



Utility of the Neutrophil-to-Lymphocyte Ratio, in Differentiating Childhood Pulmonary Tuberculosis from Bacterial Pneumonia: A Cross-Sectional Study from a Peripheral Hospital in Suburban Mumbai

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ABSTRACT

Background: Childhood pulmonary tuberculosis (TB) can clinically mimic bacterial community-acquired pneumonia (CAP), making diagnosis difficult, particularly where microbiological confirmation is delayed or unavailable. Complete Blood Count (CBC)-derived parameters, especially the neutrophil-to-lymphocyte ratio (NLR), may provide a simple and low-cost adjunct for differentiation.

Objective: To evaluate whether routine CBC parameters and the NLR can help differentiate childhood pulmonary TB from bacterial CAP.

Methods: This cross-sectional comparative study included 30 hospitalized children aged 2–14 years from a peripheral hospital in suburban Mumbai (January–July 2026), comprising 15 bacterial CAP and 15 pulmonary TB patients. Clinical features and CBC parameters, including NLR, were compared between groups based on established diagnostic criteria.

Results: The mean age was 5.85 ± 3.00 years in the pneumonia group and 7.47 ± 3.25 years in the TB group ($p=0.168$). Males constituted 60.0% of the pneumonia group and 53.3% of TB group ($p=1.000$). Mean WBC count was higher in children with pneumonia than in those with TB ($14,009.33 \pm 3,898.98$ vs. $12,038.67 \pm 3,952.76/\mu\text{L}$; $p=0.180$). The mean neutrophil percentage was also higher in pneumonia ($74.52 \pm 12.70\%$ vs. $66.46 \pm 12.32\%$; $p=0.089$), whereas lymphocyte percentage was higher in TB ($25.23 \pm 10.96\%$ vs. $18.71 \pm 11.82\%$; $p=0.128$). Mean platelet count was $282,867 \pm 71,773/\mu\text{L}$ in pneumonia and $328,200 \pm 77,015/\mu\text{L}$ in TB ($p=0.107$). CRP was higher in pneumonia than TB (17.42 ± 18.29 vs. 8.04 ± 9.21 ; $p=0.091$). The NLR was significantly higher in bacterial pneumonia than pulmonary TB (7.26 ± 6.67 vs. 3.21 ± 2.08 ; $p=0.038$), with a mean between-group difference of 4.05.

Conclusion: Among the evaluated CBC-derived parameters, NLR showed the clearest discriminatory signal between bacterial pneumonia and pulmonary TB, with higher values observed in bacterial pneumonia and may serve as an inexpensive, readily available supportive marker for differentiation. Larger multicentre studies are needed to validate its diagnostic utility.

Key-words: Childhood tuberculosis; community-acquired pneumonia; complete blood count; neutrophil-to-lymphocyte ratio; children; differential diagnosis.

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INTRODUCTION

Childhood tuberculosis (TB) remains a major cause of morbidity in high-burden countries such as India, but its diagnosis in children is notoriously difficult. Unlike adults, children with pulmonary TB rarely produce sputum, bacteriological yield is low even with modern molecular assays, and the clinical picture of fever, cough, poor feeding and lethargy overlaps substantially with that of bacterial community-acquired pneumonia (CAP).^{1,2} This overlap is particularly problematic in resource-limited healthcare settings, where chest radiography may be non-specific and confirmatory microbiological or molecular testing (such as CBNAAT/GeneXpert or mycobacterial culture) is either unavailable at the point of care or associated with turnaround delays of several days.³

Inappropriate or delayed initiation of anti-tubercular therapy, or conversely unnecessary and prolonged antibiotic use for presumed bacterial pneumonia, both carry clinical and public-health costs, including drug toxicity, cost burden on families, and the promotion of antimicrobial resistance. Therefore, there is a clinical need for simple, inexpensive, rapidly available laboratory parameters that can help clinicians triage children toward the correct diagnostic and treatment pathway while confirmatory results are awaited.^{4,5}

Recently, complete blood count (CBC) parameters as inexpensive, readily available, and routinely performed investigation that may provide useful information in the evaluation of infectious diseases. Some previous studies in adults have demonstrated the potential utility of CBC parameters, including white blood cell, neutrophil, lymphocyte, monocyte, and platelet counts, as well as derived inflammatory indices such as the neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), platelet-to-lymphocyte ratio (PLR), and neutrophil-to-monocyte-plus-lymphocyte ratio (NMLR), in differentiating pulmonary TB from CAP.^{6,7} Among these parameters, the NLR has received considerable attention because it

integrates two components of the differential leukocyte count and can be calculated without additional laboratory expenditure. NLR is obtained by dividing the absolute neutrophil count by the absolute lymphocyte count. The NLR can also be used to determine the severity of both pulmonary TB and pneumonia and also can guide us towards the management of the patient.⁸⁻¹⁰ There are very few pediatric studies in the literature with a small number of patients studying these parameters.^{11,12} Therefore, this study was conducted to evaluate the utility of routine CBC parameters, and specifically the NLR, in differentiating childhood pulmonary TB from bacterial CAP in a peripheral hospital setting in suburban Mumbai, where such a simple, universally available test could meaningfully support early clinical decision-making.

Methods

After obtaining Institutional Ethical Committee approval and written informed consent from parents or legal guardians, this hospital-based, cross-sectional, comparative study was conducted in the Department of Paediatrics of a peripheral hospital in suburban Mumbai, Maharashtra, India, over a period of seven months, from January 2026 to July 2026. All hospitalized children aged 2 to 14 years, of either sex, presenting with fever, cough, reduced playfulness and shortness of breath necessitating hospitalization, were screened for eligibility. A total of 30 children who met the eligibility criteria were enrolled by consecutive sampling and divided into two groups: Group 1 comprised children with bacterial CAP (n=15), and Group 2 comprised children with pulmonary TB (n=15).

Children were excluded if they had received antibiotics for more than 24 hours prior to admission, had a known hematological disorder or other chronic illness known to affect total and differential white blood cell counts, or had received systemic steroid therapy within the preceding 3 months, as each of these factors

can independently alter CBC parameters. Also children with Chronic Tuberculosis presenting with Pneumonia and those with Pneumonia other than Bacterial Pneumonia; like Viral, Helminthic, Fungal, mixed were also excluded as possible confounders.

Children were classified as having pulmonary TB according to the diagnostic criteria of the National Tuberculosis Elimination Program (NTEP), supported where feasible by molecular

testing (CBNAAT/GeneXpert MTB/RIF) and/or mycobacterial culture, and, in selected cases, histopathological examination of tissue specimens including lymph node biopsy. Children were considered to have bacterial CAP when clinical signs and new infiltration on chest radiograph were evident, and it completely resolved after treatment with the appropriate antibiotics. Sputum-Gram stains, cultures and blood cultures were done for microbiological detection of bacterial CAP in patients, (Table 1).

Table 1: Criteria used for allocation to the bacterial CAP and pulmonary TB groups

Basis of group allocation	Criteria applied
Group 1 – Bacterial CAP	New infiltrate on chest radiograph with compatible clinical signs, complete resolution after appropriate antibiotic therapy; sputum Gram stain/culture and blood culture performed for microbiological support.
Group 2 – Pulmonary TB	Diagnosed as per National Tuberculosis Elimination Programme (NTEP) criteria; supported by CBNAAT/GeneXpert MTB/RIF, MTB culture, and/or histopathology of tissue specimens (including lymph node) where available.

Demographic details, history, clinical findings, laboratory results and details of the clinical course were extracted from hospital records and entered into a predesigned data collection sheet. Basic investigations like CBC were done on admission including total WBC count, haemoglobin, differential neutrophil and lymphocyte percentages, and platelet count were determined on a standard hematology analyzer at the time of admission and prior to initiation of antibiotic therapy. The neutrophil to lymphocyte ratio (NLR) was studied and was calculated as the neutrophil percentage divided by the lymphocyte percentage on the admission CBC. While a precise NLR cut-off for children is yet to be established, values in the range of 1-3 are generally considered normal, with values exceeding three deemed abnormal. C-reactive protein (CRP) was measured in a subset of patients, and chest radiography and microbial culture were performed whenever clinically indicated and feasible.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Continuous variables between the two groups were compared using the independent-samples t-test/Welch t-test as appropriate. Because of the small sample size and potential non-normal distribution of NLR, the Mann–Whitney U test should preferably be used as the primary non-parametric comparison for NLR after examination of distribution. Between-group standardized effect sizes (Cohen's d) for all continuous CBC and CRP parameters were additionally derived from the reported means and standard deviations to aid interpretation of clinical significance. . Categorical variables were compared using Fisher's exact test. A p-value <0.05 was considered statistically significant.

Observations and Results

A total of 30 children were enrolled, 15 with bacterial CAP and 15 with pulmonary TB. Both

the groups were comparable and found no significant difference with respect to

demographic profile of the children as shown in table 2.

Table 2: Demographic profile of children

Variables		Pneumonia (n=15)	TB (n=15)	P value
Mean Age in years (range)		5.85 ± 3.00 (0.75–10)	7.47 ± 3.25 (2–13)	0.168
Sex, n (%)	Male	09 (60.0%)	08 (53.3%)	1.000
	Female	06 (40.0%)	07 (46.7%)	

Fever and cough were common in both groups (p=0.600 and p=1.000). Weight loss was more common in the TB group (11/15, 73.3%) compared to the Pneumonia group (3/15, 20.0%) (p=0.008). The mean weight loss was 1.52±0.75 kg (ranged 0.77-2.26kg) in the Pneumonia group and 2.67±1.23 kg (ranged

1.44-3.87 kg) in the pulmonary TB group, (p=0.004). Also, symptom duration >2 weeks (p<0.001) were significantly more frequent in TB, while shortness of breath was more common in pneumonia (p=0.070). Reduced playfulness was comparable between groups (p=1.000), (Table 3).

Table 3: Comparison of clinical characteristics between two groups

Clinical characteristics	Pneumonia (n=15)	TB (n=15)	p-value
Fever	14 (93.3%)	13 (86.6%)	0.600
Cough	14 (93.3%)	15 (100.0%)	1.000
Weight loss	03 (20.0%)	11 (73.3%)	0.008
Reduced playfulness, n (%)	11 (73.3%)	12 (80.0%)	1.000
Shortness of breath, n (%)	12 (80.0%)	07 (46.7%)	0.070
Symptom duration >2 weeks	02 (13.3%)	13 (86.7%)	<0.001

Baseline laboratory parameters are summarized in Table 4. Total WBC count, haemoglobin, neutrophil percentage, lymphocyte percentage, platelet count and CRP were comparable between two groups

with no statistically significant difference, (all p>0.05). However, NLR was significantly higher in the CAP group (7.26 ± 6.67) than in the TB group (3.21 ± 2.08; p=0.038), with statistically significant difference.

Table 4: Baseline laboratory characteristics of the study population

Variables	Pneumonia (n=15)	TB (n=15)	P value
WBC (×10 ⁹ /L)	14009.33 ± 3898.98	12038.67 ± 3952.76	0.180
Hb (g/dL)	10.67 ± 2.06	11.05 ± 1.17	0.548

Neutrophils (%)	74.52 ± 12.70	66.46 ± 12.32	0.089
Lymphocytes (%)	18.71 ± 11.82	25.23 ± 10.96	0.128
Platelets (/μL)	282867 ± 71773	328200 ± 77015	0.107
CRP (mg/L)	17.42 ± 18.29	8.04 ± 9.21	0.091
NLR*	7.26 ± 6.67	3.21 ± 2.08	0.038

Data are mean ± SD. P values by Welch independent-samples t-test. NLR = neutrophil percentage ÷ lymphocyte percentage. WBC, white blood cell count; Hb, haemoglobin; CRP, C-reactive protein; NLR, neutrophil-to-lymphocyte ratio

To place these comparisons in a clinically interpretable context alongside the p values, standardized effect sizes (Cohen's d) were derived for each continuous laboratory parameter using the reported group means and standard deviations (Table 5). The NLR showed the largest effect size among all CBC and CRP

parameters (d=0.82, a large effect), followed by CRP (d=0.65) and neutrophil percentage (d=0.64), both medium effects, despite these two not reaching conventional statistical significance consistent with the modest statistical power afforded by a sample of 15 patients per group

Table 5: Between-group effect sizes (Cohen's d) for continuous CBC and CRP parameters

Variable	Cohen's d (Pneumonia vs TB)	Interpreted magnitude
WBC (×10 ⁹ /L)	0.50	Medium
Hemoglobin (g/dL)	-0.23	Small
Neutrophils (%)	0.64	Medium
Lymphocytes (%)	-0.57	Medium
Platelets (/μL)	-0.61	Medium
CRP (mg/L)	0.65	Medium
NLR	0.82	Large

Cohen's d calculated as (mean (Pneumonia) – mean (TB)) ÷ pooled SD, using the group means and SDs reported in Table 2. Interpretation: |d|<0.2 negligible, 0.2–0.49 small, 0.5–0.79 medium, ≥0.8 large. A positive value indicates a higher value in the pneumonia group; a negative value indicates a higher value in the TB group.

DISCUSSION

TB and pneumonia both have been a major public health concern in children. It is important in public health to discriminate TB at an early stage of disease evaluation because prompt isolation and treatment of TB can reduce its transmission. In children, this situation is more critical and sometimes it is not even possible to distinguish through history, physical

examination or radiology. In this situation, a patient should start on anti-TB therapy and be closely monitored.¹³ This study was conducted to determine that results of primary laboratory investigation like CBC can provide an impression for discriminating TB from pneumonia in children. In this study, we analyzed the differences in CBC characteristics

between children with TB and pneumonia. In infectious diseases particularly in bacterial diseases, the physiological immune response of peripheral leukocytes showed that patients had increased neutrophil counts and decreased lymphocyte counts.¹⁴⁻¹⁶ The NLR has been shown to be a predictive marker for various infectious diseases by maximizing these CBC characteristics. In this cross-sectional study of 30 hospitalized children, routine CBC parameters showed considerable overlap between bacterial CAP and pulmonary TB, with the notable exception of the NLR, which was significantly higher in children with bacterial CAP than in those with pulmonary TB. This finding is consistent with the study done by Aygün D et al⁵ and Mosleh T et al¹³ they reported a significantly higher NLR in bacterial CAP than in pulmonary TB in children. A recent meta-analysis by Shojaan H et al¹⁷ revealed that multiple such studies similarly concluded that patients with TB have significantly lower NLR values than those with bacterial CAP.

Mechanistically, this pattern is thought to reflect the relative contribution of innate versus adaptive immunity to each disease process: bacterial CAP typically provokes a brisk neutrophilic response as part of acute innate immune activation, whereas the control of *Mycobacterium tuberculosis*, an intracellular pathogen, depends more heavily on cell-mediated, lymphocyte-driven immunity, which may be reflected as a relatively lower neutrophil-to-lymphocyte ratio.^{18,19} In contrast to the NLR, the individual components of the CBC including total WBC count, neutrophil percentage, lymphocyte percentage, haemoglobin and platelet count as well as CRP, did not differ significantly between groups in this study, although several showed medium effect sizes and a numerical trend in the expected direction (higher neutrophils, WBC and CRP, and lower lymphocyte percentage, in CAP versus TB). These results are consistent with those from a previous study comparing patients having TB with patients having bacterial pneumonia.^{5,20,21} But Veenstra et al²², Park et al²³ and Wang et al²⁴ showed a decrease in lymphocyte count in TB and Yoon et al²⁰

found no significant difference of lymphocyte count in addition to increase neutrophil count between two groups in their study.

Practically, the NLR is an easily assessable parameter which can be a screening adjunct, because it requires no additional blood draw or cost beyond a standard CBC with differential count. The test results are also available within minutes to hours in most peripheral laboratories, and does not depend on the sputum yield, radiological expertise or turnaround time associated with molecular and microbiological confirmation for the diagnosis.²⁵ In a resource-limited setting such as ours, where CBNAAT/GeneXpert and mycobacterial culture may not be immediately available, an elevated NLR at admission may lend an additional conclusive parameter toward a working diagnosis of bacterial CAP, prompting antibiotic therapy while confirmatory TB work-up is pursued in children whose clinical picture remains ambiguous; conversely, a low NLR in a child with a compatible clinical picture may lower the threshold or reduce the need for pursuing TB-specific investigations. It should be emphasized, however, that on the basis of this small dataset the NLR cannot be recommended as a standalone diagnostic test. A validated, pre-specified cut-off with reported sensitivity, specificity and area under the receiver operating characteristic (ROC) curve would be required before any such clinical application, ideally derived from a larger, prospectively validated cohort.

Limitations

This study has several limitations. The sample size was very small (15 per group), limiting statistical power and making the findings preliminary and also hypothesis-generating rather than confirmatory. The single-centre design at one peripheral hospital limits generalizability. Microbiological or molecular confirmation (CBNAAT/GeneXpert, culture, histopathology) was not available for all patients, and bacterial CAP was defined partly on clinical, radiological and treatment-response criteria, which may have introduced



misclassification. CRP was measured in only a subset of patients. The NLR distribution is likely right-skewed in a sample of this size, so the Welch t-test results should be corroborated with a non-parametric Mann–Whitney U test and, ideally, ROC analysis for a diagnostic cut-off — both having the need for availability of raw patient-level data. Finally, potential confounders (Tuberculosis coexistent with Pneumonia, Other types of Pneumonia apart from Bacterial Pneumonia, nutritional status, HIV status, BCG vaccination history) were not analyzed and could independently affect leukocyte counts.

Conclusion

In this small cross-sectional study of

hospitalized children, the neutrophil-to-lymphocyte ratio, but not other individual CBC parameters, differed significantly between bacterial CAP and pulmonary TB, being higher in bacterial CAP. Given its low cost, wide availability and rapid turnaround, the NLR merits further evaluation as a simple adjunctive marker to support early clinical triage of children with an ambiguous presentation of CAP and Tuberculosis in resource-limited settings, which requires validation in larger, adequately powered, multicentric studies which has diagnostic markers and tests with predefined diagnostic thresholds and confirmed with non-parametric or ROC analyses

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