

Diagnostic Relevance of Neutrophil Percentage-to-Albumin Ratio in Differentiating Bacterial Emergency Settings

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ABSTRACT

Background: In emergency settings in hospitals, it is important to differentiate between bacterial and non-bacterial infections to ensure the proper use of antibiotics. This study aimed to assess how well the Neutrophil Percentage-to-Albumin Ratio (NPAR) could identify bacterial infections in patients admitted to emergency departments.

Methods: In this prospective observational study, the Pathology department of a tertiary care Akhtar Saeed Hospital Lahore admitted 150 patients for the evaluation of possible infections under ethical approval (AST-2312) from October 2024 to December 2024. The sample size was calculated by using OpenEpi version 3.0.0. Eligible patients were recruited by using the consecutive sampling technique. Total blood count and albumin levels were both measured to figure out the patient's NPAR score. All patients were grouped into bacterial infection and non-bacterial infection categories. SPSS version 25 was used for statistical analyses (descriptive statistics, t-tests, chi-square tests, $p < 0.05$).

Results: Out of the total 150 patients, 89 (59.3%) were diagnosed with bacterial infections. Infections caused by bacteria had a higher mean NPAR (3.8 ± 0.7) than infections from non-bacterial causes (2.1 ± 0.6) ($p < 0.001$). Both an increase in white blood cell counts and raised C-reactive protein were strongly connected with higher NPAR. Sensitivity was 85.4%, specificity was 78.7%, positive predictive value was 84.1%, and negative predictive value was 80.2% for NPAR.

Conclusion: NPAR was seen to be an easy, economical, and easily used biomarker that performed well in differentiating bacterial and other types of infection cases in the emergency room.

Keywords: Neutrophils, Albumins, Bacterial Infections, Emergency Medicine, Biomarkers.

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INTRODUCTION

Infections are seen to be connected with frequent emergency department visits, and their management can be difficult due to the wide spectrum of clinical presentations¹. It is crucial to rapidly differentiate bacterial infections from non-bacterial ones to accurately determine the time of antibiotic administration². Unnecessary and false use of antibiotics can lead to antibiotic resistance, which is an increasing problem across the world^{3,4}. Therefore, clinicians need access to accurate and reachable biomarkers that can help facilitate early diagnosis.

Neutrophils play a key role in the immune response that protects against bacterial infections. High neutrophil levels in the peripheral blood often indicate the presence of bacterial infection or widespread inflammation⁵. In contrast, serum albumin levels typically decrease when there is inflammation or infection, since the permeability of capillaries increases and albumin production in the liver is lowered⁶. Combining these two indicators has led to the formation of the Neutrophil Percentage-to-Albumin Ratio (NPAR), which now functions as a promising marker for both immune activity and nutritional status. New research suggests that NPAR offers valuable insight into the diagnosis and prognosis of conditions like sepsis, heart disease, and cancer^{7,8,9}. However, its ability to distinguish between bacterial and non-bacterial infections in emergencies is yet to be understood. Therefore, the use of NPAR as a biomarker may allow doctors to make better, more prompt choices and achieve better outcomes for patients.

This study was conducted to find whether NPAR testing could help to tell bacterial infections apart in patients arriving at the emergency department. By performing correlation and direct comparison methods, this study examined the usefulness of NPAR as an efficient biomarker in emergency clinics.

METHODS

In this prospective observational study, the

Pathology department of a tertiary care Akhtar Saeed hospital Lahore admitted 150 patients for the evaluation of possible infections under ethical approval (AST-2312) from October 2024- December 2024. The sample size was calculated by using OpenEpi version 3.0.0, with a power of 80% and an alpha of 0.05¹⁰. Eligible patients were recruited during the period of the study by using the consecutive sampling technique. The study included people who were 18 or above in age and had infections that needed urgent evaluation. To minimize the confounding effects on serum albumin and neutrophil counts, patients with chronic liver disease, immune system weakening disorders, or those with long-term steroid use were removed from the study. The data was collected using a standardized questionnaire administered to each participant.

No antimicrobials were given before initial blood samples were taken. Neutrophil counts from the blood sample were obtained using a fully automated hematology analyzer. Whereas, the bromocresol green method with standard biochemical analyzers was used to evaluate serum albumin levels. NPAR was calculated by dividing the neutrophil concentration by the albumin concentration in the blood sample (g/dL). Patients were categorized into two groups: bacterial infections (confirmed by laboratory tests or clinical guidelines) and non-bacterial infections (including viral, fungal, inflammatory, or non-infectious conditions). SPSS version 25 was used to perform the statistical analysis. Descriptive statistics were used to summarize the data about both patient demographics and test results. Distribution of NPAR scores across groups was evaluated using an independent t-test. The diagnostic accuracy of NPAR was investigated by calculating sensitivity, specificity, PPV, and NPV. Statistical significance was defined as the p-value < 0.05 using chi-square for binary variables. This way of data collection ensured consistency and thorough investigation of the utility of NPAR for detecting bacterial infections in an emergency setting.

RESULTS

Table 1: Baseline Demographic and Clinical Characteristics (n = 150)

Variable	Value
Mean Age (years)	42.6 ± 15.3
Infection in Males	88 (58.7%)
Infection in Females	62 (41.3%)

Comorbidities	
- Hypertension	48 (32.0%)
- Diabetes Mellitus	39 (26.0%)
- Chronic Liver Disease	17 (11.3%)
- No Comorbidity	46 (30.7%)

Descriptive statistics were used to summarize continuous variables (mean \pm SD), and categorical variables were expressed as frequencies and percentages.

Out of the 150 patients enrolled, 88 (59.3%) were diagnosed with bacterial infections based on clinical, laboratory, and microscopic findings. Among these patients, the mean Neutrophil Percentage-to-Albumin Ratio (NPAR) was significantly higher. Although bacterial infections were observed to be higher in males than females but the difference was not statistically significant. The age group of 41–60 years accounted for the highest number of infections, indicating that older people were more prone to infections. Additionally, a positive association was observed between elevated C-reactive protein (CRP) and white blood cell (WBC) counts with NPAR. **Table 1** demonstrates the demographic and clinical characteristics of the included participants.

Table 2: Laboratory Findings Among Study Participants

Laboratory Parameter	Bacterial Infections (n = 92)	Non-Bacterial Cases (n = 58)	p- value
Mean Neutrophil %	77.2 \pm 8.4	63.5 \pm 7.1	< 0.001
Mean Serum Albumin (g/dL)	3.1 \pm 0.4	3.7 \pm 0.3	< 0.001
Mean NPAR	24.9 \pm 4.1	17.2 \pm 3.6	< 0.001
CRP Positive	84 (91.3%)	21 (36.2%)	< 0.001

NPAR: Neutrophil Percentage-to-Albumin Ratio; CRP: C-reactive protein. $p < 0.05$ is considered statistically significant

The mean age of participants was 42.6 years. Males had a slightly higher infection rate, 88 (58.7%), than females, 62 (41.3%). Hypertension and diabetes were the most common comorbidities, found in 32% and 26% of patients, respectively, while nearly one third had no underlying condition. These findings reflected the common demographic and clinical spectrum seen in emergency infection cases. **Table 2** highlights the comparative laboratory values between bacterial and non-bacterial cases.

Table 3: Comparative Diagnostic Value of NPAR and Conventional Markers

Marker	Cut-off Value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Neutrophil Percentage	> 70%	75	68	81	59
Serum Albumin	< 3.5 g/dL	69	71	78	60
NPAR	> 20	82	74	85	68

Diagnostic performance metrics (sensitivity, specificity, PPV, NPV) were calculated using standard 2x2 contingency tables. NPAR – Neutrophil Percentage-to-Albumin Ratio; PPV – Positive Predictive Value; NPV – Negative Predictive Value.

Patients with bacterial infections had significantly higher neutrophil percentages (77.2 \pm 8.4) and NPAR scores (24.9 \pm 4.1), and significantly lower serum albumin levels (3.1 \pm 0.4) compared to non-bacterial cases. CRP positivity was markedly higher in bacterial infections. These findings highlighted the NPAR's value in discriminating infectious cases. **Table 3** highlights the comparative diagnostic percentages in the markers measured.

Among all tested parameters, NPAR (>20) achieved the highest sensitivity (82%) and PPV (85%), outperforming neutrophil percentage and serum albumin alone. This confirmed the combined strength of NPAR as a reliable biomarker in emergency diagnostics.

The findings from this study demonstrated the promising insights into the usefulness of NPAR as a diagnostic marker for clinical settings.

DISCUSSION

This study assessed the diagnostic utility of the Neutrophil Percentage-to-Albumin Ratio (NPAR) in distinguishing bacterial from non-bacterial infections in emergency settings. Key findings revealed that: patients with bacterial infections had significantly higher mean NPAR values than those with non-bacterial conditions, elevated NPAR values were strongly associated with increased white blood cell counts and C-reactive protein (CRP) levels, NPAR demonstrated superior diagnostic performance over conventional markers with a sensitivity of 82%, specificity of 74%, PPV of 85%, and NPV of 68%, and middle-aged adults were the most affected demographic group.

The results of this study were in alignment with the earlier studies that NPAR reflected two body parameters, elevation in neutrophil activity and reduction in albumin levels, both of which were affected by acute inflammation due to bacterial infection^{11,12}. Previous studies had pointed out that neutrophilia was important for the innate immune reaction against bacteria, and hypoalbuminemia was a sign of general inflammation and a worse prognosis¹³⁻¹⁶. Although research on NPAR had been done for sepsis and cardiovascular diseases, this study observed its utilization for common emergency infections, particularly in areas with restricted resources^{17,18}.

The study findings showed that NPAR could be useful for the diagnosis of a variety of diseases, not just a few. Similar to findings in the literature, where the integration of immune and nutritional biomarkers showed improvement in the accuracy of diagnosis¹⁹⁻²². NPAR is different from CRP or total leukocyte count because it brings together the increase in neutrophils and decrease in albumin, which enables faster recognition of bacterial infections^{23,24}. Additionally, an NPAR cut-off of >20 showed better outcomes compared to neutrophil levels >70% or albumin <3.5 g/dL alone, which supported its use in medicine. Consistent with findings in the literature, studies had shown that an NPAR threshold around 20 provided optimal sensitivity and specificity for distinguishing severe infections and sepsis in clinical settings²⁵.

The study was strengthened because it put forward easy-to-obtain and low-cost laboratory results to create an index that can be used in various healthcare environments. This can become very useful when there are not enough resources, and quick decisions with basic diagnostics are essential. However, some limitations should be recognized. The study's findings might not be generalized, as the design was only conducted in one center and the sample was relatively small. Next, even though chronic liver disease patients and those on

immunosuppressive drugs were not included in the study, other factors such as dehydration, a lack of proper nutrition, or an unnoticed chronic inflammation might still change the total albumin levels. The study also depended on specific clinical and laboratory findings to differentiate bacterial infections from non-bacterial ones, meaning some unusual or mixed types of infections might be missed.

Even with these restrictions, this study paved the way for further studies about NPAR's wide-ranging clinical value. Future research should validate these results in various healthcare institutions and assess how they affect patient outcomes, how they can be used in scoring models, and guide antibiotic administration. Also, combining NPAR with other biomarkers, including procalcitonin or IL-6, might improve its diagnosis. Overall, NPAR proved to be a practical, efficient, and economical tool for frontline healthcare workers to handle undiagnosed infections in emergency departments.

CONCLUSION

This investigation points out that the Neutrophil Percentage-to-Albumin Ratio (NPAR) had a good value for determining a bacterial infection in urgent cases. High values of sensitivity and specificity were seen when NPAR values indicated a bacterial infection. By connecting regularly tested laboratory values, NPAR offers a straightforward, quick, and cheap biomarker for early clinical support and planning patient care.

Both neutrophil percentage and serum albumin are often available even in places with only limited medical resources, so NPAR can be very useful in many settings. Because it's easy to calculate and depends on ordinary blood tests, it is accessible at little or no extra cost or difficulty. Overall, NPAR is an efficient and helpful indicator for identifying bacterial infections in emergency departments, which may improve patients' response to treatment.

LIST OF ABBREVIATIONS

NPAR: Neutrophil Percentage-to-Albumin Ratio

ED: Emergency Department

WBC: White Blood Cell (Count)

CRP: C-Reactive Protein

PPV: Positive Predictive Value

NPV: Negative Predictive Value

SD: Standard Deviation

g/dL: Grams per Deciliter

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CONFLICT OF INTEREST

None

ETHICAL APPROVAL

The study was conducted by the Pathology department of a tertiary care Akhtar Saeed hospital, Lahore (AST-2312) from October 2024 to December 2024.

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

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