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UNVEILING THE POTENTIAL OF HEMATOLOGICAL ABERRATIONS IN HIV INFECTION AS A RELIABLE SURROGATE FOR CLINICAL STAGING

George Sarin Zacharia[١*], Anu Jacob[٢]

[١] Internal Medicine, Bronx Care Health System, New York, USA and Gastroenterology, Ahalia Hospital, Abu Dhabi, UAE.
[٢]Anesthesiology, Ahalia Hospital, Abu Dhabi, UAE.

Abstract

Background: The global incidence of HIV has declined since peaking in the mid-nineties, mainly due to advancements in diagnostics, therapeutics, and global health initiatives. Despite these advancements, resource-limited countries still face challenges accessing timely diagnostic tests and treatments. Hematological assays are one of the most widely available and least expensive laboratory tests worldwide, often with a short test-to-report time. To evaluate common hematological abnormalities in newly diagnosed HIV patients and correlate these with the WHO clinical stages of HIV infection we conducted this study.
Methods: A cross-sectional study was conducted at a tertiary care center in Kerala, India. Newly diagnosed HIV patients aged ١٥ years and above were enrolled, excluding those with chronic diseases or conditions affecting hematological profiles. Comprehensive evaluations, including hematological tests and WHO clinical staging, were performed. Statistical analyses assessed correlations between hematological parameters and clinical stages.
Results: Among ١٢٠ patients (٥٩,١٧٪ males, mostly aged ٢٥-٥٠), unprotected sexual contact was the primary transmission route. Mucocutaneous candidiasis and tuberculosis were the most common opportunistic infections. Hematological abnormalities included elevated erythrocyte sedimentation rate (٨١,٧٪), anemia (٨٠٪), reticulocytopenia (٢٦,٧٪), and thrombocytopenia (١٤,٢٪). Hemoglobin, total
Leukocyte, lymphocyte, and CD٤ counts significantly correlated with clinical stages. Hemoglobin levels showed a strong negative correlation with disease stage (r -٠,٨٢٧), with predictive values indicating stage severity. Similarly, lymphocyte counts and ESR showed significant correlations with advancing disease stages.
Conclusion: Hematological parameters, particularly hemoglobin, lymphocyte counts, and ESR, significantly correlate with the WHO clinical stages of HIV infection. These findings support the utility of these parameters as surrogate markers for assessing disease severity, especially in resource-limited settings. Further research is needed to enhance diagnostic and treatment approaches in these regions.
Keywords: HIV, AIDS, Hematological abnormalities, WHO clinical stage, Anemia

Introduction

The earliest identified isolate of HIV dates to ١٩٥٩, from Kinshasa, Congo. [١]. The first reported case of AIDS in the United States was in ١٩٨١ in homosexual men, while the first case in India was reported in ١٩٨٦ amongst female sex workers. [٢, ٣]. An outburst of cases followed these initial reports, with the disease spreading far and wide relentlessly, peaking in the mid-nineties. Since then, the epidemic has started to decline, thanks to the improvement in diagnostic and therapeutic armamentarium and the selfless services of healthcare professionals worldwide to raise awareness about this deadly disease. Worldwide, about ١,٣ million acquired HIV infection in ٢٠٢٢, an estimated decline of ٥٩٪ from ١٩٩٥ statistics [٤]. From a sexually transmitted viral infection, HIV evolved into a multisystem disease, apparently sparing none of the body systems. The pattern and degree of systemic involvement varied and worsened with advancing disease. Currently, there is no dearth of published literature regarding the involvement of individual human body systems in HIV infection. The diagnostics and therapeutics of HIV infection have evolved tremendously over the past three decades. However, these advancements are associated with massive price tags, frequently made affordable and available to the general population through extensive funding by WHO, national funding, charitable societies, and other non-profit organizations. Despite all these, access to tests and medications is limited in resource-limited countries in Africa and Asia. In many parts of the world, the availability of cytometry facilities for CD٤ count is limited, and the reports are delayed for many days. Alternate clinical and surrogate markers have been evaluated to overcome this deficit. The WHO clinical staging is the most widely accepted alternative for assessing disease severity and planning treatment [٥]. The modified Kigali combined staging system incorporates clinical stage, ESR, hematocrit, and body mass index for assessing disease severity [٦]. The current study was designed to evaluate the common hematological manifestations and their correlation with the WHO clinical stage of HIV infection.

* **Corresponding author: George Sarin Zacharia,** Internal Medicine, Bronx Care Health System, New York, USA., and Gastroenterology, Ahalia Hospital, Abu Dhabi, UAE.
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Materials and Methods

The study is a hospital-based cross-sectional study conducted at the antiretroviral therapy (ART) unit of a tertiary care referral center in Kerala, India. All newly

Diagnosed cases of HIV infection, aged fifteen years or above, were considered for the study. The exclusion criteria included those unrelated documented chronic diseases that are likely to alter the hematological profile, like chronic renal or hepatic diseases, malignancies, hematological diseases, patients on drugs that are likely to modify the hematological profile, including antiretroviral therapy, and patients not willing to participate in the study. Enrolled patients were evaluated with a detailed history and physical examination. Per protocol work-up included detailed hematology, basic metabolic profile, screening for opportunistic infections, hepatitis B (HBV), hepatitis C (HCV), and Venereal Disease Research Laboratory (VDRL) test for syphilis. Additional laboratory tests and imaging were performed for the patient's clinical presentation. The World Health Organization (WHO) staging system was adopted for the clinical staging of patients [Table ١]. The compiled data was analyzed, means were compared, and the correlation between the hematological variations and the WHO clinical stage of the disease was assessed using Pearson coefficient analysis. The hematological values were divided into quartiles using statistical software, and the sensitivity, specificity, and positive and negative predictive values were calculated for quartile limits with each hematological parameter to stage the disease with hematological parameters.

Table. ١. Showing, HIV stages.

Stage 1	Stage 2	Stage 3	Stage 4
Asymptomatic	Unexplained weight loss: <10%	Unexplained severe weight loss; >10%	Pneumocystis pneumonia
Persistent generalized lymphadenopathy	Herpes zoster	Unexplained chronic diarrhea; >1 month	Chronic cryptosporidiosis/isosporiasis
	Fungal nail infections	Unexplained persistent fever; >1 month	Recurrent severe bacterial pneumonia
	Angular cheilitis	Oral candidiasis	Recurrent septicemia
	Recurrent oral ulceration	Oral hairy leukoplakia	Cytomegalovirus infection
	Papular pruritic eruption	Pulmonary tuberculosis	Extrapulmonary tuberculosis
	Recurrent respiratory tract infections (sinusitis, tonsillitis, otitis media, pharyngitis)	Acute necrotizing ulcerative stomatitis, gingivitis or periodontitis	Chronic herpes simplex infection (orolabial, genital, anorectal); >1 month
	Seborrheic dermatitis	Severe bacterial infections (pneumonia, empyema, pyomyositis, bone or joint infection, meningitis, bacteremia)	HIV encephalopathy HIV wasting syndrome HIV-associated nephropathy or cardiomyopathy
		Unexplained anemia (<8 g/dl), Neutropenia (<500 cells/mm^3), and/or Chronic thrombocytopenia (<50000 cells/mm^3)	Invasive cervical carcinoma Lymphoma (cerebral or B-cell NHL) Kaposi sarcoma
			Central nervous system toxoplasmosis Progressive multifocal leukoencephalopathy Disseminated mycosis Extrapulmonary cryptococcosis Atypical disseminated leishmaniasis Candidiasis of the esophagus, trachea, bronchi, lungs Disseminated nontuberculous mycobacterial infection

Results

Clinical profile

A total of ١٢٠ newly diagnosed HIV-infected individuals were enrolled in the study. Table ٢ summarizes the baseline characteristics and potential risk factors for infection. Males outnumbered females; ٥٩,١٧٪ of the cohort were males. Most of the enrolled patients were middle-aged, ٢٥ – ٥٠ years old. Unprotected sexual contact was assessed to be the most likely source of infection, and most reported multiple heterosexual partners. Amongst the study group, ٣١ (٢٥,٨٪) were asymptomatic, while the rest were symptomatic, most frequently with non-specific symptoms, including fatigue, weight loss, and fever.

Mucocutaneous candidiasis was the most commonly encountered opportunistic infection in ٥٨ patients (٤٨,٣٪). The oral cavity was the most frequent site of candidiasis; others included esophageal and genital. Tuberculosis was reported in ٤٦ patients (٣٨,٣٪); ٣٣ had pulmonary tuberculosis (٢٧,٥٪), and the rest were extrapulmonary. Upon classifying per the WHO clinical staging system, ٣١ (٢٥,٨٪) belonged to Stage ١ and ٢١ (١٧,٥٪) to Stage ٢, while ٣٣ (٢٧,٥٪) and ٣٥ (٢٩,٢٪) were Stages ٣ and ٤, respectively.

Table ٢ summarizes the baseline characteristics and potential risk factors for infection.

Table 2: Distribution of patients according to age, gender, and reported risk factors					
Age	15 to 25 years: 17 (14.2%)		≥25 to 50 years: 87 (72.5%)	≥50 years: 16 (13.3%)	
Gender	Males: 71 (59.2%)	Sexual	Heterosexual	53	74.64%
			Homosexual	1	1.41%
			Combined	6	8.45%
		Percutaneous contact	Injectable Drug	2	2.82%
			Accidental	0	
			Transfusions	0	
		Both		9	12.68%
		Mother-Child		0	
	Females: 49 (40.8%)	Sexual	Heterosexual	48	97.96%
			Homosexual	0	
			Combined	0	
		Percutaneous contact	Injectable Drug	0	
			Accidental	1	2.04%
			Transfusions	0	
		Both		0	
		Mother-Child		0	

Table ٣ summarizes the profile of symptoms, opportunistic infections, and WHO staging of the study subjects.

Table 3: Profile of clinical presentation, frequent symptom & opportunistic diseases, WHO clinical stage				
Symptoms			Opportunistic diseases	
Asymptomatic 31 (25.8%)	Voluntary testing	2	Candidiasis	58 (48.3%)
	Antenatal screening	7	Tuberculosis	46 (38.3%)
	Contact tracing	22	Cryptosporidiosis	16 (13.3%)
Symptomatic 89 (74.2%)	Fever	57 (47.5%)	Bacterial infections	9 (7.5%)
	Weight loss	49 (40.8%)	Pneumocystis pneumonia	5 (4.17%)
	Excessive fatigue	59 (49.2%)	Histoplasmosis	1 case each
	Diarrhea	36 (30%)	Oral hairy leukoplakia	
	Cough	25 (20.8%)	Herpes Zoster	
	Oral thrush	17 (14.16%)	PML	
	Exaggerated insect bite reaction	37 (30.8%)	Onychomycosis	2
WHO Clinical Stage	Stage 1: 31 (25.8%)	Stage 2: 21 (17.5%)	Stage 3: 33 (27.5%)	Stage 4: 35 (29.2%)

Hematological abnormalities

The cohort's hematological abnormalities included elevated erythrocyte sedimentation rate (٨١,٧٪), anemia (٨٠٪), reticulocytopenia (٢٦,٧٪), and thrombocytopenia (١٤,٢٪). A positive direct Coombs test was detected in ٤٤ patients (٣٦,٦٧٪), of which ٢٧ belonged to clinical stage ٤ and ١٥ belonged to stage ٣.

Table ٤. Summarizes the hematological abnormalities in relation to the WHO clinical stage.

Table 4: Hematological Profile

WHO Clinical Stage	Stage 1		Stage 2		Stage 3		Stage 4	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Hemoglobin (gm/dL)	12.81	1.46	10.99	1.49	9.18	1.18	7.17	1.77
Total Leukocyte Count (x10^9/L)	7.69	2.02	7.89	2.13	7.55	2.21	4.99	1.95
Platelet Count (x10^9/L)	2.81	0.75	2.78	0.58	2.74	0.66	1.47	0.59
ESR (mm/hour)	20.03	12.10	36.43	14.37	59.09	16.42	92.63	34.79
Total Lymphocyte Count (x10^9/L)	3.78	0.89	3.25	0.81	2.49	0.47	1.39	0.45
Mean Corpuscular Volume (fL)	88.6	2.81	87.90	3.08	89.64	4.01	87.44	3.79
Reticulocyte Count (%)	0.97	0.43	1.19	0.48	1.18	0.47	1.05	0.64
CD4 Count (cells/mm^3)	606.61	102.49	403.57	47.46	284	37.73	103.86	53.10
Positive DCT (%)	3.33		5.00		45.45		71.14	

Correlation between hematological abnormalities and WHO clinical staging

Hemoglobin: A statistically significant fall in hemoglobin level was noted with advancing clinical stage of the disease (p<٠,٠١). The hemoglobin levels correlated well with the clinical stage of the disease (r -٠,٨٢٧). A hemoglobin level above the third quartile (١١,٨ gm/dl) had a positive predictive value (PPV) and sensitivity of ٧٧,٤٢٪ with a negative predictive value (NPV) and specificity of ٩٢,١٣٪ in predicting a stage ١ disease, while a hemoglobin level below the first quartile (٨,٢ gm/dl) has a PPV of ٨٩,٢٩٪ and a sensitivity of ٧١,٤٣٪ with an NPV of ٨٩,١٣٪ and specificity of ٩٦,٤٧٪ in predicting a stage ٤ disease.

Total Leukocyte Count: As the disease advanced clinically, the patient's total leukocyte count tended to drop serially but was not statistically significant between clinical stages ١, ٢, and ٣ (p ٠,٨٤). Similarly, no significant correlation was noted between total leukocyte count and clinical stage in stages ١, ٢, and ٣. However, in stage ٤, the leukopenia was statistically significant (p <٠,٠١), correlating with the advanced stage (r -٠,٥٢٨). Leukopenia (<٤ x 10^9 cells/L) had a PPV of ٨٧,٥٪ and a sensitivity of ٢٠٪ with an NPV of ٧٥٪ and specificity of ٩٨,٨٢٪ in predicting a stage ٤ disease.

Lymphocyte Count: A statistically significant (p <٠,٠١) reduction in lymphocyte count was identified, correlating (r -٠,٨٠٧) with the advancing clinical stage of HIV infection. Lymphocyte counts above the third quartile (٣,٤١ x 10^9 cells/L) had a PPV of ٧٦,٦٧٪ and sensitivity of ٧٤,٢٪ with an NPV of ٩١,١١% and specificity of ٩٢,١٣٪ in predicting a stage ١ disease. Lymphocyte count below the first quartile (١,٧٥ x 10^9 cells/L) had a PPV of ١٠٠٪ and a sensitivity of ٨٥,٧١٪, with an NPV of ٩٤,٤٤٪ and specificity of ١٠٠٪ in predicting a stage ٤ disease.

CD٤ Count: As expected, the CD٤ counts dropped in a statistically significant pattern (p <٠,٠١) with the advancing clinical stage of the infection and had the best correlation (r -٠,٩٤٤) with the clinical staging of the disease. CD٤ counts above ٥٠٠ cells/mm^3 had a PPV and sensitivity of ٩٦,٧٧٪ with an NPV and specificity of ٩٨,٨٨٪ in predicting a stage ١ disease. In contrast, a CD٤ count below ٢٠٠ cells/mm^3 had a PPV and sensitivity of ٩٧,١٤٪ with an NPV and specificity of ٩٨,٨٢٪ in identifying a stage ٤ disease. CD٤ counts between ٢٠٠ and ٥٠٠ had a PPV value and sensitivity of ٩٦,٣٠٪ with an NPV and specificity of ٩٦,٩٧٪ in diagnosing a stage ٢/٣ disease.

Platelet Count: Statistically insignificant falls in platelet counts were observed across clinical stages ١ to ٣ (p ٠,٩٢٢), and no relevant correlation was demonstrable. However, thrombocytopenia was significant in the most advanced stage (p <٠,٠١), and it correlated with stage ٤ disease (r -٠,٧٢٠). Thrombocytopenia (<١٥٠ x 10^9 cells/L) had a PPV of ٩٤,١٢٪ and a sensitivity of ٤٥,٧١٪ with an NPV of ٨١,٥٥٪ and specificity of ٩٨,٨٢٪ in predicting a stage ٤ disease.

Reticulocyte Count: There was neither a statistically significant trend in the reticulocyte counts with the advancing stage of the disease (p ٠,٣٥) nor a definite correlation between reticulocyte count and WHO clinical staging of the disease.

Mean Corpuscular Volume (MCV): There was no statistically significant trend (p ٠,٠٧) or correlation between MCV and the advancing stage.

Erythrocyte Sedimentation Rate (ESR): A rise in ESR was demonstrated with advancing infection, which was statistically significant (p <٠,٠١) with a demonstrable positive correlation between them (r +٠,٧٧٨). An ESR above the third quartile (٧٤,٢٥ mm/hour) had a PPV of ٨٦,٦٧٪ and sensitivity of ٧٤,٢٩٪ with an NPV of ٩٠٪ and specificity of ٩٥,٢٩٪ in predicting a stage ٤ disease. A value below the first quartile (٢٦,٢٥ mm/hour) had a PPV of ٨٠٪ and a sensitivity of ٧٧,٤٢٪ with an NPV of ٩٣,٢٥٪ and specificity of ٩٣,٢٦٪ in predicting a stage ١ disease. ESR between the first and the third quartiles had a PPV of ٧٥٪ and a sensitivity of ٨٣,٣٣٪ with an NPV of ٨٥٪ and specificity of ٧٧,٢٧٪ in predicting a stage ٢/٣ disease.

Direct Coombs Test: A positive Coomb's test correlated well with the advancing clinical stage of the disease (r +٠,٦٢١). The positive test had a sensitivity of ٦١,٧٦٪, specificity of ٩٦,١٥٪, PPV of ٩٥,٤٥٪, and NPV of ٧٩٪ for stage ٣/٤ disease.

Discussion

Hematological manifestations are among the most common systemic involvements in HIV infection. Amongst these is the CD٤$^+$ lymphocyte count, the cornerstone for staging, severity assessment, treatment guidance, and prognostication in HIV disease. Multiple other hematological manifestations have been reported and demonstrated to correlate with the severity of the disease. [٧]. Hematological parameters other than CD٤ might play a surrogate role in staging and prognostications, aiding the clinician in treatment decisions. This was conducted to evaluate hematological variables in HOV infections and to assess their correlation with the clinical staging of HIV infection.

Demographics and presentation: The age and sex of patients enrolled in our study were similar to those in published literature. The National AIDS Control Organization, India (NACO) HIV factsheet, adults aged ١٥+ constituted ٥٧,٩٧٪ of new cases, and women contributed only to ٢٤,٥٥٪ of new cases of HIV [٨]. CDC statistics in ٢٠٢١ reported that ٥٨٪ of new cases were in the ١٣ to ٣٤-year-old age group, with ٨١٪ male at birth [٩]. Globally, women and girls accounted for ٤٦٪ of all new cases of HIV infection in ٢٠٢٢ [١٠]. The most common mode of transmission in the study was sexual contact, frequently heterosexual. This correlated with published NACO data [١١]. However, the United States (US) statistics identified the male sex with a male as the most critical risk factor among males, while heterosexual contact among females. Per CDC United States statistics, overall, ٢٢٪ of new cases were identified to have acquired HIV infection by heterosexual contact and ٨٪ by injection drug use. CDC [١٢]. Studies from India have demonstrated a high frequency of non-specific symptoms, especially fever, generalized weakness, and weight loss at presentation, in

newly diagnosed HIV infection [١٣]. Studies from Africa, Europe, and the United States reported similar symptom profiles at presentation [١٤-١٧].

About ٢٥٪ of patients were asymptomatic at diagnosis in the current study. Bishnu et al., from Northeast India, reported nearly ١٤٪ asymptomatic at presentation [١٣]. About ٧٠٪ of the asymptomatic HIV cases in the current study were diagnosed while screening for the spouse of HIV infected, which depicts the robust screening protocols followed in our institution. In the current study, mucocutaneous candidiasis, followed by tuberculosis, was the most frequent opportunistic infection at presentation. Studies from India have consistently demonstrated a high frequency of tuberculosis at presentation, ٢٨,٧٦٪ by Sawhney et al. and ٣١,٣٩٪ by Bishnu et al [١٣, ١٨]. Studies from India have shown a variable but high prevalence of oral candidiasis, ranging as high as ٧٠٪ [١٩, ٢٠]. Puplampu et al., ٢٠٢٤, from Ghana, reported candidiasis as the most frequent opportunistic infection at presentation [٢١]. Most enrolled patients were diagnosed at diagnosis at the WHO clinical stage ٣ or ٤. Published literature from Uganda and Saudi Arabia has reported clinical stages ١ and ٢ frequently at diagnosis [٢٢, ٢٣].

However, literature from referral centers in India has reported more advanced stages at diagnosis [١٣].

Hematological abnormalities: Elevated ESR and anemia were the most frequently identified hematological abnormalities, followed by positive direct Coomb's test reticulocytopenia and thrombocytopenia. Anemia has been among the most frequent hematological abnormalities in HIV infections. Bhardwaj et al. reported anemia in ٦٩,٧٪ and thrombocytopenia in ١٥,٨٪ of subjects [٧]. Several studies have reported a high frequency of anemia in HIV infection, as high as ٩٠٪ [٢٤, ٢٥]. The anemia in HIV infection is often normocytic normochromic [٢٤]. The mechanisms of anemia might include anemia of chronic disease, myelosuppressive effects of HIV, opportunistic infections and medications, nutritional deficiencies, blood loss, malabsorption, and immune hemolysis [٧]. Studies have reported raised ESR in HIV infection compared to controls [٢٦]. ESR elevation may be attributable to the acute phase reactants, inflammation, and infections associated with HIV infection. Ndakotsu et al. reported a mean ESR of ٨٧,٦ mm/hour in symptomatic compared to ٦١mm/hour in asymptomatic HIV infection [٢٧]. Balogun et al., ٢٠٢٠, reported a mean ESR of ٨١,٨٨ mm/hour in the treatment of naïve HIV infection [٢٨]. The incidence of thrombocytopenia in our cohort was ١٤,٢٪, similar to the data published by Bhardwaj et al. (١٥,٨٪) in ٢٠٢٠. Immune and non-immune destruction, reduced thrombopoiesis, drug effects, and thrombotic thrombocytopenic purpura are the mechanisms involved in the pathogenesis of thrombocytopenia in HIV infection [٢٩]. Multiple studies have reported thrombocytopenia in HIV infection ranging from ٢,٤٪ to ٢١,٧٪ [٢٨, ٣٠].

Reticulocytopenia was identified in ٢٦,٧٪ of subjects in our cohort. Studies have reported reticulocytopenia in anemic HIV patients in the past as well [٣١]. Wankah et al. reported low reticulocyte counts in ٨٦,٣٪ of anemic treatment-naïve HIV infections, suggesting hyperproliferative anemia [٣٢]. Saleem et al., ٢٠٢٢, reported a mean reticulocyte count of ٠,٧± ٠,٥٩٪ in HIV infected compared to ١,٥ ± ٠,٨٣٪ in controls [٣٣]. A positive direct Coomb's test was reported in ٣٦,٦٧٪ of our study population. De Angelis et al. reported a positive Coombs test in ٣٤٪ of patients with HIV infection [٣٤]. Despite ٢٠-٤٠٪ of HIV patients being direct Coomb's test positive, autoimmune hemolytic anemia is quite infrequent. Though unclear, the postulated mechanisms include anti-erythrocyte antibody production, hypergammaglobulinemia, and immune complex formation [٣٥].

Correlation with WHO clinical staging: CD٤ count, hemoglobin, and total lymphocyte had a significant negative correlation with clinical stage. In contrast, ESR and Coomb's test had a positive correlation with the clinical stage of the disease. Thrombocytopenia and leucopenia correlated with the advanced stage of HV infection. Reticulocyte counts and mean corpuscular volume failed to correlate with the clinical staging of HIV infection. The correlation between hematological parameters and the severity of HIV infection has been reported in the literature, though inconsistent and variable. Dikshit et al. analyzed symptomatic versus asymptomatic HIV infection and reported statistically significant anemia and CD٤ lymphopenia in symptomatic patients; also, the hemoglobin correlated with the CD٤ counts [٢٥]. Bhowmik et al. revealed a significant association between clinical stage, anemia, and lymphopenia in the pediatric population [٣٦]. Denue et al. demonstrated the association of CD٤ counts with anemia, leucopenia, and thrombocytopenia [٣٧]. Bhardwaj et al. also demonstrated a statistically significant association between hemoglobin, platelet, and absolute lymphocyte counts with CD٤ counts [٧]. Parinitha et al. evaluated the association between hematological parameters and CD٤ count and reported a significant correlation with anemia, leukopenia, lymphopenia, and elevated ESR [٣٠]. Haile et al. also reported a statistically significant, declining trend in mean levels of hemoglobin, white cell, and platelet counts with the advancing stage of HIV infection [٣٨]. A study from Tanzania reported lymphocytopenia, <١٢٠٠ cells/mm^3, or ESR >١٢٠ mm/hour, strongly predicted a CD٤ count of <٢٠٠ cells/mm^3, with ٨٥٪ sensitivity and ٦٣٪ specificity [٣٩]. Lifson et al. identified an elevated ESR, >٦٥ mm/hour, and low hematocrit, <٣٨٪, associated with higher mortality, a useful alternative to CD٤ or absolute lymphocyte count. The Kigali staging, subsequently proposed, included the clinical stage, hematocrit, and ESR [٤٠]. De Angelis reported a positive Coomb's test more frequently in AIDS, ٥٥٪, than in HIV infected with no or minimal disease, ٢١٪ [٣٤]. Consistent with published literature, hemolysis was uncommon despite having a positive Coomb's test. Amongst all the hematological parameters, CD٤ count has the best correlation with the clinical stage of HIV infection, consistent with the published medical literature. Multiple studies have demonstrated the negative correlation between WHO clinical staging and CD٤ counts [٢٣،٤١-٤٣].

Limitations: The enrolled patients are from a single center, a tertiary care referral institution. This might have resulted in enrolling patients with more advanced or complex diseases rather than the general community patients, hence overestimating symptoms, opportunistic diseases, and advanced clinical stage at presentation. The lack of a universal health insurance system and the high degree of stigma prevailing in the community limits continuous treatment and access to healthcare. This might have resulted in partial treatment and complementary therapies in the past, which the patients might not have revealed to the investigators; neither would the investigators have identified it owing to the lack of organized electronic medical records. Further studies with larger, more diverse populations are needed to validate these findings and refine the use of hematological markers in HIV care.

Conclusions

The most frequently observed hematological abnormalities in HIV infection were elevated ESR, anemia, reticulocytopenia, and thrombocytopenia. A significant negative correlation with the clinical stage of HIV was observed, with lower levels associated with more advanced stages. Thrombocytopenia was significantly associated with stage ٤ disease. Elevated ESR correlated positively with disease severity, suggesting its potential as a surrogate marker for advanced HIV infection. A positive direct Coomb's test was noted, more common in advanced stages, although autoimmune hemolytic anemia was infrequent. CD٤ count displayed the strongest negative correlation with disease stage, reaffirming its role as a key marker for disease severity and progression. The findings from this study underscore the importance of comprehensive hematological evaluation in managing HIV-infected individuals, especially in resource-limited settings where access to CD٤ testing might be restricted. Hematological parameters such as hemoglobin, total lymphocyte count, and ESR can be surrogate markers for disease staging and prognosis.

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