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ORIGINAL RESEARCH

Predictive Role of Complete Blood Count Parameters in Evaluating Fibrosis and Pulmonary Arterial Hypertension Prognosis in Post-Tuberculosis Sequelae Patients

[1]Dr. Kaushilya Kaurav, [2]Dr. Ishani Deshmukh, [3]Dr. Sudarshan Gupta, [4]Dr. Anju Singh Kaurav, [5]Dr. Shyam Shukla, [6]Dr. Sandhya Gupta, [7]Dr. Sachin Sharma, [8]Dr. Arisha Javed, [9]Bhanu Pratap Singh Kaurav

[1,4,5,6,7,8,9]Post graduate student, [2,3]Associate Professor, Department of Respiratory Medicine, Index Medical College Hospital and Research Centre, India

Corresponding author
Dr. Sudarshan Gupta
Associate Professor, Department of Respiratory Medicine, Index Medical College Hospital and Research Centre, India

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ABSTRACT
Pulmonary tuberculosis (TB) can lead to long-term complications such as fibrosis and pulmonary arterial hypertension (PAH), which significantly affect patient outcomes. This study explores the predictive value of various hematological and biochemical parameters, including hemoglobin, red blood cell count (RBC), white blood cell count (WBC), platelet count, prothrombin time/international normalized ratio (PT/INR), and liver function tests (SGOT, SGPT, bilirubin) in the prognosis of fibrosis and PAH in post-tuberculosis patients. Our analysis indicates that certain parameters, particularly hemoglobin and platelet count, could serve as valuable predictors for these conditions, aiding in early diagnosis and management.

INTRODUCTION

Pulmonary tuberculosis remains a significant global health challenge, with numerous patients developing chronic sequelae such as pulmonary fibrosis and pulmonary arterial hypertension (PAH) post-treatment. These complications can severely impact quality of life and survival rates. Thus, identifying reliable biomarkers for early prediction and management of these sequelae is crucial. Complete blood count (CBC) and liver function tests (LFTs) are routine, accessible diagnostic tools that provide comprehensive information about a patient's health status. This study aims to investigate the predictive value of these parameters in the prognosis of fibrosis and PAH in patients who have been treated for pulmonary tuberculosis.

METHODS

Study Population

The study included 200 patients who had successfully completed treatment for pulmonary tuberculosis at least one year prior to enrollment. Participants were recruited from the pulmonology and cardiology outpatient clinics of a tertiary care hospital. Exclusion criteria comprised co-existing chronic respiratory or cardiovascular diseases unrelated to TB, active TB infection, and other significant comorbidities that could confound the study results.

Data Collection

1. **Clinical Evaluation**: A comprehensive clinical evaluation was conducted, including detailed medical history, physical examination, and symptom assessment relevant to pulmonary fibrosis and PAH.
2. **Imaging Studies**: High-resolution computed tomography (HRCT) of the chest was performed to evaluate the extent of pulmonary fibrosis. Echocardiography was used to assess the presence and severity of PAH.
3. **Blood Investigations**: CBC and liver function test parameters were measured using an automated analyzer. Parameters included: Hemoglobin, Red Blood Cell Count (RBC),

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White Blood Cell Count (WBC), Platelet Count, Prothrombin Time/International Normalized Ratio (PT/INR), Bilirubin, Serum Glutamic-Oxaloacetic Transaminase (SGOT), Serum Glutamic-Pyruvic Transaminase (SGPT)

Statistical Analysis

Statistical analysis was performed using SPSS software. Descriptive statistics were used to summarize patient demographics and blood parameters. Pearson's correlation coefficient was employed to assess the relationship between these parameters and the severity of fibrosis and PAH. Multivariate logistic regression analysis was conducted to identify independent predictors of these conditions.

The data was inputed and sanitized utilizing MS-Excel, followed by statistical analysis using Statistical SPSS-25. Quantitative variables were represented by mean value ± standard deviation & median, while qualitative data was presented as percentages (%) and proportions. Relevant statistical tests were applied to ascertain associations between variables, with a significance level set at $p < 0.05$.

RESULTS

Patient Characteristics

The study population consisted of 116 males (58%) and 84 females (42%), The majority of participants (37.5%) were in the age bracket of 46 to 60 years, followed by those over 60 years old (31%). Participants aged 31 to 45 years accounted for 19.5% of the total study population. Only 12% of study participants were in the age bracket of 18 to 30 years. The majority of patients had completed TB treatment between one and five years prior to the study.

Table 4 Distribution of study participants according to age

Age (in years)	Frequency (n)	Percentage (%)
18 – 30	24	12
31 – 45	39	19.5
46 – 60	75	37.5
> 60	62	31
Total	200	100

Table 5 Distribution of study participants according to gender

Gender	Frequency (n)	Percentage (%)
Males	116	58
Females	84	42
Total	200	100

Blood Parameter Analysis

Hemoglobin: Hemoglobin, with a mean value of 12.46 g/dL in our study population, plays a crucial role in transporting oxygen from the lungs to the rest of the body. Clinically, low hemoglobin levels, indicative of anemia, can exacerbate hypoxemia and contribute to disease progression in pulmonary conditions. Our study found a significant association between lower hemoglobin levels and more severe fibrosis and PAH ($r = -0.45$, $p < 0.01$). This finding is supported by "Harrison's Principles of Internal Medicine" (20th Edition), which notes that anemia is a common finding in chronic diseases, including those affecting the respiratory system. Anemia can worsen hypoxia, a critical factor in the pathogenesis of PAH and pulmonary fibrosis.

Red Blood Cell Count (RBC): The mean RBC count in our study population was 4.10 million cells/µL. This measure is essential for evaluating the oxygen-carrying capacity of the blood. However, our analysis found no significant correlation between RBC count and the severity of fibrosis or PAH. According to "Ganong's Review of Medical Physiology" (26th Edition), while RBC count is a crucial component of overall blood health, its direct correlation with chronic pulmonary diseases may not be as strong as other parameters, such as hemoglobin levels.

White Blood Cell Count (WBC): The mean WBC count in our study population was 6598.80 cells/µL. WBC count serves as an indicator of the immune system's activity and can reflect inflammation or infection within the body. Our analysis revealed a

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weak but significant correlation between elevated WBC counts and the severity of fibrosis ($r = 0.22$, $p = 0.05$) and PAH ($r = 0.30$, $p < 0.01$). This finding is supported by "Robbins and Cotran Pathologic Basis of Disease" (9th Edition), which discusses the role of systemic inflammation in the pathogenesis of chronic diseases, including pulmonary fibrosis and PAH. Elevated WBC counts are indicative of ongoing inflammatory processes that may contribute to the development and progression of these conditions.

Platelet Count: Platelet count, with a mean value of 292,053.15 cells/μL in our study population, is pivotal in blood clotting and plays significant roles in inflammation and tissue repair processes. Our analysis uncovered a notable correlation between higher platelet counts and the extent of fibrosis ($r = 0.38$, $p < 0.01$) as well as PAH ($p < 0.05$). This observation aligns with insights from "Williams Hematology" (9th Edition), which explains that platelets release growth factors and cytokines capable of fostering fibrosis and promoting vascular remodeling. These mechanisms contribute substantially to the pathogenesis of conditions such as pulmonary fibrosis and PAH, underlining the clinical relevance of platelet count as a biomarker in these contexts.

Prothrombin Time/International Normalized Ratio (PT/INR)

The mean PT/INR value in our study population was 11.59 seconds. PT/INR measures the time it takes for blood to clot and serves as an indicator of the coagulation system's functionality. Despite its clinical significance, our analysis did not reveal any significant correlation between PT/INR levels and the severity of fibrosis or PAH. This finding is consistent with "Harrison's Principles of Internal Medicine" (20th Edition), which highlights that while coagulation abnormalities can manifest in chronic diseases, PT/INR is typically employed in contexts such as liver disease management and anticoagulant therapy. It is not generally considered a direct marker of pulmonary fibrosis or PAH severity in clinical practice.

Bilirubin: The mean bilirubin level in our study population was 0.62 mg/dL. Bilirubin, a byproduct of red blood cell breakdown processed by the liver, is crucial in assessing liver function and can indicate liver dysfunction or hemolysis when elevated. However, our analysis did not find any significant correlation between elevated bilirubin levels and the severity of fibrosis or PAH. This observation is consistent with "Sleisenger and Fordtran's Gastrointestinal and Liver Disease" (10th Edition), which emphasizes bilirubin's primary role as a marker for liver health rather than its direct relevance to pulmonary conditions. Thus, while bilirubin remains important in assessing liver function, its clinical significance in pulmonary fibrosis and PAH appears limited based on current evidence.

Serum Glutamic-Oxaloacetic Transaminase (SGOT/AST): The mean SGOT (AST) level in our study population was 44.70 U/L. SGOT is an enzyme found in the liver and heart, and elevated levels can indicate liver damage or inflammation. Our analysis revealed a weak correlation between higher SGOT levels and the severity of fibrosis ($r = 0.25$, $p < 0.05$). This finding is supported by "Cecil Textbook of Medicine" (25th Edition), which discusses how elevated SGOT levels may reflect liver pathology, systemic inflammation, or muscle damage, all of which can occur in chronic respiratory diseases. However, it's important to note that while SGOT is indicative of liver health and inflammation, its association with pulmonary fibrosis and PAH is not as direct or well-established compared to other biomarkers like hemoglobin or platelet count.

Serum Glutamic-Pyruvic Transaminase (SGPT/ALT): The mean SGPT (ALT) level in our study population was 36.43 U/L. SGPT is an enzyme primarily found in the liver, and elevated levels typically indicate liver damage. However, our analysis did not find any significant correlation between elevated SGPT levels and the severity of fibrosis or PAH in post-tuberculosis patients. This observation is consistent with "Harrison's Principles of Internal Medicine" (20th Edition), which notes that SGPT is a sensitive marker for liver damage but is less directly related to pulmonary conditions compared to other parameters such as hemoglobin or platelet count. Therefore, while SGPT remains important in assessing liver health, its clinical relevance to pulmonary fibrosis and PAH in this patient population appears limited based on our findings and current literature

Multivariate Analysis

The multivariate logistic regression analysis conducted in our study identified hemoglobin and platelet count as robust independent predictors for both fibrosis and pulmonary arterial hypertension (PAH) among post-tuberculosis patients. Specifically, lower hemoglobin levels were associated with increased odds of fibrosis (OR = 0.8, 95% CI: 0.7-0.9) and PAH (OR = 0.7, 95% CI: 0.6-0.8), indicating that hemoglobin plays a protective role against these conditions. Conversely, higher platelet counts were linked to elevated odds of fibrosis (OR = 1.5, 95% CI: 1.1-2.1) and PAH (OR = 1.6, 95% CI: 1.2-2.2), suggesting platelets' involvement in disease progression.

These findings underscore the clinical significance of hemoglobin and platelet count as key indicators in the prognosis of fibrosis and PAH post-tuberculosis. Importantly, other parameters including RBC, WBC, PT/INR, bilirubin, SGOT, and SGPT did not demonstrate significant independent predictive value when adjusted for hemoglobin and platelet count. This highlights the specific relevance of hemoglobin and platelet count in assessing and managing these

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pulmonary complications in post-tuberculosis patients. Further research could explore underlying mechanisms and validate these findings to enhance clinical management strategies.

Table 24 Descriptive statistics of Laboratory parameters

Parameters	N	Mean	Standard Deviation
Haemoglobin	200	12.46	2.44
TLC	200	6598.80	2482.28
RBC	200	4.10	0.78
Platelets	200	292053.15	103585.00
PT/INR	200	11.59	0.24
SGOT	200	44.70	9.92
SGPT	200	36.43	11.91
Bilirubin	200	0.62	0.27

DISCUSSION

The results of this study highlight the significant predictive value of certain blood parameters, particularly hemoglobin and platelet count, in assessing the prognosis of fibrosis and PAH in post-tuberculosis patients.

Hemoglobin

Lower hemoglobin levels were consistently associated with more severe fibrosis and PAH. Anemia may exacerbate hypoxemia and contribute to the progression of these conditions. This finding is supported by "Harrison's Principles of Internal Medicine," which emphasizes the impact of anemia on chronic respiratory diseases and its role in worsening hypoxia, a critical factor in PAH and pulmonary fibrosis.

Platelet Count

Higher platelet counts were significantly correlated with the extent of fibrosis and PAH. Platelets play a crucial role in the pathogenesis of fibrotic and vascular diseases through the release of growth factors and pro-inflammatory cytokines. "Williams Hematology" describes the role of platelets in promoting fibrosis and vascular remodeling, supporting the findings of this study.

WBC Count

Elevated WBC counts showed a weak but significant correlation with fibrosis severity and PAH, indicating a potential link between systemic inflammation and these post-tuberculosis complications. "Robbins and Cotran Pathologic Basis of Disease" discusses the role of systemic inflammation in chronic diseases, highlighting the relevance of WBC counts in this context.

Liver Function Tests

While liver function tests such as SGOT and bilirubin levels were measured, their correlation with fibrosis and PAH was weak or insignificant. This suggests that liver function parameters may not be reliable predictors of these conditions in post-tuberculosis patients. "Sleisenger and Fordtran's Gastrointestinal and Liver Disease" and "Harrison's Principles of Internal Medicine" provide comprehensive discussions on the diagnostic utility of these markers, primarily in the context of liver health rather than pulmonary conditions.

CONCLUSION

This study demonstrates that certain blood parameters, particularly hemoglobin and platelet count, have significant predictive value for the prognosis of fibrosis and PAH in post-tuberculosis patients. Incorporating these parameters into routine follow-up assessments could enhance early detection and management of these complications, ultimately improving patient outcomes. Further research is needed to validate these findings and explore the underlying biological mechanisms linking these blood parameters with fibrosis and PAH in this patient population.

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