

CD4⁺ T Cell Response in HIV-Positive Women Initiating Highly Active Anti-Retroviral Therapy (HAART) at General Hospital, Kabba, Kogi State, Nigeria

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Abstract

المخلص

Reportedly, HIV-infected patients on HAART exhibited accelerated increase in the first three months. We therefore tested an hypothesis that there is no difference between 3 month follow-up and baseline CD4 counts of HIV-positive women initiating Stavudine, Lamivudine and Nevirapine at General Hospital, Kabba, Kogi State, Nigeria. As a prospective study, 100 consenting HIV-positive, HAART-naïve women aged 17-45 years were studied. Two blood samples were aseptically obtained by venipuncture from each woman before and after 3 months on HAART and assessed for pre- and post-therapeutic CD4 counts using automated FACSCount[®] System. Pertinent data of participants were obtained using questionnaire forms. For the purpose of comparison, the women were grouped into pre-therapeutic CD4 count of < 200; 200-349 and ≥ 350 cells/μl groups. SPSS 15.0 was used for the statistical analyses. The mean baseline and follow-up CD4 counts were respectively 320.03 cells/μl and 620.92 cells/μl (n =100), the latter was significantly ($P = 0.001$) higher than the former. Unlike the mean follow-up CD4 count of the women in the ≥ 350 cells/μl group, mean follow-up CD4 counts of those in the < 200 and 200-349 CD4 cells/μl groups were significant ($P = 0.001$) higher than their respective mean baseline values. The 74 women who responded “adherent” to HAART had significantly ($P = 0.001$) higher mean follow-up CD4 count contrary to that of the remaining 26 “non-adherent” women who exclusively belonged to the ≥ 350 CD4 cells/μl group. The women who responded “yes” and “no” to having diabetes/hepatitis were comparable ($P = 0.62$) in their mean follow-up CD4 counts. We concluded that 75% of the HIV-positive women had significant increase in CD4 count, hence they had short-term immunologic benefit; and that rather than the pre-therapeutic CD4 count of ≥ 350 cells/μl or having diabetes/hepatitis, it was “non-adherence” to HAART that apparently accounted for lack of therapeutic benefit among the 10 women who had < 349 CD4 cells/μl after 3 months on HAART.

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1. Introduction

In infected humans, HIV attaches to CD4 and CXCR4 surface molecules hence it preferentially infects a subset of human lymphocytes known as CD4⁺ T cells - the T helper 1 and 2 cells (Murray et al., 2000; Takahashi, 2004; NIAID, 2006). These are the cells respectively responsible for orchestrating cell-mediated and humoral immunities in humans during infections or malignancy (Cooke, 2001). During HIV infections, these cells lose their normal immunologic functions (Carcelain, 1999) followed by lysis due to productive intracellular

replication of the virus (Murray et al., 2000). The large numbers of infectious progeny virions subsequently released by the lysed cells infect other susceptible cells thereby killing more infected cells. This results in massive depletion of this subset of lymphocytes. Initially however, large numbers of new CD4⁺ T cells are produced by the HIV-infected to offset the destroyed cells which partly accounts for the long (about 5-12 years) incubation period (NIAID, 2006) of HIV disease or AIDS in the absence of antiretroviral therapy. The war of attrition induced by HIV replication continues however, until the infected body's ability to replace the massive loss of CD4⁺ T cell wanes.

The absolute count of CD4⁺ T cell (CD4 count) of healthy HIV-negative human has been variously reported to range from 500-1,696 CD4⁺ T cells/μl of whole blood (Takahashi, 2004; NIAID, 2006, Kuby, 1997, Klose et al.,

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2007), the value may be below 350 and oftentimes less than 200 cells/ μ l for HIV-positive individuals (Kuby, 1997, WHO, 2006). Such HIV victims are respectively described as immunosuppressed; and severely immunosuppressed (Anastos et al., 2004). Either of the immune statuses puts HIV-infected at increased risk for contracting opportunistic infections (OIs) which, if untreated, eventually leads to death. It follows therefore that the pivotal role of CD4⁺ T cells in fighting off infections makes their absolute number (and function) a veritable indicator of immune status for HIV and AIDS patients (Anastos et al., 2002).

Though the scourge of HIV and AIDS still ravages mankind in sub-Saharan Africa especially, the advent of highly active anti-retroviral therapy (HAART) has brought considerable succour to the affected (Gange et al., 2002; Erb et al., 2000; Bing et al., 1999) and by extension, to the care-givers and all stakeholders worldwide. The antiretroviral drugs (ARVs) comprising six different classes (FDA, 2008), selectively attack the viral enzymes (reverse transcriptase and protease) thereby preventing HIV-1 replication in infected cells while others target the viral architectural molecules to inhibit HIV entry into susceptible cells. Inhibitory effects of the ARVs pave way for the restoration of CD4⁺ T cell numbers and function in already overwhelmed HIV and AIDS victims (Carcelain, 1999, Li et al., 1998; Bucy et al., 1999; Mattapallil et al., 1999).

HAART is, however, no cure for AIDS, hence it is recommended to be taken by HIV and AIDS patients a life-time (Boschi et al., 2008; PAGAA, 2008). However, HIV-1- related morbidity and mortality have been considerably reduced by the use of HAART (Gange et al., 2002; Erb et al., 2000). Furthermore, when appropriately taken by HIV-positive pregnant women, HAART can significantly reduce mother-to-child-transmission (MTCT) of HIV-1 (Marazzi et al., 2006; Public Health Task Force, 1998). It must be noted however, that some HIV and AIDS patients on HAART show complete therapy failure while some show discrepant responses (Perin and Telenti, 1998; Barreiro et al., 1999). An adequate CD4 response for most patients on ART is defined as an increase in CD4 count in the range of 50 or 100 to 150 cells/mm³/year with an accelerated response in the first 3 months (Kaufmann et al., 2003). The accelerated increase in CD4 count within 3 months following initiation of HAART had been attributed to redistribution of CD4⁺ T cells from lymphoid tissues (Bucy et al., 1999; Carcelain et al., 1999) and proliferation of naïve CD4⁺ T cells (Pakker et al., 1998). In addition to numerical improvement, restoration of CD4⁺ T cell functions was also observed after 3 months of HAART (Li et al., 1998).

Due to shared routes of transmission, HIV and HBV infections are often found in the same individual (Konopnicki et al., 2005); though some conflicting reports abound, some studies however, have shown that the co-infection had no impact on HIV-patients on HAART regarding immune recovery (or viral suppression) (Omland et al., 2008; Law et al., 2004; Konopnicki et al., 2005). Another clinical condition, a metabolic disorder, pertinent

to the present study is diabetes. This had also been documented as having no known impact on the effectiveness of HAART (Gallant, 2001).

On realization of the devastating effects of HIV and AIDS on medical, social and economic lives of its citizens, Nigerian government demonstrated strong commitment to fighting the scourge by implementing Africa's largest ART programme (Kombe et al., 2004), with supports from PEPFAR and other donor agencies.

The three generic ARVs offered to HIV and AIDS patients in Nigeria are Lamivudine (3TC), Stavudine (d4T) and Nevirapine (NVP). This is in accordance with WHO recommendation of two nucleoside reverse transcriptase inhibitors (NRTIs) and one non-nucleoside reverse transcriptase inhibitors (NNRTI) as first-line therapy (WHO, 2006). Many authors have documented the therapeutic benefit of these drugs on people living with HIV and AIDS (PLWHAs) in different parts of the world including Nigeria (Aina et al., 2005; Badri et al., 2002; Erhabor et al., 2006; Gautam et al., 2008; Laurent et al., 2004). But before ART is offered to HIV and AIDS patients, assessment of their CD4⁺ T cells/ μ l of whole blood is essential; this is first done following laboratory confirmation of HIV infection. The CD4 count at this time is called the baseline count (pre-therapeutic count). The baseline CD4 count is useful for the determination of immunodeficiency state; to decide whether or not to initiate ART and for monitoring immunologic response of HIV patients to ART. A WHO laboratory criterion for instituting ART in a resource-limited setting, like Nigeria, is < 350 CD4 cells/ μ l (WHO, 2006). CD4 count is thereafter done regularly at 3-6 month interval as part of follow-up assessment. This is necessary to monitor response of HIV and AIDS patients to ART in order to know whether or not the therapy is effective which may necessitate modification or change in the HAART. The CD4 count can be done manually using Dynabeads[®] method or by automated technique using flow cytometry machines (Partec Cyflow[®] or BD FACSCount[®]) (Gautam et al., 2008; Erhabor et al., 2006; Nwokedi et al., 2007).

The importance of monitoring HIV and AIDS patients on ART at different centers in a resource-poor setting like Nigeria cannot be overemphasized. In addition, different studies comparing men's and women's use of HAART reported lopsidedness of use of more men than women (Lynn, 1999; Mocroft et al., 2000); reports corroborating these stated that women were underrepresented in HIV and AIDS clinical trials; less aware of their eligibility to participate in such trials, and less likely to be recruited into such studies by their health providers (Stone et al., 1997; Edelstein and Jacobson, 1999; CDC, 2006). In view of these, and the fact that there are few published studies, to the best of our knowledge, on the CD4 count response of HIV- positive, HAART-naïve women in Kogi State, Nigeria, we conducted baseline and three month follow-up CD4 count among adult HIV-positive females who initiated HAART in General Hospital, Kabba with the view to establishing benefit or lack thereof from the therapy.

2. Materials and Methods

2.1. Study Area / Population

This study was carried out between May and October, 2008 in General Hospital, Kabba, Kabba/Bunu local government area (LGA), Kogi state. The major ethnic group in kabba is the Okun (Yoruba-speaking people). Kogi state is the most centrally located state in Nigeria and bordered by nine other states. The participants were HIV-positive women attending the General Hospital.

2.2. Study design

This is a prospective cohort study. The objectives of this study were explained to the Management of General Hospital, Kabba and permission to undertake the study was subsequently granted. An officer in the hospital explained the objectives and details of the study to newly diagnosed HIV-positive, ART-naïve women attending the hospital. Altogether one hundred women verbally consented and were consecutively recruited to enroll in this study. They were interviewed and their responses documented into questionnaire forms. Each patient was given an ID number. After this, about 5 ml of blood was aseptically collected by venipuncture from each woman into K₃ EDTA BD Vacutainer® blood collection tube and the tube correspondingly labeled. Blood samples were kept at room temperature and analyzed for CD4 count within four hours of collection. After this, each woman was referred to ART section for counseling, prescription and collection of ARV drugs (i.e. Lamivudine (3TC), Stavudine (d4T) and Nevirapine (NVP)). The CD4 count so obtained was used to categorize the women into pre-therapeutic (i.e. baseline) < 200, 200-349 and ≥ 350 CD4 cells/μl groups. All the women, some of whom were pregnant, showed willingness and gave consent to start the ART regimen; they were all subsequently started on HAART since clinical guidelines recommended initiating HAART for pregnant HIV-positive (Yeni et al., 2004) and those with < 350 CD4 count/μl (DHHS, 2006). Those with OIs were appropriately referred for chemoprophylaxis. The women were informed to report in the hospital for regular medical check-ups, especially after three months for follow-up CD4 count evaluation. Five laboratory confirmed HIV-negative, apparently healthy adult females were included at follow-up as controls. The demographic data collected from the women include educational status; marital status; age; having diabetes/hepatitis; pregnancy status; presence of any infections and at follow-up, information on adherence to ART regimen. "Adherence" was defined as patient's response of compliance with ARV drug regimen.

2.3. Laboratory CD4 count

The CD4 count of each whole blood sample was prepared by adding 50 μl blood to BD reagent. Automated FACSCount® System (Becton Dickinson, USA) was used for the cell count. The CD4 count was carried out according to manufacturer's instructions.

2.4. Data analysis

The results of this study were presented with descriptive statistics. Mean values were presented together with 95% confidence interval of mean (95% CI). We used

paired and independent samples t-tests, CHI² and ANOVA to establish statistical difference or lack thereof between patients' variables. Two-tailed hypothesis was used with $P \leq 0.05$ as indicator of statistical significance, SPSS 15.0 for Windows® was used for the analyses

3. Results

One hundred (100) HIV-positive ART-naïve women initiating HAART participated in the study. While some of them were apparently healthy, some appeared physically unthrifty; however, none died during the course of the study. They had age range of 17-45 years (yrs) (mean = 31.57 yrs; 95% CI: 30.05-33.09 yrs). The women studied as control were students in tertiary institution, they had mean age of 26 yrs (n = 5; range 23-28 yrs; 95% CI: 24.25-27.75 yrs). Statistical analysis showed that the mean age of the control was significantly less ($P = 0.001$) than that of the study subjects. The women were categorized into pregnant (n = 39, mean age = 32.10 yrs) and non-pregnant (n = 61, mean age = 31.23 yrs) subsets and compared, they were statistically similar ($P = 0.59$) in mean age. Some of the HIV-positive women met the AIDS classification criterion based on their baseline CD4 count; Table 1 shows the age distribution of the women with respect to baseline CD4 count categories.

The demographic data of the HIV-positive women on HAART are as shown in Figure 1; the Figure also reveals high level (74%) of "adherence" to the ART regimen; none of the "adherent" women had decline or no-change in CD4 count at follow-up. The women comprising the 26% "non-adherent" were exclusively in the ≥ 350 cells/μl group and included 11 each with primary and secondary education and 4 having tertiary education. Other demographic/clinical data of the 26 "non-adherent" women are: married (14), unmarried single (6), divorced (4) and widow (2); "yes" to diabetes/hepatitis (16); non-pregnant (21).

In all, 74 and 26 women responded "adherence" and "non-adherence" respectively to the ART regimen. Mean CD4 counts at baseline and follow-up were 224.92 and 688.32 cells/μl respectively for the "adherent" women; the latter being significantly ($P = 0.001$) higher. Baseline CD4 counts for these women significantly ($P = 0.001$) correlated ($r = 0.87$) with their follow-up values. For the "non-adherent" women, we recorded 590.73 (350.00 – 1,112.00 cells/μl) and 429.08 cells/μl (161.00 – 940.00 cells/μl) respectively as mean baseline and follow-up CD4 counts, with the latter being significantly ($P = 0.005$) lower. We observed no significant ($P = 0.15$) correlation ($r = 0.29$) between the baseline and follow-up CD4 counts for the women in this group. Comparison of the mean follow-up CD4 counts of the "adherent" and "non-adherent" women revealed significantly ($P = 0.001$) higher value of the former. Overall, 10 women still had < 349 CD4 cells/μl at follow-up (Figure 2), 9 of whom belonged to the 26 "non-adherent" women.

Nine women in the ≥ 350 cells/μl group who responded "adherent" to ART regimen had mean follow-up CD4 count of 1,157.78 cells/μl (range: 872.00 – 1,572.00 cells/μl) which was significantly ($P = 0.001$) higher than their mean baseline cell count of 623.56 cells/μl (range: 352.00 -1,189.00 cells/μl). The mean follow-up CD4 count

of these 9 “adherent” was significantly ($P = 0.001$) higher than the corresponding mean value of the 26 “non-adherent” women. In all, 13 women showed decline in CD4 count, while 9 had no-change in CD4 count at follow-up, Table 2. These 22 women were exclusively in the ≥ 350 CD4 cells/ μl group and were among the 26 “non-adherent” women.

Overall, we observed considerable changes in the proportion of women with respect to increase in CD4 count, Figure 2. Seventy five per cent of the women had significant increase in CD4 count; this comprised the entire women in the < 200 and 201-349 CD4 cells/ μl groups (Figure 2) and 10 women from the ≥ 350 cells/ μl group. We observed that 69 (92%) of the 75 women had CD4 count of ≥ 500 cells/ μl after 3 months on HAART.

The mean baseline CD4 count of the 100 HIV-positive women was 320.03 cells/ μl (range 1-1,189 cells/ μl ; 95% CI: 269.67-370.29 cells/ μl); at follow-up their mean CD4 count was 620.92 cells/ μl (range 161-1,572 cells/ μl , 95% CI: 569.51-672.33 cells/ μl); with change in CD4 count ranging from decline to increase (mean = +300.89 cells/ μl , range: -735.00 to +711.00 cells/ μl ; 95% CI: 237.45-364.33 cells/ μl). However, CD4 count of the control evaluated at follow-up period gave mean value of 2,209.40 cells/ μl (range 1,886.0-2,551.0 cells/ μl ; 95% CI: 1,946.84-2,471.96 cells/ μl) which was significantly higher ($P = 0.001$) than mean follow-up CD4 count of the women on HAART. The mean CD4 count of the women at baseline, follow-up and mean change in CD4 count are as shown in Figure 3.

Four of the subjects (4.0%) had severely depleted CD4⁺ T cells of ≤ 5 CD4 cells/ μl , but at follow-up, they had mean increase of +398.25 cells/ μl (range 317.00-443.00 cells/ μl ; 95% CI: 343.26-453.24 cells/ μl).

Women in the three baseline CD4 groups were statistically comparable ($P = 0.88$) in mean age. Their CD4 counts are as shown in Figure 3. Those in the < 200 CD4 cells/ μl group had baseline range of 1-198 CD4 cells/ μl ($n = 37$, mean = 97.30 cells/ μl ; 95% CI: 76.34-118.25 cells/ μl) with 317-882 CD4 cells/ μl at follow-up (mean = 570.57 cells/ μl ; 95% CI: 529.10-612.03 cells/ μl). The 200-349 CD4 cells/ μl group had baseline range of 200-345 CD4 cells/ μl ($n = 28$, mean = 265.18 cells/ μl ; 95% CI: 246.19-284.17 cells/ μl); 401-1,336 CD4 cells/ μl at follow-

up (mean = 722.43 cells/ μl ; 95% CI: 649.96-794.90 cells/ μl). The ≥ 350 cells/ μl group had baseline range of 350-1,189 cells/ μl ($n = 35$, mean = 599.17 cells/ μl ; 95% CI: 522.73-675.61 cells/ μl), with 161-1,572 cells/ μl at follow-up (mean = 616.46 cells/ μl ; 95% CI: 479.19-753.72 cells/ μl).

The women who responded “yes” and “no” to having diabetes/hepatitis were 67 and 33 respectively. Those with “yes” to this clinical condition had mean baseline and follow-up CD4 counts of 312.49 and 611.66 cells/ μl respectively, with the latter being significantly ($P = 0.001$) higher. For those with “no” to diabetes/hepatitis, their mean follow-up CD4 count (639.73 cells/ μl) was also significantly ($P = 0.001$) higher than the mean baseline value (335.33 cells/ μl). While there was no significant ($P = 0.27$, $r = 0.14$) correlation between the baseline and follow-up CD4 count for the HIV-positive women with “yes” to diabetes/hepatitis, a significant ($P = 0.005$) correlation ($r = 0.48$) was observed for those with “no” to the clinical condition. A significant finding was that the mean follow-up CD4 counts of these two groups were comparable ($P = 0.62$).

Eleven and two of 16 “non-adherent” women with “yes” to diabetes/hepatitis respectively had decline and no change in their CD4 count at follow-up and represented the same women with decline and no change in CD4 count among the 67% (Figure 1) that responded “yes” to diabetes/hepatitis. Of the 33% with “no” to diabetes/hepatitis, only 2 and 7 respectively had decline and no change in their CD4 count at follow-up. These women were comparable in proportions ($\text{CHI}^2 = 0.80$; $\text{df} = 1$; $P = 0.37$) with respect to increase in their CD4 count at follow-up.

The pregnant subset of the HIV-positive women recorded baseline range of 31-1,112 CD4 cells/ μl ($n = 39$; mean = 255.87 cells/ μl ; 95% CI: 184.17-327.57 cells/ μl); at follow-up 181-1,216 CD4 cells/ μl (mean = 625.10 cells/ μl ; 95% CI: 558.94-691.26 cells/ μl) was recorded. The non-pregnant had a range of 1-1,189 cells/ μl as baseline ($n = 61$; mean = 361.05 cells/ μl ; 95% CI: 293.94-428.16 cells/ μl) and 161-1,572 CD4 cells/ μl (mean = 618.25 cells/ μl ; 95% CI: 544.92-691.58 cells/ μl) at follow-up, Figure 3.

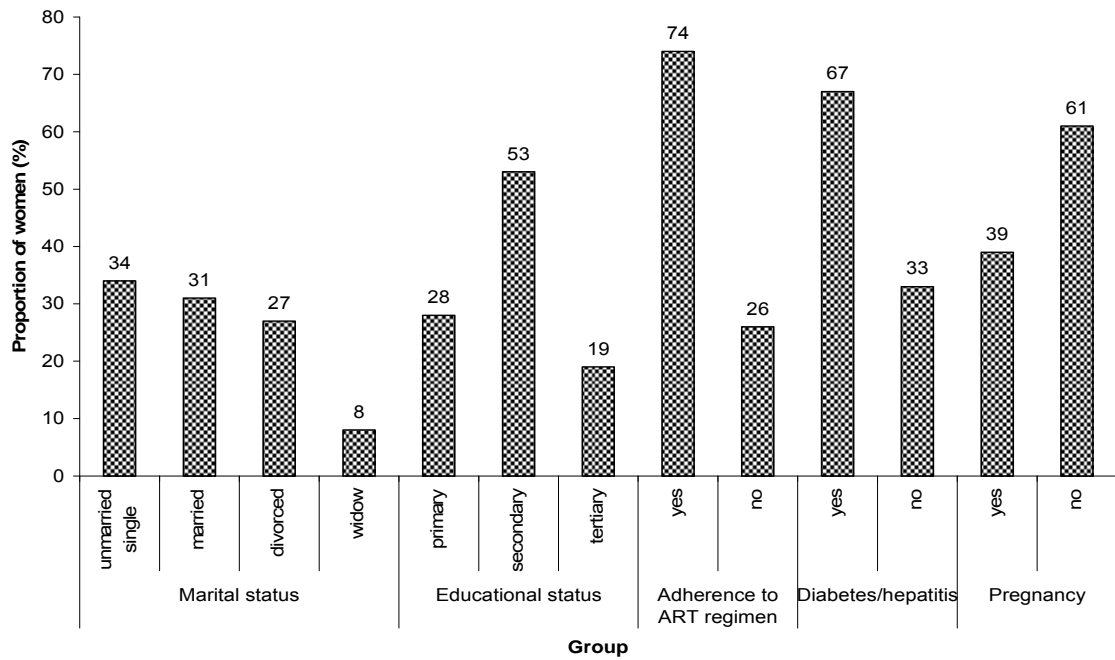


Figure 1. Demographic distribution of HIV-positive women on HAART at General Hospital, Kabba, Kogi State, Nigeria.

Table 1. Age distribution of baseline CD4 count of HIV-positive women on HAART at General Hospital, Kabba, Kogi State, Nigeria.

Age range (years)	Groups based on baseline CD4 count			Row total
	< 200	200-349	≥ 350	
17-29	18	15	15	48
30-39	11	7	13	31
40-45	8	6	7	21
Column total	37	28	35	100

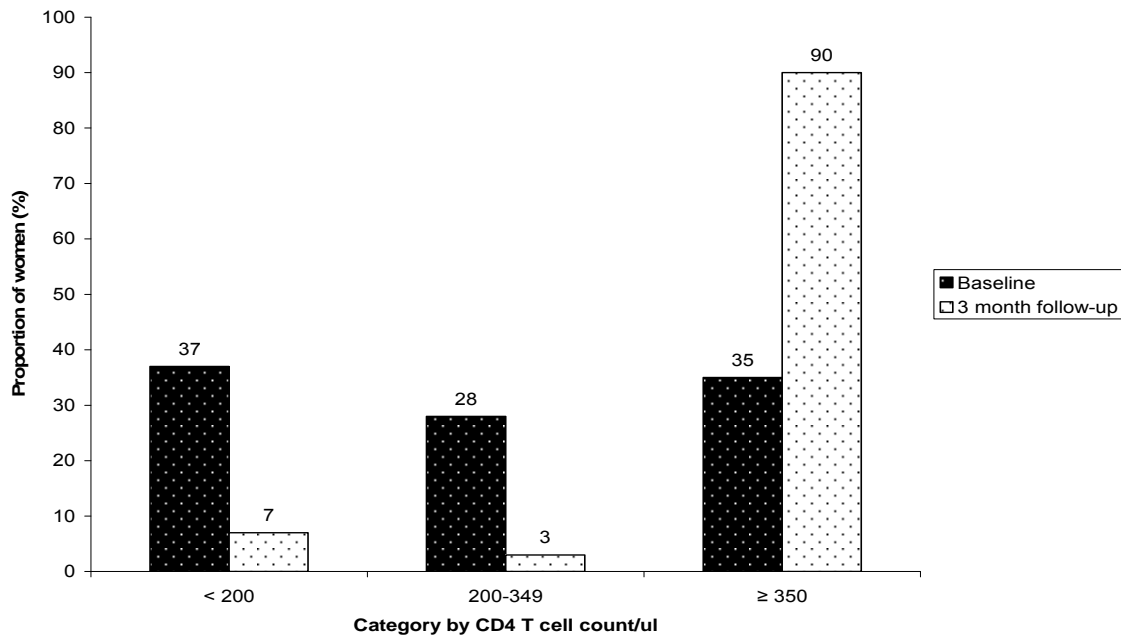


Figure 2. Proportional trend of HIV-positive women on HAART according to baseline and follow-up CD4 count categories at General Hospital, Kabba, Kogi State, Nigeria

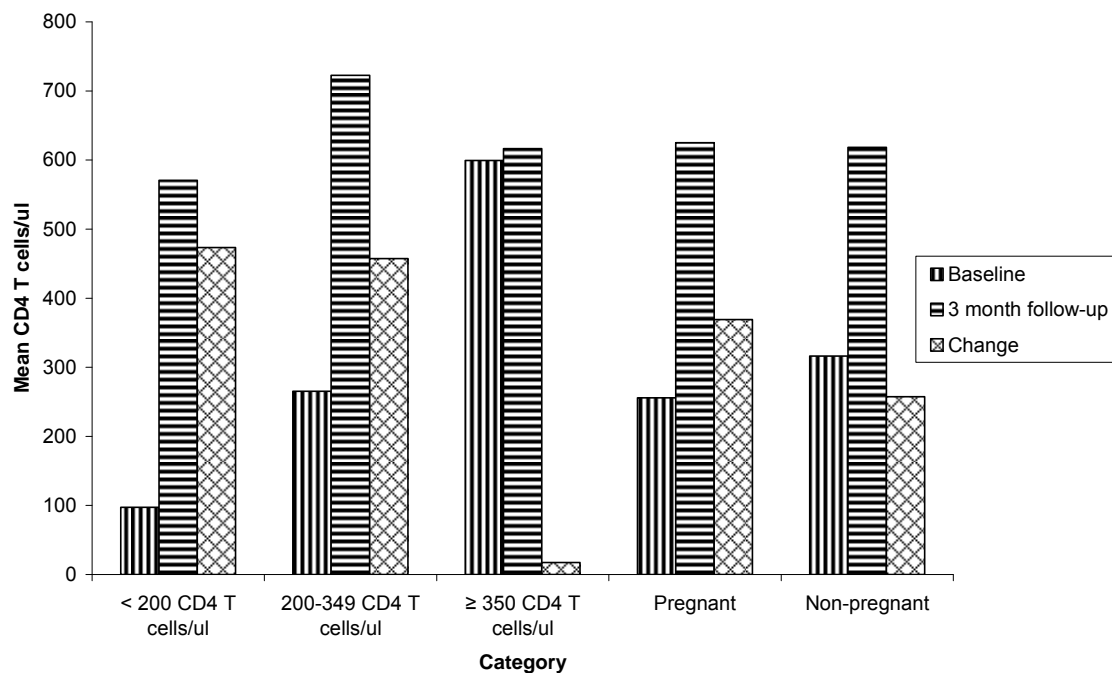


Figure 3. Mean CD4 count of HIV-positive women on HAART at General Hospital, Kabba, Kogi State, Nigeria.

Table 2. The HIV-positive women having baseline of ≥ 350 cells/ μ l with no-change or decline in CD4 count after 3 months on HAART at General Hospital, Kabba, Kogi State, Nigeria.

S/No.	Baseline	Follow-up	Change
1	867	867	0
2	423	423	0
3	946	940	-6
4	558	557	-1
5	430	430	0
6	392	392	0
7	544	544	0
8	367	367	0
9	559	559	0
10	714	714	0
11	397	397	0
12	473	470	-3
13	927	192	-735
14	694	182	-512
15	609	199	-410
16	815	200	-615
17	1,112	403	-709
18	559	193	-366
19	350	161	-189
20	450	181	-269
21	356	216	-140
22	740	193	-547

4. Discussion

This study was designed to assess the baseline and follow-up CD4 count in HIV-positive adult females initiating 3TC, d4T and NVP at General Hospital, Kabba, Kogi State, Nigeria with the view to establishing a short-term therapeutic (immunologic) benefit or lack thereof from the HAART. We observed that 37 of the women met the AIDS criteria (< 200 cells/ μ l), while 28 met the eligibility criterion for initiation of HAART according to pre-therapeutic CD4 count evaluation (WHO, 2004), Table 1.

At 3 month follow-up, 7 women still categorized as AIDS patients, 3 had 200-349 CD4 cells/ μ l with 90 women having ≥ 350 CD4 cells/ μ l (Figure 2). The 7 women that categorized as AIDS patients and 2 of the 3 that had 200-349 cells/ μ l after 3 months on HAART responded "non-adherent" to the ART regimen despite belonging to those with pre-therapeutic CD4 count of ≥ 350 cells/ μ l, Table 2.

Overall, the mean 3 month follow-up CD4 count ($n = 100$) was significantly ($P = 0.001$) higher than the mean baseline value. This indicated general immunologic benefit of the HAART to the HIV-positive women after a short-term period of 3 months. The finding that four women with pre-therapeutic AIDS-defining CD4 count of ≤ 5 cells/ μ l had mean increase of +398.25 cells/ μ l at follow-up further supported the beneficial effect of the HAART. This partly supported the findings that even advanced immune suppression can be overcome with HAART that results in CD4 counts of greater than 0.200×10^9 cells/L (Anastos, 2004) and that a CD4 count of less than 5×10^6 /L did not necessarily mean imminent death (Sabin et al., 1997). It hence implies that very low baseline CD4 count may not be as crucial to survival of HIV-positive patients on HAART as the follow-up CD4 count.

As previously reported, the statistically significant increase in the CD4 count of the women could be due to accelerated CD4⁺ T cell increase that occurs within first few months in HIV-positive patients after initiating first line ART (Bucy et al., 1999; Carcelain et al., 1999).

All the women in the < 200 cells/ μ l and 200-349 cells/ μ l groups had significantly ($P = 0.001$) higher mean CD4 count at follow-up compared to their corresponding mean baseline counts. Contrary however, was the case for the women in the ≥ 350 cells/ μ l group who had mean increase of 17.29 CD4 cells/ μ l (Figure 3) with no significant ($P = 0.80$) difference between their mean follow-up and baseline CD4 counts. The women with pre-therapeutic CD4 count of < 349 cells/ μ l therefore appeared to have more immunologic benefit than those having ≥ 350 CD4 cells/ μ l prior to HAART. Similar observations had been previously reported but in a long-term study (Erhabor et al., 2006). Though the three pre-therapeutic groups of the women differed significantly ($P = 0.001$) in mean baseline CD4 counts; at follow-up, each mean CD4 counts of the < 200 cells/ μ l and 200-349 cells/ μ l groups became comparable ($P = 0.47$ and $P = 0.12$) to that of ≥ 350 cells/ μ l group. We observed that the mean follow-up CD4 count of the 200-349 cells/ μ l group was significantly ($P = 0.03$) higher than that of the < 200 cells/ μ l group. This observation indicated poor immunologic response to HAART for those HIV-women having severely depleted

CD4⁺ T cells (i.e. < 200 cells/ μ l). As regards mean change in CD4 counts, both the < 200 cells/ μ l and 200-349 cells/ μ l groups had significantly ($P = 0.001$) higher mean change in CD4 count than that of the ≥ 350 cells/ μ l group, but the < 200 cells/ μ l and 200-349 cells/ μ l groups had comparable ($P = 0.80$) mean change, Figure 3.

With reference to only the women in the < 200 cells/ μ l and 200-349 cells/ μ l groups ($n = 65$), the change in CD4⁺ T cell count ranged from 122.0 to 1,106.0 CD4 cells/ μ l with mean change of 466.37 CD4 cells/ μ l in 3 months (assuming 90 days), this gave a mean change of about 5.18 CD4 cells/ μ l per day for each HIV-positive woman.

Comparison of the pregnant and non-pregnant subsets revealed each group had significantly ($P = 0.001$) higher mean CD4 count at follow-up than the corresponding mean baseline values. We observed that, though the two groups were just statistically ($P = 0.05$) different at mean baseline CD4 counts, they however became comparable at follow-up ($P = 0.90$). These observations showed that the 2 groups had short-term immunologic benefit from the HAART. We observed that 10 and 7 non-pregnant women respectively experience decline and no-change in CD4 count at follow-up, while only 3 each had corresponding experiences among the pregnant. Furthermore, all these 23 women were a subset of the 26 who responded "non-adherence" to ART who also belonged to the ≥ 350 cells/ μ l group. With these observations, the effect(s) of pregnancy on the change in CD4 count could not be clearly established as the non-pregnant had greater numbers of women with decline and no-change in CD4 count compared to the pregnant. A reason, for this could be the greater number of non-pregnant women in this study. A study with equal proportion of both subsets might reveal otherwise.

We recorded a composite observation that the women who responded "adherence" had significantly higher mean follow-up CD4 count compared to their baseline values unlike the significant decline among the "non-adherent" and significantly higher mean follow-up CD4 count of the "adherent" compared to that of the "non-adherent". These pointed to the positive role played by "adherence" to HAART on the CD4⁺ T cell response after 3 months. Furthermore, we observed that 9 "adherent" women belonging to ≥ 350 cells/ μ l group had significant increase in their mean CD4 count at follow-up (data not shown) and that this was significantly higher than the corresponding value of the 26 "non-adherent", this underscored the immunologic benefit of the HAART to these 9 "adherent" HIV-positive women vis-à-vis their pre-therapeutic CD4 count that was ≥ 350 cells/ μ l. It implied therefore that rather than pre-therapeutic value of ≥ 350 CD4 cells/ μ l, it was "non-adherence" to ART regimen that was apparently responsible for the non-beneficiary effect of the HAART to those who still had < 349 cells/ μ l after the 3 months.

We recorded that all the 26 "non-adherent" HIV-positive women had pre-therapeutic CD4 count of ≥ 350 cells/ μ l and that the majority of women with decline and no-change in CD4 count after 3 months also belonged to this CD4 count category (Table 2); we therefore suggested that having CD4 count above the HAART eligibility criterion probably predisposed the women to "care-free" attitude regarding compliance with the HAART regimen.

Unlike the study of Erhabor et al. (2006) who though studied 53 males and 47 females (aged: 18-56 yrs) in University of Port-Harcourt Teaching Hospital, Nigeria, and observed higher mean increase in CD4 count among the < 200 cells/ μ l group than that of the 200-350 cells/ μ l group; we observed the reverse in this study (Figure 3). The same study by Erhabor et al. (2006) concluded that there was no long-term advantage in initiating HAART at a pre-therapeutic CD4 count of > 350 cells/ μ l; we could not clearly compare the therapeutic benefit experienced by the 9 “adherent” women having \geq 350 cells/ μ l with those studied by Erhabor et al. (2006) because of the short-term period of our own study (3 months) and smaller sample size.

The mean CD4 count of 2,209.40 cells/ μ l recorded for the 5 controls was higher than the 818 cells/ μ l reported for 89 HIV-seronegative female miners (mean age: 37.5 yrs) in Jos, Nigeria (Aina et al., 2005) and the mean CD4 count of 1,295 cells/ μ l for 100 healthy controls (age 18-38 yrs) in a similar study in Kano, Nigeria (Nwokedi et al., 2007). The mean baseline CD4 count of 320.03 cells/ μ l observed here was slightly higher than mean baseline count (302 cells/ μ l) for 500 males and females HIV-positive patients reported by Nwokedi et al. (2007) and clearly higher than corresponding value of 255 cells/ μ l for 37 male and female HIV-patients studied by Mirabeau et al. (2005). The latter reported mean follow-up of 284 cells/ μ l at week 12 (3 months) for the same HIV-patients; Gautam et al. (2008) also recorded 278 cells/ μ l as the mean CD4 count after 3 months on HAART for 43 drug-naïve AIDS patients in new Delhi, India. These 2 mean values were both lower than the follow-up CD4 count of 620.92 cells/ μ l observed in this study.

We observed that both the women who responded “yes” and “no” to having diabetes/hepatitis had mean follow-up CD4 counts that were significantly ($P = 0.001$) higher than their respective mean baseline values, this reflected the two groups equally benefited from the therapy. Their statistically comparable ($P = 0.62$) mean follow-up CD4 counts apparently pointed to no observable effect of the clinical conditions on the CD4⁺ T cell response of the HIV-positive women after 3 months on HAART. This was in support of some previous studies that diabetes and hepatitis had no impact on HAART effectiveness (Omland et al., 2008; Law et al., 2004; Konopnicki et al., 2005; Gallant, 2001).

We concluded that the HAART was more immunologically beneficial over the 3-month period to the HIV-positive women with pre-therapeutic CD4 count of \leq 349 cells/ μ l than those with \geq 350 cells/ μ l. And that, in all, 75% of the women had short-term therapeutic benefit as shown by their appreciable CD4 count increase. But rather than the pre-therapeutic CD4 count of \geq 350 cells/ μ l or having diabetes/hepatitis, it was “non-adherence” to HAART regimen that apparently accounted for lack of therapeutic benefit among the 10 women who had < 200 (AIDS-defining) and 200-349 CD4 cells/ μ l, as well as, for those in the \geq 350 cells/ μ l group with decline or no-change in CD4 count after 3 months on HAART. The benefit of the therapy or lack thereof to those with \geq 350 cells/ μ l at baseline needs to be re-assessed among larger number of HIV-positive women initiating 3TC, d4T and NVP. Adherence to ART regimen needs to be continually

emphasized to intending users of HAART to increase the chance of benefiting from the therapy and to forestall possible emergence of ARV-resistant strains of HIV.

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