# Correlation of Neutrophil to Lymphocyte Ratio (NLR) and Monocyte to Lymphocyte Ratio (MLR) in Diagnosis of Bacterial Infection in Children with Acute Febrile Illness - A Retrospective Descriptive Study

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**Abstract:** ***Objective**: To determine the correlation between Neutrophil to Lymphocyte Ratio (NLR) and Monocyte to Lymphocyte Ratio (MLR) to bacterial infections in children presenting with acute febrile illness. **Methods**: Retrospective study of 127 children aged 1 month to 18 years, admitted with acute febrile illness over 3 month duration. Diagnoses were categorized as bacterial or viral based on clinical and diagnostic criteria. Neutrophil to Lymphocyte Ratio (NLR) and Monocyte to Lymphocyte Ratio (MLR) were calculated from complete blood counts. Median values were compared using Mann-Whitney U test. ROC curve analysis assessed diagnostic performance. NPV and PPV were calculated. CRP correlation and antibiotic usage were also studied using SPSS Software. **Results**: Among 127 patients, 92 were bacterial and 35 were viral. Median NLR in bacterial infections was 1.94 (IQR 1.15–3.30) and 1.06 (IQR 0.67–1.72) in viral ($p<0.01$). MLR medians were 0.33 and 0.19, respectively ($p<0.01$). NLR AUC was 0.70; MLR AUC was 0.66. NLR >1.5 showed 72% sensitivity and 61% specificity. NLR correlated moderately with CRP ($r = 0.26$, $p = 0.005$); MLR correlation was weaker ($r = 0.14$, $p = 0.121$). PPV of 86.7%, NPV 35.2% for NLR, MLR PPV of 83.6%, NPV 32.1% for MLR. NLR was slightly lower in those with prior antibiotic use. **Conclusion**: NLR and MLR are low-cost, accessible practical adjunct markers that aid in triage of acute febrile illness and in distinguishing bacterial from viral infections , especially where advanced diagnostics are limited.***

**Keywords:** NLR, MLR, bacterial infection, CRP, fever, children, ROC curve

## 1. Introduction

Acute febrile illness is one of the most frequent causes of pediatric consultations and admissions, particularly in low and middle-income countries. The ability to promptly differentiate bacterial from viral etiologies is essential to ensure timely antibiotic treatment and reduce unnecessary use of antimicrobials. The surviving sepsis campaign emphasizes the pivotal role of early detection and treatment for sepsis as any delay will worsen the prognosis. Hence initial early goal directed therapy becomes essential in children as progression from bacteremia to septicemia is rapid. Accurate diagnosis of infection and sepsis remains challenging although diagnostic measures to quantify inflammatory bio markers such as CRP, PCT, IL-6 are widely available. While routine measurements of CRP, PCT reduce the costs of sepsis treatment, the mandatory cost for these inflammatory biomarkers is a potential barrier in low or middle income countries. However, in resource-constrained settings, access to confirmatory diagnostic tools like blood cultures and molecular assays is also often limited or delayed. In recent years, ratios derived from routine complete blood counts (CBC), particularly the Neutrophil to Lymphocyte Ratio (NLR) and the Monocyte to Lymphocyte Ratio (MLR), have gained popularity as surrogate markers of inflammation and infection[1,2]. Several studies in adult populations have supported the diagnostic utility of NLR and MLR in identifying systemic bacterial infections, sepsis, and even severity of inflammation[1,3]. Their application in pediatric populations remains less well-established, especially in differentiating febrile illnesses of bacterial and viral origin[4,5]. Emerging pediatric data also supports the use of inflammatory indices such as CRP, NLR, and MLR as accessible markers in the diagnostic evaluation of febrile illnesses [6,7].

This study was designed to evaluate the correlation of NLR and MLR with bacterial infections in children with acute febrile illness, and to assess their relationship with CRP, a commonly used inflammatory biomarker. The study also aimed to examine whether prior antibiotic use influenced these ratios.

## 2. Methods

In this retrospective study, 127 children aged between 1 month to 18 years admitted with history of acute febrile illness were included over a 3 month period. Study was conducted at the Department of Paediatrics, BGS Global Institute of Medical Sciences, Bengaluru. Ethical approval was obtained prior to data collection. Cases with incomplete data or chronic haematological conditions were excluded.

These children were categorized as to have either bacterial or viral infection based on duration of symptoms, clinical findings and laboratory parameters. The NLR ratio and MLR ratio were calculated from CBC. The other inflammatory markers such as CRP, serum albumin, blood culture reports were collected. Serum procalcitonin were measured in very sick children only. Median values were compared using Mann-Whitney U test. ROC curve analysis assessed diagnostic performance. NPV, PPV were calculated using SPSS software.

**Diagnosis Classification:**Diagnoses were reviewed from discharge summaries and laboratory records. Diagnoses such as pneumonia, UTI, tonsillitis, TB, otitis media and externa, abscesses, and enteric fever were classified as bacterial. Diagnoses like viral fever, bronchiolitis, dengue, hepatitis, URTI, and HRAD were classified as viral.

**Data Collection:** Data collected included age, gender, CBC (neutrophil, lymphocyte, monocyte counts), CRP level (mg/L), Ser.PCT, detailed history, documented history of prior antibiotic use>48hrs, culture reports. NLR and MLR were calculated by dividing absolute neutrophil and absolute monocyte counts by absolute lymphocyte count respectively.

**Statistical Analysis:** Descriptive statistics were presented as medians and interquartile ranges (IQR). The Mann-Whitney U test compared NLR and MLR between bacterial and viral groups. ROC curve analysis was performed for NLR and MLR to evaluate diagnostic performance, and optimal cut-offs were determined. Spearman's correlation was used to assess associations with CRP. Analysis was done using SPSS Software.

A PPV of 86.7% for NLR means that when NLR is elevated (>1.5), there's a high likelihood that the child has a bacterial infection. This is clinically valuable in prioritizing early antibiotic initiation. However, the NPV of 35.2% suggests that a low NLR does not effectively rule out bacterial infection. Thus, while helpful in confirming bacterial etiology, NLR should not be used in isolation to exclude it.

In contrast, MLR showed slightly lower PPV (83.6%) and NPV (32.1%), along with a lower AUC of 0.66, inforcing that it is less reliable than NLR for clinical decision-making.

These findings highlight NLR as a practical adjunct biomarker in the triage of febrile children, especially where laboratory resources are constrained.

## 3. Results

Of the 127 patients included, 92 were classified under bacterial and 35 under viral infections.

**NLR and MLR Distribution:**
- Median NLR in bacterial group: **1.94** (IQR 1.15–3.30)
- Median NLR in viral group: **1.06** (IQR 0.67–1.72)
- Median MLR in bacterial group: **0.33** (IQR 0.20–0.45)
- Median MLR in viral group: **0.19** (IQR 0.12–0.29)

Both comparisons were statistically significant (**$p < 0.01$**)

**Table 1:** NLR and MLR Comparison between Groups

| Group | Marker | Median | Mean | SD | p-value |
|---|---|---|---|---|---|
| Bacterial | NLR | 1.94 | 2.47 | 2.27 | <0.01 |
| Viral | NLR | 1.06 | 1.59 | 1.5 | <0.01 |
| Bacterial | MLR | 0.33 | 0.39 | 0.29 | <0.01 |
| Viral | MLR | 0.19 | 0.25 | 0.19 | <0.01 |

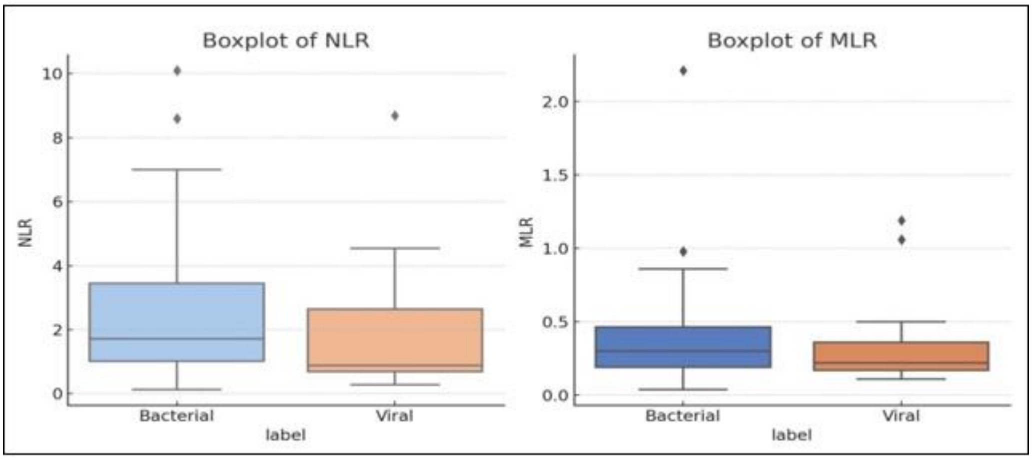


**Figure 1:** Box and Whisker Plot

**Table 2:** ROC Curve Analysis for NLR, MLR

| Marker | AUC | 95% CI | Cut-off | Sensitivity | Specificity |
|---|---|---|---|---|---|
| NLR | 0.7 | 0.61–0.78 | >1.5 | 72% | 61% |
| MLR | 0.66 | 0.57–0.75 | >0.25 | 68% | 60% |

**ROC Curve Analysis:**
- NLR AUC: **0.70** (95% CI: 0.61–0.78)
- MLR AUC: **0.66** (95% CI: 0.57–0.75)
- NLR cut-off >1.5 → Sensitivity **72%**, Specificity **61%**
- MLR cut-off >0.25 → Sensitivity **68%**, Specificity **60%.**

International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

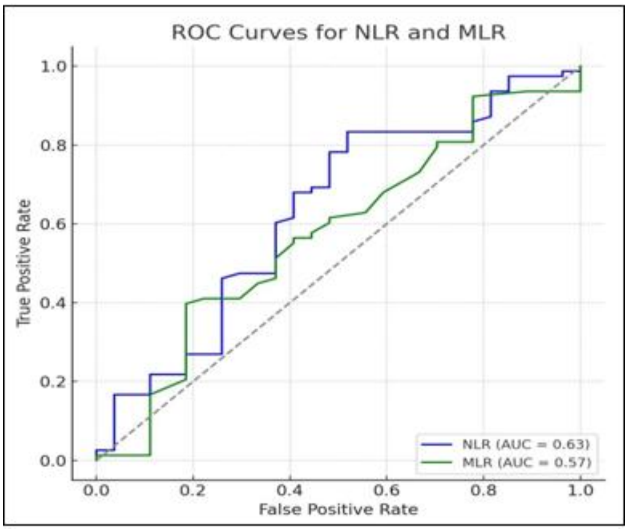


**Figure 2:** ROC Curve for NLR and MLR

**Table 3:** NLR, MLR Diagnostic performance Summary
Diagnostic Performance Summary for NLR and MLR

| Marker | Cutoff | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) |
|---|---|---|---|---|---|
| NLR | >1.5 | 72 | 61 | 86.7 | 35.2 |
| MLR | >0.25 | 68 | 60 | 83.6 | 32.1 |

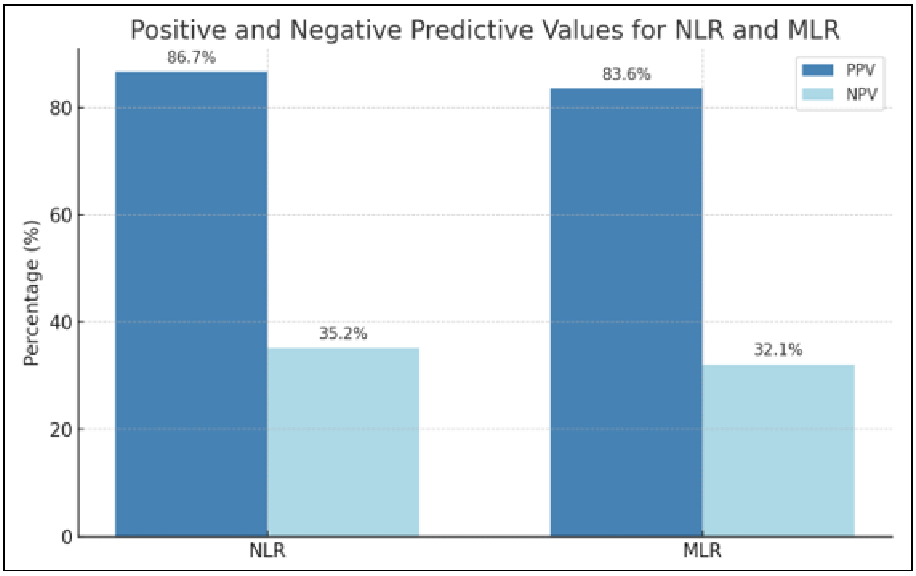


**Figure 3:** Bar Chart: Positive and Negative Predictive values of NLR and MLR

**CRP Correlation:**
- NLR correlated significantly with CRP (**r = 0.26**, **p = 0.005**)
- MLR correlation with CRP was weaker and not significant (**r = 0.14**, **p = 0.121**)

**Table 4:** Spearman Correlation with CRP

| Marker | Spearman r | p-value |
|---|---|---|
| NLR | 0.26 | 0.005 |
| MLR | 0.14 | 0.121 |

**Antibiotic Usage Subgroup:**
Median NLR was lower in children with prior antibiotic use (1.76 vs 2.08), suggesting partial attenuation of inflammation. This difference was not statistically tested due to subgroup size but is noted as clinically relevant.

## 4. Discussion

Currently, CRP, WBC-Leukocytosis, and neutrophil counts are the most frequently used parameters for early diagnosis of bacterial infection. Neutrophilia and lymphocytopenia are well-established markers of severe bacterial infection. Serum procalcitonin and IL-6 have become widely used in recent years, but are often expensive and require higher centres for availability.

The NLR and MLR ratios are cost-effective parameters, easily obtained without additional cost. This study demonstrates the utility of NLR and MLR in distinguishing bacterial from viral infections in children with acute febrile illness. Our findings align with earlier studies in both adult and pediatric populations[2,3], supporting their use in routine practice.

The ROC curve analysis showed NLR had better diagnostic performance than MLR. An NLR AUC of 0.70 indicates moderate discriminatory power. Clinicians may consider NLR >1.5 as a helpful cut-off to raise suspicion for bacterial etiology[4].

The significant correlation of NLR with CRP reinforces its role as an inflammatory marker. MLR had a weaker correlation and lower AUC, suggesting it may be less reliable alone[6]. Recent studies have emphasized NLR, MLR as adjunct markers, especially where CRP or culture is unavailable[8,9].

Our observation of lower NLR values in children who had received prior antibiotics echoes previous reports, possibly reflecting blunted inflammatory response[5,7].

**Limitations:** This was a retrospective, single center study. Microbiological confirmation was not available in all cases, and diagnostic misclassification is possible. Nevertheless, the consistent NLR performance strengthens its practical value.

**What this study add's**

NLR, easy to calculate from CBC with better PPV supports its use as a triage tool in emergency and helps reduce inadvertent use of antibiotics.

## 5. Conclusion

NLR and MLR are useful adjuncts to clinical evaluation in febrile children. They can be calculated from routine CBC and are especially valuable in low-resource settings where advanced testing is limited. NLR showed better sensitivity, specificity, and predictive value than MLR, and its correlation with CRP supports its diagnostic role.

NLR, with its better performance, supports its use as a triage tool in emergency and outpatient pediatric settings.

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