

Original Research Article

A STUDY OF ASSOCIATION OF INFLAMMATORY MARKERS (C-REACTIVE PROTEIN, RED CELL DISTRIBUTION WIDTH, NEUTROPHIL LYMPHOCYTE RATIO) WITH DISEASE SEVERITY AND RESPONSE TO ANTITUBERCULAR TREATMENT IN ACTIVE PULMONARY TUBERCULOSIS PATIENTS

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ABSTRACT

Background: Pulmonary tuberculosis is associated with systemic inflammation, which may reflect disease burden and early response to antitubercular therapy. Simple biomarkers such as CRP, RDW, neutrophil lymphocyte ratio, neutrophils, and lymphocytes may help assess disease severity and treatment response. **Objectives:** The study aimed to correlate mean levels of CRP, RDW, and NLR with disease severity in active pulmonary tuberculosis and to assess their change from baseline to 8 weeks after antitubercular therapy.

Materials and Methods: This cross-sectional observational study included 100 sputum-positive pulmonary tuberculosis patients aged >18 and <70 years at Kamla Nehru Chest Hospital, Jodhpur. Baseline clinical evaluation, chest radiological severity assessment, and inflammatory marker estimation were performed and repeated after 8 weeks of ATT.

Results: Mean age was 45.75 ± 13.86 years, with male predominance 83.00%. Moderate radiological disease was most common 48.00%. CRP significantly increased with baseline severity, from 43.20 ± 19.84 in mild to 88.82 ± 31.53 in severe disease, $p < 0.0001$.

Conclusion: CRP showed the strongest association with radiological severity and treatment response. After 8 weeks of ATT, CRP, RDW, neutrophils, and NLR decreased, while lymphocytes increased. Persistently sputum-positive patients showed higher inflammatory markers, supporting their clinical utility in treatment monitoring.

Keywords: Pulmonary tuberculosis, C-reactive protein, red cell distribution width, neutrophil lymphocyte ratio, antitubercular therapy, radiological severity, sputum conversion.

INTRODUCTION

Pulmonary tuberculosis is a common infectious disease that mainly affects the lungs and continues to be an important public health problem. In active pulmonary tuberculosis, the body develops a strong inflammatory response against *Mycobacterium tuberculosis*. This inflammation may vary from mild to severe disease, depending on bacterial load, immunity, nutrition, and extent of lung involvement. Therefore, simple blood-based inflammatory

markers may help in understanding disease activity and patient condition.^[1]

During tuberculosis infection, inflammatory and immune changes can be measured through routine or easily available blood investigations. C-reactive protein is an acute-phase protein that rises during infection and inflammation. Higher CRP levels may reflect active disease and greater inflammatory burden. Studies have suggested that inflammatory biomarkers can help in predicting treatment

outcome after the initial months of antitubercular therapy.^[2]

Apart from CRP, hematological markers such as red cell distribution width and neutrophil lymphocyte ratio are also gaining importance. RDW shows variation in red blood cell size and may increase in chronic inflammation, anemia, nutritional deficiency, and ongoing infection. Tuberculosis-associated anemia is commonly reported, and changes in blood parameters may reflect the systemic effect of pulmonary tuberculosis on the patient's body.^[3,4]

Neutrophil lymphocyte ratio is calculated from the neutrophil and lymphocyte counts. It is a simple marker of inflammation and immune imbalance. In tuberculosis, neutrophils may increase due to inflammation, while lymphocyte response may change according to immune status and disease activity. NLR has been studied as a useful marker in tuberculosis screening and may help identify patients with higher inflammatory activity.^[5]

Assessing disease severity in pulmonary tuberculosis usually depends on symptoms, sputum examination, radiological findings, and clinical response. However, these methods may not always fully show the patient's inflammatory status. Biomarkers such as CRP, RDW, and NLR can provide additional information because they are inexpensive, repeatable, and available from routine blood tests in many healthcare settings.^[6,7]

MATERIALS AND METHODS

Study Type: Cross Sectional observational Study

Study location: This study was conducted at Kamla Nehru Chest Hospital, Department of Pulmonary Medicine, Jodhpur, Rajasthan.

Inclusion and Exclusion Criteria

Inclusion Criteria

- We will include all patients with a diagnosis of active pulmonary tuberculosis (sputum positive) age >18 yr and <70 yr.

Exclusion Criteria

We will exclude all patients with following comorbidities from our study sample:-

- Old sputum positive for TB patients, or Defaulter
- Cases of COPD, Bronchial Asthma, Ischaemic Heart Disease, Decompensated Liver Disease, Diabetes Mellitus, Renal Failure, HIV Positive, Peripheral Vascular Disease, Collagen Vascular Disease and Autoimmune Disease.
- We also excluded those patients who are not willing to participate in this study.

Sample Size: 100

Methodology: The study will be conducted after ethical approval. Eligible pulmonary tuberculosis patients will undergo history taking, clinical examination, blood sampling for CRP, RDW and NLR, and chest X-ray evaluation using standard precautions.

Statistical Analysis: Descriptive statistics will be used for analysis. Data will be analyzed using SPSS version 20. Quantitative data will be expressed as mean $\pm$ SD, qualitative data as frequency/percentage, using t-test, chi-square test, and p-value significance.

RESULTS

In This Study the baseline characteristics and radiological severity of 100 active pulmonary tuberculosis patients. In age distribution, 18 patients (18.00%) were in the 18–30 years age group, 24 patients (24.00%) were in the 31–43 years age group, 34 patients (34.00%) were in the 44–56 years age group, and 24 patients (24.00%) were aged >56 years. The mean age was 45.75 ± 13.86 years. In gender distribution, 83 patients (83.00%) were male and 17 patients (17.00%) were female. According to radiological severity, 38 patients (38.00%) had mild disease, 48 patients (48.00%) had moderate disease, and 14 patients (14.00%) had severe disease. Thus, most patients were male, most belonged to the 44–56 years age group, and moderate radiological severity was most common.

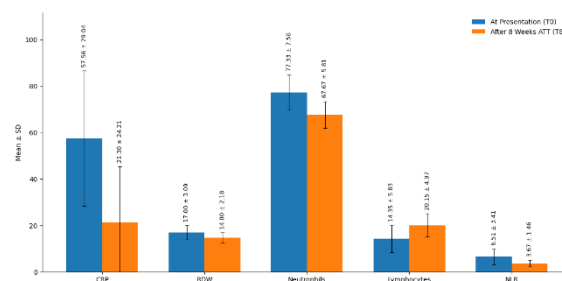


Figure 1: Overall Change in Inflammatory Markers from Baseline to 8 Weeks of ATT

Figure 1 shows the overall change in inflammatory markers from baseline to 8 weeks after ATT. Mean CRP decreased from 57.56 ± 29.04 to 21.30 ± 24.21 , mean RDW decreased from 17.00 ± 3.09 to 14.80 ± 2.18 , mean neutrophils decreased from 77.33 ± 7.58 to 67.67 ± 5.81 , and mean NLR decreased from 6.51 ± 3.41 to 3.67 ± 1.46 . Mean lymphocytes increased from 14.35 ± 5.83 to 20.15 ± 4.97 . These findings suggest improvement in inflammatory status after 8 weeks of antitubercular treatment.

Table 1: Gender-wise Change in Main Inflammatory Markers After 8 Weeks ATT

Marker	Gender	T0 Mean $\pm$ SD	T8 Mean $\pm$ SD	P value
CRP	Male	58.12 $\pm$ 28.98	23.06 $\pm$ 26.09	0.001
CRP	Female	54.82 $\pm$ 30.04	12.71 $\pm$ 6.40	0.001
RDW	Male	16.90 $\pm$ 2.93	14.82 $\pm$ 2.22	0.001
RDW	Female	17.48 $\pm$ 3.83	14.68 $\pm$ 2.00	0.005

NLR	Male	6.62 ± 3.24	3.74 ± 1.54	0.001
NLR	Female	5.97 ± 4.21	3.31 ± 0.93	0.005

Table 1 shows gender-wise changes in inflammatory markers after 8 weeks of ATT. In males, CRP decreased from 58.12 ± 28.98 to 23.06 ± 26.09, RDW from 16.90 ± 2.93 to 14.82 ± 2.22, and NLR from 6.62 ± 3.24 to 3.74 ± 1.54, all statistically significant with p=0.001. In females, CRP decreased from 54.82 ± 30.04 to 12.71 ± 6.40, RDW from 17.48 ± 3.83 to 14.68 ± 2.00, and NLR from 5.97 ± 4.21 to 3.31 ± 0.93, with significant p-values of 0.001, 0.005, and 0.005, respectively. This suggests significant improvement in inflammatory markers in both males and females after treatment.

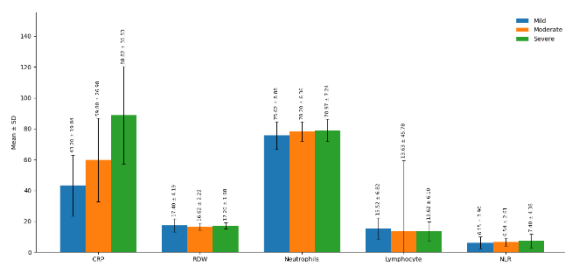


Figure 2: Association of Biomarkers with Radiological Disease Severity at Presentation

Table 2: Biomarkers According to Radiological Severity After 8 Weeks of ATT

Biomarker	Total Mean ± SD	Mild Mean ± SD	Moderate Mean ± SD	Severe Mean ± SD	P value
CRP	21.30 ± 24.20	13.00 ± 8.22	18.70 ± 16.81	52.72 ± 44.24	0.001
RDW	14.80 ± 2.17	14.73 ± 2.30	14.45 ± 1.91	16.17 ± 2.32	0.032
Neutrophils	67.66 ± 5.81	65.98 ± 6.44	68.06 ± 4.33	70.87 ± 7.15	0.02
Lymphocytes	20.14 ± 4.97	20.21 ± 4.97	20.34 ± 4.64	19.28 ± 6.25	0.781
NLR	3.67 ± 1.46	3.52 ± 1.19	3.58 ± 1.16	4.37 ± 2.57	0.149

In table 2, After 8 weeks of ATT, CRP increased with severity from 13.00 ± 8.22 in mild to 52.72 ± 44.24 in severe cases (p=0.001). RDW and neutrophils were also significantly higher in severe

cases (p=0.032 and p=0.020). Lymphocytes and NLR were not significantly associated with severity (p=0.781 and p=0.149).

Table 3: Biomarkers and Sputum Status After 8 Weeks of ATT

Biomarker	Total Mean ± SD	Sputum Positive n=7	Sputum Negative n=93	P value
CRP	21.30 ± 24.20	79.18 ± 33.35	15.62 ± 11.13	0.001
RDW	14.80 ± 2.17	17.95 ± 3.02	14.56 ± 1.92	0.002
Neutrophils	67.66 ± 5.81	76.57 ± 7.58	66.99 ± 5.11	0.001
Lymphocytes	20.14 ± 4.97	13.59 ± 5.70	20.64 ± 4.58	0.005
NLR	3.67 ± 1.45	6.62 ± 2.94	3.45 ± 1.00	0.002

In Table 3, After 8 weeks of ATT, sputum-positive patients had higher CRP (79.18 ± 33.35 vs 15.62 ± 11.13), RDW (17.95 ± 3.02 vs 14.56 ± 1.92), neutrophils (76.57 ± 7.58 vs 66.99 ± 5.11), and NLR (6.62 ± 2.94 vs 3.45 ± 1.00) than sputum-negative patients. Lymphocytes were lower in sputum-positive patients (13.59 ± 5.70 vs 20.64 ± 4.58). All differences were statistically significant, suggesting these biomarkers are associated with treatment response.

DISCUSSION

In the present study of 100 active pulmonary tuberculosis patients, the mean age was 45.75 ±

13.86 years, with maximum patients in the 44–56 years age group 34.00%. Males predominated 83.00%, while females were 17.00%. Moderate radiological disease was most common 48.00%, followed by mild 38.00% and severe disease 14.00%. After 8 weeks of ATT, inflammatory markers improved, with CRP decreasing from 57.56 ± 29.04 to 21.30 ± 24.21, RDW from 17.00 ± 3.09 to 14.80 ± 2.18, neutrophils from 77.33 ± 7.58 to 67.67 ± 5.81, and NLR from 6.51 ± 3.41 to 3.67 ± 1.46, while lymphocytes increased from 14.35 ± 5.83 to 20.15 ± 4.97. CRP, RDW, and NLR significantly declined in both males and females. These findings are similar to Stefanescu et al. (2021),^[2] who reported lower CRP after 2 months of

treatment and biomarker association with culture negativity. They also align with Goletti et al. (2018),^[8] who supported host-derived biomarkers for treatment monitoring. The improvement is comparable with do Socorro Nantua Evangelista et al. (2018),^[9] where second-month sputum conversion predicted successful outcome. In contrast, Tola et al. (2020).^[10] studied MDR-TB children, limiting direct comparison. CRP showed significant association with radiological severity at presentation, rising from 43.20 ± 19.84 in mild disease to 59.80 ± 26.98 in moderate and 88.82 ± 31.53 in severe disease, with $p < 0.0001$. RDW 17.00 ± 3.09 , neutrophils 77.33 ± 7.58 , lymphocyte 14.35 ± 5.83 , and NLR 6.51 ± 3.41 were not significantly associated with baseline severity. After 8 weeks of ATT, CRP remained significantly higher in severe disease 52.72 ± 44.24 , with $p=0.001$; RDW $p=0.032$ and neutrophils $p=0.02$ also differed significantly. Sputum-positive patients after 8 weeks had higher CRP 79.18 ± 33.35 , RDW 17.95 ± 3.02 , neutrophils 76.57 ± 7.58 , and NLR 6.62 ± 2.94 , with lower lymphocytes 13.59 ± 5.70 . These findings are similar to Stefanescu et al. (2021).^[2] and Goletti et al. (2018).^[8] supporting biomarkers in treatment monitoring, and comparable with do Socorro Nantua Evangelista et al. (2018).^[9]

CONCLUSION

This study concluded that inflammatory markers, particularly CRP, have clinically meaningful association with disease severity and early treatment response in active pulmonary tuberculosis. In 100 sputum-positive patients, moderate radiological disease was most common, and CRP showed a significant rise with increasing radiological severity at presentation, from 43.20 ± 19.84 in mild disease to 88.82 ± 31.53 in severe disease, with $p < 0.0001$. After 8 weeks of ATT, CRP, RDW, neutrophils, and NLR decreased, while lymphocytes increased, indicating reduction in systemic inflammation. Persistently sputum-positive patients had higher CRP, RDW, neutrophils, and NLR, and lower lymphocytes than sputum-negative patients. Thus, CRP appears to be the most consistent marker, while RDW, neutrophils, lymphocytes, and NLR may support monitoring treatment response.

Conflict of Interest: None.

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Ethical Approval: Obtained.

Consent: Written consent secured.

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