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Original Research Article

PREVALENCE OF LOWER RESPIRATORY INFECTIONS AMONG HIV-POSITIVE INDIVIDUALS AND THEIR ASSOCIATION WITH IMMUNE STATUS (CD4 COUNT) IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Human Immunodeficiency Virus (HIV) compromises the immune system, predisposing affected individuals to opportunistic infections, particularly of the lower respiratory tract. Respiratory infections significantly contribute to the morbidity and mortality among HIV-positive patients, especially in those with declining CD4 cell counts. Present study was conducted to evaluate the prevalence of lower respiratory infections among HIV-positive individuals and their association with immune status (CD4 count) in a tertiary care hospital.

Materials and Methods: A cross-sectional study was conducted on 100 HIV-positive adult inpatients at Rajindra Hospital, Patiala. Patients were evaluated clinically and through laboratory investigations including CD4 count, sputum microscopy, CBNAAT, culture, and radiological imaging. Statistical analysis assessed correlations between CD4 count and specific respiratory infections.

Results: Tuberculosis was the most common LRTI (64%), followed by bacterial pneumonia (30%) and Pneumocystis jirovecii pneumonia (6%). Bacterial pneumonia predominated in patients with CD4 >200 cells/µL, while PJP occurred mostly in those with CD4 <50 cells/µL. A significant inverse relationship was observed between the number of presenting complaints and CD4 count ($p<0.001$).

Conclusion: Tuberculosis and bacterial pneumonia are the leading respiratory infections in HIV patients. The risk and severity of infections correlate strongly with declining CD4 counts. Early evaluation and management of respiratory symptoms are essential for improving outcomes in HIV-infected individuals.

Keywords: HIV, CD4 Count, Tuberculosis, Bacterial Pneumonia.

INTRODUCTION

Acquired Immunodeficiency Syndrome (AIDS) was first recognized in the United States in the summer of 1981, when the U.S. Centers for Disease Control and Prevention (CDC) reported the unexplained occurrence of *Pneumocystis jirovecii* (formerly *P. carinii*) pneumonia in five previously healthy homosexual men in Los Angeles and of Kaposi's sarcoma (KS), with or without *P. jirovecii* pneumonia, in 26 previously healthy homosexual men in New York and Los Angeles.[1] The disease was soon recognized in male and female injection drug users, hemophiliacs and blood transfusion recipients, among female sexual partners of men with AIDS, and among infants born to mothers with AIDS or a history of injection drug use.[1]

HIV is the etiologic agent of AIDS; it belongs to the family of human retroviruses (Retroviridae) and the subfamily of lentiviruses.[1] The hallmark of HIV disease is a profound immunodeficiency resulting primarily from a progressive quantitative and qualitative deficiency of helper T cells (CD4+ cells), occurring in a setting of polyclonal immune

activation.[1] Immune system activation and inflammation, although essential for an appropriate immune response, are aberrant and chronic in HIV-infected individuals, contributing significantly to viral replication, immune dysfunction, and an increased risk of other chronic conditions. These complications can manifest even after prolonged viral suppression, including cardiovascular disease through endothelial cell dysfunction.[1]

HIV-negative individuals typically have CD4 counts ranging from 600 to 1200/mm³. In contrast, HIV-infected individuals show counts usually below 500/mm³, and patients with AIDS have 200 CD4+ cells/mm³ or fewer.[2]

As of April 30, 2000, a total of 96,694 HIV-positive individuals were reported in India out of 3.6 million tested.[3] Maharashtra had the highest burden, followed by Tamil Nadu.[3] In 2007, India had an estimated 2.31 million people living with HIV/AIDS, with an adult HIV prevalence of 0.34%³. Among the total infected population, 39% were women and 3.5% were children.[3] High prevalence rates were recorded in key risk groups such as individuals attending STD clinics (3.6%), female sex workers (5.1%), injection drug users (7.2%), and men who have sex with men (7.4%).[3] According to the 2010 UNAIDS report, new HIV infections had declined by 20% globally from the peak in 1999, with 2.6 million new infections in 2009 compared to 3.1 million in 1999.[4] Between 2001 and 2009, the infection rate in India declined by more than 25%, with the adult prevalence dropping from 0.36% in 2006 to 0.31% in 2009.[4] By 2009, 2.39 million people in India were living with HIV/AIDS, down from 2.5 million in 2001. According to UNAIDS, India achieved a 50% reduction in new infections since 2000. Among high-risk groups, prevalence remained high at 4.9% for female sex workers, 7.3% for MSM, and 9.2% for IDUs.[4]

In Punjab, the adult HIV prevalence was 0.27% as per the 2012 Punjab AIDS Control Society report. Prevalence among males was 0.32%, and among females 0.22%. As of December 2012, 26,946 HIV-positive individuals were registered for pre-ART care, and 16,112 were actively receiving ART.[5]

India currently ranks third globally in HIV burden. In 2017, adult HIV prevalence was estimated at 0.2%, translating to 2.1 million individuals living with HIV due to the large national population.[6,7] Increasing awareness among the general and high-risk populations about HIV prevention has been a key goal under NACP IV. However, as of 2017, only 22% of young women (aged 15–24) and 32% of young men were aware of HIV prevention methods.[8]

AIDS is a fatal illness that weakens the immune system, rendering individuals susceptible to a range of life-threatening opportunistic infections, neurological disorders, and malignancies.[9]

Present study was conducted to evaluate the prevalence of lower respiratory infections among HIV-positive individuals and their association with immune status (CD4 count) in a tertiary care hospital.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted in the inpatient wards of the Department of Medicine at Rajindra Hospital, Patiala. The study aimed to determine the prevalence of lower respiratory tract infections (LRTIs) among HIV-positive individuals and assess their association with immune status, particularly CD4 cell count. A total of 100 adult patients with confirmed HIV seropositivity were consecutively enrolled in the study. The diagnosis was made in accordance with the National AIDS Control Organisation (NACO) guidelines. Written informed consent was obtained from all participants prior to inclusion.

Inclusion Criteria

- Adult patients (≥18 years) diagnosed as HIV seropositive as per NACO guidelines.

Exclusion Criteria

- Patients with known pre-existing respiratory diseases (e.g., asthma, COPD, lung cancer).\
- Patients with significant comorbidities unrelated to respiratory infection (e.g., cardiovascular or neurological diseases).
- Pregnant HIV-positive women.
- Patients on chronic immunosuppressive therapy or with other immunosuppressive disorders.

Diagnostic and Evaluation Procedures

HIV diagnosis was confirmed by ELISA and verified with the Western blot method in applicable cases. Patients underwent a focused clinical and diagnostic evaluation to confirm LRTIs and assess immune function.

Clinical Assessment

Detailed history and physical examination were performed to detect respiratory symptoms suggestive of LRTI (e.g., cough, fever, breathlessness, chest pain).

Laboratory and Diagnostic Tests

- **CD4 Count**: Performed using flow cytometry to assess immune status.
- **Chest Radiograph (X-ray)**: To detect radiological signs of LRTI.
- **Sputum Analysis**:
  - Ziehl-Neelsen staining for acid-fast bacilli.
  - Gram staining and culture for bacterial pathogens.
  - CBNAAT for Mycobacterium tuberculosis detection.
- **CT Chest**: Done when clinically indicated to support diagnosis.
- **Pleural Fluid Analysis**: Performed in cases with suspected pleural involvement.

Data Analysis

All clinical and laboratory data were documented using a structured proforma. Statistical analysis was carried out to determine the prevalence of LRTIs and examine their association with CD4 count. Appropriate statistical tools were used, and a p-value < 0.05 was considered statistically significant.

RESULTS

Table 1 shows the demographic and disease-wise distribution of the study population. Among 100 HIV-positive patients, the most affected age group was 41–50 years, comprising 50% of cases. This was followed by 31–40 years (26%), while both 21–30 and 51–60 years contributed 12% each. This highlights a peak prevalence of HIV infections in middle-aged adults. In terms of gender, 69% were males and 31% were females, indicating a statistically significant male predominance. Regarding the disease types, tuberculosis was the most prevalent lower respiratory tract infection (64%), followed by bacterial pneumonia (30%), and Pneumocystis jirovecii pneumonia (6%). The distribution of these infections was statistically highly significant ($P < 0.001$).

Table 2 presents the correlation between bacterial pneumonia and CD4 count among HIV-positive individuals. The majority of bacterial pneumonia cases (60%) occurred in patients with a CD4 count of 201–500 cells/µL, suggesting that bacterial infections can occur even in moderately immunocompromised patients. The rest of the cases were spread across lower CD4 categories: 151–200 (20%), 101–150 (13.3%), and 50–100 (6.7%), with no cases observed below 50 cells/µL. The strong statistical significance ($P < 0.001$) indicates a clear pattern linking higher CD4 counts with bacterial pneumonia prevalence, contrasting with other opportunistic infections that appear more often at lower CD4 levels.

Table 3 shows the relationship between tuberculosis infections and CD4 count. Out of 64 TB patients, the largest portion (37.5%) had CD4 counts between 201–500 cells/µL, followed by 28.1% in the 151–200 range and 21.9% in the 101–150 range. Only a small fraction had severely reduced CD4 counts: 9.4% between 50–100 and 3.1% below 50. This indicates that tuberculosis can manifest across all levels of immune suppression in HIV-positive individuals, although its frequency increases with falling CD4 count. The correlation was found to be highly significant ($P < 0.001$). Table 4 illustrates the correlation between Pneumocystis jirovecii pneumonia (PJP) and CD4 count. Of the six PJP cases, five (83.3%) had CD4 counts less than 50 cells/µL, and one (16.7%) was in the 50–100 range. No cases were reported above 100 cells/µL. This distribution strongly supports the opportunistic nature of PJP, which is predominantly seen in patients with profound immunosuppression. The correlation was statistically highly significant ($P < 0.001$), confirming that lower CD4 count is a major risk factor for PJP development.

Table 5 highlights the relationship between the number of presenting complaints and CD4 count. Patients who reported 0–2 complaints had a relatively preserved immune function with a mean CD4 count of 253.19 cells/µL. As the number of complaints increased to 3–4, the mean CD4 dropped to 150.33, and further declined to 102.33 in those with 5–6 complaints. This inverse trend clearly demonstrates that patients with more severe or multiple symptoms tend to have lower CD4 counts, reflecting deeper immunosuppression. The statistical significance of this trend was high ($P < 0.001$).

Table 6 presents findings from sputum culture and sensitivity analysis in bacterial pneumonia cases. Streptococcus pneumoniae was the most commonly isolated organism (23.3%), followed by Hemophilus influenza (13.3%), Staphylococcus aureus (10%), and Pseudomonas aeruginosa (6.7%). Interestingly, nearly half the samples (46.7%) showed no bacterial growth, which may be attributed to prior antibiotic use or limitations in culture methods. These findings emphasize the importance of empirical treatment in suspected bacterial pneumonia among immunocompromised patients.

Table 7 displays the results of sputum AFB testing in 64 tuberculosis patients. Only 17 cases (26.6%) were AFB-positive, whereas the majority (73.4%) were negative. This low positivity rate suggests the frequent occurrence of smear-negative or extrapulmonary TB in HIV-positive patients, likely due to their weakened immune responses. Despite the low detection rate, the finding was statistically highly significant ($P<0.001$), supporting the necessity of comprehensive diagnostic evaluation beyond AFB smear alone in HIV-associated TB. Table 8 show that in all 64 tuberculosis patients, sputum for CBNAAT was done. 28 (43.8%) cases were CBNAAT positive, while 36 (56.2%) cases were CBNAAT negative. Statistically, this finding is insignificant.

Table 1: Demographic and Disease-wise Distribution of Study Population

Category	Subgroup	Number	Percentage (%)
Age Group	**21–30**	12	12.0
	31–40	26	26.0
	41–50	50	50.0
	51–60	12	12.0
	Total	**100**	**100.0**
Gender	**Male**	69	69.0
	Female	31	31.0
	Total	**100**	**100.0**
Disease Type	**Bacterial Pneumonia**	30	30.0
	Tuberculosis	64	64.0
	Pneumocystis Jirovecii Pneumonia	6	6.0
	Total	**100**	**100.0**

P value (Disease distribution): <0.001 **Significance:** HS

Table 2: Correlation between bacterial pneumonia and CD4 count

CD4 count (cells/µL)	Bacterial pneumonia	Percentage
<50	0	0
50–100	2	6.7
101–150	4	13.3
151–200	6	20.0
201–500	18	60.0
Total	**30**	

P value: <0.001; **Significance**: HS

Table 3: Correlation between tuberculosis infections and CD4 count

CD4 count (cells/µL)	Tuberculosis	Percentage
<50	2	3.1
50–100	6	9.4
101–150	14	21.9
151–200	18	28.1
201–500	24	37.5
Total	**64**	

P value: <0.001; **Significance**: HS

Table 4: Correlation between Pneumocystis jirovecii pneumonia and CD4 count

CD4 count (cells/µL)	Pneumocystis jirovecii pneumonia	Percentage
<50	5	83.3
50–100	1	16.7
101–150	0	0
151–200	0	0
201–500	0	0
Total	**6**	

P value: <0.001; **Significance**: HS

Table 5: CD4 count in relation to number of presenting complaints in study population

No of Presenting Complaints	No. of Patients	Mean CD4	S.D
0–2	52	253.19	15.02
3–4	45	150.33	10.07
5–6	3	102.33	32.00

P value: <0.001; **Significance**: HS

Table 6: Culture and sensitivity

Bacteria	Number	Percentage
Hemophilus influenza	4	13.3
Pseudomonas aeruginosa	2	6.7
Staphylococcus aureus	3	10
Streptococcus pneumoniae	7	23.3
No growth	14	46.7
Total	**30**	**100**

Table 7: Sputum for AFB in TB patients

AFB	Number	Percentage
Present	17	26.6
Absent	47	73.4
Total	**64**	**100.0**

P value: <0.001; **Significance**: HS

Table 8: Sputum for CBNAAT in TB patients

CBNAAT	Number	Percentage
Present	28	43.8%
Absent	36	56.2%
Total	**64**	**100.0%**

P value: 0.317, **Significance**: NS (Not Significant)

DISCUSSION

In this study, out of 100 HIV-positive patients, about 50 (50%) of patients were between 41–50 years of age. 26 (26%) patients were in the 31–40 years age group, followed by 12 (12%) patients in both the 51–60 and 21–30 years age groups. Maximum patients were in the 41–50 years age group. This difference was statistically highly significant. Findings are similar to the study conducted by Kumar et al.[10], in which 38% patients were in the 31–40 years group, 36% in 21–30 years, and 24% were above 40 years. In another study by Dhadke et al.[11], maximum

patients were in the age group of 31–50 years, which is comparable to the present study. In terms of gender-wise distribution, 69% were males and 31% were females, with a male-to-female ratio of 2.2:1. This was statistically highly significant. These findings are similar to a study conducted by Ahidjo A et al.[12], where 56.7% were males and 43.3% were females (ratio 1.3), and another by Dhadke et al.[11], with a ratio of 1.7. Regarding disease-wise distribution, tuberculosis was found in 64% of patients, bacterial pneumonia in 30%, and pneumocystis jirovecii pneumonia in 6%. These findings are similar to the study by Kumar A et al.[10], with 72% TB, 22% bacterial pneumonia, and 6% PJP, and Dhadke et al.[11], who reported 71%, 22%, and 7% respectively.

Out of 30 bacterial pneumonia patients, 18 (60%) had CD4 counts in the range of 201–500 cells/µL, 6 (20%) had 151–200, 4 (13.3%) had 101–150, and 2 (6.7%) had 50–100. None had CD4 counts <50. Thus, 60% had CD4 >200, and 40% had CD4 <200. This was statistically highly significant. Similar findings were noted in a study by Toshniwal et al.[13], where 50.9% had CD4 200–500 and 31.37% had <200. Dhadke et al.[11] reported that bacterial pneumonia cases mostly had CD4 >201 (40.9%) and >500 (22.76%), with very few below 100, which aligns with our findings.

Among 64 TB patients, 24 (37.5%) had CD4 counts between 201–500 cells/µL, 18 (28.1%) had 151–200, 14 (21.9%) had 101–150, 6 (9.4%) had 50–100, and 2 (3.1%) had CD4 <50. Overall, 37.5% had CD4 >200. This correlation was statistically highly significant. These findings are consistent with Halgarkar Charushila et al.[14], who reported similar percentages across CD4 strata. In another study by Dhadke et al.[11], 36.61% of TB patients had CD4 201–500, and 19.71% had 151–200, aligning closely with our results.

Out of 6 patients, 5 (83.3%) had CD4 <50 and 1 (16.7%) had 50–100. None had CD4 >100. This was statistically highly significant. These findings are comparable to Dhadke et al.[11], where 71.8% had CD4 <50 and none had CD4 >150. Toshniwal et al.[13] also found that all PJP patients had CD4 <200, confirming that PJP is an infection strongly associated with advanced immunosuppression.

Among 100 HIV-positive patients, those with 0–2 complaints had a mean CD4 of 253.19, while those with 3–4 complaints had a mean of 150.33. Only 3 patients had 5–6 complaints, and their mean CD4 count was 102.33. This indicates that more clinical complaints are associated with lower CD4 counts. This relationship was statistically highly significant and mirrors the findings of Singh et al.[15], who also found that the number of presenting complaints increased as CD4 count declined.

Of the 30 cases, *Streptococcus pneumoniae* was the most common isolate (23.3%), followed by *Hemophilus influenza* (13.3%), *Staphylococcus aureus* (10%), and *Pseudomonas aeruginosa* (6.7%). No growth was observed in 14 cases (46.7%). This could be due to prior antibiotic use or limitations in bacterial yield. These findings are similar to those of Falco V et al.[16], who reported *S. pneumoniae* in 34%, *H. influenza* in 18%, and *P. aeruginosa* in 8.3% of cases.

Among 64 TB patients, only 17 (26.6%) were AFB-positive, while 47 (73.4%) were negative. The low positivity rate may reflect atypical or smear-negative TB presentations in immunocompromised patients. This finding was statistically highly significant. It aligns with studies by Affusim C et al.[17] (AFB positive in 32.5%) and Conde MB et al.[18] (29.7% AFB positivity), supporting the need for more sensitive TB diagnostics like CBNAAT or radiological evidence in HIV-positive populations.

CONCLUSION

Respiratory infections are a major cause of morbidity in HIV-positive individuals, with tuberculosis being the most common, followed by bacterial pneumonia. The risk and severity of these infections increase with declining CD4 counts. Early diagnosis and timely management are crucial to reduce complications. All HIV-seropositive patients presenting with respiratory symptoms should undergo prompt evaluation. Proactive care can significantly improve outcomes and reduce mortality in this vulnerable population.

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