SciMedCentral

Clinical Research in HIV/ AIDS

Research Article

Predictors of CD4 Count Changes after Initiation of Antiretroviral Treatment in University of Gondar Hospital, Gondar in Ethiopia

Mihiretu M. Kebede[1]*, Desalegn T. Zegeye[2] and Berihun M. Zeleke[2,3]

[1]University of Gondar Hospital, Gondar in Ethiopia, Japan
[2]Department of Epidemiology and Biostatistics, University of Gondar, Ethiopia
[3]Department of Public Health & Preventive Medicine, Monash University, Australia

***Corresponding author**
Mihiretu M. Kebede, Department of Health Informatics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia, Tel: 251-913-173-333; Email: mihiretaabush@gmail.com

Submitted: 21 July 2014

Accepted: 20 August 2014

Published: 20 August 2014

Keywords
- CD4 count
- CD4 count change
- Antiretroviral treatment

Abstract

Background: The effort for preventing HIV/AIDS (Human Immune Deficiency Syndrome/Acquired Immune Deficiency Syndrome) ranges from behavioral intervention to introduction of antiretroviral Treatment (ART) program. ART has dramatically improved the livelihood of people living with HIV/AIDS. World Health Organization(WHO) recommends the optimum time for initiating ART should be guided by CD4 (Cluster Differentiation 4) count and clinical staging. Predictors of the change of CD4 count after initiation of ART are important for patient monitoring and AIDS prognosis prediction. This study aimed to investigate predictors of CD4 count change among patients on ART in University of Gondar Hospital, North West Ethiopia.

Methods: A cross sectional study was conducted among HIV/AIDS patients taking ART. A total of 2935 adults having at least two CD4 count values were included in the study. The study used both the ART data base and reviewed patient charts. The primary outcome measure was CD4 count change. Correlation and multiple linear regression analysis were used to identify predictors of CD4 count change.

Result and discussion: The median CD4 count has increased from 139 cells/ul at the initiation of ART to 356 cells/ul at the most recent visit. A median CD4 count change of 208 (IQR 224) cells/microliter was observed after 194.4(IQR 148.6) weeks on ART. The median rate of CD4+ T cell increase was1.06 cells/week on ART. Age (β = 97.59, p=0.000), Baseline CD4 count (β = 0.222, p=0.000), hemoglobin level (β = 4.029, p=0.000) were significant predictors of CD4 count change. Patient's functional status when commencing ART, WHO clinical stage, ART adherence status, cotrimoxasole adherence status, educational status, marital status were also found to be significant predictors of CD4 count change.

Conclusion: Age when starting ART, educational status, marital status, WHO clinical staging, baseline hemoglobin level, baseline CD4 count, ART adherence status, cotrimoxasole adherence status, functional status, and recent follow up CD4 are significant predictors of CD4 count change. Clinicians need to closely monitor patients who initiated ART at a lower baseline hemoglobin level, and/or CD4 count level.

ABBREVIATIONS

AIDS: Acquired Immune Deficiency Syndrome; ART: Anti-Retroviral Treatment; CD4: Cluster Differentiation 4; CD8: Cluster Differentiation 8; CDC: Center for Disease Control; HAART: Highly Active Anti-Retroviral Treatment; HIV: Human Immunodeficiency Virus; I-TECH: International Training and Education and Center on HIV/AIDS; WHO: World Health Organization

INTRODUCTION

International and national guidelines advocate the use of CD4 count for treatment decisions, as a predictor of disease progression, a criterion for treatment initiation, and as a marker of treatment outcome in both adults and children. Therefore it is recommended at multiple instants in the course of patient care. After tested for HIV, positive results will go to CD4 count for staging the disease and assessing eligibility for ART. Most guidelines say an adult patient is eligible for ART, if his/her CD4 count is less than 200 or 350 cells per micro liter. After starting ART it is recommended to have CD4 counts every 3-6 months, but if a patient is not initially eligible, it is recommended to have every 6-12 months. As ART program is expanding the need for CD4 count becomes very high [1].

The effort for preventing HIV/AIDS ranges from behavioral intervention to introduction of ART program [2]. Once ART is started, it is needed to take the treatment throughout lifetime, and because of the associated side effects long term continuation is found to be a major challenge. Because of this problem, WHO recommends the optimum time for initiating ART should be

guided by CD4 count and clinical staging. In developed countries plasma viral load (viral load rising above 10,000 copies/μl) and CD4 counts are used to for monitoring and assessment of initiating therapy [3]. But in developing countries, where resources are limited and access to advanced laboratory set up is not widely available, WHO clinical staging is mainly followed to initiate therapy [3,4]. However, WHO continuously advocates wider access to monitoring tools, particularly CD4 testing, to guide the initiation and monitoring of ART [4].

A research done in South Africa however tells that treatment shall be initiated immediately after one is known to be infected with HIV independent of CD4 or viral load results, meaning to initiate anti-retroviral therapy HIV status is enough. And it claims this strategy would save lives and resources that have been lost for CD4 and viral load monitoring by the previous strategies [5]. Ethiopia uses WHO clinical staging which recommends clinical stage 1 and 2 should have access to CD4 testing to decide when to initiate treatment and CD4 count ≤350/mm3 irrespective of clinical stage for initiation of therapies & patient monitoring; and patients with clinical staging 3 and 4 should start treatment irrespective of CD4 count [6].

Predictors of the changes of CD4 count that ART will come up with are numerous. Studies around the world reported that ethnicity, pre ART CD4 and CD8 cell count, Viral load [7], duration of ART and functional status [8] as significant predictors of CD4 count change. Total leukocyte count, hemoglobin level, gender, history of AIDS, and weight predicted CD4 count recovery [9].

Literatures that are aimed to predict the absolute CD4 count change is lacking in Ethiopia. This study would be very helpful to look further our client's future and to make some recommendations for better progress, management and resource allocation.

WHO health statistics 2011 reports the number of people living with HIV/AIDS grows to an estimated 33.3 million in 2009, 23% higher than what was in 1999. The overall growth of this pandemic remain stabilized and the new infection rate is 19% lower than 1999. The increasing number of people living with HIV is due to the wide use of life prolonging effects of ART. In December 2009, ART was available for more than 6 million people globally. Yet, availability of ART service coverage remain low (36%) in low and middle income countries with significant variation across regions. Africa has 37% of ART coverage, with 3.9 million people are receiving ART [10].

The February 2010 Ethiopian monthly ART update report, reports there are cumulative number of people ever started ART are 246,347 with significant variation in age groups. Non pregnant females greater than 14 years of age account the highest number (125,599) [11]. The 2007 single point estimate reports the adult prevalence of HIV/AIDS to be 2.7% in 2011(7.7% urban and 0.9% rural) [12].

The life expectancy of people living with HIV is increasing because of the effects of ART. Initiation of therapy in our country is mainly guided by CD4 count and WHO staging. And the need to follow patients taking ART is important to monitor their progress. But following patients for a long period of time requires human, material and financial resources. It requires serial measurement of CD4 counts, which is complex cytometric procedure requiring highly standardized laboratory and well trained professionals.

The change in CD4 count is the difference between base line CD4 and most recent follow up CD4 counts. The base line CD4 count is the Initial CD4 count measured when a patient is ever enrolled on ART. There will be follow up CD4 counts measured after being enrolled on ART to assess immune system reconstitution. Therefore there will definitely be a change in CD4 counts, either negative, zero or positive. CD4 count change is affected by numerous predictors so this study will investigate different factors associated with CD4 count change after initiation of ART.

OBJECTIVES

The objective of this study is to identify predictors of CD4 count changes in University of Gondar Hospital, North West of Ethiopia, 2013.

METHODS

Ethical considerations

Ethical approval was obtained from the institute of Public Health and college of Medicine and Health Science, University of Gondar and support letter was obtained from University of Gondar Hospital. This research was done using secondary data and all study subjects within the ART data base are anonymized for the purpose of de-identification and maintaining confidentiality. The data set is kept confidential. It is protected by using password to protect it from unwanted manipulations and unethical usage.

Study setting

This study was conducted in University of Gondar Hospital in 2013. University of Gondar Hospital started free ART service since March 2005.In December 2012, the university hospital reported a total of 6444 patients have ever enrolled for ART, among these 3888 (1561 male, 2327 female) were reported actively taking the treatment. 77 (36 male, 41 females) of the 3888 are taking second line the remaining 3412 are under first line regimen. The hospital's ART Clinic is constructed by 2 physicians,1 Master of Public Health professional (RH), 2 Health Officers, 6 Nurses (2 Degree Nurse, 4 Diploma Nurses), 2 data clerks, 2 data base administrators, 3 case managers, 8 adherence counselors and 2 cleaners. The facility is linked with laboratory department which has CD4 counting machines (1 Celldyn and 1 FACS Callybur CD4 counting machines).

Study design

Cross sectional study was conducted. Variables were taken both from the ART data base and patients' cards. The primary outcome measure was CD4 count change which can be calculated by subtracting baseline CD4 count from most recent follow up CD4 count. Socio-demographic variables, baseline and follow up clinical as well as laboratory variables were included as independent variables.

Data collection

Data was collected both from ART data base and from the review of patient charts. The ART electronic data base was an

MS access data base composed of many tables and relationships including the baseline and the follow up tables. Around 20 variables were taken from the MS Access data base and changed in to the excel spread sheet format.

As discussed earlier, part of the data was collected from the ART data base, and it was collected by the ART data base administrator, and the manually entered data was collected by one ART Nurse working in the ART clinic and Card Clerk working together. The data base which is collected for their own purpose does not include all the required variables important for predicting CD4 count changes. That is why there was a need to include excel manual extraction format prepared by the investigator for the purpose of this research. One card clerk and one computer literate ART nurse entered the manual extraction format from the patient card folders by taking out the patient card folders from the archive department. At the same time, this manually extracted document is appended with the electronic data sets by using the patient identifier code called Medical Record Number. With this number, the data base and the data collected from the manual patient card folder are connected together to produce one excel spreadsheet data format with the required variables. From this excel sheet, some variables like CD4 count change, time gap in a week were computed from the baseline and follow up data using the excel insert function applications. The CD4 count change is derived from the baseline and the current CD4 counts, by subtracting the baseline CD4 count from the most recent follow up count. And the time gap in week, which is the time that ART user has been on ART since he/she started is calculated by the following formula inserted in the excel insert formula application.

The formula comes from the idea that there are 7 days in a week, there are 30/4 weeks in a month and there are around 52.14 weeks in a year. Using this concept, the following equation was derived. Day, month and year were written in Ethiopian calendar in separate columns in excel sheet. The Ethiopian calendar has 13 months in one year and 30 days in each month but the 13th month has only 5.25 days. Therefore the formula doesn't work for the 13th month, Pagume. To avoid this problem, while entering the data , if we have any date in Pagume (Ethiopian 13th month), we changed the ART start day by adding the days in pagume, and the follow up date will also slide to another new date by considering the number of days added.

Duration of ART = ((Follow up day – ART start day)/7 + (Follow up month – ART start month)*30/4 + (Follow up Year – ART start year)*52.14)

Assume that, ART start day as "d1", follow up day "d2", ART start month "m1", follow up month "m2", ART start year "y1" and follow up year "y2", it can be simplified by the following equation.

Duration of ART = ((d2-d1)/7 + (m2-m1)*30/4 + (y2-y1)*52.14)

Data quality

The principal investigator gave training how to fill the manual extraction formats and supervises the overall quality of data collection process and also the investigator was together with the data collectors in almost all the time during the data collection. While filling the excel manual extraction format part of the data was checked by crosschecking the electronic based data sets with the paper based documents and check out for matches and also many of the manually filled documents were cross checked for similarity and consistency with the electronic data sets.

Source population

All HIV positive patients dataset is present in the ART clinic.

Study population

All adult ART clients dataset which is registered in the ART data base and has baseline and follow up CD4 counts was included in the study.

Inclusion criteria: All adult (age greater than 14) ART clients who started ART and have baseline and follow up CD4 count after starting ART.

Exclusion Criteria: Clients who started ART and their information is incomplete, unreadable or their manual record is lost, and also clients who have not at least one follow up CD4 count measure.

Sample size and sampling procedures

From all the 3888 adults who ever started ART and actively taking the drug during the time this investigation is undertaken, a total of 2935(75.5%) were included in this study. The remaining ART users were under the exclusion criteria and were not included.

Operational definitions

ΔCD4- it is the difference between base line CD4 and most recent follow up CD4 counts

Time gap the difference between the date (MM/DD/YYYY) when 1st CD4 count is measured at the start of ART and the date (MM/DD/YYYY) when most up-to-date CD4 count is measured. It is calculated by the following formula entered in excel functions.

Duration of ART in weeks = ((d2-d1)/7 + (m2-m1)*30/4 + (y2-y1)*52.14)

Good ART Adherence: People living with HIV/AIDS on antiretroviral therapy registered to have taken 95% or higher of their prescribed ART medication or missed <= 3 doses as to their agreement with health care provider.

Poor ART Adherence: level of Adherence below 95% of their prescribed ART medication or missed >3 doses as to their agreement with health care provider.

Good Cotrimoxasole adherence: Patients who are on ART and are registered to have taken 95% or higher of the prescribed cotrimoxasazole medications or missed <= 3 doses as to their agreement with health care provider.

Poor Cotrimoxazole adherence: Registered level of Adherence below 95% of their prescribed Cotrimoxazole medication or missed >3 doses of cotrimoxasazole as to their agreement with health care provider.

Data processing and analysis

The data identified for data analysis was collected,

preprocessed, assessed, consolidated, cleaned, recoded, transformed and changed to appropriate format to be ready for analysis.

The MS excel 2013 spreadsheet format is transported in to SPSS version 20, variables recoded and analyzed. Descriptive statistics were used to describe the socio-demographic characteristics of study participants. Pearson correlation and point biseries correlation statistics were computed to investigate the correlation between the independent variables and dependent variable. Bivariate and multivariate linear regression analyses were used to identify associated predictors. Model fit was examined using Omnibus comparison test. Tolerance or Variance inflation factor, Eigen values and condition index were used as colliniarity diagnostic tools. Regression coefficients of the final model and their 95% confidence intervals were used as measures of association between the predictors and dependent variable. A p value of less than .05 was considered to be statistically significant.

RESULT

Baseline characteristics

Of the total of 2935 patients who were included in this study, 60.9% (1785) were females and 48.6% (1426) of them were married. The mean age of the clients is about 33.5 years (SD 8.63), nearly half of them (48.6%) were married (Table 1).

The mean baseline hemoglobin level was 13.2 mg/dl (SD 2.27). The mean weight and CD4/CD8 ratio of patients when started the ART was 49kg (SD 9.232) and 0.19(SD 0.15) respectively. The median CD4 count, CD8 cell count and platelet count of patients was 139 cells/µl, 853cells/µl, 259,000 cells/µl respectively.

Of the total patients who started ART, 79.3% of patients were with functional status of working and 60.7% of patients were on WHO stage III at the initiation of ART. About 37% of patients were taking AZT-3TC-NVP ART regimen. And for 33.4% of patients who were on ART, their original regimen was changed to other combination during their follow up period (Table 2).

The median CD4 count has increased from 139 cells/ul, at the initiation of ART to 356 cells/ul, at the most recent visit. A median CD4 count change of 208 (IQR 224) cells/µl was observed after 194.4(IQR 148.6) weeks on ART (Figure 1). The median rate of CD4+ T cell increase was 1.06 cells/week on ART.

Predictors of CD4 count change

A multivariate linear regression model is built and the model fit shows 80.7% of the variability in CD4 count change is explained by the model. The mode is significant: Omnibus test (F=219.925, p<0.001). Multicollinearity among predictors was less evident, because the variance inflation factor, Tolerance, Eigen values and the condition indices were all very good.

The factors found to predict CD4 count and their associated beta coefficients are shown in Table 3. In univariate analysis baseline CD4 count (r=0.104, p=0.000), age at the initiation of ART(r=0.289, p=0.000), duration of ART(r=0.268, p=0.000) and recent follow up CD4 count (r=0.885, p=0.000) were significantly correlated with CD4 count change. Sex (point bi-series correlation r= -0.1, p=0.000), poor ART adherence (Point bi-series correlation r=-0.197, p=0.000), poor Cotrimoxasole adherence (Point bi-series correlation r=-0.16, p=0.000) were also significantly correlated with CD4 count change.

Table 1: Socio-demographic characteristics of patients on ART in University of Gondar Hospital, 2013.

Variables		Frequency	%
Sex	Female	1785	**60.9**
	Male	1150	39.2
Educational status	No formal education	792	27.0
	Primary	887	30.2
	Secondary	888	30.3
	Tertiary	368	12.5
Employment	Employed	568	19.4
	Farmer	329	11.2
	Not Employed	124	4.2
	Retired	13	0.4
	Self Employed	1901	**64.8**
Marital Status	Divorced	407	13.9
	Married	1426	**48.6**
	Separated	647	22
	Single	83	2.8
	Widow/widower	372	12.7
Religion	Orthodox	2699	**92.0**
	Muslim	208	7.1
	Others	28	1
Total		2935	100

Table 2: Clinical and follow up characters tics of patients who were on ART in University of Gondar Hospital, 2013.

Variable		Frequency	Percentage
Functional status	Ambulatory	497	16.9
	Bedridden	120	4.1
	Working	2318	79
WHO clinical stage	Stage I	298	10.2
	Stage II	478	16.3
	Stage III	1783	60.7
	Stage IV	376	12.8
Type of ART regimen	AZT-3TC-NVP	1092	37.1
	AZT-3TC-EFV	352	12
	d4t(30)-3TC-EFV	300	10.2
	d4t(30)-3TC-NVP	634	21.6
	d4t(40)-3TC-EFV	11	0.4
	d4t(40)-3TC-NVP	33	1.1
	OTHER	513	17.5
ART adherence status	Good	2899	98.8
	Poor	36	1.2
Cotrimoxasole adherence status	Good	2905	99
	Poor	30	1
Regimen change	Yes	979	33.4
	No	1956	66.6

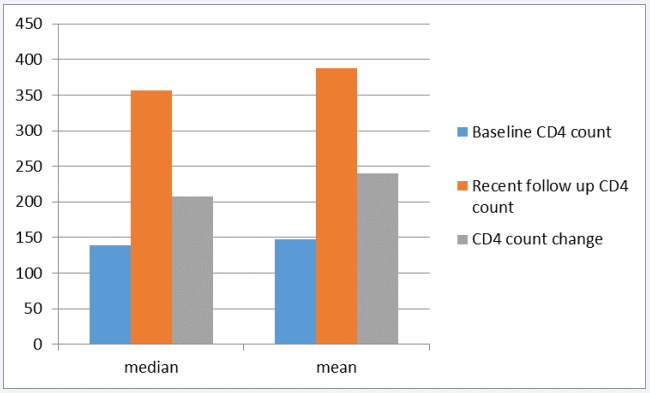

Figure 1 The median and mean CD4 count change among patients on ART in University of Gondar Hospital, 2013.

It is known that many factors could influence CD4 count change. In a multiple linear regression analysis model that included many factors, the association of several factors with CD4 count change was investigated. Variables including age at the initiation of ART (β=97.59, p value 0.000), baseline CD4 count (β =0.22, p value 0.000), baseline hemoglobin level (Beta=4.029, p value 0.000), poor ART adherence status (β =-111.2, p value 0.000), poor Cotrimoxasole adherence status (Beta=-60.88, p value .014), secondary Educational status(β = 11.2, p value 0.024), bedridden functional status of the patient at the initiation of ART(β =-22.13, p value 0.016), WHO clinical stage of the patient and recent follow up CD4 count were significantly associated with the CD4 count change (Table 3).

Sex, religion, employment status, CD8 cell count, CD4/CD8 ratio, platelet count, the type of ART regimen at start, condition of

Table 3: Multivariate predictors of CD4 count change among patients on ART in University of Gondar Hospital, 2013.

Predictor Variable	Pearson Correlation/or Point-Biseries correlation		Regression			
	R	P value	Coefficient	SE	95%CI	P value
Intercept			-218	22.4	-261.9, -174	.000
Baseline CD4 count	0.104	0.000	0.222	0.058	0.108, 0.336	.000
Hemoglobin	0.056	0.000	4.029	1.573	0.946, 7.113	.01
Education						
No formal education	Ref	Ref	Ref	Ref	Ref	Ref
Primary	-0.030	0.073	0.66	4.88	-8.9, 10.2	.897
Secondary	0.034	0.051	11.2	4.98	1.45, 20.97	**.024**
Tertiary	0.048	0.011	4.24	7.29	-10.06, 18.53	.124
ART adherence status						
Good	Ref	Ref	Ref	Ref	Ref	Ref
Poor	-0.197	0.000	-111.2	21.98	-154.3, -68.01	.000
Cotrimoxasole adherence status						
Good	Ref	Ref	Ref	Ref	Ref	Ref
Poor	-0.16	0.000	-60.88	24.79	-109.49, -12.27	.014
Functional status						
Working	Ref	Ref	Ref	Ref	Ref	Ref
Ambulatory	-0.065	0.001	0.58	4.88	-8.98, 10.14	0.905
Bedridden	-0.004	0.42	-22.13	9.17	-40.11, -4.14	.016
Marital Status						
Single	Ref	Ref	Ref	Ref	Ref	Ref
Married	0.047	0.013	11.78	5.47	1.05, 22.5	.031
Divorced	-0.009	0.337	17.4	6.24	5.17, 29.6	.005
Separated	-0.011	0.297	-5.69	12.05	-29.32, 17.95	.637
Widow/widower	-0.008	0.345	16.7	7.15	2.68, 30.71	.02
WHO clinical staging						
Stage I	Ref	Ref	Ref	Ref	Ref	Ref
Stage II	-0.061	0.002	23.01	7.24	8.8, 37.21	.002
Stage III	0.075	0.000	27.28	6.3	14.92, 39.63	.000
Stage IV	0.047	0.011	47.61	7.67	32.57, 62.65	.000
Recent follow up CD4 count	0.885	0.000	0.79	0.009	0.77, 0.81	.000
Age	0.289	0.000	97.59	12.9	72.23, 122.95	.000

regimen change during treatment, current ART regimen, duration of ART, Liver function test and Renal function test results were not found to be significantly associated with CD4 count change.

DISCUSSION

This study aimed to investigate the predictors of CD4 count change among patients on antiretroviral treatment in University of Gondar hospital, North West Ethiopia. The findings of this study shows that baseline CD4 count (β =0.222, p=0.000), hemoglobin (β =4.029, p=0.000), age (β =97.59, p=0.000) were significant predictors of CD4 count change. Patient's functional status when commencing ART, advanced WHO clinical stages, poor ART adherence status, poor cotrimoxasole adherence status, educational status, marital status were also found to be significant predictors of CD4 count change. Studies have shown that starting ART at higher CD4 count has better immune reconstitution and better CD4 count results [13].

A study done in Boston Massachusetts, 2005 reported that hemoglobin level and sex were significant predictors of CD4 count [14].

Patients who were bedridden when starting ART predicted a reduction in CD4 count change by 22.13 times (p value 0.016). If a patient on ART has poor antiretroviral and cotrimoxasole adherence status, there will be a reduction in CD4 count change by 111.2 (0.000) and 60.88(p value 0.014) times respectively than those who have good ART and cotrimoxasole adherence. Higher age (Beta=97.59, p=0.000), secondary education, marital status, advanced clinical stages (p=0.000) and recent CD4 count predicted improvement in CD4 count change. This finding is related with the study done in United States that has shown, patients who have self-reported poor adherence status have a loss of CD4 count [15].

The findings of this study are also consistent with research literatures that reported CD4 count change is affected by numerous predictors. CD4 count change after the initiation of ART is known to be good predictor of Health Related Quality of Life. A study done in Southern State USA reported that CD4 count change is significant predictor of Health related quality of life [16].

A retrospective cohort study by Ayalu and colleagues in Ethiopia found that duration of ART and functional status were found to be significant predictors of CD4 count change [8]. However, this study didn't find any significant association between the duration of ART and CD4 count change. This difference might be due to the difference in study design and the sample size used for this study is large.

Similar to the findings of this study, a study done in Sub Saharan Africa in 2006 by Stephan D Lawn showed the baseline CD4 count and age were significantly associated with CD4 count change [17].

LIMITATIONS

Both the ART data base and ART patient's chart are secondary sources, therefore all the problems related with using secondary data applies to this study.

This study lacks some important predictors that are known to potentially affect CD4 count change like Viral load, presence of chronic diarrhea, presence of AIDS defining illness and nutritional status of the patient need to be included if better result is to be achieved.

CONCLUSION

Age when starting ART, educational status, marital status, WHO clinical staging, baseline hemoglobin level, baseline CD4 count, ART adherence status, cotrimoxasole adherence status, functional status, and recent follow up CD4 are significant predictors of CD4 count change.

It looks evident that clinicians need to closely monitor patients who initiated ART at a lower baseline hemoglobin level, and/or CD4 count level. Strategies to improve ART and cotrimioxasole adherence need to be also encouraged. Understanding the multifactorial CD4 count change after the initiation of ART requires advanced study researches that include numerous predictors like Viral load values, nutritional status, presence of AIDS defining Illnesses.

ACKNOWLEDGEMENTS

I would like to thank the full bright scholar in Ethiopia, Professor Anna O' Connel of the Ohio State University who gave me the advanced Biostatistics training. I would also like to thank people who are working in the University Gondar Hospital ART clinic, I-TECH Ethiopia ART data base administrators and the Archive (card) room workers.

Authors' contributions

1) MK have made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data and preparation of manuscript

2) DZ have been involved in drafting the manuscript or revising it, scholarly critics for important intellectual content, have given final approval of the version to be sent for publication

3) BZ have been involved in drafting the manuscript or revising it scholarly critics for important intellectual content, have given final approval of the version to be sent for publication

REFERENCES

1. Trevor P, Emily W, Richard F, Bekezela N, Fabiana A, Yoko S, Maurine M. Challenges in Implementing CD4 Testing in Resource-Limited Settings:Cytometry Part B (Clinical Cytometry). Wiley InterScience Clinical Cytometry Society. 2008; 74: 123–130.

2. Abebe Y, Abate S, Zewde A, Alebachew A, Doherty M, Habtegiorgis A, et al. Guideline for HIV Care/ART Clinical Mentoring in Ethiopia. editors. In: Addis Ababa, Ethiopia. 2007.

3. Jaffar S, Grosskurth H, Amuron B, Namara G, Nabiryo C, Coutinho A. Use of WHO clinical stage for assessing patient eligibility to antiretroviral therapy in a routine health service setting in Jinja. Uganda AIDS Research and Therapy. 2008; 5: 4.

4. WHO. Antiretroviral Therapy for HIV infection in adults and adolescents. Recommendations for a Public Health approach. Editors. In: Geneva: WHO Press. 2006.

5. Johnstone S, Hargrove J, Williams B. Antiretroviral therapy initiated soon after HIV diagnosis as standard care: potential to save lives?. HIV/AIDS - Research and Palliative Care. 2011; 3: 9-17.

6. WHO: Antiretroviral therapy for HIV infection in adults and adolescents Recommendations for a public health approach. In: Geneva: WHO Press. 2010.

7. Smith CJ, Sabin CA, Youle MS, Loes SK-d, Lampe FC, Madge S, et al. Factors Influencing Increases in CD4 Cell Counts of HIV-Positive Persons Receiving Long-Term Highly Active Antiretroviral Therap. Infectious Diseases Society of America. 2004; 190: 1860-1868.

8. Reda AA, Biadgilign S, Deribew A, Gebre B, Deribe K. Predictors of Change in CD4 Lymphocyte Count and Weight among HIV Infected Patients on Anti-Retroviral Treatment in Ethiopia: A Retrospective Longitudinal Study. 2013; 10: 1371.

9. Mwamburi M, Ghosh M, Fauntleroy J, Gorbach SL, Wanke CA. Predicting CD4 count using total lymphocyte count: A sustainable tool for clinical decisions during haart use. The American Society of Tropical Medicine and Hygiene. 2005; 73: 58-62.

10. WHO: World Health Statistics 2011. editors. In: WHO Library Cataloguing-in-Publication Data. 2011.

11. FHAPCO-MOH. Monthly HIV care and ART updates, updates as of end of tir 2002 (February 2010), editors. In: Ethiopia, Addis Ababa: FHAPCO. February 2010.

12. FHAPCO-MOH. Single Point HIV Prevalence Estimate. editors. In: June 2007.

13. Kitahata M, Gange SS, Abraham A, Merriman B, Saag M, Justice A, et al. Effect of early versus deferred antiretroviral therapy for HIV on survival. N Engl J Med. 2009; 360: 1815–1826.

14. Mwamburi M, Ghosh M, Fauntleroy J, Gorbach SL, Wanke CA. Predicting CD4 Count Using Total Lymphocyte Count: A Sustainable Tool for Clinical Decissions During HAART Use. The American Society of Tropical Medicine and Hygiene. 2005; 73: 58-62.

15. Haubricha RH, Littlea SJ, Currierd JS, Forthalc DN, Kempere CA, Beallf GN, et al. The value of patient-reported adherence to antiretroviral therapy in predicting virologic and immunologic response. AIDS Patient Care and STDs. 1999; 13: 1099-1107.

16. Huanguang, Uphold CR, Arnp-Bc F, Wu S, Chen GJ, Duncan PW. Predictors of Changes in Health-Related Quality of Life Among Men with HIV Infection in the HAART Era. AIDS Patient Care and STDs. 2005; 19: 395-402.

17. Lawn SD, Myer L, Linda-Gail, Wood R: CD4 cell count recovery among HIV-infected patients with very advanced immunodeficiency commencing antiretroviral treatment in sub Saharan Africa. BMC Infectious Diseases. 2006; 6: 59.

Cite this article

Kebede MM, Zegeye DT, Zeleke BM (2014) Predictors of CD4 Count Changes after Initiation of Antiretroviral Treatment in University of Gondar Hospital, Gondar in Ethiopia, Japan. Clin Res HIV/AIDS 1(2): 1008.