e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(12); 2874-2879

Original Research Article

Correlation of Serum Procalcitonin to Creatinine Ratio and Neutrophil-to-Lymphocyte Ratio in Tropical Fever–Induced Acute Kidney Injury and Their Association with Clinical Outcomes

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Received: 01-09-2025 / Revised: 15-10-2025 / Accepted: 21-11-2025
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Conflict of interest: Nil

Abstract

Background: Acute kidney injury (AKI) is a significant complication of tropical infections like dengue, malaria, leptospirosis, scrub typhus, and typhoid fever. Early detection of kidney issues and predicting outcomes is essential. Serum procalcitonin (PCT) and the neutrophil-to-lymphocyte ratio (NLR) have appeared as quick and cost-effective markers of inflammation.

Objective: To evaluate the relationship between the serum PCT-to-creatinine ratio (PCR) and NLR with the severity of AKI and clinical outcomes in patients with tropical fever.

Methods: A hospital-based, cross-sectional study took place in the Department of Nephrology at IMS & SUM Hospital in Bhubaneswar from June 2023 to June 2024. Researchers assessed one hundred adults diagnosed with AKI related to tropical fever. They gathered demographic, biochemical, and blood data. PCR and NLR were calculated and compared with kidney function measures and outcomes such as the need for dialysis, progression of chronic kidney disease (CKD), and death.

Results: Males made up 64% of the cases. Dengue (32%) and leptospirosis (28%) were the most common causes. The average serum creatinine level was 3.8 ± 1.9 mg/dL, the mean PCT was 5.2 ± 3.1 ng/mL, the PCR was 1.32 ± 0.55, and the NLR was 7.4 ± 3.2. Both PCR and NLR showed strong positive correlations with creatinine ($r = 0.68$, $p < 0.001$ and $r = 0.61$, $p < 0.001$). ROC analysis showed an area under the curve (AUC) of 0.84 for PCR and 0.79 for NLR in predicting the need for dialysis. The mortality rate was 10% and those who did not survive had higher PCR and NLR levels ($p < 0.001$).

Conclusion: Both the PCT-to-creatinine ratio and NLR strongly correlate with AKI severity and predict negative outcomes in tropical infections. These markers could be useful and affordable tools for early risk assessment.

Keywords: Tropical fever, AKI, Procalcitonin, Neutrophil-to-lymphocyte ratio, Outcome prediction.

Introduction

Tropical infectious diseases are a major cause of acute fever in India and other tropical areas. Infections like dengue, malaria, leptospirosis, scrub typhus, and typhoid can lead to systemic inflammation and multi-organ dysfunction, including acute kidney injury (AKI). AKI occurs in 20–50% of severe tropical infections and greatly increases both illness and death rates [1,2].

The causes of tropical AKI include reduced blood flow to the kidneys, immune-related damage to kidney filters, and direct harm from pathogens. Even with better critical-care facilities, death rates remain high, especially when renal injury is discovered late [3]. Traditional measures like serum creatinine and urine output only rise after considerable kidney damage, which makes it hard to detect issues early [4].

Recently, indices based on inflammation, such as the neutrophil-to-lymphocyte ratio (NLR) and infection markers like serum procalcitonin (PCT), have attracted interest for predicting risks. NLR shows the

balance between innate and adaptive immunity, with higher levels indicating a stronger inflammatory response [5]. PCT, a precursor to calcitonin, rises during bacterial infections and systemic inflammation [6]. Its levels correlate with how severe the infection is and the degree of kidney damage [7,8].

Since inflammation is a common factor in both infection and kidney injury, using these markers together might improve predictive accuracy. This study examines the relationship between the PCT-to-creatinine ratio (PCR) and NLR in cases of AKI associated with tropical fevers, as well as their links to clinical outcomes.

Materials and Methods

Study Design and Setting: This observational study took place at the Department of Nephrology, IMS & SUM Hospital, Bhubaneswar, Odisha, from June 2023 to June 2024.

Study Population: Adults (18 years and older) diagnosed with tropical fever and meeting KDIGO 2012 criteria for AKI were included.

Inclusion criteria:

• Confirmed dengue, malaria, leptospirosis, scrub typhus, or typhoid fever

• AKI onset following infection diagnosis

Exclusion criteria:

• Pre-existing CKD stage 3 or higher

• Pregnancy

• Recent exposure to nephrotoxic drugs

Sample Size: Based on a tropical AKI prevalence of 48%, the sample size was calculated to be 100.

Data Collection: We recorded clinical and biochemical parameters: serum creatinine, blood urea, electrolytes, PCT, complete blood count, ESR, and CRP. NLR is the ratio of absolute neutrophil to lymphocyte counts. PCR equals PCT (ng/mL) divided by creatinine (mg/dL).

Outcomes: We followed patients during hospitalization and for 3 months for:

• Need for dialysis

• Recovery of kidney function

• Progression to CKD

• Death

Statistical Analysis: We analyzed the data using SPSS v26. We calculated means ± SD for continuous variables and frequencies for categorical data. Correlations were determined using Pearson coefficients. ROC curves were used to find cutoff values for predicting severe AKI. We set significance at $p < 0.05$.

Ethics: We obtained approval from the Institutional Ethics Committee and written informed consent.

Results

Demographic Profile

Table 1: Gender Distribution of Patients

Gender	Number	Percentage
Male	64	64 %
Female	36	36 %
Total	**100**	**100 %**

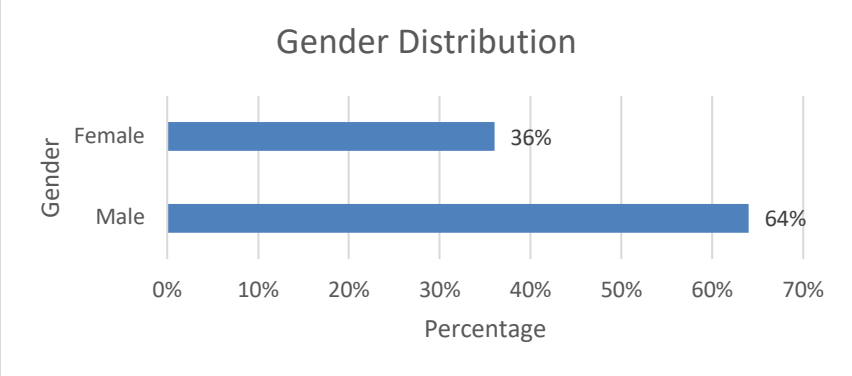

Figure 1: Gender distribution

Mean age = 41 ± 12 years. Most patients were between 31–50 years.

Table 2: Comorbidities and Addiction History

Parameter	Number	Percentage
Hypertension	28	28 %
Diabetes mellitus	26	26 %
Chronic liver disease	8	8 %
Alcohol use	22	22 %
Smoking	19	19 %

Etiology of Tropical Fever

Table 3: Distribution of Tropical Infections

Infection	Number	Percentage
Dengue	32	32 %
Leptospirosis	28	28 %
Malaria	18	18 %
Scrub Typhus	12	12 %
Typhoid	10	10 %
Total	**100**	**100 %**

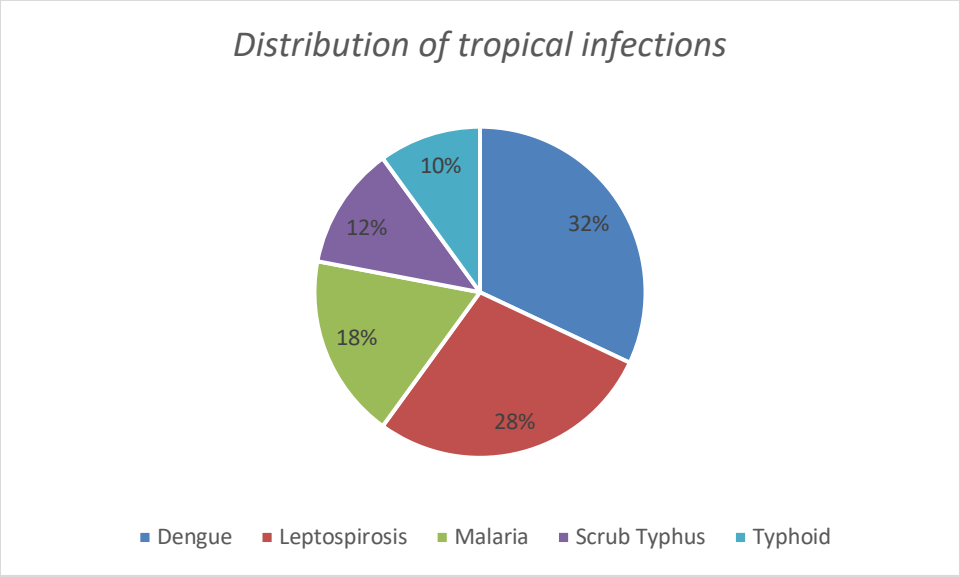

Figure 2: Pie chart showing distribution of tropical infections

Laboratory Parameters

Table 4: Baseline Biochemical and Haematological Parameters

Parameter	Mean ± SD
Serum Creatinine (mg/dL)	3.8 ± 1.9
Blood Urea (mg/dL)	92 ± 40
PCT (ng/mL)	5.2 ± 3.1
PCR (PCT/Cr ratio)	1.32 ± 0.55
NLR	7.4 ± 3.2
Haemoglobin (g/dL)	10.8 ± 1.9
Platelet count (×10⁹/L)	126 ± 54

Correlation Analyses: Both PCR and NLR correlated positively with serum creatinine ($r = 0.68$ and 0.61, $p < 0.001$).

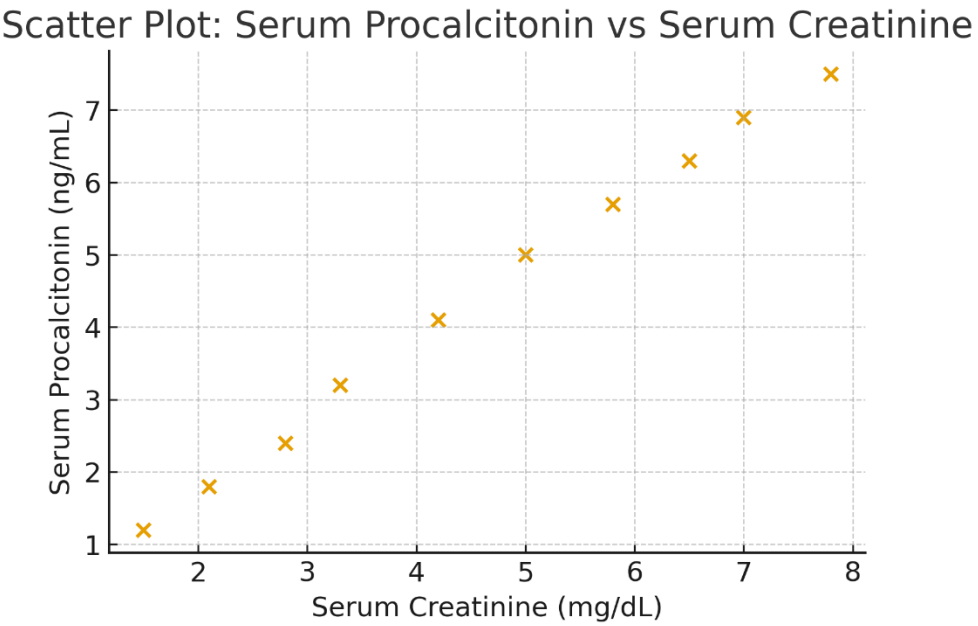

Figure 3: Scatter plot: PCT vs Creatinine

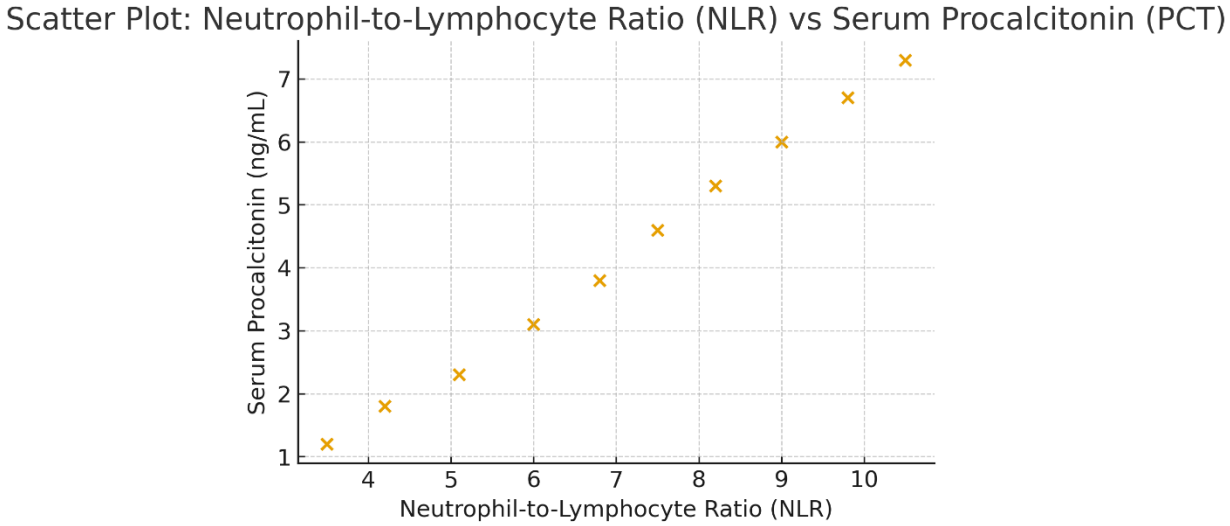

Figure 4: Scatter plot: NLR vs PCT

Diagnostic Accuracy

Table 5: ROC Analysis of Biomarkers for Predicting Severe AKI (Dialysis Requirement)

Biomarker	AUC	Cut-off	Sensitivity	Specificity
PCR	0.84	> 0.20	82 %	79 %
NLR	0.79	> 6.5	76 %	72 %
Serum Creatinine	0.76	> 4.0 mg/dL	70 %	65 %

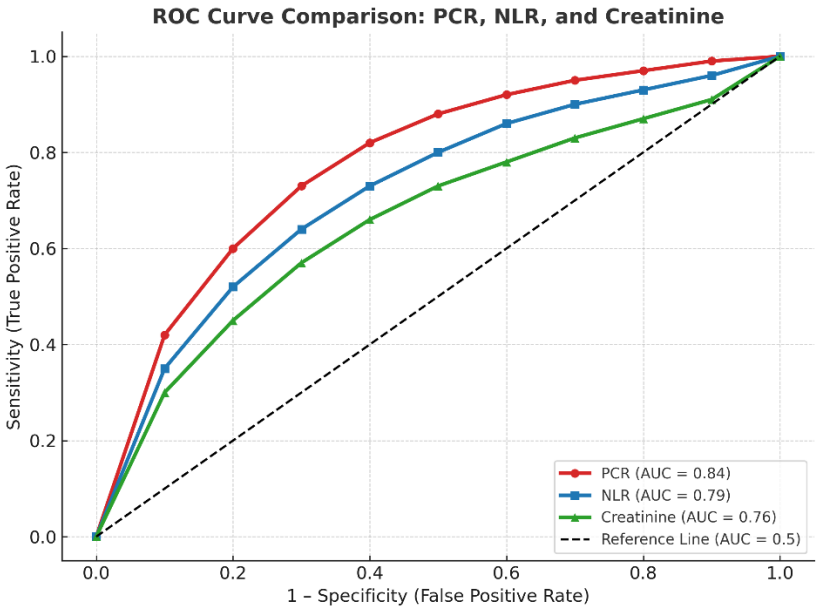

Figure 5: ROC curve comparison of PCR, NLR, and creatinine

Outcome Distribution: % recovered, 32 % of patients required dialysis, 14% developed CKD, and 10% died.

Table 6: Biomarker Comparison Across Outcome Groups

Outcome	Mean PCR	Mean NLR	p-value
Recovered	0.91 ± 0.31	5.4 ± 2.1	—
Dialysis	1.46 ± 0.48	8.1 ± 2.8	< 0.001
Death	1.72 ± 0.62	9.5 ± 3.5	< 0.001

Subgroup Observations

- **Dengue:** High PCR (> 1.4) and NLR (> 8) predicted severe AKI; mortality = 9 %.
- **Leptospirosis:** Non-oliguric AKI in 78 %; hypokalaemia common.
- **Malaria:** Correlation between parasitic index and creatinine (r = 0.54).
- **Scrub Typhus:** Multiorgan dysfunction and higher NLR (9.2 ± 2.5).
- **Typhoid:** Mostly mild AKI; all recovered.

Discussion

This study shows that the procalcitonin-to-creatinine ratio and neutrophil-to-lymphocyte ratio are strongly linked to kidney problems and outcomes in AKI caused by tropical fever.

Comparison with Literature: Our results are similar to those of Zheng et al., who found that inflammatory ratios are connected to ICU mortality [9]. Ahn et al. also noted that NLR serves as an independent predictor of AKI outcomes [10]. Likewise, Herget-Rosenthal et al. observed that rising PCT coincides with a declining glomerular filtration rate in sepsis-related AKI [11].

Mechanism: PCT rises in response to bacterial toxins and cytokines (IL-6, TNF-α) [15]. Reduced kidney clearance increases its levels. NLR indicates the level of systemic inflammation, showing neutrophil activation and lymphocyte suppression during stress [17]. A high NLR links to endothelial dysfunction and microvascular injury, both crucial to the development of AKI [18].

Clinical Implications: Both measures are inexpensive, quick to obtain, and do not need special reagents. In low-resource tropical areas, they can help doctors identify high-risk patients for early dialysis or closer monitoring.

Outcome Relevance: Mortality (10%) and CKD progression (14%) in our group align with national data (8–15%) [19]. Consistently high PCR and NLR during recovery predicted CKD, indicating that ongoing inflammation may hinder full recovery of kidney function [22].

Limitations: The single-center design and small subgroup sizes may affect the general application of our findings. We did not perform serial biomarker monitoring.

Future Scope: Larger multicenter studies that include serial PCT/NLR trends and integration with new markers (NGAL, cystatin C) could improve predictions in tropical AKI.

Conclusion

Tropical infections continue to be a common and preventable cause of AKI in developing countries. A high PCT-to-creatinine ratio and NLR are reliable, low-cost signs of inflammation that correlate well with the severity of AKI, the need for dialysis, and mortality. Regular use of these measures in assessments of febrile illness could allow for the early identification of high-risk patients and timely interventions.

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