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Survival Analysis of Adult Human Immune Virus Infected Patients under Antiretroviral Treatment at Wachamo University Nigist Ellen Mohammed Memorial Hospital, Southern Ethiopia

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ABSTRACT

Background: Accurate estimates of expected survival times, survival rates of patients and variables that influence survival of Acquired Immune Deficiency Syndrome are important for planning health service interventions. The objective of this study was to estimate mortality rate and to identify survival predictors of adult HIV infected patients under ART at Wachamo University Nigist Ellen Mohammed memorial referral hospital.

Methods: A hospital based retrospective record review was conducted from April to May 2018. All adult HIV positive patients on antiretroviral treatment at WUNEMM Hospital between 2013and 2017 were included. Data were entered using Epi-Data version 3.1 and exported to SPS version 20 for analysis. Mortality rate/100 person-years were calculated. Cox proportional hazards regression was used to predict the risk of death. Kaplan-Meier curves were also used to estimate survival probability of HIV infected patients under ART. P-value <0.05 was considered as statically significant.

Results: The study participants contributed 1169.39 person-years of observation. Over the study period, the total mortality rate was 2.22 per 100 person-years at risk. Kaplan-Meier survival estimation showed that overall estimated survival duration after ART initiation was 59.85 (95%CI: 58.613-61.091) months. Being on bedridden (AHR: 4.571, 95% CI: (1.344, 15.553) and ambulatory (AHR: 4.028, 95% CI: (1.685, 9.628)) functional status, Co-trimoxazole preventive therapy (AHR: 3.038, 95% CI: (1.010, 9.145)) and being anemic (AHR: 2.719, 95% CI: (1.060, 6.979)) were important predictors of mortality.

Conclusion: A lower level of mortality was detected among adult patients on antiretroviral treatment in WUNEMMRH. Ambulatory and bed ridden functional status, Co-trimoxazole preventive therapy and low baseline hemoglobin level were significant predictors of survival for patients under ART. Strengthening screening program for early initiation of ART and rising awareness on early treatment seeking should get due attention to increase the survival of patients on ART.

Keywords: Survival, ART, HIV/AIDS, Predictors

Abbreviations: AIDS: Acquired Immune Deficiency Syndrome; ART: Antiretroviral Treatment; BMI: Body Mass Index; CI: Confidence Interval; CTP: Co-Trimoxazole Therapy; EDHS: Ethiopian Demographic and Health Survey; Hgh: Hemoglobin; HIV: Human Immune Deficiency Virus; SPSS: Statistical Package for Social Sciences; PYO: Person Year Observation; UNAIDS: United Nations Programme on HIV/AIDS; WUNEMMRH: Wachamo University Nigist Eleni Mohamed Memorial Referral Hospital; WHO: World Health Organization

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INTRODUCTION

The Human Immunodeficiency Virus (HIV) [1] causes Acquired Immune Deficiency Syndrome (AIDS). The vast majority of people living with HIV are located in low- and middle- income countries, with an estimated 25.5 million living in sub Saharan Africa. Among this group 19.4 million are living in East and Southern Africa, which saw 44% of new HIV infections globally in 2016 [2]. ART (Antiretroviral Treatment) began in 2003. Free ART was launched in Ethiopia in 2005. An estimated 738,976 Ethiopians are currently living with HIV and all of them require ART [3]. Currently in Ethiopia, 367000 adults and 23400 children are taking ART. Based on 2014 estimate, ART need was 542 121 for adults and 178500 for children under 15 years of age [4]. Survival patterns after HIV infection among African populations in the era before ART form a clear demarcation for measuring future successes of treatment programs [5]. Assessment of the survival patterns among HIV-infected patients who are on ART is important to determine the effectiveness of the ART program. Moreover, identifying significant determinants of survival in HIV-infected patients is necessary to target those at increased risk of death. Mortality rates and its determinants among HIV patients on ART in different studies across the globe demonstrate that important determinants differ from place to place. There are also regional variations of clinical benefit of ART for AIDS patients in terms of mortality reduction and improved quality of life, with higher rates of case fatality in poor countries. Even though there have been improvements in service delivery and utilization, since the introduction of ART services in Ethiopia, a research not yet available in the study area. Therefore, this study estimated mortality rate and identified survival predictors of adult HIV infected patients under ART.

METHODS

Study area

The study was conducted in Wachamo University Nigist Eleni Mohamed Memorial referral Hospital (WUNEMRH). The Hospital is found in Hosanna Town. Hossana town is located 230 and 194 km from the capital city of Ethiopia, Addis Ababa and regional capital city, Hawassa, respectively. The hospital renders comprehensives HIV/AIDS related services including voluntary counseling and testing, provider initiated testing and counseling, prevention of mother-to-child transmission and ART program. During the study, there are about 1103 HIV/AIDS adult patients attending ART in the hospital.

Study design and period

Retrospective cohort study was conducted from May to June 2018.

Study participants

The study population were all adult (>15 years) HIV positive patients on antiretroviral treatment at WUNEMM Hospital between 2013 and 2017. Adults (>15 years) HIV-infected patients who had no follow-up visits and in addition, patients without date of ART initiation and date of occurrence of events (i.e., death, loss to follow up, and transferred out) were excluded from study.

Sample size

Total sampling method was used; where all adult HIV/AIDS patients attending ART in the hospital from January 1, 2013 to December 30, 2017 was considered for analysis. About 507 records of patients were included in the study.

Data collection

Data were collected by checklist. Five data collectors and two supervisors were recruited for data collection. Patients' chart numbers were collected from ART registration book and by using the chart numbers, patients' chart were retrieved by card room workers. Data collected on demographic factors included age, sex, educational level, marital status, religion. On clinical characteristics Body Mass Index (BMI), baseline hemoglobin (Hgh) level, active Tuberculosis (TB) during ART, World Health Organization (WHO) clinical stages, CD4 count, ART regimen, drug allergy, ART regimen change and functional status were collected.

DATA ANALYSIS

Data were entered using Epi-Data version 3.1 and exported to SPSS version 20 and STATA version 11 for analysis. Kaplan-Meier models were used to estimate survival probability after ART initiation. Log rank tests were used to compare survival curves among the categories of each variable. Model diagnostics was done using the maximum likelihood estimation and the Hosmer-Lemeshow goodness-of-fit. The cox-proportional hazard model was used to assess the relationship between the independent variables and mortality. The univariate cox-regression analysis was used to estimate the unadjusted Hazard Ratios (HRs) and the stepwise (backward LR) multivariate cox-regression analysis was performed to estimate the adjusted hazard ratios. The probability for the stepwise regression was 0.05 for entry of the variables and 0.10 for removal of the variables. P-values less than 0.05 were considered as statically significant.

RESULTS

Socio-demographic characteristics of the participants

About 507 HIV infected adult patients were included in this study. Of these, 312 (61.5%) were females. The median age was 30 years with inter quartile range (IQR) of 25 to 38 years. About half (50.1%) of the patients were protestants. Majority (71.8%) patients were married. Regarding educational level, 199 (39.3%) attended primary education.

The mean BMI was 19.60 (SD=3.02). Half of participants (49.9%) lived in Urban **(Table 1)**.

Table 1. Socio-demographic characteristics of patients under ART in WUNEMMRH, Southern Ethiopia.

Variables	Total (N and %), N=507
Sex	
Male	195 (38.5%)
Female	312 (61.5%)
Age category (years)	
15-29	202 (39.8%)
30-44	237 (46.7%)
45-59	64 (12.6%)
≥ 60	4 (0.8%)
Residence	
Urban	253 (49.9%)
Rural	254 (50.1%)
Educational level	
No education	131 (25.8%)
Primary education	199 (39.3%)
Secondary education	152 (30%)
Tertiary education	25 (4.9%)
Marital status	
Single	125 (24.7%)
Married	364 (71.8%)
Separated/Divorced	4 (0.8%)
Widow/widower	14 (2.8%)
Religion	
Protestants	254 (50.1%)
Orthodox	169 (33.3%)
Muslim	53 (10.5%)
Catholic	17 (3.4%)
Other*	14 (2.8%)

*: Adventists, Only Jesus

Clinical characteristics

The baseline mean Hgh of the participants was 13.30 (SD=+2.21). About 69 (13.6%) patients had active TB during treatment. The mean weight at base line was 52.8 kg (SD=9.65). The baseline median CD4 count was 239 (cells/μl) (IQR=116-388 cells/dl). About 187 (36.9%) patients were at WHO clinical stage I and 133 (26.1%) were at WHO clinical stage III. More than three forth (76.5%) of the participants were in working functional status and 95 (18.7%) were in ambulatory status. Most of adult HIV-infected patients (92.5%) were recommended TDF+3TC+EF regimen at initiation of treatment. Baseline regimen change was recommended for 9 (1.8%) patients. Reasons for

regimen change was nausea 6 (1.2%), numbness/tingling/pain 2 (0.4%) and abdominal pain 1 (0.2%). More than half (56.2%) patients' have used CTP (co-trimoxazole therapy) **(Table 2)**.

Table 2. Clinical characteristics of patients under ART in WUNEMMRH, Southern Ethiopia.

Variables	Total (N and %), N=507
Active TB during treatment	
Yes	69 (13.6%)
No	438 (86.4%)
Functional status	
Working	388 (76.5%)
Ambulatory	95 (18.7%)
Bedridden	24 (4.7%)
Baseline weight(kg)	
<60	399 (78.7%)
$\geq$ 60	108 (21.3%)
WHO clinical stages	
Stage I	187 (36.9%)
Stage II	122 (24.1%)
Stage III	133 (26.2%)
Stage IV	65 (12.8%)
Base line CD4+ (cells/µl) (n=427)	
<50	42 (9.8%)
50-99	50 (11.7%)
100-200	91 (21.3%)
>200	244 (57.1%)
Baseline hemoglobin (g/dl)	
<10	36 (7.1%)
$\geq$ 10	471 (92.9%)
Body mass Index	
<18.5	195 (38.5%)
$\geq$ 18.5	312 (61.5%)
Co-trimoxazole therapy	
Yes	285 (56.2%)
No	222 (43.8%)

Survival analysis

Of 507 HIV infected patients, 66 (13.0%) were lost to follow up (LTF), 69 (13.6%) transferred out to other ART centers, 26 (5.1%) died and 346 (68.2%) alive at the 30th December, 2017. Of died patients, 2 (7.7%) died within 3 months after start of treatment **(Figure 1)**.
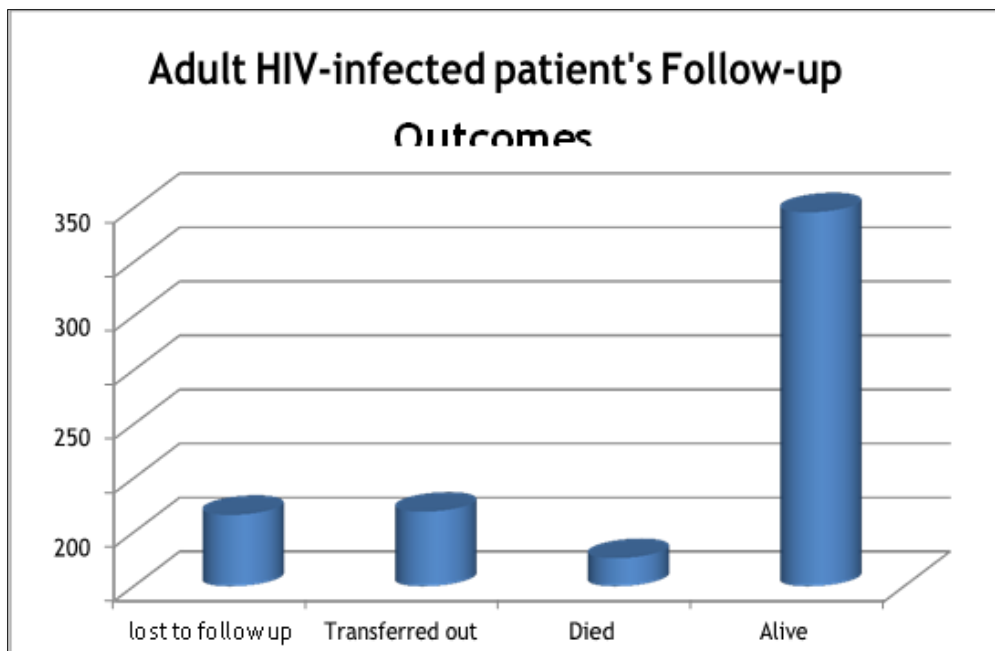
Figure 1. Adult HIV-infected patient's follow up outcomes in WUNEMMRH, Southern Ethiopia.

The median survival duration was 26.50 with an IQR of 11.97 to 43.67 months. Kaplan-Meier survival estimation showed that overall estimated survival duration after ART initiation was 59.85 months. The study participants contributed 1169.39 PYO. The total mortality rate was 2.22 per 100 person-years at risk. The rate of LTF was 5.64 per 100 PYO. Kaplan-Meier analysis of survival status revealed that males show better survival than females. The estimated survival was 59.235 months in males and in females. Age 15-29 years indicated higher survival time **(Table 3)**. From baseline clinical characteristics of patients, those in WHO clinical stage II survived better, 61.633 months than those in WHO clinical stage IV, 49.409 months. Patients with Hgb <10 g/dl showed lesser survival, 45.046 months than those with higher >10 g/dl Hgb, 60.562 months **(Table 4)**.

Table 3. Kaplan-Meier analyses of survival status for patients on antiretroviral treatment by socio-demographic characteristics of HIV patients, in NEMMRH, 2013-2017.

Variables	Estimated survival in months	Standard error	Confidence interval (CI 95%)
Sex			
Male	59.235	1.098	57.083-61.387
Female	57.882	0.725	56.460-59.303
Age category (years)			
15-29	60.365	0.912	58.578-62.153
30-44	56.404	0.937	54.567-58.242
>=45	57.101	1.536	54.090-60.113
Residence			
Urban	57.316	0.869	55.613-59.019
Rural	60.032	0.882	58.303-61.760
Educational level			
No education	57.000	0.976	55.088-58.912

Primary education	57.303	0.889	55.562-59.045
>=Secondary education	58.684	1.248	56.238-61.130
Marital status			
Single	54.924	1.259	52.457-57.391
Others	60.296	0.680	58.963-61.629
Religion			
Muslim	53.572	2.286	49.092-58.052
Orthodox	61.596	0.775	60.076-63.115
Protestant	56.159	0.936	54.324-57.994
Other*	58.932	1.693	55.613-62.250

*Adventist, only Jesus

Table 4. Kaplan-Meier analyses of survival status for adult patients on antiretroviral treatment by clinical characteristics of HIV patients, in NEMMRH, 2013-2017.

Variables	Estimated survival in months	Standard error	Confidence interval (CI 95%)
Active TB during treatment			
Yes	49.862	2.078	45.788-53.936
No	60.502	0.614	59.298-61.706
Functional status			
Working	61.532	0.510	60.533-62.531
Ambulatory	49.386	2.068	45.333-53.041
Bedridden	45.623	4.805	36.204-61.091
Baseline weight (kg)			
<60	56.837	0.740	55.386-58.287
$\geq$ 60	62.551	0.611	61.353-63.749
WHO clinical stages			
Stage I	59.926	0.521	58.905-60.947
Stage II	61.633	0.875	59.918-63.347
Stage III	54.669	1.475	51.779-57.559
Stage IV	49.409	2.345	44.812-54.006
Base line CD4+ (cells/µl) (n=427)			
<50	46.259	3.183	40.020-52.497
50-99	52.763	2.712	47.448-58.079
100-200	57.556	1.212	55.181-59.932
>200	61.658	0.608	60.465-62.850
Baseline hemoglobin (g/dl)			

<10	45.046	4.034	37.140-52.952
$\geq$ 10	60.562	0.584	59.416-61.707
Body mass Index			
<18.5	54.552	1.226	52.149-56.955
$\geq$ 18.5	61.495	0.583	60.352-62.639
Co-trimoxazole therapy			
Yes	58.259	1.002	56.294-60.223
No	59.510	0.573	58.387-60.634

Log rank test for different groups of patients showed differences in survival and hazard curves. Active TB during treatment (P=0.010), baseline weight (P=0.029) and Hgh (P<0.001) showed significance association in Log rank test **(Figures 2-5)**.
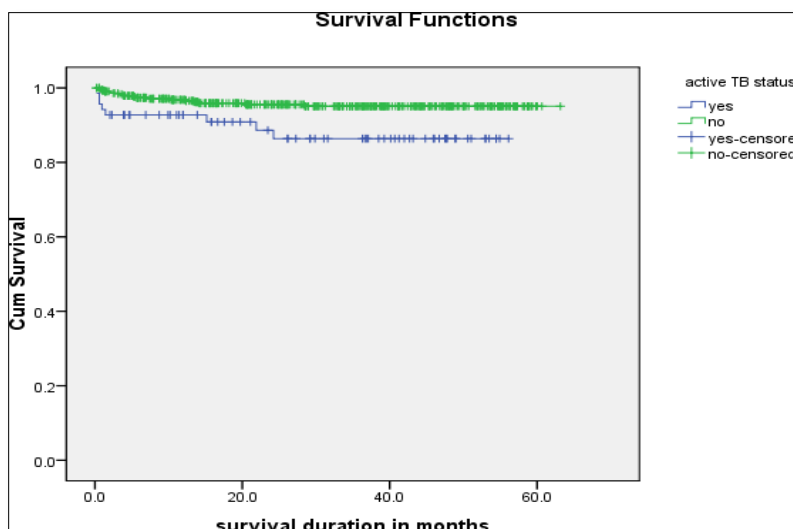
Figure 2. Survival functions of patients on ART by active TB during treatment, NEMMRH, 2013-2017 (Log rank test p=0.010).
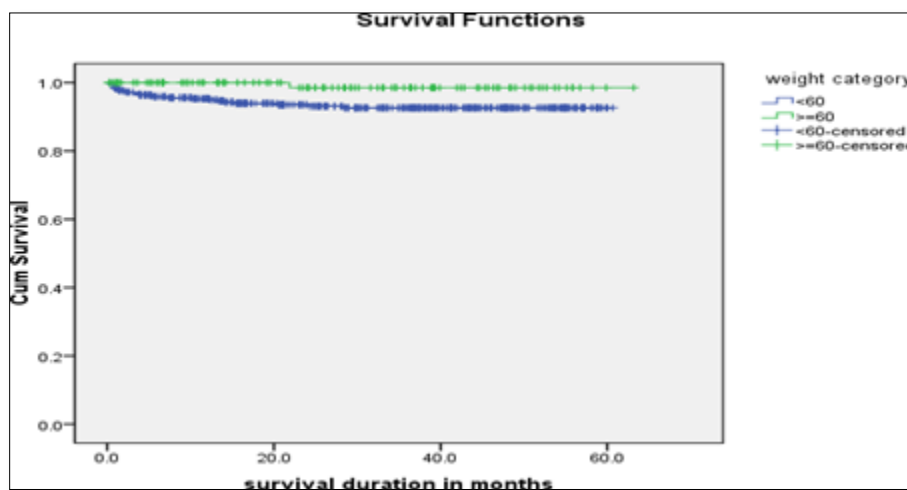

Figure 3. Survival functions of patients on ART by baseline weight NEMMRH, 2013-2017 (Log rank test p=0.029).
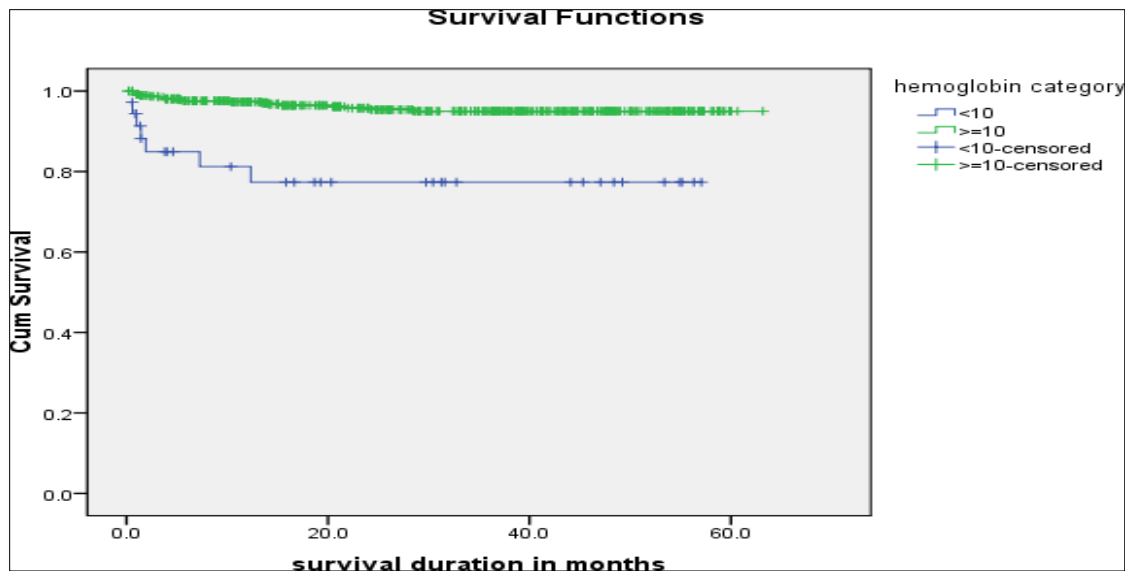
Figure 4. Survival functions of patients on ART by hemoglobin NEMMRH, 2013-2017 (Log rank test p=0.029).
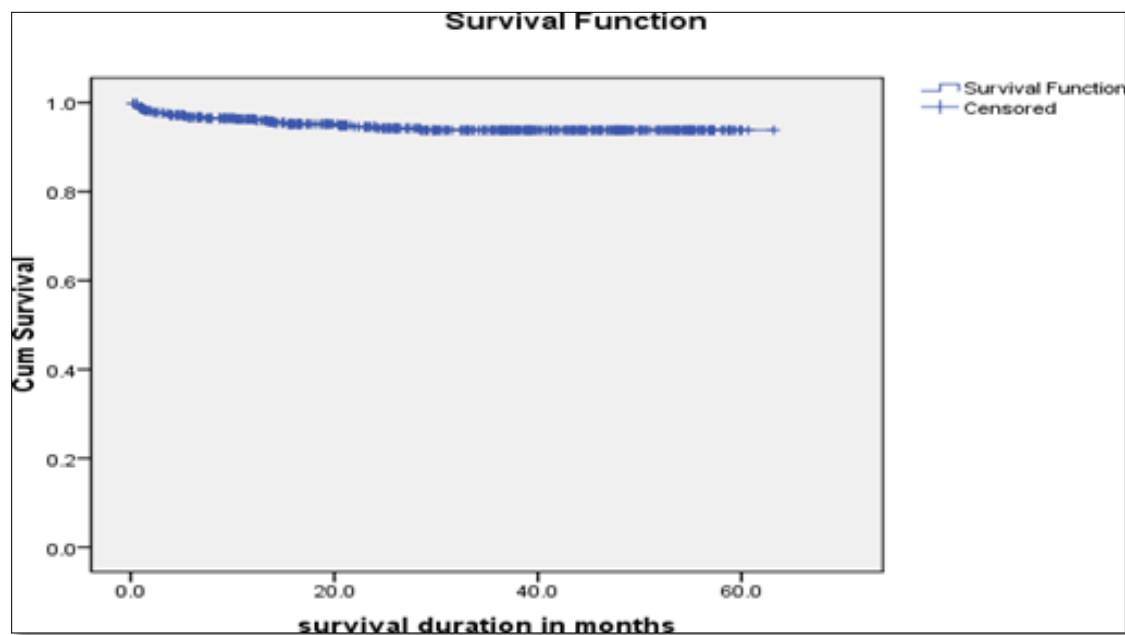

Figure 5. Kaplan-Meier survival curve of adult HIV-infected patients on ART, NEMMRH, 2013-2017.

The proportional hazards cox regression analysis results

Variables that were significantly associated at bivariate analysis were further examined in multivariate analysis. Results of bivariate analysis showed that active TB during treatment (p<0.05), functional status (p<0.001), WHO stages (p<0.005), baseline CD4+ (p<0.001), baseline Hgb (P<0.001), BMI (p<0.005) and CPT (p<0.005) as candidate for multivariate analysis **(Table 5)**.

Table 5: Bivariate cox regression analysis of patients under ART at WUNEMMRH during January 2013 to December 2017.

Variables	CHR	P-value
Age	1.003	0.879
Sex	1.389	0.404
Residence	1.139	0.744
Educational level		0.395
No education	0.525	0.228
Primary education	0.637	0.306
Marital status	0.670	0.331
Active TB during treatment	2.846	0.014
Functional status		0.000
Working	0.131	0.001
Ambulatory	0.747	0.613
Baseline weight	6.793	0.060
WHO clinical stages		0.002
Stage I	0.080	0.001
Stage II	0.165	0.007
Stage III	0.654	0.337
Base line CD4+ (cells/µl) (n=427)		0.000
<50	8.401	0.000
50-99	5.216	0.004
100-200	1.750	0.386
Baseline hemoglobin(g/dl)	5.965	0.000
Body mass Index	3.561	0.003
Co-trimoxazole therapy	4.113	0.004

In multivariate proportional hazards cox regression analysis; Functional status, Baseline Hgh level and CPT were significant predictors of mortality **(Table 6)**. The risk of death was 4 times higher among patients with baseline ambulatory functional status (AHR: 4.028, 95% CI: (1.685, 9.628) and patients who with bedridden functional status were about 5 times more likely to die (AHR: 4.571, 95% CI: (1.344, 15.553) compared to patients with working functional status. Patients who had given CPT were 3 times more likely to die (AHR: 3.038, 95% CI: (1.010, 9.145) compared to who had not given CPT. The hazard of death was 3 times higher on HIV patients with baseline Hgh level <10 g/dl (AHR: 2.719, 95% CI: (1.060, 6.979)) as compared to those patients with baseline Hgh level >10 g/dl.

Table 6. Predictors of mortality for patients under ART at WUNEMMRH during January 2013 to December 2017.

Variables	AHR at (95% CI)	P-value
Functional status		
Working	1.00	0.004
Ambulatory	4.028 (1.685, 9.628)	0.002
Bedridden	4.571 (1.344, 15.553)	0.015
Baseline hemoglobin (g/dl)		
<10 g/dl	2.719 (1.060, 6.979)	0.037
>10 g/dl	1.00	
Co-trimoxazole therapy		
Yes	3.038 (1.010, 9.145)	0.048
No	1.00	

DISCUSSION AND CONCLUSION

This study tried to estimate mortality rate and predictors of survival in HIV infected patients under ART at WUNEMMRH. The overall estimated survival duration after ART initiation was 59.85 months. This is comparable with study conducted in Debre Markos and Adis Ababa, Ethiopia, which showed average survival of patients after ART 65.22 and 67 months respectively [6,7]. In contrary to this study, survival of patients after ART initiation was 48 months in study conducted in Wollo, Ethiopia. This might be due to short study period of time, in which death is very high in early periods of treatment and more than 1000 subjects were in WHO stage IV as compared to current study [8]. There is also survival difference between current study and study conducted at Armed Forces Hospital, Ethiopia, which showed survival of patients after ART initiation 72 months [9]. This difference might be due to difference in having better information on HIV/AIDS, better clinical care and nutrition. In current study, the total mortality rate was 2.22 per 100 PYO. This is similar with study conducted in Adama, which showed mortality rate of 2.1 per 100 PYO. Similarly, study conducted in Ethiopia showed 2.03 per 100 persons at risk [10,11]. However, the finding is in contrary to study conducted in Nepal, which revealed overall mortality rate of 6.33 per 100 person years at risk. This high mortality in Nepal might be due to lack of prior access to ART service, stigma and discrimination related to HIV/AIDS. The difference might also be due to shortage of diagnostic facility and proper screening of opportunistic infections and limited availability of prophylaxis. The rate of LTF was 5.64/100 PYO. This finding is lower than the study of Arba Minch, which showed LTF rate 8.2/100 PYO. Finding of Adama, Ethiopia, also showed 11.5/100 PYO [11,12]. The median survival time for the study cohort was 26.50 months. Study conducted in Arba Minch revealed that 13.4% patients were lost from follow up [11]. Other study

conducted in Côte d'Ivoire also showed rate of LTF program, to a certain extent, reflects the degree of underestimation of mortality [13]. The risk of death was higher among patients with baseline ambulatory and bedridden functional status than working functional status. The finding is in line with study conducted at Armed Forces General Teaching Hospital [8]. Other studies also showed that ambulatory and bedridden patients were more likely to die compared to those engaged in active working [10,11,14]. CPT is a feasible, well-tolerated and inexpensive intervention for people living with HIV to reduce HIV-related morbidity and mortality. However, this study revealed that patients who had given CPT were more likely to die as compared to who had not given CPT. The reasons for this might be co-trimoxazole prophylaxis is recommended for adults (including pregnant women with severe or advanced HIV clinical disease (WHO stage 3 or 4) and/or with a CD4 count of ≤ 350 cells/mm^3. This stage is stage where there is high mortality. In current study, this high mortality in those who were taking CPT might be implication for late initiation of ART [15]. The hazard of death was higher on HIV patients with baseline Hgh level <10 g/dl as compared to those patients with baseline Hgh level >10 g/dl. This finding was similar with studies of Ethiopia, which showed patients with anemia were at high risk of death after ART initiation [10,16-18]. In current study, mortality rate is low. The estimated mean survival time of patients was 59.85 months. Ambulatory and bed ridden functional status, CPT and low baseline Hgh level were predictors of survival for patients under ART. Strengthening screening program for early initiation of ART and rising awareness on early treatment seeking should get due attention to increase the survival of patients on ART.

LIMITATIONS

Since secondary data were used, in which some important variables were not documented well and not analyzed due to

missing values. These are occupation, regimen change and side effects.

DECLARATIONS ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance was obtained from Ethics Review Committee of Hossana College of Health Sciences. Permission letter was obtained from Wachamo University Nigest Elleni Mohamad Memorial Referral Hospital. Other concerned bodies of the hospital were informed about the study. All the information retrieved was kept in the way that could not interfere in personal confidentiality.

AVAILABILITY OF DATA AND MATERIALS

The authors do not have full mandate to share the data since they are the property of the funding institution.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

TY conceived the research idea, conducted the data collection, data analysis and data interpretation and wrote and reviewed the paper. SM conducted the data collection, data analysis and data interpretation and reviewed the paper. TL approved the proposal, participated in data analysis and revised subsequent draft of the paper. All authors read and approved the final manuscript.

REFERENCES

1. UNAIDS (2000) AIDS and HIV infection information for United Nations employees and their families. Geneva. Switzerland.

2. UNAIDS (2017) Ending AIDS: Progress towards the 90-90-90 targets. Geneva. Switzerland.

3. Ethiopian Ministry of Health (2017) National guidelines for comprehensive HIV prevention, care and treatment. Addis Ababa.

4. Ethiopian Public Health Institute (2017) HIV related estimates and projections for Ethiopia. Addis Ababa.

5. Isingo R, Zaba B, Marston M, Ndege M, Mngara J, et al. (2007) Survival after HIV infection in the pre-anti-retroviral therapy era in a rural Tanzanian cohort. AIDS 21: S5-S13.

6. Assefa T, Wencheko E (2012) Survival analysis of patients under chronic HIV-care and antiretroviral treatment at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. Ethiop J Health Dev 26: 22-29.

7. Abebe N, Alemu K, Asfaw T, Abajobir AA (2014) Survival status of HIV positive adults on antiretroviral treatment in Debre Markos Referral Hospital, north-west Ethiopia: Retrospective cohort study. Pan Afr Med J 17: 88.

8. Ayalew J, Moges H, Sahu O, Worku A (2014) Identifying factors related to the survival of AIDS patients under the follow-up of antiretroviral therapy (ART): The case of South Wollo. Int J Data Envelopment Anal Operations Res 1: 21-27.

9. Kebebew K, Wencheko E (2012) Survival analysis of HIV-infected patients under antiretroviral treatment at the Armed Forces General Teaching Hospital, Addis Ababa, Ethiopia. Ethiop J Health Dev 26.

10. Biadgilign S, Reda A, Digaffe T (2012) Predictors of mortality among HIV infected patient taking antiretroviral treatment in Ethiopia: A retrospective cohort study. AIDS Res Ther 9: 15.

11. Abebe TW, Chaka TE, Misgana GM, Adlo AM (2016) Determinants of survival among adults on antiretroviral therapy in Adama Hospital Medical College, Oromia Regional state, Ethiopia. J HIV AIDS 2.

12. Mulissa Z, Jerene D, Lindtjørn B (2010) Patients present earlier and survival has improved, but pre-ART attrition is high in a six year HIV cohort data from Ethiopia. PLoS One 5: e13268.

13. Toure S, Kouadio B, Seyler C, Traore M, Dakoury-Dogbo N, et al. (2008) Rapid scaling-up of antiretroviral therapy in 10,000 adults in Côte d'Ivoire: 2 year outcomes and determinants. AIDS 22: 873-882.

14. Bhatta L (2012) Survival pattern and determinants of survival in adult HIV-infected patients on antiretroviral treatment in far-western development region, Nepal. University of Tromsø, Tromsø, Norway (thesis).

15. WHO (2014) Supplementary section to the 2013 WHO consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Chapter 8 – Prevention, screening and management of common co-infections.

16. Worku A, San Sebastian M (2009) Pattern and determinants of survival in adult HIV patients on antiretroviral therapy, Jimma, Ethiopia (Master thesis).

17. Ergete D (2011) predictors of mortality among human immunodeficiency virus infected patients' records in Gondar University Hospital, Ethiopia. University of South Africa (Thesis).

18. Tarekegn S (2011) The effect of HAART on incidence of tuberculosis among HIV infected patients in Hawassa University Referral Hospital, South Ethiopia: A retrospective cohort study (Master thesis in AAU). Addis Ababa University, Ethiopia.