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A comparative study of volume, scatter, and conductivity parameters of leukocytes in tuberculous and bacterial pneumonias

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Abstract

Background: Differentiating tuberculous from bacterial community-acquired pneumonia (CAP) is challenging due to overlapping clinical features. Cell population data (CPD) from automated hematology analyzers offer a potential point-of-care tool for rapid, cost-effective differentiation based on leukocyte characteristics.

Methods: This analytical cross-sectional study was conducted over 12 months (July 2022–June 2023) at a tertiary care center in Uttarakhand, India. Adult patients with clinical and radiological evidence of pneumonia were enrolled after ethical approval and informed consent. Cases were classified as tuberculous or bacterial pneumonia based on sputum microbiology, molecular testing, culture, and treatment response. Hematological parameters, including CPD from the Unicel DxH 800 (Beckman Coulter), were analyzed. Statistical analysis was done using SPSS v22.0. Multiparametric analysis integrated clinical variables, routine haematological indices, and leukocyte VCS parameters. Principal component analysis was used for exploratory dimensionality reduction, followed by multivariable logistic regression with discriminatory performance assessed using receiver operating characteristic analysis.

Results: Among 193 patients, 74 had tuberculous and 119 had bacterial pneumonia. Tuberculous cases were younger, predominantly male, and had longer fever and cough. Hematologically, they showed lower hemoglobin, hematocrit, MCV, and MCH, but higher RDW and platelet counts. Eosinopenia and increased monocyte percentages were observed. CPD analysis revealed significant differences in lymphocyte (MN-V-LY, MN-AL2-LY), monocyte (MN-MALS-MO, MN-UMALS-MO, MN-LMALS-MO, MN-LALS-MO, MN-AL2-MO), eosinophil (MN-AL2-EO), and early granular cell (MN-UMALS-EGC, SD-MALS-EGC) parameters. Multivariable logistic regression demonstrated good discriminatory performance for tuberculous pneumonia (sensitivity 78.4%, specificity 75.6%), outperforming individual markers. Principal component analysis showed partial separation between tuberculous and bacterial pneumonia, driven mainly by coordinated changes in monocyte scatter and lymphocyte-related parameters, supporting a multiparametric diagnostic signature rather than a single dominant variable.

Conclusion: Tuberculous pneumonia showed distinct hematological and CPD alterations, particularly in monocyte and lymphocyte parameters. These reflect underlying immunological differences but overlap with bacterial patterns limits diagnostic specificity. Monocyte scatter parameters were the most consistently altered in TB cases. Multiparametric analysis suggests that differentiation between tuberculous and bacterial pneumonia arises from coordinated immune-cellular patterns rather than isolated haematological markers. The findings emphasize the dominant contribution of monocyte-related parameters and support the use of integrated diagnostic approaches over single-parameter thresholds.

Background

The etiology of community acquired pneumonia (CAP) ranges across a diversity of bacteria and viruses and includes Mycobacterium tuberculosis in an endemic country like India. The clinical features viz.

fever, cough, expectoration, hemoptysis, bronchial breathing, and rales on examination, as well as infiltrates on chest imaging are non-specific in terms of etiology. (1) India accounts for 23 percent of the global pneumonia cases and 27 percent of the world tuberculosis (TB) burden. (2, 3, 4) WHO TB statistics anticipated 2,590,000 million cases in India for 2021, emphasizing the need of early diagnosis and timely intervention. (5) Pulmonary tuberculosis as such has diagnostic difficulties ranging from non-specific clinical and radiological features compounded by poor interpretative skills, difficult to culture organism, poor role of tuberculin sensitivity testing, poor sensitivity of Ziehl Neelsen staining and microscopy, poor availability of PCR based tests and delayed presentation. (6)

It is imperative to look for a simple, inexpensive, sensitive, and specific point-of-care test to differentiate between bacterial and tuberculous community-acquired pneumonias.

Automated hematology analyzers having advanced VCS (volume, conductivity, and scatter) technology provide information beyond the routine parameters assessed in hemogram that have an ability to detect intrinsic biophysical characteristics of over 8000 leukocytes. (7) The cell population data (or VCS parameters) of WBC subpopulation are known to undergo changes during an inflammatory process-such as increase in size, volume, granularity, variation in volume heterogeneity, etc. (8) VCS parameters of leukocytes have a documented and proven role in differentiating common etiologies of acute undifferentiated febrile illness (AUFI) viz. viral, bacterial, malarial and rickettsial infections. (9, 10, 11) They are also used as an early marker of sepsis and treatment response. (12) Thus, the potential role of cell population data to aid in timely diagnosis and intervention is being explored extensively. Data collected from the new DxH800 hematology analyzer (Beckmann Coulter) includes cell population data parameters which are optically and electronically calculated using three independent energy sources, as every individual leukocyte passes through the aperture. Impedance measures cell volume with accurate size, along with degree of cell size variation; radio frequency opacity determines conductivity based on internal composition of cells; and laser beam measures light scatter according to cell granularity and nuclear structure. When compared to older Coulter haematology analysers (such as the LH 780), the Beckmann Coulter has a new flow cell design that supports multiple angles of light scatter measurements in addition to volume, and conductivity, measurements. (7) Subsequently, the parameters include volume (V)- mean (MN) and standard deviation (SD); conductivity (C)- MN and SD; and 5 different light scatter parameters viz, median angle light scatter (MALS), lower median angle light scatter (LMALS), upper median angle light scatter (UMALS), axial light loss measurement (AL2), and low-angle light scatter (LALS)- MN and SD; each for neutrophils (NE), lymphocytes (LY), monocytes (MO), eosinophils (EO) and early granulated cells (EGC). (7) All these characteristics add to the cell population data (CPD) parameters. The values of these parameters will presumably differ between infected and non-infected individuals and amongst different types of infections.

High mean neutrophil volume, low mean neutrophil conductivity, low lower median angle light scatter as well as high mean monocyte volume has been observed in infectious group as compared to control group in a study by Lee et al. (13) Higher mean neutrophil volume has also been observed in gram-positive as compared to gram-negative bacteria related sepsis. (14) Further, certain characteristic

changes tend to be prominent particularly in tuberculosis infection. An increased mean neutrophil conductivity, mean monocyte conductivity, and mean monocyte volume in active pulmonary tuberculosis as compared to CAP has been well demonstrated. (8, 15)

With the incriminating evidence of the utility of the CPD parameters in diagnosing tuberculosis, we conducted this study to compare the VCS parameters of the leucocytes among the two etiological groups (tuberculous and bacterial) of community acquired pneumonia and assessed its diagnostic potential.

Materials and methods

This was an analytical cross-sectional study conducted in a tertiary referral center of the north Indian state of Uttarakhand over a period of 12 months (July 2022- June 2023) after obtaining institutional research and ethical committees' approval (vide approval letter no. SRHU/HIMS/ETHICS/2024/33). All adult patients (over the age of 18 years) with a clinical diagnosis of pneumonia were included after obtaining an informed written consent. Pneumonia was defined as fever (> 100° F) > 4–5 days, with features of lower respiratory tract infection (like cough, dyspnea, chest pain or sputum production) and suggestive radiological features (like lobar consolidation, interstitial infiltrates and/or cavitation, effusions). (16) Tuberculous pneumonia was considered in patients with sputum smear positivity by Ziehl Neelsen (ZN) staining, sputum positivity by CB-NAAT for M. tuberculosis, growth of M. tuberculosis organism on BACTEC blood culture system / MGIT liquid culture system or resolution of clinical features of pneumonia by anti-tuberculous treatment (ATT) in 2 weeks. Bacterial pneumonia was considered in patients with sputum smear positivity by gram staining and negative by ZN staining, growth of the causative organism on aerobic culture and sensitivity, or response to antibiotics (as per the IDSA guidelines) in 2 weeks judged by clinical and radiological response to antibiotics. Unconscious patients, those requiring ventilatory support, with associated acute coronary event, stroke, malignancy, and autoimmune illnesses; those who developed healthcare associated infections and/ or on immunosuppressive drugs were excluded from the study. Demographic and clinical data was collected, suitable blood samples were drawn and chest x-ray and sputum for gram stain, ZN stain, culture and/or CBNAAT, BACTEC cultures were performed at the time of hospitalization for diagnostic purposes. Peripheral blood EDTA samples were analyzed on Unicel DxH 800 (Beckman Coulter, CA, USA) automated hematology analyzer and all seven categories of CPD were measured in neutrophils, lymphocytes, monocytes, eosinophils, and early granular cells. (7) The collected data was entered into a Microsoft Excel sheet, and statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 22.0. Any association between categorical variables was calculated via non-Parametric tests viz Chi square and Fisher Exact test wherever applicable. Unpaired T-test was used to compare the means of normally distributed variables, while the Mann Whitney U test was used to compare medians of non-parametric data. A p-value < 0.05 was considered statistically significant. To evaluate the significance of cutoff levels, the power of variables and the area under the curve (AUC) for the receiver operating characteristic (ROC) curve were used. Sensitivity, specificity, and the area under

the curve were estimated using the ROC curve approach. The area under the curve were considered better when AUC was close to 1 and worse when it was 0.5.

Results

The mean age of patients affected with pneumonia (n = 193) was 48.4 ± 15.8 years with male preponderance (63.2%). Most patients were aged between 31–40 years (n = 45, 23.3%) and 57.5% had radiological evidence of lobar consolidation. Of the 193 subjects, 74 had tuberculous pneumonia; the remaining 119 individuals had pneumonia due to bacterial etiology. Table 1 shows the comparison of demographic data and hematological indices between the two groups. Demographically, patients with tuberculous pneumonia were significantly younger (43.9 ± 13.4 years) compared to those with bacterial pneumonia (49.6 ± 16.8 years; p = 0.01). The male-to-female ratio was also notably higher in the tuberculous group (2.7:1 vs. 1.3:1; p = 0.02). Additionally, the duration of fever was significantly longer in the tuberculous group (12.4 ± 7.2 days) than in the bacterial group (5.8 ± 4.0 days; p < 0.01). The duration of cough was also found to be longer in the tuberculous group (10.8 ± 6.4 days) than in the bacterial group (6.8 ± 2.9 days; p < 0.01). Regarding clinical features, fever was significantly more frequent in tuberculous pneumonia patients (85.1%) than in bacterial cases (69.7%; p < 0.01), however the frequency of cough was comparable between the two groups. Other symptoms such as expectoration, dyspnea, and chest pain did not differ significantly between the two groups.

In red cell indices, patients with tuberculous pneumonia had significantly lower haemoglobin levels (10.63 ± 2.06 gm/dl vs. 11.59 ± 2.51 gm/dl; p = 0.007), haematocrit (33.17 ± 5.92% vs. 35.17 ± 6.57%; p = 0.028), MCV (p = 0.028), and MCH (p = 0.007). They also showed higher red cell distribution width (RDW; p = 0.021), higher platelet counts (p = 0.015), and reduced mean platelet volume (MPV; p = 0.001), all of which were statistically significant. Regarding white cell indices, although total WBC count and neutrophil count did not differ significantly, the absolute eosinophil count was significantly lower in the tuberculous group (p = 0.003). Differential WBC count analysis also showed that tuberculous pneumonia had higher monocyte (p = 0.045) and eosinophil (p = 0.001) percentages, and lower basophil percentages (p = 0.009).

Table 2 presents a comparative analysis of VCS parameters of leukocytes in patients with tuberculous versus bacterial pneumonia. The comparison spans across different leukocyte types; analyzing both mean (MN) and standard deviation (SD) of various VCS-derived metrics. While neutrophilic characteristics were comparable in the two etiological groups, among lymphocyte indices, the mean volume (MN-V-LY) was significantly higher in tuberculous pneumonia patients (90.7 ± 5.8) compared to those with bacterial pneumonia (88.7 ± 5.1; p = 0.039). Additionally, SD-UMALS-LY (upper median angle light scatter) and MN-AL2-LY (axial light loss) also showed significant differences (p = 0.022 and p = 0.022 respectively), indicating potential morphological and internal complexity differences in lymphocytes between the two groups. For monocyte parameters, multiple statistically significant differences were observed. MN-MALS-MO (median angle light scatter), MN-UMALS-MO (upper median angle light scatter), MN-LMALS-MO (lower median angle light scatter), and MN-AL2-MO were all

significantly lower in the tuberculous group (p-values: 0.00, 0.001, 0.00, and 0.001 respectively). Notably, SD-LMALS-MO was higher in tuberculous pneumonia (15.8 ± 2.1 vs. 14.9 ± 2.2; p = 0.002), suggesting increased heterogeneity in the light scatter of monocytes. Eosinophil indices showed fewer significant differences, with only MN-AL2-EO being significantly lower in tuberculous patients (113.9 ± 7.1 vs. 117.7 ± 12.3; p = 0.003), indicating a potential alteration in internal eosinophil structure or granularity. For early granulated cells, two parameters reached statistical significance: SD-MALS-EGC and MN-UMALS-EGC. Tuberculous pneumonia patients exhibited higher variability in median angle light scatter (SD-MALS-EGC, p = 0.018) and a lower mean upper median angle light scatter (MN-UMALS-EGC, p = 0.033), possibly reflecting structural or maturation differences in granulocyte precursors. Notably, monocyte scatter characteristics (MALS, UMALS, LMALS, and AL2) showed the most consistent and pronounced differences between the two groups. Although significant, the cut-off values for each of the significant leukocyte parameters could not be derived due to low sensitivity and specificity.

A multivariable logistic regression model was constructed to evaluate the combined discriminatory ability of clinical variables, hematological indices, and leukocyte VCS parameters. Variables demonstrating statistical significance on univariate analysis ($p < 0.05$) were entered into the multivariable model. On adjusted analysis, duration of fever, hemoglobin level, platelet count, monocyte percentage, and monocyte VCS parameters—specifically MN-MALS-MO, MN-UMALS-MO, and SD-LMALS-MO—emerged as independent predictors of tuberculous pneumonia. The final model demonstrated a sensitivity of 78.4%, specificity of 75.6%, and an overall diagnostic accuracy of 76.7%. Although the individual predictors exhibited modest odds ratios, their combined inclusion in the multivariable model resulted in a significant improvement in discriminatory performance compared with any single parameter analyzed in isolation.

Principal component analysis was performed on the integrated dataset comprising clinical variables, conventional hematological indices, and leukocyte VCS parameters to explore the underlying multivariate structure. The first three principal components accounted for 34.1% of the total variance. The first principal component (PC1, 14.2%) was predominantly driven by monocyte scatter parameters, including MN-MALS-MO, MN-UMALS-MO, and MN-LMALS-MO, along with platelet-related indices. The second principal component (PC2, 11.6%) was largely influenced by lymphocyte volume and scatter characteristics, notably MN-V-LY, SD-UMALS-LY, and MN-AL2-LY, while the third principal component (PC3, 8.3%) primarily reflected variability-based parameters, particularly SD-LMALS-MO and SD-MALS-EGC. Visual inspection of PCA score plots demonstrated partial but meaningful separation between tuberculous and bacterial pneumonia clusters, indicating that the observed group differences were driven by coordinated multiparametric patterns rather than a single dominant variable. [Figure 1,2]

Discussion

With overlapping clinical features of pneumonias due to different etiologies, post-validation our observations can potentially be utilized for differentiating tuberculous from bacterial pneumonias. Clinically, the presence of fever and the extended duration of symptoms—especially fever and cough—

were noted in patients with tuberculous pneumonia, reflecting the chronic course of tuberculosis, consistent with findings from previous studies. (17, 18) As per the observations by Schuurmans to consider unexplained cough of 2–3 weeks duration an indicator of pulmonary tuberculosis, (19) the mean duration of cough was significantly higher in the tuberculous group. (17, 18) All patients in our study with cavitary and fibrocystic changes on radiography had tuberculous pneumonia, consistent with the observations made previously. (17, 20)

Haematologically, patients with tuberculous pneumonia showed significantly lower haemoglobin levels (10.63 g/dL) and haematocrit (33.17%), which emerged as key findings. Additionally, red cell indices including MCV, MCH, and MCHC were notably decreased, suggesting the presence of iron-deficiency anaemia or anaemia of chronic disease. This pattern of microcytic, hypochromic anaemia has also been reported in earlier studies involving TB patients. (18, 21) Platelet counts were significantly higher in cases of tuberculous pneumonia (300.35 ± 168.72 x 10^3/μL), and the presence of thrombocytosis in TB has been well documented in earlier studies, often attributed to cytokine-mediated inflammation, particularly involving interleukin-6 (IL-6). (18, 21) We also observed that the mean platelet volume (MPV) was lower in the tuberculous pneumonia group compared to the bacterial pneumonia group. In our study, white cell parameters in tuberculous pneumonia cases showed leucocytosis (10.35 ± 4.72 × 10^3/μL), neutrophilia (elevated absolute neutrophil count: 8.22 ± 4.57 × 10^3/μL), and lymphopenia (reduced absolute lymphocyte count: 1.11 ± 0.64 × 10^3/μL), likely reflecting immune modulation associated with tuberculosis. While these findings are in line with those reported by Shah et al. (18) and Farhadian et al. (21), they did not reach statistical significance when compared to bacterial pneumonia cases. Nonetheless, they underscore the diagnostic and prognostic value of basic haematological tests such as complete blood counts in pulmonary tuberculosis, particularly in settings with limited resources. Notably, a statistically significant eosinopenia (reduced absolute eosinophil count: 0.12 ± 0.16 × 10^3/μL) was observed in the tuberculous group compared to the bacterial group. Existing literature also highlights an association between an elevated monocyte-to-lymphocyte ratio and increased likelihood of tuberculosis. (22) In line with this, our study found significantly higher percentages of monocytes, eosinophils, and basophils in the tuberculous group, supporting these previously reported observations.

Among the VCS parameters studied, neutrophil parameters were comparable in the two groups suggesting that neutrophils as a part of innate immunity play a role in tuberculosis, same as in community acquired bacterial infections. (23) The macrophages, dendritic and natural killer cells are also involved in the pathogenesis of tuberculosis and bacterial pneumonia. (24) The role of lymphocytes in tuberculosis infection has been well established. (25) In the present study, the tuberculous group showed a higher mean lymphocyte volume—indicating larger lymphocyte size—as well as lower standard deviation of upper median angle light scatter and lower mean axial light loss, both of which suggest changes in lymphocyte granularity or membrane complexity. Similarly, Park et al. demonstrated the diagnostic relevance of lymphocyte CPD parameters in tuberculosis when analyzed as part of a multivariate model. (26) Although some CPD parameters in our study showed statistically significant differences, the low AUC values limited their overall diagnostic utility. In contrast, Sun et al. reported increased mean lymphocyte conductivity in TB patients—a finding not observed in our study. (27)

The findings of this study highlight a clear impact of *Mycobacterium tuberculosis* on monocyte CPD properties, particularly the scatter parameters. Monocyte VCS parameters have shown significant variability across different forms of tuberculosis and pneumonia. Chen et al. demonstrated that in active tuberculosis, monocytes exhibit markedly increased volume, conductivity, and scatter values—particularly LMALS and LALS—compared to latent TB, reflecting enhanced cellular activation and internal complexity. (28) Similarly, studies by Shen et al. and Sun et al. reported increased monocyte size and structural complexity in active TB relative to healthy or latent TB individuals. (15, 29) In contrast, our findings show a consistent and significant reduction across most mean monocyte scatter parameters in the tuberculous group (MALS, UMALS, LMALS, LALS, AL2) compared to the bacterial group, suggesting diminished internal complexity. Notably, the variability in parameters such as SD-LMALS-MO is greater in TB, indicating higher heterogeneity among monocytes. These observations highlight the pivotal role of monocytes in the immune response against tuberculosis. Although monocyte activation is a hallmark of active TB, the nature and intensity of this activation are influenced by the comparator group, with bacterial pneumonia provoking a more robust inflammatory response, as noted in this study. The monocyte-related immune and cellular alterations captured by VCS metrics are more pronounced in the progression from latent to active TB (15, 28, 29) than in comparisons between different pulmonary infections. Hence, monocyte-related parameters emerge as particularly reliable indicators for detecting active TB; however, their diagnostic value becomes less distinct when broader comparisons involve other respiratory infections with overlapping inflammatory responses.

Eosinophil VCS parameters did not provide clinically useful differentiation between tuberculous and bacterial pneumonias. Their statistical and diagnostic performance was weak, except for MN-AL2-EO, which showed a significant p-value but low AUC, limiting its practical relevance. The clinical significance of eosinophil VCS parameters in predicting drug-induced liver injury during anti-tubercular treatment has been demonstrated, yet, per se the changes due to mycobacterial infection on eosinophil cell properties is a novel area of interest. (30) Early granular cells in peripheral blood serve as markers of a left shift in granulocyte maturation. This shift, commonly seen in certain infections, reflects an increased presence of immature myeloid precursors in circulation. Mycobacterial infections are known to stimulate hematopoietic progenitor cells, leading to the appearance of such immature cells in the bloodstream. (31) Tamburini et al. documented the influence of tuberculosis on specific populations within the myeloid and lymphoid lineages and explored their potential as biomarkers for detecting active TB infection. (32) In our study, the mean upper median angle light scatter (UMALS) of early granular cells was found to be lower in the tuberculous group, suggesting that TB may impact this cell population. However, the clinical relevance of this observation requires further investigation and validation.

In the present study, multiparametric analytical approaches were applied to overcome the limited diagnostic utility of individual hematological and leukocyte VCS parameters in differentiating tuberculous from non-tuberculous pneumonia. As shown in Fig. 1, principal component analysis revealed partial but consistent separation between the two groups, indicating that disease-related differences arise from coordinated alterations across multiple clinical and cellular variables rather than from a single dominant biomarker. The observed overlap between clusters is biologically plausible and reflects shared

inflammatory responses between bacterial and tuberculous infections, particularly during early disease or severe inflammation. Notably, monocyte-derived scatter and variability parameters contributed substantially to the principal components, supporting the central role of the monocyte–macrophage axis in the immunopathogenesis of tuberculosis.

While PCA served as an exploratory tool to confirm the presence of a multiparametric signal, clinically meaningful discrimination was achieved only through supervised modeling. As demonstrated in Fig. 2, the multivariable logistic regression model integrating clinical features, conventional hematological indices, and leukocyte VCS parameters showed strong apparent discriminatory performance on internal analysis, substantially outperforming any individual parameter analyzed in isolation. These findings emphasize the limitations of single cut-off–based approaches and highlight the potential of combining multiple weak predictors into an integrated diagnostic framework. Importantly, the observed performance represents internal model behavior, and external validation in independent cohorts will be essential to establish generalizability and clinical applicability, particularly in tuberculosis-endemic settings.

Limitation of the study

The study has several limitations, including a relatively small sample size and being conducted at a single tertiary care center in North India, which may limit the generalizability of the findings. The cross-sectional design restricts the ability to establish causality between cell population data (CPD) parameters and pneumonia type. Exclusion criteria, such as the omission of patients with immunosuppressive conditions, may further limit the applicability of the results. The study also did not account for potential confounding factors like prior antibiotic use and relied on various diagnostic techniques, introducing variability in pneumonia classification. Additionally, the focus on VCS parameters without exploring other potential biomarkers or diagnostic tools, combined with the dependence on a specific hematology analyzer, may affect the replicability and broader applicability of the findings.

Conclusion

The study concludes that cell population data (CPD) parameters, particularly, MN-V-LY, MN-AL2-LY; MN-MALS-MO, MN-UMALS-MO, MN-LMALS-MO, MN-LALS-MO, MN-AL2-MO; MN-AL2-EO; MN-UMALS-EGC have significant potential as diagnostic tools for differentiating between tuberculous and non-tuberculous pneumonia. These parameters, derived from routine hematology analyzers, offer a rapid and cost-effective approach to support clinical decision-making in resource-limited settings. Despite the study's limitations, the findings suggest that CPD parameters could be valuable adjuncts in the early diagnosis of pneumonia, helping to guide appropriate treatment strategies and improve patient outcomes. Further research with larger, more diverse populations is recommended to validate these findings and explore additional biomarkers.

Declarations

Ethical Considerations: This study was approved by the Ethics Committee of Himalayan Institute of Medical Sciences (Ethics Code: SRHU/HIMS/ETHICS/2024/33) on February 02, 2024.

Consent to participate: All participants provided written informed consent prior to enrolment in the study.

Availability of data and materials: All data generated during this study are included in this published article [and its supplementary information files].

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Author Contributions:

Tanvi Nagpal: Acquired and analysed the data, drafted the manuscript, drafted the final version

Sohaib Ahmad: Conceptualized the article, interpreted the data, revised the draft manuscript, approved the final version

Mansi Kala: Conceptualized the article, interpreted the data, approved the final version

Shubhanshu Chawla: Interpreted the data, approved the final version

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Figures

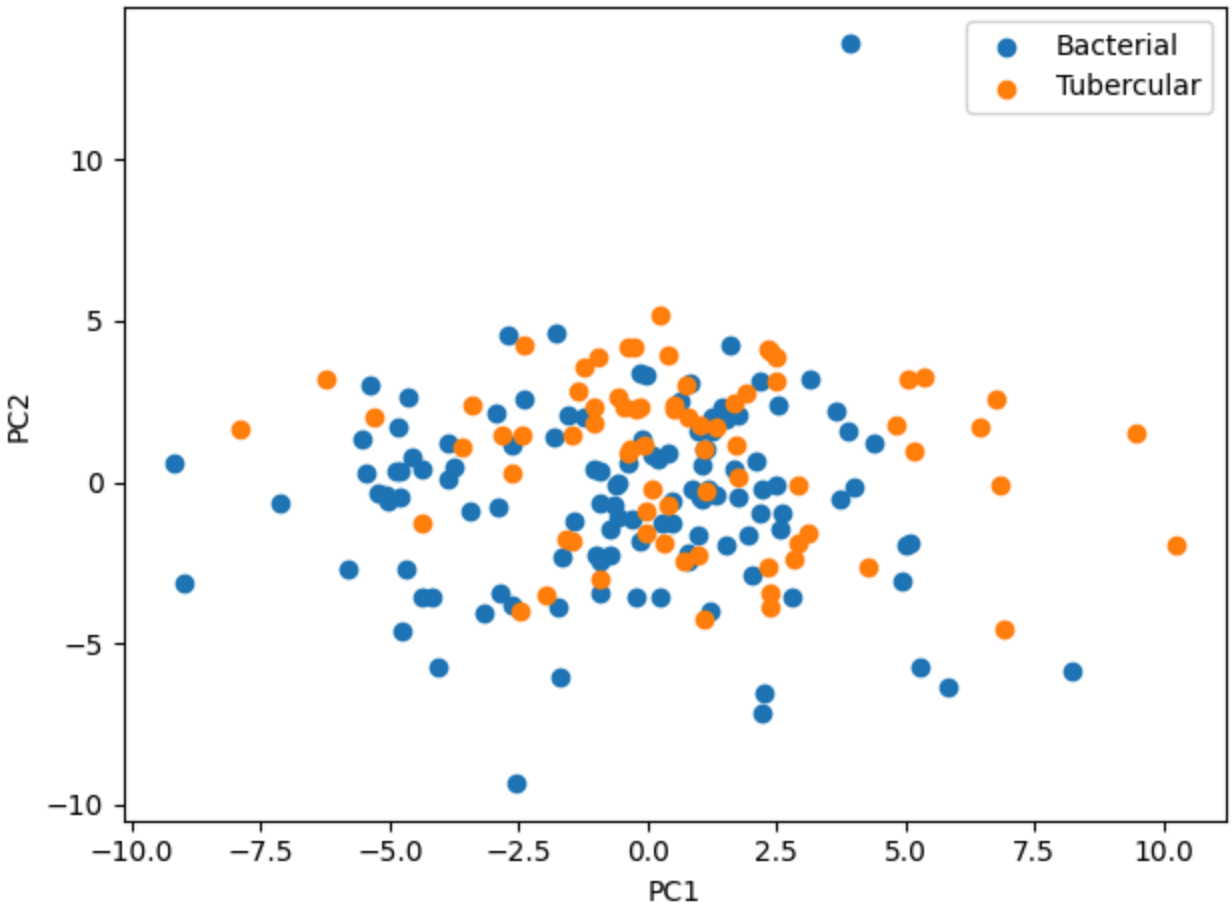


Figure 1

Principal component analysis score plot demonstrating multiparametric separation between tuberculous and bacterial pneumonia

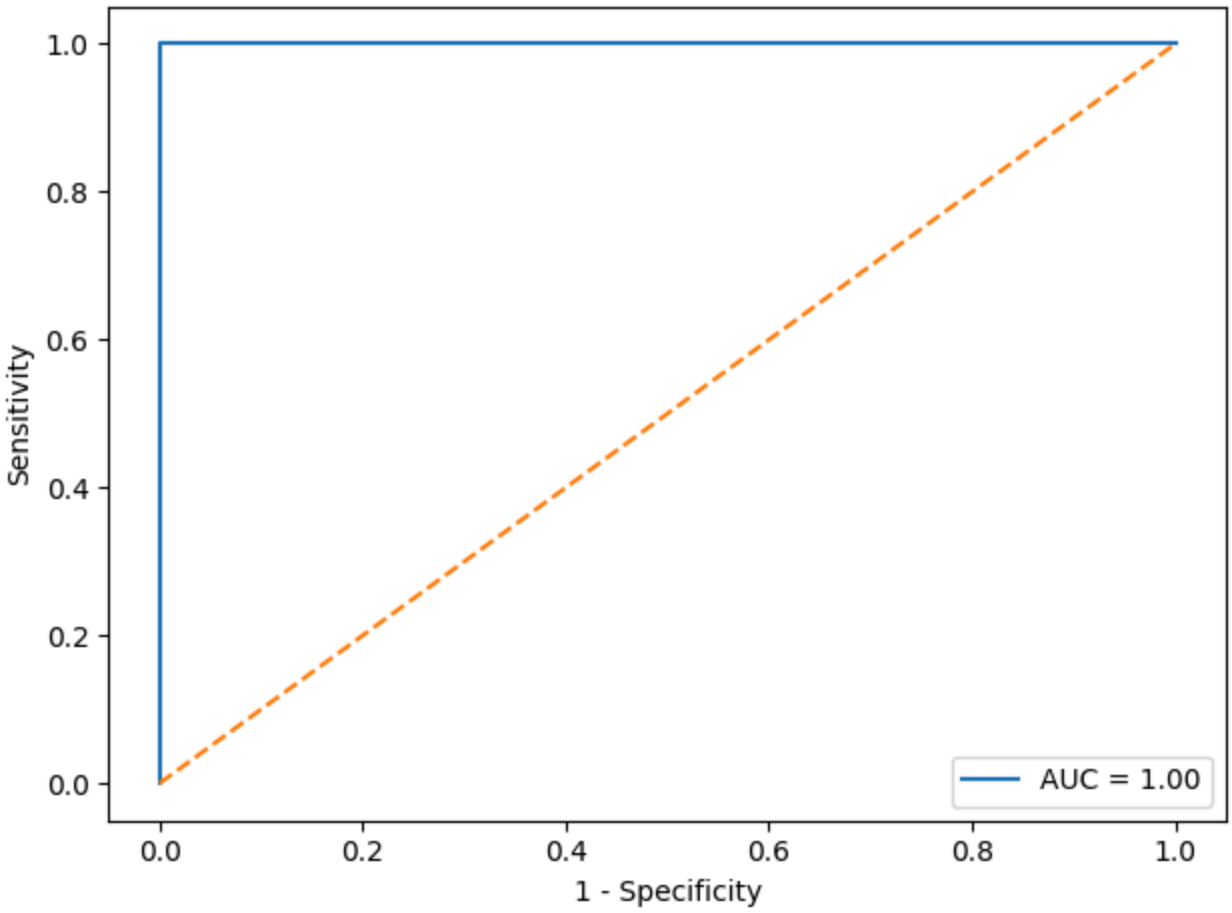


Figure 2

Receiver operating curve (ROC) of the multivariable model differentiating tuberculous from bacterial pneumonia

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Dr.Tanviresults.xlsx