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Biological Profile of People Living with HIV under Antiretroviral Therapy at the Ambulatory Treatment Center in Dakar, Senegal

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Abstract

Introduction: Human immunodeficiency virus (HIV) infection remains a public health problem despite the advent of antiretroviral therapy (ART). Prolonged use of ART has been associated with various metabolic toxicities. This study aims to evaluate biological parameters in patients living with HIV who are receiving treatment at the Ambulatory Treatment Center (CTA). **Methodology:** This was a retrospective, descriptive, and analytical study conducted between January 2021 and December 2024, a period of three years. The study included all patients living with HIV who were followed at the CTA of the Fann University Hospital Center and had undergone biological testing. **Results:** During the study period, 163 patients were included, with a mean age of 38 years ± 11.94. We noted a male predominance (92 men and 71 women, for a male-to-female ratio of 1.3). From a virological standpoint, HIV-1 was the most frequent, accounting for 93.3% of cases. TLD remained the predominant treatment regimen at the time of the study, used in 91.4% of cases, followed by TAF + FTC + DTG (5.6%). At month 36, 70% of patients had normal hemoglobin levels, and anemia had decreased to 27.1%. Renal function remained generally preserved, with an eGFR > 90 mL/min/1.73m^2 in 65.3% of patients. Transaminase levels

improved significantly, with a decrease in elevated AST and ALT. Viral load, mostly detectable at baseline (M0), became undetectable in more than 90.9% of patients by month 12 and remained so until month 36. **Conclusion:** The results confirm the efficacy and tolerability of antiretroviral therapy. Regular laboratory monitoring allows for the early detection of potential metabolic complications.

Keywords

Biological Profile, Antiretroviral, PLHIV

1. Introduction

Human immunodeficiency virus (HIV) infection remains a major public health problem worldwide, with 40.8 million [37.0 million - 45.6 million] people living with HIV (PLHIV) globally (2024), more than two-thirds (5.1 million) of whom are in West and Central Africa. As of the end of December 2024, 31.6 million [27.8 - 32.9 million] people had access to antiretroviral therapy, compared to 7.7 million [6.7 - 8 million] in 2010, but still below the target of 34 million for 2025 [1]. In Senegal, according to the report issued by the National AIDS Control Council (CNLS) in 2023, the number of adults and children living with HIV was estimated at 41,880 (37,263 - 46,874). In the Senegalese population aged 15 - 49 years, the prevalence of HIV is 0.34% in women and 0.25% in men [2]. Since the advent of antiretroviral therapy in the mid-1990s, morbidity and mortality among patients infected with the human immunodeficiency virus have decreased dramatically worldwide [3], with a considerable increase in life expectancy and a significant reduction in the risk of opportunistic infections [4]. However, prolonged use of antiretroviral therapy (ART) has been associated with various metabolic and organ toxicities, including an increased risk of chronic kidney disease, diabetes, and liver damage. Furthermore, long-term ART may affect neurocognitive function, although the extent of this association varies across studies [5]. Some antiretrovirals, such as zidovudine, long used as first-line therapy, have been progressively abandoned in current treatment regimens due to their hematological side effects, particularly anemia [6], and their poorer tolerability in older patients. Modern protocols now favor combinations that are better tolerated by patients. Furthermore, it has been shown in the literature that HIV primarily infects hematopoietic cells; however, various cell-cell interactions can lead to metabolic dysfunction in other cells [3] [4]. The assessment of biological parameters provides real-time evidence of both the status and progression of an infection and the efficacy and tolerability of treatment for that infection [7]. This assessment, performed during the initiation and monitoring of HIV infection and often combined with immunological, virological, and molecular evaluations, is an important complement to the clinical evaluation of infected patients. Among other things, it helps determine the op-

timal time to initiate or modify treatment [8]. Therefore, our primary objective was to determine the biological characteristics of people living with HIV (PLHIV) at the Ambulatory Treatment Center (CTA).

2. Methodology

This was a retrospective, descriptive, and analytical study covering the period from January 2021 to December 2023 (36 months). The follow-up time points **M0**, **M12**, **M24**, and **M36** correspond to the time elapsed since each participant's individual inclusion (and not the overall study timeline), where **M0** is the time of inclusion, and **M12**, **M24**, and **M36** represent 12, 24, and 36 months after inclusion. Our work focused on patients living with HIV, followed at the Ambulatory Treatment Center (CTA), who had undergone laboratory testing. All patients living with HIV (PLHIV) who were registered and monitored at the Dakar CTA, naive to antiretroviral treatment (ART) at M0, had an accessible medical record, and whose biological follow-up, carried out with the support of the center's medical biology laboratory, was available and up to date at the different times of the study, namely at treatment initiation (M0), at M12, M24, and at the thirty-sixth month M36, were included in our study. People living with HIV (PLHIV) who were transferred into the CTA, those whose biological test results were not available, and those with incomplete medical records were not included in the study. Data were collected using Excel software from patient medical records. The variables studied included: sociodemographic parameters (age, sex, marital status), clinical characteristics (HIV type, treatment regimen used, weight), and biological parameters (CD4+ T-cell count, HBsAg, blood glucose, plasma viral load, hemoglobin levels, transaminases, creatinine, and glomerular filtration rate (GFR)). Blood samples were collected in the CTA's blood collection room and transported under optimal conditions to the medical biology laboratory. A Yumizen H500 analyzer was used for complete blood count (CBC). Biochemical parameters were determined using the A25 Biosystems biochemical analyzer. Glomerular filtration rate (GFR) was determined using the Cockcroft-Gault formula. Viral load was quantified using the Abbott m2000 RT instrument. CD4 T-cell count was measured using the BD FACSCount instrument. Data were entered and analyzed using SPSS version 23.0 and presented in tables and figures. The Shapiro-Wilk and Kolmogorov-Smirnov tests of normality were performed to verify the distribution of continuous variables, including transaminases (AST and ALT). These tests showed that the transaminases did not follow a normal distribution. Therefore, to compare transaminase values between HBsAg-positive and HBsAg-negative groups, the non-parametric Mann-Whitney U test was used. The relationship between viral load and biological parameters was assessed using Spearman's rank correlation coefficient, adapted for non-normally distributed variables. The significance threshold was set at $p < 0.05$. This study was conducted in accordance with the ethical principles of biomedical research.

3. Results

3.1. Descriptive Study

3.1.1. General Characteristics of the Population

The study included a total of 163 participants with a mean age of 38 ± 11.94 years. Men were the majority (56.4%) with a sex ratio of 1.3. The majority of patients were infected with HIV-1 (96.3%) (Table 1).

Table 1. Basic characteristics of the studied population.

Parameters	Modalities	Effectives (percentages) N (%)
Inclusion	N = 163	
Mean age	38 years ± 11.94	
Sex	Female	71 (43.6)
	Male	92 (56.4)
	Sex rate	1.3
Matrimonial status	Single	81 (49.7)
	Divorced	10 (6.2)
	Monogamous marriage	59 (36)
	Polygamamous marriage	8 (5)
	Widower	5 (3.1)
HIV	HIV 1	157 (93.3)
	HIV 2	6 (3.7)
Clinical stage	Stage 1	110 (67.3)
	Stage 2	24 (14.8)
	Stage 3	22 (13.6)
	Stage 4	7 (4.3)
HBsAg	Positive	12 (7.4)
	Negative	143 (92.6)
CDTL 4 at MO	<200	30 (50.8)
	200 - 349	11 (18.6)
	350 - 500	8 (13.6)
	>500	10 (16.9)

3.1.2. Age Group (Years)

The most represented age group was [25 - 35[with 35.6% of our patients (Figure 1).

3.1.3. Treatment Regime (Initiation and Current Treatment)

The majority of patients initiated treatment with the TLD regimen (95.7%). At the time of the study, TLD remained predominant (91.4%), followed by TAF + FTC + DTG (5.6%) (Table 2).

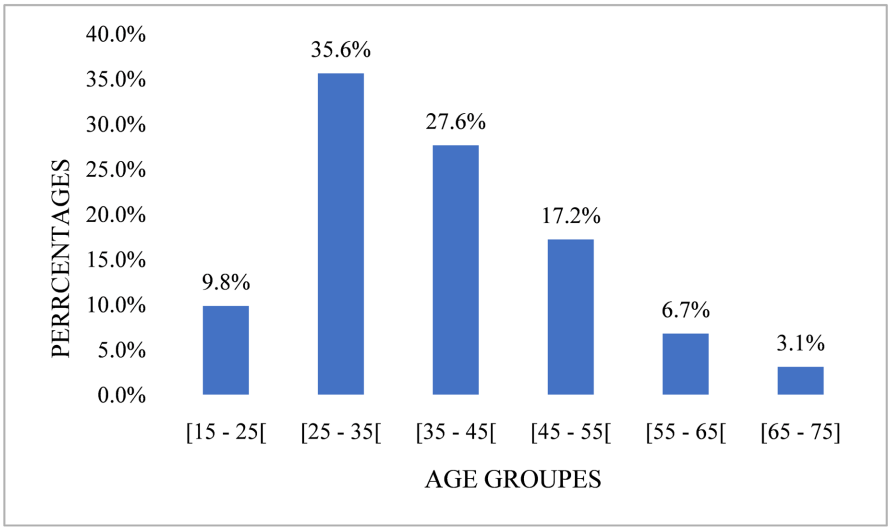

Figure 1. Distribution of patients according to age.

Table 2. Distribution of patients according to treatment regimen (initiation and current treatment).

Therapeutic protocol	Initiation	Current treatment
	Effective (%)	Effective (%)
TLD (TDF + 3TC + DTG)	156 (95.7)	149 (91.4)
TDF + 3TC + EFV	3 (1.8)	2 (1.2)
TDF + FTC + RAL	1 (0.6)	0 (0)
ABC + 3TC + DTG	3 (1.9)	3 (1.8)
TAF + FTC + DTG	0 (0)	9 (5.6)
Total	**163 (100)**	**163 (100)**

3.1.4. Evaluation of Biological Parameters

We noted normal hemoglobin levels (12 - 16.5 g/dL) in 57.4% of our patients at baseline (M0), and in 70% at 36 months (M36). Anemia was present in 40% of patients at M0 and 27.1% at M36. Blood glucose levels were between 0.7 and 1.05 g/L in 91.1% of patients, with 8.9% having values > 10.5 g/L. Creatinine levels were between 5 and 12 mg/L in 80.1% of patients at M0 and in 75.5% at M36. Our patients had a GFR > 90 mL/min/1.73m^2 at M0 (53.4%), a proportion that remained stable at M12 (53.1%) and M24 (59%). The proportion of patients with normal AST levels (≤40 IU/L) increased from 79.4% at baseline (M0) to 93.3% at month 36 (M36), while those with elevated AST levels (>40 IU/L) decreased from 20.6% to 6.7%. The majority of patients had normal ALT levels (≤45 IU/L), increasing from 82.6% at M0 to 89.8% at M36, while elevated ALT levels (>45 IU/L) decreased from 17.4% to 10.2%. At baseline, the majority of patients had a detectable viral load, with 32.6% having a very high viral load (>100,000 copies/mL). By month 12 (M12), more than 90.9% had undetectable viral loads (<40 copies/mL), and this proportion remained stable until month 36 (Table 3).

Table 3. Evolution of biological parameters.

Parameters	Modalitiess	M0	M12	M24	M36
		Effectives (%)	Effectives (%)	Effectives (%)	Effectives (%)
Hemoglobin (g/dL)	**<12**	62 (40)	30 (21)	18 (18)	13 (27.1)
	12 - 16.5	89 (57.4)	106 (74.1)	81 (81)	34 (70)
	>16.5	4 (2.6)	7 (4.9)	1 (1)	1 (2.1)
	Total	**155 (100)**	**143 (100)**	**100 (100)**	**48 (100)**
Creatinin (mg/L)	**<5**	2 (1.2)	2 (1.4)	0 (0)	0 (0)
	5 - 12	129 (80.1)	103 (70.1)	78 (78)	37 (75.5)
	>12	30 (18.6)	7 (28.6)	22 (22)	12 (24.5)
	Total	**161 (100)**	**147 (100)**	**100 (100)**	**49 (100)**
GFR (mL/min/1.73m²)	<15	2 (2.1)	0 (0.0)	0 (0)	0 (0)
	[15 - 30[	1 (0.6)	1 (0.7)	3 (3)	2 (4.1)
	[30 - 60[	19 (11.8)	17 (11.6)	5 (5)	6 (12.1)
	[60 - 90[	53 (32.9)	51 (34.7)	33 (33)	9 (18.4)
	>90	86 (53.4)	78 (53.1)	59 (59)	32 (65.3)
	Total	**161 (100)**	**147 (100)**	**100 (100)**	**49 (100)**
AST (IU/L)	**≤40**	123 (79.4)	132 (89.2)	87 (88.8)	42 (93.3)
	>40	32 (20.6)	16 (10.8)	11 (11.2)	3 (6.7)
	Total	**155 (100)**	**148 (100)**	**98 (100)**	**45 (100)**
ALT (IU/L)	**≤45**	128 (82.6)	131 (87.9)	92 (92)	44 (89.8)
	>45	27 (17.4)	18 (12.1)	8 (8)	5 (10.2)
	Total	**155 (100)**	**149 (100)**	**100 (100)**	**49 (100)**
Viral load (copies/mL)	<40	0 (0)	130 (90.9)	84 (92.3)	44 (95.7)
	40 - 10^3	24 (26.9)	8 (5.6)	6 (6.6)	1 (2.2)
	10^3 - 10^4	16 (18)	0 (0.0)	0 (0)	1 (2.2)
	10^4 - 10^5	20 (22.5)	3 (2.1)	0 (0)	0 (0)
	>10^5	29 (32.6)	2 (1.4)	1 (1.1)	0 (0)
	Total	**89 (100)**	**143 (100)**	**91 (100)**	**46 (100)**
Blood sugar (g/L)	**<0.7**	0 (0)	-	-	-
	0.7 - 1.05	51 (91.1)			
	>10.5	5 (8.9)			
	Total	**56 (100)**			

3.2. Analytical Study

3.2.1. Analysis of the Association between HBsAg and AST/ALT

AST and ALT levels were significantly higher in HBsAg-positive patients at baseline (M0) ($p = 0.001$ and $p = 0.002$), while no significant difference was observed at the 24- and 36-month follow-ups (Table 4).

Table 4. Association between HBsAg and AST/ALT.

Transaminases	HBS1AG	N	Mean	p-value
AST M0	Negative	143	74.61	0.001
	Positive	12	118.38	
ALT M0	Negative	143	74.83	0.002
	Positive	12	115.83	
ALT M24	Negative	93	49.97	0.508
	Positive	7	57.50	
AST M24	Negative	92	48.72	0.289
	Positive	6	61.42	
ALT M36	Negative	47	24.40	0.157
	Positive	2	39.00	
AST M36	Negative	44	22.59	0.166
	Positive	1	41.00	

3.2.2. Analysis of the Association between Viral Load and Biological Parameters

At baseline (M0), no significant correlation was found between viral load and biological parameters, although blood glucose and eGFR showed a negligible but non-significant positive correlation. At 12 months (M12), only the correlation between viral load and hemoglobin was significant ($r = -0.203$; $p = 0.018$), indicating a negligible inverse linear correlation. During 24 months (M24), no biological parameter was significantly associated with viral load, except for creatinine, which showed a significant, negligible inverse linear correlation ($r = -0.214$; $p = 0.043$). And at 36 months (M36), no significant correlation was found between viral load and the biological parameters studied (Table 5).

Table 5. Association between viral load and biological parameters.

Months	Parameters	Effectives (N)	Coefficient of correlation (r)	p-value
M0	Hb	89	0.018	0.873
	Gly	31	0.229	0.215
	CREA	88	−0.097	0.368
	GFR	88	0.196	0.067
	AST	84	0.057	0.608
	ALT	84	−0.135	0.221
M12	Hb	135	−0.203	0.018
	CREA	141	−0.080	0.324
	GFR	141	−0.124	0.141
	AST	141	0.017	0.842
	ALT	140	0.101	0.234

Continued

	Hb	89	0.136	0.205
	CREA	90	0.214	0.043
M24	GFR	90	0.139	0.19
	AST	89	0.032	0.763
	ALT	87	0.119	0.273
	Hb	45	0.033	0.089
	CREA	46	0.035	0.0816
M36	GFR	46	0.05	0.712
	AST	46	0.0259	0.082
	ALT	42	−0.144	0.362

4. Discussion

At the end of our study, which took place at the CTA over a period of three years, we recorded 163 patients, with a male predominance (n = 92), resulting in a sex ratio of 1.3, contrary to several studies in the literature that report a female predominance [9]-[11].

The 25 - 35 age group was the most frequent, representing 35.6% of patients, followed by the 35 - 45 age group, which represented 27.6% of our cohort. These are relatively young subjects. Our results were comparable to those of Kanté *et al*., with the 25 - 34 age group coinciding with 35.83% of their study population and the 35 - 44 age group with 25.92% [12]. A study conducted in Mali in 2009 by Coulibaly also found the 25 - 44 age group to be the predominant age group [13]. This age group corresponds to that of peak sexual activity, exposing individuals to the risks of sexually transmitted infection transmission. Single patients constituted the majority at 49.7% of cases, followed by monogamous married individuals at 36%. In comparison, Noupieng Kamgang reported in her study that 79.5% were married, 4.7% were single, 10.2% were widowed, and 5.7% were divorced [14]. Our results could be explained by the fact that single individuals, often younger and sexually active, have an increased risk of HIV exposure due to risky behaviors such as multiple partners or unprotected sex [15] [16]. The percentage of patients infected with HIV-1 was estimated at 93.3%. The majority were included at clinical stage 1, representing 67.3%. These data are consistent with those of Karfo *et al*., who estimated the HIV prevalence in their study at 80.9% [10]. This predominance would be explained by the fact that HIV-1 is more widespread, more virulent and more transmissible than HIV-2 [17]. In our cohort, almost all patients initiated treatment with the TLD regimen (95.7%), which remained predominant at the time of the study (91.4%). This trend reflects the recommendations of the WHO and the national HIV program, which now advocate TLD as first-line treatment due to its high efficacy and tolerability [18]. TDF is widely used for its antiviral activity and its overall good tolerance, while DTG is distinguished by its rapidity of action and its robustness against the emergence of resistance [19]. Similar results were observed in the

study conducted by Zoungrana-Yameogo *et al*., with 76% of patients receiving TLD in 2022 and 91% in 2023 [20]. The presence of patients receiving TAF + FTC + DTG (5.6%) reflects therapeutic diversification, often driven by tolerability concerns, particularly renal or bone toxicity of TDF. The proportion of anemic patients decreased from 40% at baseline to 27.1% at month 36. This favorable trend demonstrates the efficacy of triple therapy, which allows for a progressive restoration of hematopoiesis [21]. Our results are consistent with previously published data, which also show a reduction in the frequency of anemia after the initiation of antiretroviral therapy [22] [23]. Regarding blood glucose levels, we observed that 91.1% of patients had normal blood glucose at baseline (M0). These observations align with the study by Sagna in Burkina Faso, which showed glucose disturbances in a quarter of his patients [24]. These data on chronic hyperglycemia in our study population are consistent with the prevalence of diabetes in Senegal [25]. The frequency of patients with elevated AST (>40 IU/L) decreased from 20.6% to 6.7%, and that with elevated ALT (>45 IU/L) from 1.74% to 10.2% at month 36. This reflects a progressive decrease in hepatic cytolysis. This improvement likely reflects the efficacy of antiretroviral therapy [26]. It should be noted that the elevated transaminases at baseline were probably caused by patients co-infected with the hepatitis B virus (HBsAg positive in 7.4% of our patients). Several studies have demonstrated this [27] [28]. Renal function assessment showed a generally stable creatinine level, between 5 and 12 mg/L in approximately 80% of patients, and a GFR greater than 90 mL/min in more than half of them. The study published by Noupieng Kamgang in Mali showed creatinine clearance between 60 and 90 mL/min for 62.5% of these patients [14]. Deckert in Zambia also showed good improvement in renal function for a large majority of these patients after antiretroviral treatment [29].

These results suggest good renal tolerance of antiretrovirals, although tenofovir (TDF) is known for its nephrotoxicity [30]. However, in our cohort, 5.6% were receiving TAF + 3TC + DTG due to decreased renal function, reflecting a change in treatment regimen likely due to the potential nephrotoxicity of TDF. At baseline, many of our patients had a very high viral load (32.6% >100,000 copies/mL), but more than 90.9% were undetectable (<40 copies/mL) by month 12, a proportion that remained stable up to 95.7% at month 36. Bocoum observed in his study that after 12 months of follow-up on antiretroviral therapy (ART), 71.5% of these patients had undetectable viral loads, 13.2% had a viral load between 40 and 1000 copies/mL, and 15.8% experienced virological failure. At 24 months, 60.4% had undetectable viral loads, 12% had a viral load between 40 and 1000 copies/mL, and 28% had a viral load > 1000 copies/mL [31]. Our results demonstrate good patient adherence and the efficacy of antiretroviral treatment. Statistical analysis of our data revealed a correlation between certain biological parameters and viral load.

5. Conclusions

Biological analysis revealed a progressive improvement in biological parameters during follow-up:

- An increase in hemoglobin levels, reflecting a reduction in cases of anemia;
- An improvement in glomerular filtration rate and stable creatinine levels;
- A progressive normalization of transaminases;
- A sustained virological suppression (over 90% undetectable viral load at months 12, 24, and 36).

These results confirm the efficacy and tolerability of the antiretroviral treatment implemented within the framework of the national HIV care program. They also highlight the importance of regular biological monitoring to allow for the early detection of potential metabolic, renal, or hepatic complications.

The variation in the number of biological results available at different follow-up times can be explained by several factors, including loss to follow-up, transfers, deaths, incomplete records, as well as constraints related to access to examinations, follow-up organization, and resource availability.

Looking ahead, it would be advisable to strengthen the monitoring of comorbidities related to the chronicity of treatment, particularly metabolic disorders, and to extend this type of study to a larger population for better representativeness.

This study has certain limitations, notably its retrospective and single-center nature, which may limit the generalization of the results. Moreover, the number of patients with complete data at 36 months was small, due to loss to follow-up and missing data. Finally, the subgroup of HBsAg-positive patients was very limited in the later stages of follow-up, which restricts the scope of analyses in this specific group.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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