus criteria. [13-15]

### Statistical Analysis

The Statistical Package for the Social Sciences, version 26.0, was used to analyze the data. The normality of the continuous variables was assessed using Kolmogorov Smirnov. All continuous data were expressed as mean and standard deviation (SD) for the normally distributed data and median and interquartile range for the non-normally distributed data. The categorical variables were expressed as absolute frequency (percentages). For comparison purposes, an independent Student's t-test, Mann Whitney U test, and the chi-square ($\chi$ 2) test were used. The diagnostic validity measures included Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Overall Accuracy. The analysis involved the construction of a receiver operating characteristic (ROC) curve and calculation of the area under the curve (AUC). There was a statistically significant finding at p-value of <0.05.

## RESULTS AND DISCUSSION

Out of 325 patients, aged adults, who were diagnosed with decompensated liver cirrhosis and ascites, 75 patients (23.07%) were determined to have active SBP secondary to an increased ascitic PMN count ≥250 cells/mm3. Consequently, the other 250 patients (76.92%) did not meet the diagnostic criteria for SBP and formed the non-SBP group.

### Diagnostic Accuracy of Neutrophil-to-Lymphocyte Ratio (NLR)

The assessment of the systemic inflammatory response using NLR proved to be a valuable diagnostic tool in the differential diagnosis of patients with SBP and sterile ascites. The best cutoff point for the NLR was found to be 5.6.

At an NLR cutoff level of 5.6, 61 out of 75 confirmed SBP cases actually had an NLR above the cutoff point, which makes 81.33% of true positive results, while 14 patients actually had a negative result, making 18.67% of false negatives. Among 250 patients without SBP, 211 or 84.4% had a negative NLR test result, while 39 or 15.6% had a false positive result.

The diagnostic accuracy of the NLR test at the cutoff point of 5.6 can be described using the following metrics:

- Sensitivity: 81.33%
- Specificity: 84.40%
- Positive predictive value: 61.00%
- Negative predictive value: 93.78%
- Overall accuracy: 83.69%

Thus, the diagnostic accuracy of the neutrophil-to-lymphocyte ratio can be summarized using the following table:

**Table 1: Diagnostic Accuracy of Neutrophil-to-Lymphocyte Ratio (NLR)**

| NLR Status | SBP Positive | Non-SBP (Negative) | Total |
|---|---|---|---|
| **NLR > 5.6 (Positive Test)** | 61 | 39 | 100 |
| **NLR ≤ 5.6 (Negative Test)** | 14 | 211 | 225 |
| **Total** | 75 | 250 | 325 |

### Diagnostic Accuracy of Mean Platelet Volume Essay

Platelet Indices Analysis: The increased MPV was also statistically associated with the occurrence of infected ascitic fluid. In this study, a cutoff point of 8.9 fL was chosen for the diagnosis of SBP.

At an 8.9 fL MPV cutoff point, out of 75 patients with SBP, 52 were correctly diagnosed with high MPV levels (True Positives, TP), while 23 were diagnosed with lowered MPV (False Negatives, FN). Out of 250 patients without SBP, 202 had normal MPV levels (True Negatives, TN), while 48 had falsely high MPV results (False Positives, FP).

The validity of a cutoff point of 8.9 fL for diagnosing SBP by evaluating MPV levels is demonstrated below:

- Sensitivity: 69.33%
- Specificity: 80.80%
- Positive Predictive Value (PPV): 52.00%
- Negative Predictive Value (NPV): 89.78%
- Overall Accuracy: 78.15%

**Table 2: Diagnostic Accuracy of Mean Platelet Volume Essay**

| MPV Status | SBP Positive | Non-SBP (Negative) | Total |
|---|---|---|---|
| **MPV > 8.9 fL (Positive Test)** | 52 | 48 | 100 |
| **MPV ≤ 8.9 fL (Negative Test)** | 23 | 202 | 225 |
| **Total** | 75 | 250 | 325 |

### Receiver Operating Characteristic (ROC) Analysis

ROC curves mathematically evaluated the discriminatory abilities of both parameters. The analysis proved that NLR has a higher overall predictive capability for SBP than MPV. Although MPV demonstrated a significant Area Under the Curve (AUC), establishing its role as a valid systemic inflammatory factor, its discriminatory powers, sensitivity, and accuracy were below that of the NLR parameter.

## DISCUSSION

Spontaneous bacterial peritonitis remains a crucial predictor of patient survival in cases of decompensated liver cirrhosis. As it is often complicated by acute kidney injury and significant short-term mortality, a rapid, low-cost means for diagnosis is of immense value. Our findings highlight the efficacy of NLR as a non-invasive measure of this condition, best utilized at a diagnostic threshold of 5.6.

The identified sensitivity of 81.33% and specificity of 84.40% demonstrate that the NLR effectively encapsulates the massive systemic inflammatory response occurring simultaneously to a localized peritoneal infection. Most importantly, the impressive NPV of 93.78% implies that a cirrhotic patient with concurrent ascites and an NLR < 5.6 has a very low chance of a concomitant active SBP infection. In the busy setting of overcrowded emergency rooms, such a high level of confidence in the NPV would allow clinicians to safely delay definitive ascitic cell count tests while withholding broad-spectrum antibiotics.

The results of our study are consistent with recent academic literature. Seyedi et al. confirmed in a meta-analysis that the NLR acts as an incredibly valid biomarker for early prediction of SBP. [1] Likewise, Janka et al. identified that the NLR independently predicted short-term mortality, highlighting the immense clinical utility provided by identifying the 5.6 cutoff seen in our cohort.[2] The accuracy of the NLR relies upon the two-fold physiological response to acute endotoxemia, namely an explosive demargination of innate neutrophils and a dramatic stress-induced apoptosis of lymphocytes.

Parallel studies of MPV identified values >8.9fL to have limited diagnostic potential, an overall diagnostic accuracy of 78.15%. This highlights the fundamental pathophysiological concept of active platelet consumption and simultaneous megakaryocyte activation occurring in cases of SBP. [9-12] MPV proves to be an inferior diagnostic tool compared to NLR. The moderate sensitivity of MPV is heavily hindered by the unique pathophysiology of end-stage liver disease. Patients with advanced cirrhosis uniformly demonstrate massive baseline hypersplenism and diminished hepatic thrombopoietin production, limiting the diagnostic window during de novo sepsis. This concept is consistent with Abudeif et al., who validated the use of both MPV and NLR for diagnosis of SBP but determined NLR to have vastly improved overall accuracy.[3]

NLR and MPV, individually and in combination, cannot replace a traditional paracentesis. However, they offer valuable information for risk stratification. In instances where paracentesis is either technically challenging or institutionally delayed, rapid calculation of these values allows physicians to confidently begin empirical antibiotic treatment earlier in the treatment timeline.

### Limitations of Study

The strength of this study is limited by several methodological constraints. Being a retrospective, single-center study, the findings might not be globally applicable, as local microbiological resistance patterns and patient demographics might differ significantly. The study only used a single baseline measurement of complete blood counts. Dynamic changes of NLR and MPV during therapy were not evaluated. Lastly, prolonged long-term survival data were not captured, limiting the ability to definitively characterize the ultimate prognostic impact of these hematological cutoffs on overall mortality.

## CONCLUSION

Routine blood tests show that both neutrophil/lymphocyte ratio (NLR) and mean platelet volume (MPV) are simple, cheap, and quick indicators for spontaneous bacterial peritonitis in patients with liver cirrhosis. However, the results of this study suggest that while neutrophil/lymphocyte ratio (NLR) with an optimal cut-off value of 5.6 is significantly superior in terms of sensitivity, specificity, and overall diagnostic accuracy to MPV, another promising biomarker. Moreover, due to the very high negative predictive value of NLR, it may be a good initial screening tool to identify patients who do not require further diagnostic procedures. Calculating these two blood indices upon admission appears to be an effective method to determine the need for immediate antibiotic therapy, thus improving survival rates among cirrhotic patients with spontaneous bacterial peritonitis.

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