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DETERMINANTS OF NON-ADHERENCE TO ANTIRETROVIRAL THERAPY AND MODELING PROGRESSION OF ADHERENCE LEVEL: AT YIRGALEM REGIONAL HOSPITAL, ETHIOPIA; JANUARY, 2012

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ABSTRACT

Non-adherence is a global problem and has been seen in all diseases. According to WHO, adherence to long-term therapies in chronic illnesses averages 50% in developed countries? Adherence to HAART is challenging, because patients need almost perfect adherence of at least 95 percent to keep viral load at undetectable levels as long as possible and maintain the functionality of the immune system. Poor adherence to antiretroviral therapy increases the risk of incomplete viral suppression, disease progression and death. The purpose of this study was to assess the level and factors associated with non-adherence to antiretroviral therapy. A random sample of 368 patients were taken from the ART clinic at Yirgalem Regional Hospital from September 2006 to July 2011.Adherence levels were measured using methods pill count, pill identification test, and self-report. Descriptive statistics and both Bivariate and multivariate Logistic Regression were used to analyzed the data. Homogeneous Semi-Markov Stochastic Model was used to reveal the conditional probability of staying in non-adherence. The Multivariate Logistic Regression Method showed that the gender (sex), family size, social support available to the patients, ART knowledge of the patients, time on ART in month, and baseline CD4 counts/mm^3 were significant factors associated with non-adherence to ART medications. The conditional probability of staying in non-adherence, until a given time in month was higher than staying in adherence. Thus, it is suggested that health-care providers need to be watchful about adherence levels of patients. Specifically males, who have been on ART for several months, living in large family members, lack of social support, having high baseline CD4 counts/mm^3, and having poor knowledge of ART.

Keywords: ART, Conditional probability, Adherence levels and factors related to non-adherence.

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Contribution/ Originality

ZAI conceived and designed the study. He also wrote the paper. AT contributed in the design, conduct and write-up of the paper. He also approved the manuscript. TTT, HTA and CMA contributed in the conduct and analysis of the study. Also, they prepared the manuscript. All of the authors have read and approved the manuscript.

1. INTRODUCTION

1.1. Background of the Study

Earlier projections had suggested that about 45 million people would be infected between 2002 and 2010 unless the world succeeded with concerted preventive effort [1]. The number of people living with HIV/AIDS (PLWHA) in Ethiopia is about 1 million, with prevalence in the urban and rural population 7.7% and 0.9% respectively [2, 3]. The introduction of highly active anti-retroviral therapy (HAART) in 1996 recommended protocol for the treatment of human immunodeficiency virus type 1 (HIV-1) infection significantly decreased morbidity and mortality rates across high-income countries, by reducing often viral replication to undetectable levels [4]. However, complete eradication is not feasible with the current treatment options: drug-resistant variants can ultimately develop in patients even under HAART pressure. Though; adherence may play a crucial role for the development time. It is important to note that non-adherence includes not taking medications at prescribed time intervals and non-compliance to dosing instructions regarding dietary or fluid intake [5]. It is necessary to understand the degree of medication adherence needed to effectively and durably control HIV replication. The viral mutants display different degrees of decreasing susceptibility to the ongoing treatment regimen and often cross resistance to other agents. This results in virology rebound and eventually disease progression [6].

There has been important progress over the past decade in simplifying dosing frequency and pill burden [7]. Patients who develop acquired resistance may transmit these drug-resistant strains. Non-adherence in patients on anti-HIV therapy is the strongest predictor of failure to achieve viral suppression below the level of detection [8].

1.2. Statement of the Problem

It is known that adherence to HAART is challenging, because patients need almost perfect adherence of at least 95 percent to keep viral load at undetectable levels as long as possible and maintain the functionality of the immune system. Poor adherence to antiretroviral therapy increases the risk of incomplete viral suppression, disease progression, and death [5]. Although the use of highly active antiretroviral therapy in the treatment of HIV infection has led to considerable improvement in morbidity and mortality; without strict patient adherence to complex drug regimens; viral replication may ensue and drug-resistant strains of the virus may emerge [9]. A recent study of adherence levels found that a pooled estimate of only 77 percent of people taking antiretroviral medications in sub-Saharan Africa adhered to the regimen [10].

Depending on the drug under study, Adherence to ARV varies between 37 to 83 percent [11]. Several studies have shown varying levels of adherence. More than 10 percent of patients report missing one or more medication doses on any given day. and more than 33 percent report missing doses in the past two to four weeks [12].

In the Ethiopian setting; studies reported 81.2% and 82.8% adherence to more than 95% of doses [13, 14]. Prevalence of adherence in the week before interview was 74.2%. Main reasons of non-adherence cited by the patients were being busy or simply forgetting (51%), change in daily routine (9.4%). and being away from home (8.3%). Non-adherence was commoner among patients reporting symptoms in the past four weeks [15].

1.3. Significance of the Study

Taking ART medicines is not an easy task since it is life-long treatment. Non-adherence remains a major concern and this necessitates the need for the development of interventions to maintain optimal adherence. What is compulsory from HIV patients is extended (lifetime) adherence to ART. As a result, it is important to estimate the adherence rate over time. However such studies are limited in the literature, hence the motivation for this study. It is hoped that the findings generated from this study might have several contributions; studies show that adherence tends to decrease over time and in this study the lifetime of adherence is predicted. The qualitative and quantitative information collected in this study may be made available to health planners like Ministry of Health.

1.4. Objectives of the Study

1.4.1. General Objective

The general objective is to determine the level of adherence of patients to ART, factors affecting it and to predict the lifetime of optimal adherence in the ART clinic of Yirgalem Hospital from March to June, 2003 E.C.

1.4.2. Specific Objectives

The specific objectives of this study are:-

- To determine the proportion of adherent and non-adherent clients to ART in the Clinic of Yirgalem Hospital.
- To determine factors responsible for non-adherence to ART in the Clinic.
- To Predict the Transition time of Adherence Level of HIV/AIDS Patient

2. METHODOLOGY

2.1. Study Area and Population

A cross sectional study was conducted at Yirgalem Regional Hospital. The town has a total population of 215,693 and located 317 Km South of Addis Ababa. In April 2003, ART delivery had started at Yirgalem Regional Hospital with aid from the Norwegian Lutheran Mission

(NLM). The target population of the study was adult HIV/AIDS patients taking combined antiretroviral therapy (ART) at the ART Clinic of the Hospital from 2006 to July, 2011.

2.2. Inclusion and Exclusion Criteria

The study was considering all HIV patients following ART and been on ARVs treatment for 3 months or more during the study period. Participants had to be at least 15 years of age, medically eligible for ART initiation, and willing to give written informed consent for enrolment. Those patients who have Co-infection for TB and other chronic disease were eliminated from this study.

2.3. Study Variables

Dependent variable: Adherence status "of HIV patients

The Independent variables: Demographic data, Psychological variables (Feeling Depression, Confidence to disclose HIV status, partners Support); Disease related variables (Reasons for not taking medicine as prescribed, Side effects experienced, Frequency of side effects and Distance traveled to get service); Patient-care provider relationship and treatment regimen

2.4. Operational Definition

The best response to ART is seen when adherence is 100%. Levels of adherence below 95% have been associated wit**h** poor suppression of HIV viral load and a lower increase in CD4 count. If a patient is taking treatment once daily, twice a day and three times a day; 95% adherence means missing no more than one, three and four dose a month respectively.

2.5. Sample Size and Sample Selection Procedure

Sample size: The sample size for this study was for proportions under 95% confidence level and suppose the maximum allowable difference between the maximum likelihood estimate and the unknown population parameter, denoted by d, desired to be 0.05, i.e. an absolute precision of d=0.05.

The sample size was calculated as:

$$n = \frac{Z^2 p(1-p)}{d^2} = (1.96)^2(0.3)(0.7)/0.05 = 322 \text{ plus } 10\% \text{ non-response} = 358$$

Where Z is the upper $\alpha/2$ points of standard normal distribution with α =0.05 significance level, which is Z =1.96. The degree of precision d usually is set by the investigator. The parameter p=0.3represents proportion of non-adherent taken from literatures.

2.6. Sampling Procedure

Simple random sampling was a basic probability selection scheme in which a predetermined number of units from a population list were selected, so that each unit on that list has an equal

chance of being included in the sample. In this study, from the sampling frame; those who started the medication in the ART Clinic of the Hospital and those who had been transferred from other facilities were given sequential order number. A simple random sampling procedure was then applied on this list. The Clinic's appointment record logbook was also be used in order to select patients who were going to come on that data collection day. During the random sampling process patients who didn't come at the time of the study and those who lost or transferred to other ART center were being substituted by the next random number. The patients who had been selected by simple random sampling procedure were expected to give their response during their visit to the Clinic.

Data collection and source of data: Primary and secondary data was incorporated; the ART Clinic's register was used to retrieve data on: types of regimen, disease stage, patient's adherence level, and duration of therapy. Primary data were collected through a structured questionnaire that was designed to gather information on Socio-economic, Demographic, Psychosocial, Treatment regimen, Patient characteristic, and Service provision variables. The ART Clinic's register was the only sampling frame for this study because ART register is exhaustive, non-repetitive, traceable list of patients on ART who was coming to the Clinic for their regular drug refill and some of them for medical follow up during the months March to July, 2011. Volunteer patients completed a questionnaire provided by the data collectors. The data collectors were being selected from the people who provided ART service. Adherence was measured using self-report, pill count and pill identification test. In this study a patient was classified as optimum adherence (>=95%) and non-adherent (<95%).

Statistical analysis: Logistic regression analysis extends the techniques of multiple regression analysis to research situations in which the outcome variable is categorical. By considering this, the maximum likelihood and non-iterative weighted least squares are the two most computing estimation methods used in fitting logistic regression model in this study. So that; the univariate logistic regression analysis based on Pearson"s chi-square, was used to investigate the association between adherence level and categorical explanatory variables. And Spearman"s correlation coefficients, used to measure of association between rank order of adherence level and other ordinal variables. In addition to the randomness in the different states in which the adherence of patients to ART; in this study homogeneous semi-Markov reliability stochastic model is proposed for predicting the lifetime of adherence to ART. As mentioned above the maximum likelihood and non-iterative weighted least squares are the two most computing estimation methods used in fitting logistic regression model. After taking in consideration the assumptions stated SPSS v.no.20 and R packages were used to analyze our data.

3. RESULTS

3.1. Descriptive Statistics

Results in Table 4.1 show that among 368 patients under study, 12.5% were non-adherent to ART medication. 43.5% were males and 56.5% females, 67.4% of the respondents were in the age

category of 31-49 years. 49.2% of them were married while 21.2% were divorced. 54.1% of the respondents were Orthodox and 37% of them were Protestant. 36.4% of them were having their own business while 28.8% had no jobs. 70.9% of the respondents reported that their incomes per month were below 500 birr and only 1.4% of them earned between 1001 and 2500 birr per month. 57.8% of the respondents reported that their levels of education were elementary and secondary. More than a half (54.1%) of the respondents lived in rented houses. About 60.9% lived in large family sizes with more than 3 members.

Table-4.1. Demographic and Socio-economic Characteristics for a Sample of 368 HIV/AIDS Patients on ART in Yirgalem Regional Hospital

Characteristics		**Frequency**	**Percent (%)**
Gender	Male	160	43.5
	Female	208	56.5
Age	15-30 years	104	28.3
	31-49 years	248	67.4
	50-60 years	16	4.3
Marital Status	Never married	53	14.4
	Married	181	49.2
	Separated/Divorced	78	21.2
	Widowed	45	12.2
	Others	11	3.0
Employment Status	Employee	128	34.8
	Own Business	134	36.4
	No Job	106	28.8
Income per Month in Birr	Below 500	261	70.9
	501-1000	102	27.7
	1001- 2500	5	1.4
Educational Level	No education	40	10.9
	Basic education	58	15.8
	Elementary and Secondary	213	57.9
	Certificate or Diploma	39	10.6
	Degree and above	18	4.9
Housing Status	Living in own house	103	24.2
	Living in rent house	317	74.4
	Other	6	1.4
Family Size	Less than 4	144	39.1
	Greater than 4	224	59.9

Results in Table 4.2 indicate that 40.8% of the respondents had baseline body weight between 50 and 60 kg.38.3% and 20.9% of them had body weight 50 kg or less and between 60 and 95 kg, respectively. Majority (75.5%) of the respondents had access to ART in less than 50 km and 44.8% of the respondents stayed on ART for 50 months and more.

Table-4.2. Patients-related Characteristics for a Sample of 368 HIV/AIDS Patients on ART in Yirgalem Regional Hospital

Characteristics		Frequency	Percent (%)
Distance Traveled to Get Service (km)	50 and less	278	75.5
	51-75	38	10.3
	76 -100	26	7.1
	101-300	26	7.1
Baseline Weight (kg)	50 and less	141	38.3
	50- 60	150	40.8
	60-95	77	20.9
Time on ART (month)	Less than 50	203	55.2
	More than 59	165	44.8

Results in Table 4.3 shows that 39.7% of the respondents were under WHO stage III. While 29.6%, 22.0% and 8.7% of patients were in stage II, IV and I of WHO treatment regimen respectively. 47.8% of the respondents were using d4T (30 or 40)/3TC/NVP (1a) treatment combination and only 6.8% of them were using AZT/3TC/EFV (1d) combination. 45.7% of them were had baseline CD4 counts/mm^3 ofbetween 101. While only 12.8% of them had more than 300 CD4 count. 38.0% of the respondents reported that they were not facing any side effects. Stomach upset, diarrhea and nausea or vomiting were experienced as side effects of 24.5% of the respondents. 19.3% and 18.2% of them also faced headache and fatigue respectively.

Table-4.3. Treatment-regimen Characteristic for a Sample of 368 HIV/AID Patients on ART at Yirgalem Regional Hospital

Characteristics		Frequency	Percentage (%)
Baseline WHO Stage	WHO I	32	8.7
	WHO II	109	29.6
	WHO III	146	39.7
	WHO IV	81	22.0
Baseline CD4 Counts/mm^3	Less than 100	78	12.8
	101-200	168	20.4
	201-300	75	45.7
	More than 300	47	21.2
Side-effect	GI disturbances	90	24.5
	Headache	71	19.3
	Fatigue	67	18.2
	No side-effect	140	38.0

3.2. Univariate Logistic Regression Analysis

According to our methodology; Pearson"s chi-square and Spearman's correlation coefficients were used to select potential explanatory variables to be used in the multivariate logistic regressions. Table 4.4 indicated that gender, religion, housing status, baseline treatment regimen and ARV drug in use were statically associated with adherence level of patients.

Table-4.4. Association between Adherence Level and Nominal Measure Variables for a Sample of 368 HIV/AIDS Patients on ART

Explanatory Variables	Pearson Chi-Square		
	Value	Df	P-value
Gender	8.189*	1	0.004
Marital status	1.829	4	0.768
Religion	6.226*	4	0.183
Employment Status	0.183	2	0.912
Housing status	5.146*	2	0.076
Side-effects Experienced	3.843	3	0.279
			Continue
Reasons for not taking Medicine	7.453	6	0.281
Baseline WHO Stage	5.852*	3	0.119
ARV Drug in Use	11.465*	4	0.022

*Significant at 25% level

Results in Table 4.5 shows that female patients were 67.8% less likely at risk of non-adherence to ART than male patients. For every increase in the family size of HIV patients by one, the probability of being at risk of non-adherence to ART increases by 24.9%. A patient who got social support most of the time was 85.2% less likely at risk of non-adherence to ART than a patient who did not get any social support at all. A patient who strongly agreed about the importance of ART was 76.7% less likely at risk of non-adherence to ART than a patient who doubted about the importance of ART. Patients whose baseline CD4 counts/mm^3 within 201 up to 300 were 6.125 times more likely to be non-adherence on ART services.

Table-4.6. The Final Multivariate Logistic Regression Model for HIV/AIDS Patients of non-adherence on ART at Yirgalem Regional Hospital

Covariates	Frequency (%)	P-Value	AOR (95.0% C.I.)
Sex	160(43.5)	0.008	1*
Male	208(56.5)	0.016	0.322(0.128 -0.810)
Female			
Family Size	144(39.1)	0.007	1*
Less than 4	224(59.9)	0.016	1.249(1.043-1.496)
Greater than 4			
Social support		0.002	1*
None of the time	44(11.96)	0.211	2.395(0.610-9.404)
A little of the time	46(12.50)	0.070	0.209(0.038-1.140)
Some of the time	64(17.40)	0.018	0.148(0.030 -0.725)
Most of the time	87(23.64)	0.110	0.365(0.106-1.254)
All the time	127(34.51)		
ART Knowledge		0.028	1*
Uncertain	45(12.23)	0.193	0.352(0.073-1.697)
Agree	48(13.04)	0.008	0.233(0.080-0.680)
Strongly agree	275(74.73)		
Time on ART	203(55.2)	0.004	1*
Less than 50 months	165(44.8)	0.023	1.026(1.004-1.049)
Greater than 50 months			

Baseline CD4 count/mm3		0.013	1*
More than 300	47(12.77)	0.409	2.398(0.300-19.133)
201 – 300	75(20.38)	0.047	6.125(1.028-36.491)
100 – 200	168(45.65)	0.102	0.257(0.050-1.308)
Less than 100	78(21.20)		

At 5% significance level

3.3. Discussion and Interpretation of the Results of Classical Logistic Regression

The study has provided an insight into the factors that determine non-adherence to ART at the clinic, in Yirgalem Regional Hospital. The variables, that significantly determined non-adherence to ART medication, were selected using forward likelihood ratio method in the multivariate logistic regression analysis. And the most important covariates identified were gender (sex), family size, social support available to the patients, ART knowledge of the patients, time on ART and CD4 count/mm^3.

Female patients were 67.8% less likely at risk of non-adherence to ART than male patients (AOR = 0.322 and 95%CI: 0.128, 0.810). And the result is analogous to the earlier results found in South Africa by Dahab [16] and in USA by Chesney [12]. Family size of an HIV-patient was the other significant covariate of non-adherence to ART. The odds ratio indicates that for every increase of family size of an HIV-patient by one, the probability of being at risk of non-adherence to ART increases by 24.9% (AOR=1.249, 95% CI: 1.043, 1.496); Which is similar with the study done at California Collaborative Treatment Group [17]. The other covariate which had significant association with non-adherence to ART was social support available to patients. This covariate has five categories. The odds ratio indicate that a patient, who has social support most of the time, is 85.2% less likely at risk of non-adherence to ART than a patient who do not get any social support at all (AOR = 0.148, with 95% CI: 0.030, 0.725). Hence a patient who never gets social support has high probability of interrupting the ART follow up prescribed by physician. Mills, et al. [10] also stated that Social support provision improves adherence level.

Earlier studies also have confirmed the present recorded positive association between social support and adherence to ART [18-22] Living alone and a lack of support have been associated with an increase in sub-optimal adherence [23]. Two studies in Ethiopia, Southern Nation and Nationalities peoples Region (SNNPR) have also shown similar outputs by [15, 24].

ART knowledge of a patient had also significant influence on non-adherence to ART. The odds ratio indicate that a patient who strongly agreed about the importance of ART was 76.7% less likely at risk of non-adherence to ART than a patient who had uncertainty about the benefits of ART (with AOR = 0.233 and 95% CI: 0.080, 0.680). And the finding is supported by Motashari [21]; who stated that positive attitude of patients for ART increases the level of adherence.

However, the trend looks that an increase in knowledge on ART increases adherence, similar results have also been observed in earlier studies conducted in Ethiopia [15, 24]. Wenger [25] also reported that a good level of understanding about HIV by the patient impact favorably upon a patient's ability to adhere.

One of the factors that determine non-adherence to ART medication was months that a patient stays on ART. The odds ratio indicate that for every increase of one month a patient stay on ART treatment, the probability of being at risk to non-adherence increases by 2.6% (coeff. 0.026, OR 1.026, P=0.023, CI 1.043, 1.496):indicating that, HIV patients who stay for a several months on ART were more likely at risk of non-adherence to ART medication. This result is similar to the study conducted in Brazil [26], where a longer time elapsed since diagnosis of HIV, implied a greater risk of non-adherence, and also to the study in Nigeria [27], where patients who had a total ART duration of more than six months were at high risk to non-adherence. Similar results were also reported by Dahab [16] in South Africa.

The last covariate that had significant effect on non-adherence to ART was patient"s baseline CD4 counts/mm^3, the odds ratio indicated that, a patient whose baseline CD4 counts/mm^3 had been between 201 and 300 was 6.125 times more likely at risk of nonadherence to ART than whose baseline CD4 counts/mm^3 was less than 100 (coeff. 1.812, OR 6.125, P=0.047, CI: 1.028, 36.491). Other levels of baseline CD4 counts/mm^3 were insignificant at 5% significant level. Similar results were observed in the study conducted in Nigeria by Charurat, et al. [27], where patients who had more than 200, baseline CD4 counts/mm^3 were at high risk of non-adherence. Contrary results to this, Paterson [5] reported that adherence of 95% or more to ART resulted in higher CD4 counts/mm^3.

3.4. Predicting Transition time of Adherence Level of HIV/AIDS Patient

The conditional probability of being in the next state after a month t given the starting state $i \in \{OA\ ,\ NA\}$ was plotted. As we can see from the figure4.1 the general shape of the conditional probability patterns were similar with the conditional probability of being in the State II (NA) from State I (OA) which is increasing rate. But after 49 months on ART approximate probability 0.202, and increase slowly after wards, and the conditional probability of being in State I (OA) from State
II (NA) is with an elevated rate at the early time and lower rate as time increase.

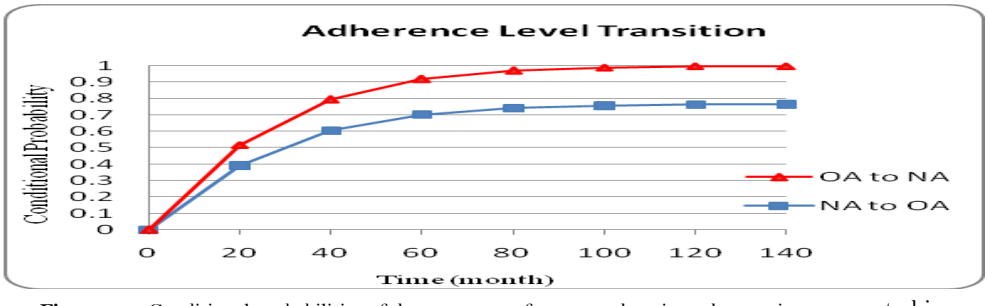

Figure-4.1. Conditional probabilities of the next state after a month t given the starting state ented in

Figure 4.2 below. As we can see from the figure, generally the conditional $i \in \{OA\ ,\ NA\}$

The conditional probability of staying in the starting state until month t is pres probability of staying in State II (NA) at a given month is higher than staying in State I (OA). For instance if an HIV/AIDS patient had "Non-adherence" at the beginning; with 0.305 probability and he/she stayed in this state until 25 months. But the conditional probability of saying in "optimum adherence" until 25 months was 0.100. However the conditional probability of staying in starting state decreases with time in month.

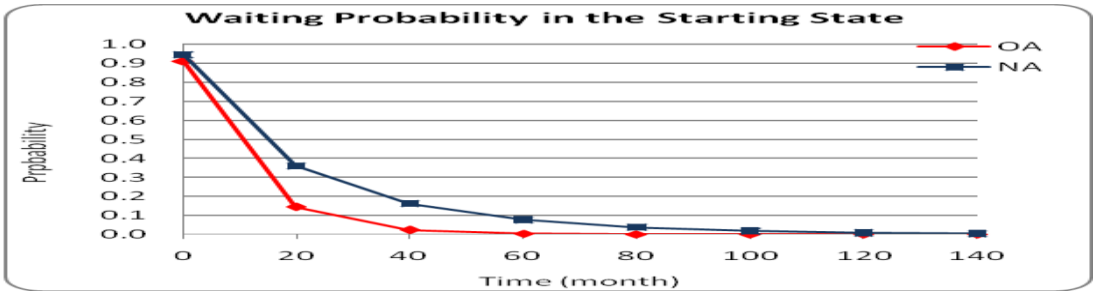

Figure-4.2. Waiting Probability in the Starting State against Time in Month

3.5. Discussion and Interpretation of Results of Homogenous Semi-Markov Model

Results of Homogeneous Semi-Markov Modeling showed that adherence level of a patient depended on their current state of adherence level. The conditional probability of being in the next state increased rapidly in the initial times period and then kept slowly increasing over time. The conditional probability of being in OA after any given time, starting in NA state was higher than being in NA, starting in OA. For example, after 40 months period of time on ART, the conditional probability of a patient being in OA starting in NA and being in NA starting in OA were 0.61 and 0.19, respectively. The conditional probability of a patient staying in NA state, starting in NA was higher than staying in the OA, starting in OA, for instance the conditional probability of a patient staying in NA and OA until 60 months' time period were 0.078 and 0.004, respectively. Probability of staying in non-adherence state at a given time was higher than that of staying in the adherence state. This result was similar to the study conducted in Brazil [26], where a longer time elapsed since diagnosis of HIV, implied a greater risk of non-adherence, and also to the study in Nigeria [27], where patients, who had a total ART duration of more than six months, were at high risk to non-adherence.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

The aim of adherence to ART is to make sure adequate virological suppression so as to prevent the occurrence of a drug resistance mutant cell and improve the health condition of

HIV/AIDS patients. One of the objective of this study was thus to determine factors that might affect adherence level of patients who were under the follow up of ART.

The multivariate logistic regression analysis of the data obtained from the ART clinic at Yirgalem Regional Hospital showed that the factors that significantly affected non-adherence to ART of patients were sex, family size; social support available to a patient, ART knowledge of a patient, time a patient stays on ART, baseline CD4 counts/mm^3.

The Homogeneous Semi-Markov Model showed that the adherence level of a patient depended on his/her current state of adherence level. The conditional probability of being in the next state increased rapidly in the initial times period and then kept slowly increasing over time. Patient's conditional probability of staying in non-adherence state at a given time was higher than that of staying in the adherence state.

4.2. Recommendations

The first step headed for tackling the problem of antiretroviral medication non-adherence is to accurately identify patients who are at high risk of non-adherence; and it would be useful to initiate programs that call attention to deal with strategies for improving the effectiveness of education that could enforce patients employ to their treatment.

Though there are patients who attain optimum-adherence, however, a number of HIV patients still having problem of ART medication non-adherence. The results of this study underlined that social support available to the patient is significantly associated with non-adherence. Therefore, health care providers need to make sure that the involvement of relatives, friends and/or community members in supporting the patient's medication adherence.

Health workers should be cautious when a patient has higher baseline CD4 counts/mm^3, when this is the case, appropriate measures should be provided. Counseling patients that they should keep taking their ART medication, it is supposed to be a life-long treatment.

For those patients who stay on ART for several months; health care providers have to give much attention to patients‟ situation on following ART medication; it might be because they are bored of taking the medication. As per the results of this study, poor knowledge of ART adherence was significantly associated to non-adherence, thus health care providers should be engaged to provide education on the benefits of adherence to ART, and continue to underline the role of careful ART adherence in sustaining patient's improved health status.

The results of this study also underlined that, patients who have large family member and male patients were at high risk of non-adherence, and hence they should be given special attention and decrease the family members they were living with.

4.3. Limitation of the Study

The first limitation of this study was the non-inclusion of additional adherence level measurement tools. Note that, better and more reliable results might be found, if further tools would have been incorporated.

The other shortcoming of this study was the non-inclusion of further parameters (such as the viral load). But note that results might differ, if the viral load were included.

Finally, though there were possible interactions between variables; these were not handled in this study; this was due, mainly, to time constraints.

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