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To Study the Correlation of Viral Load and Cd4 Count of Patients on Antiretroviral Treatment in A Tertiary Care Hospital

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HIGHLIGHTS

1. Study evaluates the correlation between viral load and CD4 countin HIV patients.
2. Conducted among patients receiving antiretroviral therapy (ART) in atertiary care hospital.
3. Observed inverse relationship: higher viralload linked to lower CD4 counts.
4. Effective ART shown to reduce viral load and improve immune status.
5. Findings support regular monitoring for better treatment out comes.

Key words:
HIV
CD4 Count
Viral Load
Antiretroviral Therapy
Opportunistic Infections
Tuberculosis

ABSTRACT

Background: HIV remains a major public health issue in India, where monitoring CD4 counts and viral loads is crucial for treatment planning and outcome assessment. While viral load is the gold standard for evaluating HIV progression, limited resources often necessitate reliance on CD4 counts, especially in low-income settings. **Objectives:** This study aimed to (1) analyze the clinical profile and opportunistic infections (OIs) in HIV-positive patients, (2) assess changes in CD4 counts and viral loads before and after 12 weeks of antiretroviral therapy (ART), and (3) determine the correlation between viral load and CD4 count. **Methods:** A prospective observational study was conducted on 90 HIV-positive patients admitted to a tertiary care hospital from January to December 2019. Patients underwent clinical evaluation, laboratory investigations including CD4 counts and viral loads at baseline and after 12 weeks of ART. Statistical analysis included descriptive statistics, paired t-tests, and Pearson's correlation coefficient. **Results:** Among 90 participants, 64.4% were male. The most common symptoms were fever (77%) and loss of appetite (74%). Tuberculosis was the leading OI, with extrapulmonary TB present in 22% of cases. Baseline mean CD4 count was 218 cells/μL, with 36% of patients having CD4 <100 cells/μL. Post-ART, mean CD4 count increased to 245 cells/μL, and 78% achieved undetectable viral loads (<50 copies/mL). A significant inverse correlation was found between CD4 count and viral load ($r = -0.72$, $p<0.05$). **Conclusion:** CD4 count and viral load are critical, complementary markers in HIV management. Regular monitoring post-ART leads to improved immune status and viral suppression. In resource-limited settings, CD4 count remains a practical alternative, though scaling up viral load testing is recommended for enhanced care.

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INTRODUCTION

Human Immunodeficiency Virus (HIV) is a retrovirus that targets CD4+ T-cells, leading to progressive immune suppression and acquired immunodeficiency syndrome (AIDS) [1]. With an estimated 2.1 million cases, India has a significant HIV burden [2]. Antiretroviral therapy (ART) has transformed HIV into a manageable condition by suppressing viral replication and restoring immune function [3]. Effective monitoring is essential to assess treatment response and prevent compli cations such as opportunistic infections (OIs)[4].

Viral load, measured by real-time polymerase chain reaction (RT-PCR), is the gold standard for monitoring HIV progression, as it quantifies HIV RNA in plasma [5]. However, in resource-limited settings, viral load testing is often inaccessible due to cost and logistical barriers [6]. CD4 count, reflecting immune status, serves as a practical alternative [7]. The World Health Organization (WHO) recommends CD4 count monitoring where viral load testing is unavailable [8]. A high viral load typically corresponds to a low CD4 count, indicating advanced disease [9]. ART aims to suppress viral load to undetectable levels (<50 copies/mL) while increasing CD4 counts, reducing OI risk [10]. In India, late diagnosis and TB co-infection are common, making the correlation between viral load and CD4 count critical for patient outcomes [11].

This study aims to describe the clinical profile and opportunistic infections (OIs) among HIV-positive patients admitted to a tertiary care hospital. It also seeks to evaluate changes in CD4 count and viral load before and after 12 weeks of antiretroviral therapy (ART). Additionally, the study assesses the correlation between viral load and CD4 count to provide insights that can guide effective HIV manage ment.

MATERIAL AND METHODS

Study Design and Setting: This prospective observational study was conducted at a tertiary care hospital from January 2019 to December 2019. The study was approved by the hospital's Institutional Ethics Committee.

Study Population: Ninety HIV-positive patients were enrolled in the study based on specific inclusion and exclusion criteria. Inclusion required a confi - rmed HIV-positive status using ELISA and Western Blot assays, age between 18 and 65 years, and admission to medical wards. Patients were excluded if they were under 18 or over 65 years of age, pregnant, had incomplete medical records, or refused to provide consent. Data were collected from patient records and included demographic information such as age, sex, and risk factors like sexual trans mission or intravenous drug use. Clinical symptoms recorded included fever, weight loss, cough, loss of appetite, and dysphagia, among others. Physical examination findings covered pallor, lymphadenopathy, organomegaly, and systemic signs. Investigations comprised CD4 counts measured by flow cytometry, viral load determined through RT-PCR (with undetec table levels defined as <50 copies/mL), and routine laboratory tests including hemograms, liver and renal function tests, imaging (chest radiographs, ultrasono graphy, CECT), and microbiological tests like sputum culture, AFB staining, blood and CSF cultures, and FNAC or biopsy when needed. Treatment details documented included the ART regimen initiated, use of antibiotics, and other supportive therapies.Patients were initiated on ART per national guidelines, typically tenofovir, lamivudine, and efavirenz [12]. Follow-up assessments at 12 weeks included CD4 count and viral load measurements.

Statistical Analysis: Data were analyzed using Microsoft Excel 2016 and SPSS version 25. Descriptive statistics (means, percentages) summarized demographic and clinical data. Pearson's correlation coefficient assessed the correlation between CD4 count and viral load. Paired t-tests compared pre- and post-ART changes. A p-value <0.05 was significant.

RESULTS

Demographic Profile: Among 90 patients study, 58 (64.4%) were male, and 32 (35.6%) were female (male-to-female ratio: 1.8:1). Ages ranged from 20–60 years, with 68 (75.6%) aged 30–50 years, 15 (16.7%) aged 20–29 years, and 7 (7.8%) aged 50–60 years. Sexual contact was the primary transmission mode (82%), followed by blood transfusion (10%) and intravenous drug use (5%).

Clinical Symptoms: Fever (69 patients, 77%), loss of appetite (67, 74%), and weight loss (56, 62%) were the most common symptoms. Other symptoms included generalized weakness (49%), cough (37%), and shortness of breath (36%). Table 1 summarizes symptoms.

Table : 1 Diagnosis of cases of study participants

Symptoms	Number of Patients	Percentage (%)
Fever	69	77
Loss of Appetite	67	74
Weight Loss	56	62
Generalised Weakness	44	49
Cough	33	37
Shortness of Breath	32	36
Headache	24	27
Dysphagia	20	22
Vomiting	14	16
Epigastric Pain	8	9
Chest Pain	7	8
Memory Impairment	6	7
Bleeding	4	4
Burning Micturition	3	3
Seizure Episode	2	2
Desquamative Rash	1	1

Physical Examination: Pallor was the most common sign (35%), followed by oral candidiasis (20%), lymphadenopathy (15%), and tachypnea (12%). Respiratory involvement was noted in 40 patients (44%), neurological abnormalities in 25 (28%), and gastrointestinal findings in 15 (17%).

Opportunistic Infections: Tuberculosis was the leading OI, with extrapulmonary TB in 20 patients (22%), pulmonary TB in 13 (15%), and disseminated TB in 6 (7%). Pneumocystis jirovecii pneumonia (PCP) and candidiasis occurred in 11 (12%) and 12 (13%) patients, respectively. Other Ois included cryptococcal meningitis (6%) and cytomegalovirus (CMV) esophagitis (4%). Table 2 details the clinical profile.

Table 2: Distribution of clinical profile

Clinical Profile	Number of Patients	Percentage (%)
Extrapulmonary TB	20	22
Pulmonary TB	13	15
Disseminated TB	6	7
Pneumocystis jirovecii Pneumonia	11	12
Candidiasis	12	13
Cryptococcal Meningitis	5	6
CMV Esophagitis	4	4
HIV-Associated Nephropathy (HIVAN)	3	3
Progressive Multifocal Leukoencephalopathy (PML)	2	2
CNS Vasculitis	2	2
Pyelonephritis	2	2
Lymphoma	2	2
HIV-Associated Neurocognitive Disorder (HAND)	3	3
Others (e.g., Strongyloidiasis)	5	6

CD4 Count and Viral Load: At baseline, 32 patients (36%) had CD4 counts <100 cells/μL, 19 (21%) had 100–200 cells/μL, and 16 (18%) had >400 cells/μL. The mean CD4 count was 218 cells/μL (SD: 170). Viral loads ranged from 10,000 to >1,000,000 copies/mL, with 60% of patients having >100,000 copies/mL.

Table 3: Distribution of CD4 counts at presentation and follow-up

CD4 Count (cells/μL)	At Presentation (%)	At Follow-Up (%)
<100	32 (36)	28 (31)
100–200	19 (21)	20 (22)
200–300	10 (11)	17 (19)
300–400	13 (14)	5 (6)
>400	16 (18)	20 (22)

The table data 3 represent the Post-ART (12 weeks), patients with CD4 counts <100 cells/μL decreased to 28 (31%), and those with >400 cells/μL increased to 20 (22%). The mean CD4 count rose to 245 cells/μL (SD: 165, $p<0.01$). Viral load was undetectable (<50 copies/mL) in 70 patients (78%). Table 3 shows CD4 count distribution.

Table 4: Correlation of mean CD4 count with clinical profile

Clinical Profile	Mean CD4 Count at Presentation (cells/µL)	Mean CD4 Count at Follow-Up (cells/µL)
Extrapulmonary TB	190	210
Pulmonary TB	330	360
Disseminated TB	110	180
Pneumocystis jirovecii Pneumonia	160	140
Candidiasis	200	240
CMV Esophagitis	55	120
Pyelonephritis	620	650
HIVAN	180	210
CNS Vasculitis	95	110
Cryptococcal Meningitis	75	110
PML	65	60
HAND	530	490
Lymphoma	165	160

Table 4 shows mean CD⁴ counts for OIs. Pyelonephritis had the highest baseline CD⁴ count (6²0 cells/µL), while CMV esophagitis (55 cells/µL) and PML (65 cells/µL) had the lowest. Post-ART, TB-related OIs (e.g., disseminated TB: ¹¹0 to ¹80 cells/µL) and cryptococcal meningitis (75 to ¹¹0 cells/µL) showed significant CD⁴ increases. PCP and PML had minimal improvement.

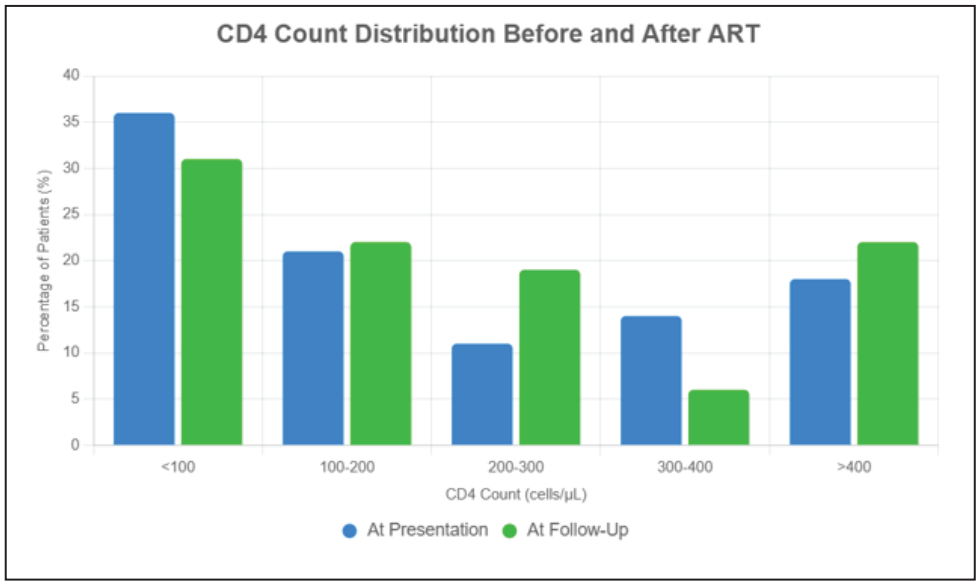

Figure 1: CD4 Count Distribution at Presentation and Follow-Up

Correlation Analysis: A strong inverse correlation existed between CD4 count and viral load at baseline ($r = -0.72$, $p<0.05$). Patients with viral loads >100,000 copies/mL had mean CD4 counts of 150 cells/μL, while those with <10,000 copies/mL had 400 cells/μL. Post-ART, patients with undetectable viral loads showed a mean CD4 increase of 80 cells/μL ($p<0.01$), especially in TB and cryptococcal meningitis cases.

DISCUSSION

This study provides insights into the clinical and immunological profile of HIV patients in a tertiary care setting. The male preponderance (1.8:1) aligns with studies suggesting higher risk behaviors or healthcare access among males [13,14]. The 30–50-year age group was most affected, reflecting the sexually active population's vulnerability [15].

Clinical Presentation: Fever, loss of appetite, and weight loss were predominant, consistent with systemic inflammation and advanced HIV [16,17]. Pallor (35%) suggests anemia, common in HIV due to chronic disease or OIs like TB [18].

Opportunistic Infections: TB was the most common OI, with extrapulmonary TB (22%) more prevalent than pulmonary TB (15%), indicating advanced immunosuppression [19]. PCP and candidiasis were frequent, reflecting respiratory and mucosal involvement [20]. AIDS-defining illnesses (e.g., CMV esophagitis, cryptococcal meningitis) were linked to CD4 counts <100 cells/μL, highlighting CD4's predictive value [21].

CD4 Count and Viral Load: At baseline, 57% of patients had CD4 counts <200 cells/μL, indicating late diagnosis [22]. Post-ART, the mean CD4 count increased by 27 cells/μL, and 78% achieved undetec table viral loads, demonstrating ART efficacy [23]. TB and cryptococcal meningitis showed significant CD4 recovery, likely due to effective treatment protocols [24]. Limited improvement in PCP and PML may reflect severe immunosuppression or immune reconstitution inflammatory syndrome (IRIS) [25].

The inverse correlation between CD4 count and viral load ($r = -0.72$) supports their complementary roles [26]. High baseline viral loads predicted low CD4 counts, while post-ART viral suppression facilitated CD4 recovery [27].

Comparison with Literature: Doshi et al. [16] reported 85% of patients with CD4 counts <200 cells/μL, higher than our 57%, possibly due to improved HIV testing. Sarvepalli et al. [17] found lower mean CD4 counts for pulmonary TB (74.5 cells/μL) compared to our 330 cells/μL, suggesting regional or population differences. The TB prevalence aligns with studies emphasizing integrated HIV-TB care [19].

Implications:

CD4 count is a reliable tool in settings lacking viral load testing, as endorsed by WHO [8]. However, scaling up viral load testing could enhance precision [28]. Early diagnosis and ART initiation are critical to reduce TB-related morbidity [29].

Limitations:

This study has several limitations, including a small sample size of 90 patients and a short follow-up period of only 12 weeks. It did not include serial measurements of CD4 counts and viral loads, which could have provided more detailed insights into treatment response over time. Additionally, potential confo - unding factors such as adherence to antiretroviral therapy and the presence of immune reconstitution inflammatory syndrome (IRIS) were not fully evaluated. Future research should focus on larger, multicenter studies with extended follow-up durations and regular monitoring of immunological and virological markers. Implementing point-of-care viral load testing may also help overcome resource limitations and improve patient management in similar settings[30].

CONCLUSION

CD4 count and viral load are vital for HIV management. The high TB prevalence and late presentation underscore the need for early diagnosis and integrated TB-HIV care. ART improved CD4 counts and suppressed viral loads, particularly for TB and cryptococcal meningitis. In resource-limited settings, CD4 monitoring is effective, but expanding viral load testing could further optimize outcomes. Streng thened screening and timely ART are essential to reduce HIV morbidity in India.

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