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Immunovirological and Biochemical Evaluation of HIV-1-Infected Adolescents and Young People Aged 15 to 24 under Antiretroviral Treatment (ART) at the Center of Psycho-Medico-Social Support in N'Djamena—Chad

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Abstract

Introduction: Human immunodeficiency virus (HIV) infection is a major public health problem. Sub-Saharan Africa bears a heavy burden, with over 25.6 million people infected, and Chad is one of the countries most affected by HIV-1. Among infected adolescents and young people, biological monitoring is essential in the management of HIV infection. Objective: to contribute to improving the management of adolescents and young people aged 15 - 24 undergoing antiretroviral treatment. Methodology: we carried out the study at the Psycho Médico-Social Support Center in N'Djamena, prospective and cross-sectional from April 2019 to December 2020. The study population consisted of all adolescents and young people aged 15 to 24 infected with HIV-1 and put on antiretroviral treatment. Data collection was based on an interview using a series of questionnaires on a collection form. CD4 T-cell counts were determined by flow cytometry (PIMATM), viral load by molecular biology (ABBOTT m2000 Real Time HIV-1) and biochemical assays by spectrophotometer (Stardust MC15Diasys). Results: The most represented age group was

between 20 and 24 years (78.1%). The sex ratio was 0.16 men to women. In the study population, 59.6% of patients were on Viraday and 50% on Duovir-N were immunocompetent with TCD4 > 500 cells/µl and 6.4% and 12.5% of patients were severely immunosuppressed (TCD4 < 200 cells/µl). More than the majority of patients (51.9%) on viraday and 45.4% on Duovir-N had an undetectable plasma viral load, 29.6% and 36.4% of patients had a detectable plasma viral load of >1000 copies/ml. Biochemical tests (ALT, ASAT, creatinine and blood glucose) were normal. **Conclusion:** This study shows that triple antiretroviral therapy on infection leads to an improvement in the quality of life of people living with HIV (PLHIV).

Keywords

HIV-1, Adolescents, Youth, ARVs, Biological Parameters

1. Introduction

Acquired Immunodeficiency Syndrome (AIDS) is a set of clinical and biological manifestations secondary to damage to the body by a retrovirus, known as Human Immunodeficiency Virus (HIV) [1]. Worldwide, the number of people living with HIV (PLHIV) is estimated at 36.7 million, including 34.5 million adults, 17.8 million women aged 15 and over, and 2.1 million children (<15 years). Sub-Saharan Africa bears the heavy burden of this infection, with over 25.6 million people infected, predominantly women [2]. In Chad, according to the Enquête Démographique et de Santé et à Indicateurs Multiples (EDST-MICS 2014-2015), HIV prevalence in the general population was estimated at 1.6% and 4.6 among young people aged 15 to 24 [3]. Indeed, the care and monitoring of HIV infection are individualized and appear multidisciplinary. In the absence of appropriate treatment, death occurs as a result of the progressive destruction of CD4 T lymphocytes, favoring the onset of opportunistic infections [4]. Antiretroviral therapy (ART) allows sufficient control of viral replication to achieve immune restoration, viral suppression and improved quality of life if patients are compliant and undergo periodic laboratory check-ups [5]. The overall aim of the study was to contribute to improving the management of HIV-1 infected adolescents and young people aged 15 to 24 on ART in N'Djamena, Chad.

2. Patients and Method

The study population consisted of all HIV-1-infected adolescents and young people between the ages of 15 and 24 who were put on antiretroviral treatment in the period from April 2019 to December 2020. All HIV-1-infected adolescents and young people aged between 15 and 24, on antiretroviral treatment and followed up at the APMS with their consent or the consent of one of their parents, were included in the study. This study did not include HIV-1-infected adolescents and young people aged 15 to 24 who had been placed on antiretroviral treatment at

APMS without their consent or that of one of their parents; patients whose age was less than 15 and/or greater than 24.

The sociodemographic variables and therapeutic regimen in this study were: Age; sex; origin; occupation; marital status; modes of transmission; antiretroviral regimen. Paraclinical variables were: viral load, CD4 T lymphocyte count and biochemical parameters (transaminase, creatinine and blood glucose).

Patients were recruited consecutively and exhaustively. Samples were obtained by taking 5 ml of venous blood in an EDTA (Ethylene Diamine Tetra Acetic) tube at the elbow for virological and immunological evaluations, and 5 ml of blood in a dry tube for biochemical analyses (samples taken from dry tubes were techniqued no later than 2 h after sampling), using the necessary sampling tools (alcohol tourniquet, etc.). Samples were taken from 8 a.m. to 10 a.m., and processed in the laboratory at 11 a.m. and 2 p.m.

Raw data from routine patient follow-up were collected from pre-established collection sheets with variables, entered into Word 2010 and analyzed in Excel and SPSS. Descriptive statistics were performed to determine baseline patient characteristics. The level of statistical significance was set at 0.05.

Samples taken for biochemical analysis were transported in a cool box at a temperature of 2˚C - 8˚C to the Miroir laboratory. Viral load samples were aliquoted in cryotubes and stored at −20˚C. They were then analyzed in order of age in the laboratory of the Renaissance University hospital complex (CHU-RN), *i.e.,* the oldest samples were analyzed first.

The following technical equipment was used during our investigation: well-established investigation sheets; vacutainer needles; dry tubes; EDTA tubes; plastic sockets; markers; blue and red pens; gloves; micropipettes; tips (yellow, blue); lab coat; electric centrifuge; reagents for: transaminase, creatinine, blood glucose, CD4 T, viral load; Instruments (Stardust MC15 Diasys, Alere PIMATM, Abbott m2000rt).

3. Results

In our study, 110 adolescents and young people were registered, of whom (95/110) (86.4%) were female and (15/110) (13.6%) male, giving a sex ratio of 0.16 M/F. The majority of the cohort was between 20 and 24 years (86/110) (78.2%), with an average age of 21.22 years and a median of 22 years. The age variance was 5.82 years and the standard deviation 2.41 years (**Table 1**). Our results show that participation was highest among single people (67/110) (60.9%) and married people (27/110) (25.5%). The majority of participants were housewives (39/110) (35.5%), students (33/110) (30%) and shopkeepers (25/110) (22.7%). In this study, the main routes of HIV infection for these adolescents and young people were sexual (97/110) (88.2%) and vertical (Mother-Child) (13/110) (11.8%). We found (94/110) (85.5%) of patients were on TDF + FTC + EFZ (VIRADAY) and (16/110) (14.5%) on AZT + 3TC + NVP (DUOVIR N). The majority of adolescents and young people who had been on TDF + FTC + EFZ for more than 3 years (18/30) (60%) (56/110) (59.6%) were immune restored (TCD4 > 500 cells/µl). In our cohort, only 65 patients underwent plasma viral load testing, of whom (54/65) (83.07%)

were on TDF + FTC + EFZ and (11/65) (16.92%) on AZT + 3TC + NVP, of whom 90.9% had immune restoration (TCD4 > 500 cells/µl) and an undetectable viral load (CVP < 50 copies/ml) for more than 3 years on ART.

Table 1. Below details the results obtained.

Demographic and health survey with multiple indicators (introduction)					
Age (year)					
	Median (IQR)	21.22 (15 - 24)			
	Variance (an)	5.82			
Standard deviation		2.41			
	15 - 19 n. (%)	24 (21.8)			
	20 - 24 n. (%)	86 (78.2)			
Gender	Female n. (%)	95 (86.4)			
	Male n. (%)	15 (13.6)			
Marital status	Single n. (%)	67 (60.9)			
	Divorced n. (%)	12 (10.9)			
	Widow (er) n. (%)	31 (28.2)			
Profession	Housewife n. (%)	4 (3.6)			
	Tradeswoman n. (%)	39 (35.5)			
	Student n. (%)	25 (22.7)			
	Student n. (%)	33 (30)			
	Civil servant n. (%)	10 (9.1)			
	Student n. (%)	3 (2.7)			
Source of contamination	Mother - Child n. (%)	13 (11.8)			
	Sexual n. (%)	97 (88.2)			
Therapeutic regimen (ARVs)					
	TDF + FTC + EFZ n. (%)	94 (85.5)			
	AZT + 3TC + NVP n. (%)	16 (14.5)			
TCD4 values (cell/µl) as a function of ART and duration (year)		TDF + FTC + EFZ	AZT + 3TC + NVP	<3 ans	>3 ans
	<200 n. (%)	6 (6.4)	2 (12.5)	4 (5)	4 (13.3)
	200 - 500 n. (%)	32 (34)	6 (37.5)	30 (37.5)	8 (26.6)
	>500 n. (%)	56 (59.6)	8 (50)	46 (57.5)	18 (60)
Plasma viral load (CV) values (copies/ml) as a function of ART and duration (year)		TDF + FTC + EFZ	AZT + 3TC + NVP	<3 ans	>3 ans
	<50 n. (%)	28 (51.9)	5 (45.4)	23 (51.1)	10 (50)
	50 - 1000 n. (%)	10 (18.5)	2 (18.2)	6 (13.3)	6 (30)
	>1000 n. (%)	16 (29.6)	4 (36.4)	16 (35.5)	4 (20)

Continued

Cross between CVP (copies/ml) and TCD4 (cell/µl) values		<50	50-1000	>1000	
	<200 n. (%)	00 (0.0)	1 (1.5)	00 (0.0)	
	200 - 500 n. (%)	3 (4.6)	1 (1.5)	17 (26.2)	
	>500 n. (%)	30 (46.2)	10 (15.4)	3 (4.6)	
Blood glucose values (g/l) according to ART regimen		TDF + FTC + EFZ	AZT + 3TC + NVP	<3 ans	>3 ans
	0.70 - 1.10 n. (%)	86 91.5	12 75	63	25
	<0.70 - >1.10 n. (%)	8 8.5	4 25	80	30
Transaminase values (IU) according to therapeutic regimen					
		TDF + FTC + EFZ	AZT + 3TC + NVP	<3 ans	>3 ans
ALAT (UI)	<40	90 (95.7)	16 (100)	77	29
	>40	4 (4.3)	0 (0.0)	3	1
ASAT (UI)	<37	87 (92.6)	15 (93.7)	73	28
	>37	7 (7.4)	1 (6.3)	7	2
Creatinine values (mg/l) according to therapeutic regimen	6 - 13	91 (96.8)	16 (100)	78	29
	<6 - >13	3 (3.2)	0 (0.0)	2	1

Among patients on TDF + FTC + EFZ (28/44) (51.9%) had an undetectable viral load (VLC < 50 copies/ml) and (16/44) (29.6%) had treatment failure (VLC > 1000 copies). Among patients on AZT + 3TC + NVP (5/11) (45.4%) had an undetectable viral load (VLP < 50 copies/ml) and (4/11) (36.4%) had high viremia (VLP > 1000 copies/ml). All biochemical assays were normal.

4. Discussion

In our study, we enrolled 110 patients. The 20 - 24 age group (78.2%) was the most represented, with an average age of 21.22 and a median age of 22. Our results differ from those reported by Lozès *et al.* in 2012 [6], who observed a high representation in the 25 - 45 age bracket (70.7%). The median age of 38 years was reported in the study by Bangoura *et al.* in 2015 [7]. This difference could be explained by the fact that our study population consisted of adolescents and young people aged 15 - 24.

Females were in the majority, with 86.4% and an M/F sex ratio of 0.16. The female predominance observed in our study corroborates national data where HIV prevalence is higher among women (1.8%) than men (1.3%) EDS-MICS 2015 [3] and this could be explained by the socioeconomic, sociocultural and biological vulnerability of women.

In our study, 60.9% were single. Our results corroborate those of Ballo [8] with 50%, which can be explained by the sexual activity of young people and the context of polygamy. With regard to professional status, we observed a high mobilization of housewives with 35.5%. 88.2% of patients were infected by the sexual route and

11.8% by the transverse route. All patients were on first-line ART, combining 2 NRTIs and 1 NNRTI. Two combination therapies were observed: Viraday (TDF + FTC + EFZ) and Duovir-N (AZT + 3TC + NVP). 85.5% of patients were on Viraday (TDF + FTC + EFZ) and 14.5% on Duovir-N (AZT + 3TC + NVP). These results reflect national recommendations on the management of PVV [9]. Line regimens of ART are motivated by therapeutic failure of the previous line regimen. With regard to combination therapy, the WHO recommends the TDF + FTC + EFZ-based treatment regimen, as it is better tolerated and has low toxicity and undesirable side-effects. 58.2% of patients had TCD4 > 500 cells/µl, 34.5% had T CD4 between 200 - 500 cells/µl and 7.3% had T CD4 < 200 cells/µl. 59.6% of Viraday patients and 50% of Duovir-N patients were immunocompetent (TCD4 > 500 cells/µl). Our results differ from those of Koné *et al.* in 2019, who found 80.3% of patients to be immunocompetent [10]. A significant association between TCD4 level and therapeutic regimen was not observed in our study ($p > 0.05$).

Among patients on ART for 1 year, 50% were immunocompetent. Among those on ART for more than 3 years, 60% were immunocompetent. Our data are lower than those observed by Lozès *et al.* in 2012 [6] where 86% of patients were immunocompetent after 1 year of ART, but similar to those of Dolo in 2011 [11] where 58.8% immunocompetence observed for the same duration of treatment. Immunological success is a sign of the efficacy of ART in patients in our study.

A total of 65 patients had their viral load measured, of whom 50.8% had an undetectable VVC (VVC < 50 copies/ml) and 30.7% were in virological failure (VVC > 1000 copies/ml). There was no significant association ($p = 0.7621$) between ARV regimen and CVP. Among patients with undetectable CVP, respectively, 40%, 63.6%, 37.5% and 50% had been on treatment for 1 year, 2 years, 3 years and more than 3 years. Our results differ from those of Konaté in 2018 [12], where an undetectable CVP rate of 57.4%, 74.4%, 84% and 63%, respectively, for the same treatment durations, was observed.

In our study, 46.2% of patients were immunologically successful (TCD4 > 500 cells/µl and a CVP < 50 copies/ml), 4.6% immunologically successful associated with virological failure (CVP > 1000 copies/ml and TCD4 > 500 cells/µl) and, no cases of immuno-virological failure (TCD4 < 200 cells/µl and CVP < 50 copies/ml). There was a significant difference ($p = 0.0202$) between CD4 levels and viral load. The virological and immuno-virological success observed in our study could be explained by the efficacy of ART, patient adherence and compliance to treatment, and regular clinical and biological follow-up of patients. The interpretation of immuno-virological discordance varies according to the profile. In the case of virological success associated with immunological failure, the erroneous change of therapeutic line is avoided because, in this case, the immunological failure is the consequence of the slowness of the patient's body to restore the CD4 count, Koné *et al.* in 2019 [12].

Evaluation of biochemical parameters showed a normal rate. A similar normal blood glucose level was reported by Dicko K in 2008 (95.7%) [13]. Among patients

with normal blood glucose levels, 91.5% were on Viraday (TDF + FTC + EFZ) and 75% were on Duovir-N (AZT + 3TC + NVP). No significant association was observed between blood glucose levels and treatment regimen ($p > 0.05$).

A normal level of 96.4% ALAT and 91.8% ASAT was observed in patients in our study. A significant association between ALAT and treatment and ASAT and treatment was not observed, with respective values of $p = 0.5457$ and $p = 0.4954$. ALAT and ASAT levels remained predominantly normal regardless of treatment duration. Concerning creatinine results, normal levels were observed in 97.3% of patients. There was no significant association ($p = 0.7691$) between ARV treatment and creatinine. Normal creatinine values were observed irrespective of treatment duration. In the majority of cases, TDF + FTC + EFZ and AZT + 3TC + NVP combination therapies did not affect liver and kidney function or glucose metabolism. These results can be explained by the good tolerance of these molecules in our patients.

5. Conclusion

A prospective, cross-sectional study was conducted on the immunovirological and biochemical evaluation of adolescents and young people aged 15 to 24 on ART in N'Djamena. The majority of patients restored their immunity and compliance was satisfactory, with 65 out of 110 receiving a viral load. 51.9% on Viraday and 45.4% on Duovir-N had an undetectable viral load, and biochemical parameters were normal. The efficacy of triple antiretroviral therapy on infection has led to an improvement in the quality of life of people living with HIV. Molecular characterization and genotyping of HIV type 1 strains in adolescents and young people on ART will enable us to carry out HIV genotyping tests, identify antiretroviral-resistant strains, and propose a more simplified treatment regimen.

Conflicts of Interest

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

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Appendices

Appendix 1: Data collection form

I. Socio-demographic information

Order no. _____

Date: _____/_____/_____

Patient code: _____

Age: _____

Sex: □Male □Female

Marital status: □Married □Single □Divorced □Widowed

Profession: _____

Quartier:_____

Telephone number:_____

II. Mode of HIV transmission

Mother - child Yes□ No □

Sexual Yes□ No □

Autres:_____

III. Antiretroviral treatment

When did you start ART?

Date: _____/_____/_____

Which combination are you on?: _____

IV. Immunovirological parameters

Initial or latest CD4 T count: _____

Initial viral load (VL) or last VL result: _____

V. Biochemical parameters

Transaminase (ALAT/ASAT): Yes□ No □

If yes, value:_____

-Blood glucose: Yes□ No □

If yes the value:_____

-creatinine: Yes□ No □

If yes the value:_____

VI. Results during the study

VI.1 Immunovirological and biochemical parameters

CD4 T count:_____

Viral load measurement:_____

Transaminase: ALAT: _____ ___ ASAT: _____

Blood glucose: _____

Creatinine: _____

Note:

_____

_____

_____

_____

The interviewer