Original Article

Hematological Changes in Newly Diagnosed Pulmonary Tuberculosis: A Cross-Sectional Study

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Abstract

Background: Pulmonary tuberculosis (PTB) is frequently associated with hematological abnormalities that may indicate disease severity, guide prognosis, and assist in monitoring therapeutic response. Recognizing these alterations can enhance clinical assessment and patient management. This study aimed to evaluate the hematological profile of smear-positive PTB patients. **Material and Methods:** This cross-sectional study included 50 newly diagnosed sputum smear–positive PTB patients. Demographic data, complete blood counts, erythrocyte sedimentation rate (ESR), and differential leukocyte counts were recorded. Inclusion criteria were age ≥14 years and sputum smear positivity for Mycobacterium tuberculosis. Patients with extrapulmonary TB, HIV infection, chronic renal or hepatic disease, malignancy, pregnancy, or prior anti-tubercular therapy were excluded. Data were analyzed using descriptive statistics. **Results:** The highest proportion of patients was aged 36–45 years (26%) and 46–55 years (26%), with a male predominance (70%). Anemia was present in 88.6% of males (<13 g/dL) and 86.7% of females (<12 g/dL), predominantly normocytic normochromic. Leucocytosis (>11,000/cm³) occurred in 70%, neutrophilia (>80%) in 40%, lymphocytopenia (<20%) in 68%, and monocytopenia (<2%) in 30%. Thrombocytosis (>4 lakh/mm³) was seen in 18% and thrombocytopenia (<1.5 lakh/mm³) in 10%. ESR was elevated in all patients. **Conclusion:** Hematological abnormalities are common in PTB, with anemia, leucocytosis, lymphocytopenia, and thrombocytosis being predominant. These alterations, reflecting the inflammatory nature of TB, may serve as cost-effective adjunctive markers for disease assessment and monitoring. Incorporating routine hematological evaluation into TB management protocols is recommended.

Keywords: Pulmonary tuberculosis, anemia, leucocytosis, lymphocytopenia, thrombocytosis.

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Introduction

Tuberculosis (TB) continues to rank among the top ten causes of mortality worldwide and remains the foremost cause of death from a single infectious pathogen, surpassing HIV/AIDS.[1] Pulmonary tuberculosis (PTB), caused predominantly by Mycobacterium tuberculosis, constitutes the majority of TB cases, with India alone accounting for approximately 27% of the global TB burden.[2] Despite significant progress in diagnostic tools, chemotherapeutic regimens, and public health initiatives, TB persists as a major challenge in high-burden countries, especially in resource-constrained healthcare systems.

Beyond its well-recognized pulmonary manifestations, TB exerts systemic effects that extend to the hematopoietic system. Hematological abnormalities are frequent in active PTB and may include anemia, leukocytosis or leukopenia, lymphocytopenia, monocytopenia, thrombocytosis, and thrombocytopenia.[3,4] These alterations are attributed to the chronic inflammatory milieu, immune dysregulation, nutritional deficiencies, and, in some cases, direct or indirect suppression of bone marrow function. The type and degree of these changes can reflect disease severity, serve as potential indicators of prognosis, and provide supplementary information for clinical decision-making.[5]

Anemia, often normocytic normochromic, is the most common abnormality and is largely mediated by anemia of chronic disease mechanisms, though iron deficiency may coexist. Depending on the disease phase and host response, Leukocyte and platelet abnormalities may arise from cytokine-driven marrow stimulation or suppression. Elevated erythrocyte sedimentation rate (ESR) is a well-known marker of inflammation in PTB, but it is non-specific.

Although multiple studies have evaluated hematological profiles in TB patients across different geographical settings, the prevalence patterns vary considerably due to differences in population demographics, nutritional status, comorbidities, and

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disease burden.[3,4] Data from Telangana, India, particularly in newly diagnosed smear-positive PTB patients, remains limited. Understanding these patterns in the local context could provide valuable, low-cost adjunctive tools for baseline assessment, monitoring therapeutic response, and potentially predicting complications.

In this context, the present study assessed the hematological profile of newly diagnosed sputum smear-positive PTB patients. It highlighted its potential utility in patient evaluation and management as an adjunctive parameter.

Materials and Methods

Study Design and Setting: This investigation was a cross-sectional observational study. It was carried out over 18 months, from September 2018 to February 2020, in the Department of Respiratory Medicine, Mamata Medical College and General Hospital, Khammam, in collaboration with the District Tuberculosis Centre, Khammam. Both centers serve as tertiary care referral facilities, managing a significant caseload of pulmonary tuberculosis (PTB) cases, thus providing an appropriate setting for the study.

Sample Size and Patient Selection: 50 patients were enrolled using a consecutive sampling method. Eligible patients were newly diagnosed with PTB based on sputum smear microscopy for acid-fast bacilli (AFB) and had not commenced anti-tubercular therapy (ATT) at the time of recruitment.

Inclusion Criteria

- Age ≥14 years
- Confirmed sputum smear positivity for Mycobacterium tuberculosis using Ziehl–Neelsen (Z–N) staining

Exclusion Criteria:

- Patients were excluded if they had:
- Extrapulmonary or miliary TB
- Known HIV infection
- Chronic renal or hepatic disorders
- Any form of malignancy
- Pregnancy

Current or prior history of ATT use before enrollment

Data Collection Following consent, a structured proforma was used to record demographic details, relevant medical history (past TB history, comorbidities, lifestyle factors), and presenting symptoms. Clinical examination included a complete general physical assessment and a detailed respiratory system examination.

Investigations: All enrolled patients underwent the following investigations:

Complete Blood Picture (CBP), including red cell indices and differential leukocyte count (performed using an automated hematology analyzer and confirmed with peripheral smear when indicated)

Erythrocyte Sedimentation Rate (ESR) using the Westergren method

Random Blood Sugar (RBS) to rule out uncontrolled diabetes

ICTC and HBsAg testing to identify concomitant infections

Chest X-ray (PA view) for radiographic assessment of pulmonary involvement

Sputum microscopy for AFB using Z–N staining on both spot and early morning samples, following RNTCP/NTEP protocols

Definitions Used: Hematological abnormalities were defined according to standard cut-offs:

Anemia: Hemoglobin <13 g/dL in males and <12 g/dL in females (WHO criteria)

Leukocytosis: Total WBC count >11,000 cells/cm³

Leucopenia: Total WBC count <4,000 cells/cm³

Neutrophilia: Neutrophil proportion >80% of total leukocytes

Lymphocytopenia: Lymphocyte proportion <20% of total leukocytes

Monocytopenia: Monocyte proportion <2% of total leukocytes

Thrombocytosis: Platelet count >4 lakh/mm³

Thrombocytopenia: Platelet count <1.5 lakh/mm³

Statistical Analysis: Data entry was performed using Microsoft Excel, and statistical analysis was carried out using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were presented as frequencies and percentages. Given the descriptive nature of the study, no inferential statistical tests were applied. Graphical representation was employed where appropriate to illustrate distribution patterns.

Ethical Considerations: Before initiation, the study obtained ethical clearance from the Institutional Ethics Committee, Mamata Medical College, Khammam. After explaining the study objectives and procedures in their local language, all participants gave written informed consent. Confidentiality and anonymity of patient data were strictly maintained throughout the study.

Results

Demographic Characteristics: The study included 50 newly diagnosed sputum smear–positive pulmonary tuberculosis patients. The mean age of the cohort was 44.2 ± 13.1 years, with the largest proportion of patients in the 36–45 years (26%) and 46–55 years (26%) age groups. Males predominated (70%), yielding a male-to-female ratio of 2.3:1 [Table 1].

Table 1: Age and Gender Distribution of Patients (n = 50)

Age group (years)	Male n (%)	Female n (%)	Total n (%)
14–24	3 (6.0)	0 (0.0)	3 (6.0)
25–35	7 (14.0)	5 (10.0)	12 (24.0)
36–45	10 (20.0)	3 (6.0)	13 (26.0)
46–55	9 (18.0)	4 (8.0)	13 (26.0)
56–65	3 (6.0)	1 (2.0)	4 (8.0)
>65	3 (6.0)	2 (4.0)	5 (10.0)
Total	35 (70.0)	15 (30.0)	50 (100.0)
Mean age ± SD: 44.2 ± 13.1 years			

Hemoglobin Levels and Anemia Prevalence: Anemia was highly prevalent, affecting 88.6% of male patients and 86.7% of female patients. The mean hemoglobin was 10.6 ± 1.5 g/dL in males and 10.4 ± 1.4 g/dL in females, with the majority of cases being normocytic normochromic anemia [Table 2].

Table 2: Hemoglobin Levels and Prevalence of Anemia

Parameter	Male (n=35)	Female (n=15)	Total (n=50)
Mean Hb ± SD (g/dL)	10.6 ± 1.5	10.4 ± 1.4	10.5 ± 1.5
Anemia present n (%)	31 (88.6)	13 (86.7)	44 (88.0)
No anemia n (%)	4 (11.4)	2 (13.3)	6 (12.0)
Predominant anemia type	Normocytic normochromic	Normocytic normochromic	Normocytic normochromic

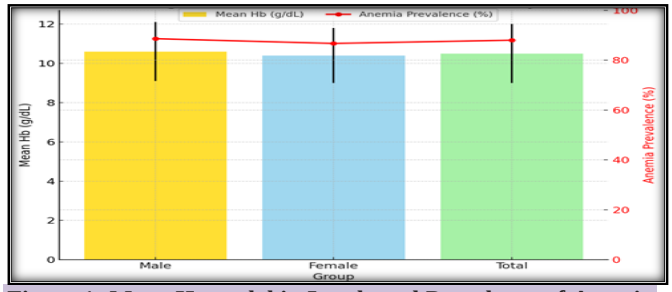

Figure 1: Mean Hemoglobin Levels and Prevalence of Anemia by Gender

Leukocyte Profile

Leucocytosis (>11,000 cells/cm³) was observed in 70% of patients, while the remaining 30% had WBC counts within the normal range—no cases of leucopenia (<4,000 cells/cm³) were noted. Neutrophilia (>80% neutrophils) was present in 40% of patients, lymphocytopenia (<20% lymphocytes) in 68%, and monocytopenia (<2% monocytes) in 30%. The total WBC count was 12,780 ± 2,150 cells/cm³ [Table 3].

Table 3: Leukocyte Profile

Parameter	n (%)	Mean ± SD
Leukocytosis (>11,000)	35 (70.0)	
Normal WBC (4,000–11,000)	15 (30.0)	
Leucopenia (<4,000)	0 (0.0)	
Mean total WBC (cells/cumm)	–	12,780 ± 2,150
Neutrophilia (>80%)	20 (40.0)	Mean neutrophil %: 77.4 ± 9.2
Lymphocytopenia (<20%)	34 (68.0)	Mean lymphocyte %: 18.2 ± 6.5
Monocytopenia (<2%)	15 (30.0)	Mean monocyte %: 3.1 ± 1.2

Platelet Profile: Thrombocytosis (>4 lakh/mm³) was detected in 18% of cases, while thrombocytopenia (<1.5 lakh/mm³) occurred in 10%. The majority (72%) had platelet counts within the normal range. The mean platelet count for the cohort was 3.12 ± 0.98 lakh/mm³ [Table 4].

Table 4: Platelet Profile

Parameter	n (%)	Mean ± SD (lakh/mm³)
Thrombocytosis (>4)	9 (18.0)	
Normal platelets (1.5–4)	36 (72.0)	
Thrombocytopenia (<1.5)	5 (10.0)	
Mean platelet count	–	3.12 ± 0.98

Table 5: ESR Findings

ESR Status	n (%)	Mean ± SD (mm/hr)
Elevated ESR	50 (100)	68.4 ± 16.7
Normal ESR	0 (0.0)	–

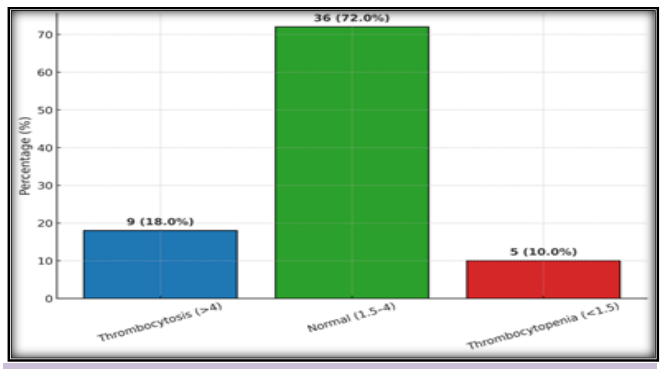

Figure 2: Platelet Profile Distribution

Erythrocyte Sedimentation Rate (ESR)

An elevated ESR was recorded in all patients, with a mean value of 68.4 ± 16.7 mm/hr, consistent with the chronic inflammatory nature of pulmonary tuberculosis [Table 5].

Discussion

The present study reaffirms that hematological abnormalities are highly prevalent among newly diagnosed pulmonary tuberculosis (PTB) patients, with anemia, leucocytosis, lymphocytopenia, and thrombocytosis emerging as the most frequent findings. These alterations reflect the chronic inflammatory state, immune dysregulation induced by

Mycobacterium tuberculosis, and the host's systemic response to infection.

Anemia: Anemia was observed in nearly nine out of ten patients, comparable to the 86–92% prevalence reported in earlier studies from Pakistan and Africa.[6-8] Normocytic normochromic anemia predominated, consistent with anemia of chronic disease driven by pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), which impair iron mobilization and reduce erythropoietin responsiveness.[9] Shyama et al,[9] similarly noted a predominance of normocytic anemia in PTB, with resolution following successful anti-TB therapy. Atoma et al,[10] demonstrated that anemia correlates with disease severity and can serve as a marker for treatment monitoring.

Leukocyte alterations

In 70% of cases, Leucocytosis reflects an active acute-phase response to infection, while neutrophilia (40%) indicates bacterial inflammatory activity. Lymphocytopenia, observed in 68%, is likely due to redistribution of lymphocytes to granulomatous lesions, as described by Farhadian et al,[11] in their systematic review. Monocytopenia, though less commonly highlighted, was present in 30% of patients in our study. This contrasts with earlier findings from Mali, where monocytosis was more frequent,[7] suggesting possible variation in immune kinetics based on disease stage, comorbidities, or genetic factors. Atmosa et al,[10] noted that monocytopenia could be linked to advanced disease or immune exhaustion, warranting further investigation.

Platelet abnormalities: Thrombocytosis (18%) in our cohort aligns with observations by Baynes et al., who attributed the phenomenon to IL-6–driven megakaryopoiesis during chronic inflammation. Sanogo et al,[7] and Kahase et al,[8] similarly documented elevated platelet counts in active TB, which may normalize with treatment. Conversely, thrombocytopenia (10%) may result from bone marrow suppression, immune-mediated platelet destruction, or hypersplenism, as suggested by Shafee et al.[6] Recognition of platelet abnormalities is essential, as severe thrombocytopenia can complicate management and increase bleeding risk.

ESR elevation: An elevated erythrocyte sedimentation rate (ESR) was found in all patients, underscoring its high sensitivity in TB detection. However, as emphasized by Farhadian et al,[11] ESR lacks disease specificity and should be interpreted in conjunction with clinical and microbiological findings.

Comparisons with literature: Our results align with studies from South Asia and sub-Saharan Africa,[6–8,10–12] which consistently report anemia, leucocytosis, and lymphocytopenia as dominant hematologic patterns in PTB. Notably, Hullalli et al,[12] highlighted that hematological changes are often more pronounced in TB patients with diabetes mellitus comorbidity, suggesting that metabolic status can influence blood profile alterations.

Clinical implications: Routine hematological profiling offers a cost-effective, widely accessible adjunct for assessing disease burden, guiding baseline evaluations, and monitoring therapeutic response in PTB, especially in low-resource settings. Hemoglobin, WBC differential counts, platelet counts, and ESR provide valuable supplementary data alongside sputum microscopy and radiological assessment. Integrating these parameters into TB management protocols could enhance prognostication and support early identification of treatment non-response.

Limitations: This study's cross-sectional design precludes temporal correlation with treatment response. Serial monitoring could better elucidate dynamic changes in hematologic parameters.

Conclusion

Hematological abnormalities are highly prevalent among patients with pulmonary tuberculosis, with anemia, leukocytosis, lymphocytopenia, and thrombocytosis emerging as the most frequent alterations. These changes likely reflect the chronic inflammatory state and immune dysregulation associated with active disease. Given their ease of assessment, low cost, and broad availability, routine hematological parameters can serve as valuable adjunctive markers for initial disease evaluation, treatment response monitoring, and early detection of complications. Integrating these investigations into standard TB management protocols may enhance clinical decision-making, particularly in resource-limited settings. Further large-scale studies are warranted to validate their prognostic value and explore their role in guiding individualized treatment strategies.

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Conflicts of interest

There are no conflicts of interest.

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