RESEARCH PAPER

Eosinopenia as a Diagnostic and Prognostic Marker of Sepsis in Intensive Care Unit Patients

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ABSTRACT

Background: Sepsis remains a leading cause of morbidity and mortality in intensive care units (ICUs). Eosinopenia, defined as an absolute eosinophil count (AEC) ≤50 cells/cu.mm, has been proposed as a simple, inexpensive marker of acute infection. This study aimed to evaluate eosinopenia as a diagnostic and prognostic marker of sepsis in ICU patients.

Methods: A hospital-based cross-sectional study was conducted over three months in the Medical ICU at SVMCH & RC, Puducherry. Forty adult ICU patients were enrolled and categorized into infectious (n=20) and non-infectious (n=20) groups. AEC was measured within 24 hours of admission. ROC curve analysis, sensitivity, specificity, and correlation with SOFA score were assessed.

Results: Mean AEC was significantly lower in the infectious group (38.5 ±21.4 vs. 112.6 ±45.3 cells/cu.mm; $p<0.001$). Eosinopenia was present in 75% of infected patients versus 25% in non-infected patients ($p=0.0015$). Sensitivity and specificity were both 75%, with AUC of 0.81 (95% CI: 0.68–0.94). Significant inverse correlation between AEC and SOFA score ($r=-0.62$, $p<0.001$) and between eosinopenia and ICU mortality ($p=0.01$) were observed.

Conclusion: Eosinopenia is significantly associated with sepsis, disease severity, and ICU mortality. As a rapid, inexpensive, and routinely available laboratory parameter, AEC may serve as a useful adjunct marker for early diagnosis and risk stratification of sepsis, particularly in resource-limited settings.

Keywords: Sepsis, Eosinopenia, Absolute Eosinophil Count, Intensive Care Unit, SOFA Score, Biomarkers, Diagnostic Marker, Prognostic Marker

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INTRODUCTION

Sepsis remains one of the leading causes of morbidity and mortality among patients admitted to intensive care units (ICUs) worldwide. Despite advances in antimicrobial therapy, organ support strategies, and critical care monitoring, sepsis continues to impose a substantial clinical and economic burden [1,2]. The rapid progression of the disease, coupled with its nonspecific early manifestations, often results in delayed recognition and initiation of appropriate therapy, adversely affecting patient outcomes.

Sepsis is currently defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. According to the Sepsis-3 consensus, organ dysfunction is identified by an increase of two or more points in the Sequential Organ Failure Assessment (SOFA) score in the presence of suspected or confirmed infection [2,3]. However, in routine clinical practice, many patients initially present with features of systemic inflammatory response syndrome (SIRS) — including fever or hypothermia, tachycardia, tachypnea, and leukocytosis or leukopenia — which also occur in non-infectious inflammatory conditions such as pancreatitis, trauma, burns, and drug reactions, creating diagnostic uncertainty [4].

The definitive diagnosis of sepsis relies on microbiological confirmation through blood culture or identification of a pathogen from clinical specimens. However, culture results typically require 48–72 hours, delaying targeted antimicrobial therapy. In the interim, clinicians often initiate empirical broad-spectrum antibiotics, which may contribute to antimicrobial resistance, drug-related adverse effects, and increased healthcare costs [5]. Therefore, there is a compelling need for simple, rapid, inexpensive, and reliable biomarkers that can assist in the early identification of sepsis.

Several biomarkers such as C-reactive protein (CRP), procalcitonin (PCT), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and serum lactate have been studied for early detection and prognostication in sepsis [6-8]. Although some demonstrate reasonable diagnostic performance, their routine use is limited by cost and limited availability in resource-constrained settings. In contrast, the absolute eosinophil count (AEC), obtained as part of a routine complete blood count (CBC), is inexpensive, widely available, and rapidly measurable — making it an attractive alternative biomarker [4,9].

Eosinopenia, defined as a decreased absolute eosinophil count in peripheral blood, has long been recognized as a physiological response to acute infection and stress [10]. During sepsis, several mechanisms contribute to eosinopenia: suppression of bone marrow release, decreased cytokine-mediated eosinophil survival, and migration of circulating eosinophils into inflamed tissues under the influence of chemotactic mediators such as complement component C5a [10]. Additionally, endogenous corticosteroid release during acute stress further reduces circulating eosinophil levels.

Previous studies have evaluated eosinopenia as a potential diagnostic marker for sepsis. Abidi et al. [4] demonstrated that eosinopenia had good sensitivity and specificity in distinguishing infected from non-infected critically ill patients on ICU

admission. Similarly, Hussain et al. [5] reported that an AEC <50 cells/cu.mm was significantly associated with sepsis. Furthermore, eosinopenia has also been associated with disease severity and mortality [11,12].

Despite accumulating evidence, eosinopenia remains underutilized in routine ICU practice, particularly in resource-limited environments where advanced biomarkers may not be readily accessible. Given its simplicity, cost-effectiveness, and rapid availability, the present cross-sectional study was undertaken to evaluate eosinopenia as a diagnostic and prognostic marker of sepsis in ICU patients in a tertiary care Centre at Puducherry.

MATERIALS AND METHODS

A hospital-based cross-sectional analytical study was undertaken in the Medical ICU, Department of General Medicine in a tertiary care hospital at Puducherry for a period of three months after IEC approval (Ref: SVMCH/IEC/2025/XXX). Twenty adult patients (≥18 years) with infectious causes (sepsis, severe sepsis, septic shock per Sepsis-3) and twenty with non-infectious inflammatory diseases (SIRS, pancreatitis, trauma, metabolic disorders) were concurrently included. Based on the prevalence of eosinopenia from earlier research, the sample size was determined using the two-proportion Z-test, obtaining 20 patients per group. Informed consent and ICU admission with an AEC measurement within 24 hours were prerequisites for inclusion. Patients with hematological disorders, immunosuppression, chemotherapy, autoimmune or parasitic eosinophilic diseases, corticosteroid usage within 48 hours, allergic disorders, pregnancy, lactation, or refusal of permission were excluded from the study.

Group Classification: The infectious group included patients with positive blood culture or positive culture/microscopy from clinical specimens (urine, sputum, cerebrospinal fluid, pleural fluid, ascitic fluid, pus, or wound swab). The non-infectious group included patients admitted with SIRS or other inflammatory conditions without microbiological evidence of infection.

Data Collection Procedure: Demographic details (age, sex) after enrolment were recorded. Clinical parameters including temperature, heart rate, respiratory rate, blood pressure, and SpO_2 were documented at admission. The Sequential Organ Failure Assessment (SOFA) score was calculated at admission to assess organ dysfunction severity. All data were extracted from standardized case record forms and patient case sheets.

Laboratory Investigations: Approximately 2 mL of venous blood was collected under strict aseptic precautions in EDTA-containing vacutainer tubes for complete blood count (CBC). Samples were analyzed within two hours of collection using an automated hematology analyzer (Sysmex XN-series). Absolute eosinophil count (cells/cu.mm), total leukocyte count, and differential counts were recorded and verified by the laboratory technician.

A single set of blood culture was obtained prior to initiation of antibiotic therapy using standard aseptic technique (two sets from separate sites wherever feasible) and transported immediately to the microbiology laboratory for processing per standard hospital protocol (BacT/Alert system). Culture reports were reviewed after 48–72 hours for group classification and clinical management.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel 2019 and analyzed using IBM SPSS Statistics version 23.0 (IBM Corporation, Armonk, NY, USA). Categorical variables were expressed as frequency and percentage; continuous variables as mean ± standard deviation (SD). The Chi-square test (χ^2) was used to assess associations between categorical variables. Independent samples t-test was used to compare continuous variables between groups. Pearson's correlation coefficient (r) was used to evaluate the linear relationship between AEC and SOFA score. Diagnostic performance of eosinopenia was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the receiver operating characteristic (ROC) curve (AUC). A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 40 patients admitted to the Medical ICU during the study period were included. Based on microbiological confirmation and clinical evaluation, 20 patients were categorized into the infectious group and 20 into the non-infectious group, each constituting 50% of the total study population (Table 1).

Table 1. Distribution of Study Population

Group	Number of Patients (n)	Percentage (%)
Infectious Group	20	50%
Non-Infectious Group	20	50%
Total	40	100%

The mean age of the study population was 54.2 ±16.8 years. Patients in the infectious group had a slightly higher mean age (57.6 ±15.4 years) compared to the non-infectious group (50.8 ±17.6 years); this difference was not statistically significant (p=0.18). Males constituted 62.5% of the total population, with comparable gender distribution between groups (p=0.74). The mean SOFA score was significantly higher in the infectious group (7.4 ±2.1 vs.[3].2 ±1.5; p<0.001), indicating greater severity of illness among septic patients (Table 2).

Table 2. Baseline Characteristics of Study Participants

Parameter	Infectious Group (n=20)	Non-Infectious Group (n=20)	p-value
Mean Age (years)	57.6 ± 15.4	50.8 ± 17.6	0.18
Male Gender, n (%)	13 (65%)	12 (60%)	0.74
Mean SOFA Score	7.4 ± 2.1	3.2 ± 1.5	<0.001*

* Statistically significant (p<0.05)

The mean AEC was significantly lower in the infectious group compared to the non-infectious group (38.5 ±21.4 vs.[112].6 ±45.3 cells/cu.mm; p<0.001). When categorized using the cutoff value of ≤50 cells/cu.mm, 15 patients (75%) in the infectious group had eosinopenia compared to only 5 patients (25%) in the non-infectious group. The association between eosinopenia and sepsis was statistically significant (χ^2=10.0, p=0.0015) (Tables 3 and 4, Figure 1).

Table 3. Comparison of Mean Absolute Eosinophil Count Between Groups

Parameter	Infectious Group (n=20)	Non-Infectious Group (n=20)	p-value
Mean AEC (cells/cu.mm)	38.5 ± 21.4	112.6 ± 45.3	<0.001*

AEC: Absolute Eosinophil Count; * Statistically significant (p<0.05)

Table 4. Distribution of Eosinopenia (AEC ≤50 cells/cu.mm) Between Groups

AEC Category	Infectious Group (n=20)	Non-Infectious Group (n=20)	Total (n=40)	p-value
≤50 cells/cu.mm (Eosinopenia)	15 (75%)	5 (25%)	20	
>50 cells/cu.mm (Normal)	5 (25%)	15 (75%)	20	
Total	20	20	40	0.0015*

Chi-square test applied ($\chi^2 = 10.0$); * Statistically significant (p<0.05)

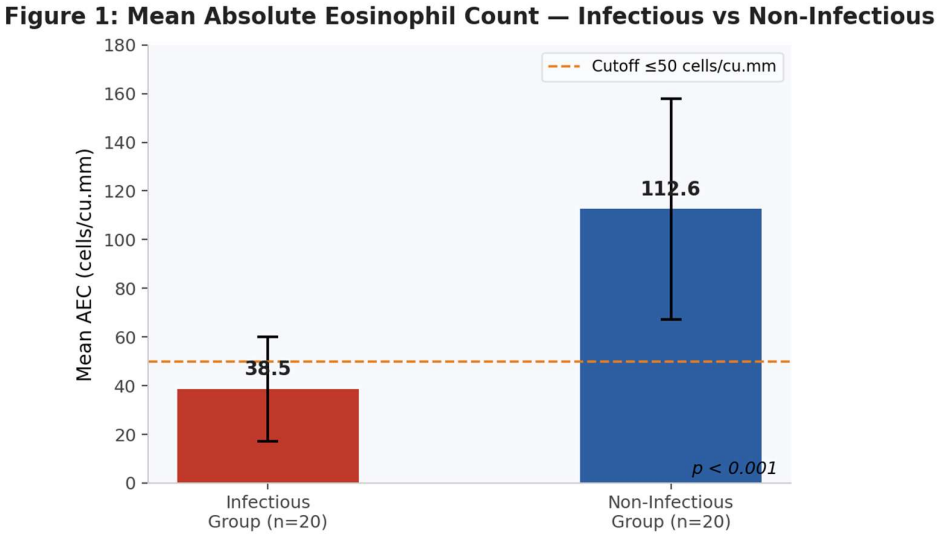

Figure 1: Mean Absolute Eosinophil Count (Mean ± SD) in Infectious vs. Non-Infectious Groups (p<0.001). The orange dashed line denotes the diagnostic cutoff of 50 cells/cu.mm

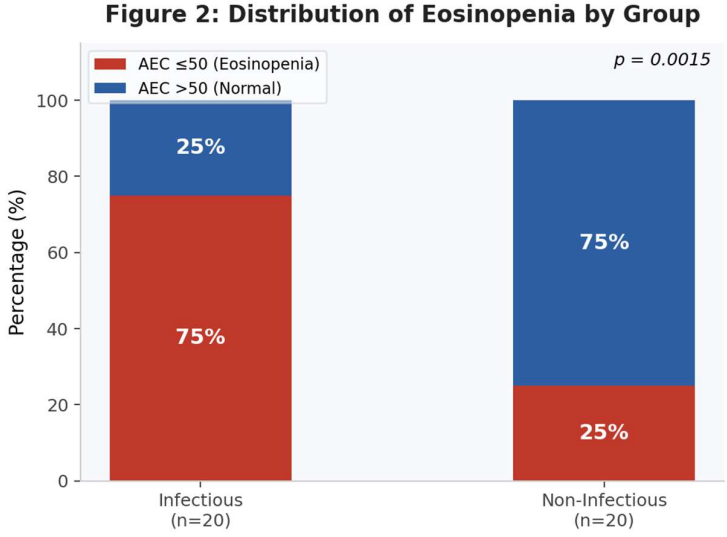

Figure 2: Stacked Bar Chart Showing Distribution of Eosinopenia (≤50 cells/cu.mm) and Normal AEC (>50 cells/cu.mm) in Infectious vs. Non-Infectious Groups (p=0.0015)

Using an AEC cutoff of ≤50 cells/cu.mm, eosinopenia demonstrated sensitivity of 75% and specificity of 75% in identifying sepsis among ICU patients. The PPV and NPV were both 75%, indicating moderate diagnostic accuracy (Table 5). ROC curve analysis revealed an AUC of 0.81 (95% CI: 0.68–0.94; p<0.001), indicating good discriminatory ability of AEC in predicting sepsis (Figure 3).

Table 5. Diagnostic Performance of Eosinopenia in Predicting Sepsis

Diagnostic Parameter	Value
Sensitivity	75.0%
Specificity	75.0%
Positive Predictive Value (PPV)	75.0%
Negative Predictive Value (NPV)	75.0%
Area Under ROC Curve (AUC)	0.81
95% Confidence Interval	0.68 – 0.94
p-value (AUC significance)	<0.001*

* Statistically significant (p<0.05); AEC cutoff: ≤50 cells/cu.mm

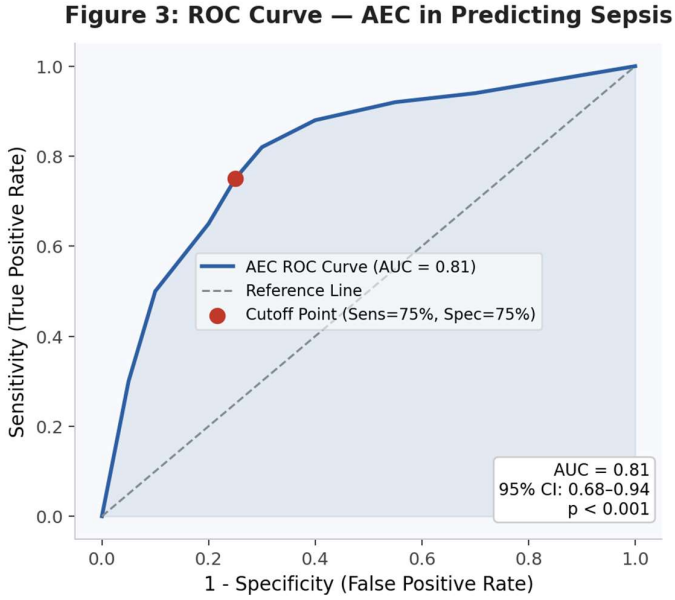

Figure 3: Receiver Operating Characteristic (ROC) Curve of Absolute Eosinophil Count in Predicting Sepsis (AUC=0.81; 95% CI: 0.68–0.94; p<0.001). The red dot denotes the optimal cutoff point (Sensitivity=75%, Specificity=75%).

A significant negative correlation was observed between AEC and SOFA score at admission (Pearson r = −0.62, p<0.001), indicating that lower eosinophil counts were associated with greater severity of organ dysfunction (Table 6, Figure 4). Patients with higher SOFA scores consistently demonstrated lower AEC values.

Table 6. Pearson Correlation Between AEC and SOFA Score

Variable Pair	Pearson r	p-value
AEC vs. SOFA Score	−0.62	<0.001*

* Statistically significant (p<0.05)

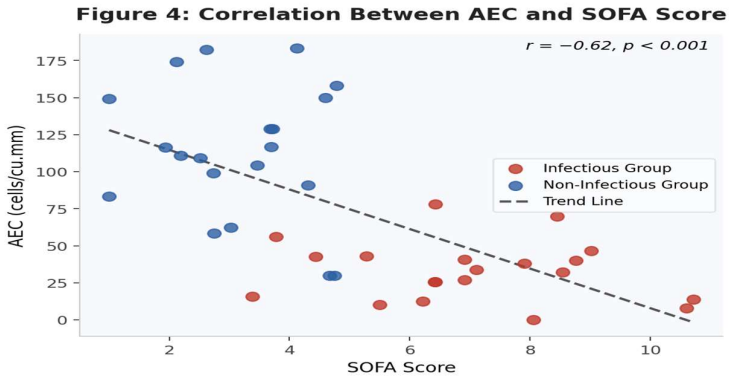

Figure 4: Scatter Plot Showing Negative Correlation Between Absolute Eosinophil Count (AEC) and SOFA Score (r=−0.62, p<0.001). Red circles = Infectious Group; Blue circles = Non-Infectious Group

Of the 40 patients, 9 (22.5%) expired during ICU stay. Among non-survivors, 8 patients (88.9%) had eosinopenia (AEC ≤50 cells/cu.mm), whereas only 1 patient with AEC >50 cells/cu.mm expired. The association between eosinopenia and ICU mortality was statistically significant (p=0.01) (Table 7, Figure 5).

Table 7. Association between Eosinopenia and ICU Outcome

Outcome	AEC ≤50 (n=20)	AEC >50 (n=20)	Total (n=40)	p-value
Survived	12 (60%)	19 (95%)	31	
Expired	8 (40%)	1 (5%)	9	
Total	20	20	40	0.01*

Fisher's Exact Test applied; * Statistically significant (p<0.05)

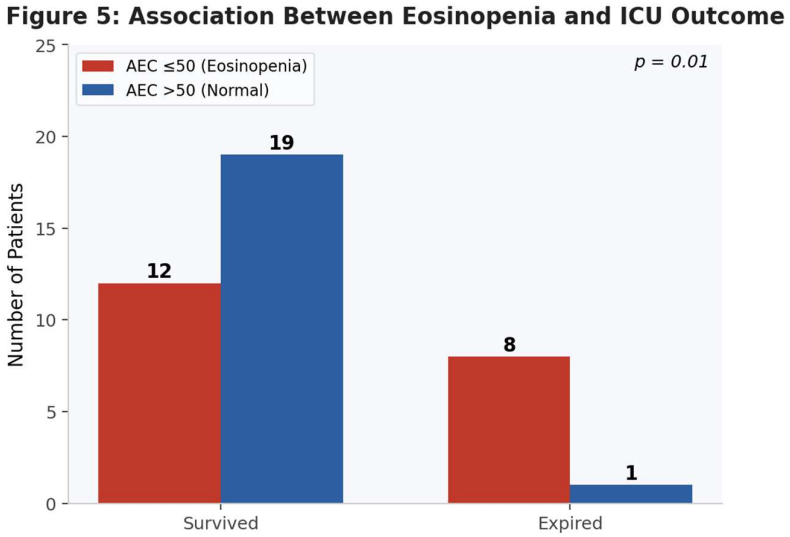

Figure 5: Bar Chart Showing Association Between Eosinopenia (AEC ≤50 cells/cu.mm) and ICU Outcome (Survival vs. Mortality). Eosinopenia was significantly associated with ICU mortality (p=0.01)

DISCUSSION

Sepsis remains a major cause of morbidity and mortality among critically ill patients admitted to intensive care units. Early diagnosis is crucial for prompt initiation of appropriate antimicrobial therapy and supportive management.

Differentiating infectious causes of systemic inflammation from non-infectious conditions continues to be a major clinical challenge [1,2,13]. The present study was conducted to evaluate eosinopenia as a diagnostic and prognostic marker of sepsis in ICU patients.

The current study examined 40 patients admitted to the ICU, with an equal distribution between infectious and non-infectious categories. The study population was predominantly male (62.5%), with a mean age of 54.2 ±16.8 years. These demographic results are similar to those reported by Abidi et al. [4], which reflects the general epidemiological pattern of increased ICU admissions among middle-aged and older males, and Hussain et al. [5], where the mean age was roughly 53 years with a male predominance.

The severity of illness, as assessed by SOFA score, was significantly higher in the infectious group compared to the non-infectious group (7.4 ±2.1 vs.^{3}.2 ±1.5; p<0.001). This confirms that septic patients exhibit greater organ dysfunction at presentation, consistent with findings from multiple prior studies [3,11,13].

The current study found that the infectious group had considerably lower mean AEC than the non-infectious group (38.5 ±21.4 vs.^{112}.6 ±45.3 cells/cu.mm; p < 0.001). Eosinopenia was present in 75% of patients in the infectious group and only 25% of patients in the non-infectious group (p=0.0015) using a threshold of ≤50 cells/cu.mm. This result is in line with the findings of Hussain et al. [5], who found that 98.5% of patients with eosinopenia had sepsis, and Abidi et al. [4], who showed that eosinopenia had a high diagnostic accuracy in separating ICU patients who were infected from those who were not. These results were further supported in a multicenter investigation by Liu et al. [12].

The pathophysiological basis of eosinopenia in sepsis is multifactorial. Acute infection triggers stress-mediated endogenous corticosteroid release, which suppresses eosinophil production and promotes apoptosis [10]. Chemotactic factors such as complement component C5a facilitate migration of eosinophils from circulation to inflammatory sites. Suppression of interleukin-5 (IL-5), which regulates eosinophil survival, further contributes to reduced peripheral eosinophil counts. The immunopathological insights of van der Poll et al. and Bass et al. provide mechanistic support for eosinopenia as a reliable physiological correlate of sepsis [14,10].

Eosinopenia showed a 75% sensitivity and 75% specificity for predicting sepsis in the current investigation, with an AUC of 0.81 (95% CI: 0.68–0.94), demonstrating high discriminatory capacity. Higher specificity (91%) and sensitivity (80%) at a comparable threshold were observed by Abidi et al. [4]. The specificity was 97%, while the sensitivity was just 65%, according to Hussain et al. [5]. In a case-control research involving both adult and pediatric patients, Wibrow et al. [7] validated the usefulness of eosinopenia as a bloodstream infection marker. Variations in sample size, patient demographic, illness severity, and selected threshold values can all contribute to differences in diagnostic success [9].

A significant negative correlation between AEC and SOFA score (r=−0.62, p<0.001) was observed, indicating that lower eosinophil counts correspond to greater organ dysfunction. Sharma et al. similarly reported an inverse relationship between

AEC and SOFA/qSOFA scores, indicating that eosinopenia parallels disease severity over time [11]. These findings are further supported by recent evidence from Liu et al. and van der Poll et al. [12, 14].

The prognostic value of eosinopenia was demonstrated by its significant association with ICU mortality (p=0.01): 88.9% of non-survivors had AEC ≤50 cells/cu.mm. Hussain et al. reported that 76.9% of non-survivors had AEC <50 cells/cu.mm [5]. These findings suggest that eosinopenia may serve not only as a diagnostic marker but also as a prognostic indicator. Schuetz et al. and Hotchkiss et al. have emphasized the need for biomarkers that simultaneously support diagnosis and prognostication in sepsis care [6,15].

AEC has a number of useful advantages over CRP and procalcitonin, including being readily available, affordable, and included in standard CBC testing [7,8]. The on-going need for basic biomarkers in critically ill patients has been emphasized by Pierrakos et al. and Gaini et al. [7,8]. Eosinopenia can be a useful supplementary tool in resource-constrained environments like the one in this study. However, rather than being employed as a stand-alone diagnostic marker, it should be interpreted in conjunction with clinical observations and other laboratory values.

Limitations of the present study include the relatively small sample size (n=40) from a single center, which limits generalizability. Serial eosinophil measurements were not performed, which could have provided insight into dynamic changes in AEC over the ICU course. Future multicentric, longitudinal studies with larger sample sizes are needed to validate these findings and establish standardised cutoff values.

CONCLUSION

The current study shows that among critically ill patients admitted to the intensive care unit, eosinopenia is strongly linked to sepsis. Absolute eosinophil counts were substantially lower in patients in the infection group than in the non-infectious group (p<0.001). With an AUC of 0.81, an AEC of ≤50 cells/cu.mm demonstrated good diagnostic accuracy in separating sepsis from non-infectious inflammatory disorders.

A significant inverse correlation between AEC and SOFA score (r=−0.62) confirmed that lower eosinophil levels are associated with greater severity of organ dysfunction. Furthermore, eosinopenia was significantly associated with ICU mortality (p=0.01), suggesting its potential role as a prognostic marker.

Given that eosinophil count is a simple, rapid, inexpensive, and routinely available laboratory parameter as part of the complete blood count, it may serve as a useful adjunct tool in the early identification and risk stratification of septic patients, particularly in resource-limited settings. Eosinopenia should be interpreted in conjunction with clinical findings and other laboratory investigations rather than as a standalone diagnostic marker.

Further large-scale, multicentric, prospective studies with serial measurements are recommended to validate the diagnostic and prognostic utility of eosinopenia and to establish standardized cutoff values for routine clinical practice.

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