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Statistical Modeling and Analysis of Mother-To-Child Transmission of HIV: A Case Study in Referral Hospital and Health Center of Hawassa Town, South Nation Nationality People, Ethiopia

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Abstract Mother-to-Child Transmission of HIV (MTCT) is the major source of HIV infection among children under the age of 15 years. Within the prevention programs, package of services including HIV counseling and testing, provision of prophylactic antiretroviral (ARV) drugs for mothers and babies, safe delivery practices and infant feeding counseling is being given. This study is thus to model mother-to-child transmission of HIV and survival of HIV infected babies. The data were obtained from Health Centre and Referral Hospital at Hawassa town recorded from year 1999-2001. Bayesian logistic regression, Kaplan Meier method & Cox proportional hazards model are applied. The results of the analysis showed that among the 200 children who HIV positive 16% died were. Another finding is that about 97.3% of the total pregnant women were married and 41.3% of them were illiterate. Among 802 mothers, 97 or 12.1% are HIV positive. From the 97 HIV positive pregnant women, a majority (92.8%) had good knowledge about HIV transmission and AIDS disease. However 94.9% of them had very low knowledge about the prophylaxis treatment and ART medication. The variables age, marital status and occupation are the main significant factors that may expose the mothers to HIV infection. Pregnant women who were married and in elementary occupation were more likely to be infected than those who were unmarried and in higher occupation. Moreover, analysis of the children data showed that variables low weight, low CD4 count of children and interaction of both with age decrease the hazard of time to death by 15%, 2% and 0% respectively. Conclusion considering the prevailing high level of HIV infection rate among MTCT clients, re-organization of the PMTCT services especially raising the level of awareness of MTCT/PMTCT among pregnant women is important to prevent the babies from HIV infection.

Keywords: *adults, babies, country, women*

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1. Introduction

HIV/AIDS Epidemic Worldwide: HIV/AIDS is the most formidable epidemic in recorded history. The HIV/AIDS epidemic has become a serious health and development problem in many countries around the world. According to the joint United Nation programme on HIV/AIDS [1], an estimated 33.4 million people worldwide were living with HIV at the end of 2008, of which 22.4 million were found in Sub-Saharan Africa. Other 1.4 million persons have already died from the disease since the beginning of the epidemic, mostly in Africa. And about 350,000 infants now become infected each year, about 90 percent of whom are African children. Overall, more than 90 percent of the new infections each year are found in the developing countries. In many regions of the world, new HIV infections are heavily concentrated among young people (15 - 24) years of age. Among adults 15 years and older, young people accounted for 40% of new HIV infections [2].

HIV/AIDS Epidemic in Ethiopia: The adult HIV prevalence in Ethiopia seems to be leveled off at 2.1% since 2005 [3]. The general HIV prevalence in country is (2.1%) which is considered to be the lower than that in Uganda and Kenya [2]. According to the Single Point Estimate published by Ministry of Health (MOH) and HIV/AIDS Prevention and Control Office (HAPCO), the number of people living with HIV in the country is 980,000 in year 1999 E.C. The prevalence among women is 1.5 times higher than the prevalence among men and has been estimated to be 3.5% among antenatal attendees.

In 2007 alone, 75,420 pregnant women were living with the virus and the annual HIV positive births were 14,148. Over 64,000, children under the age of 14, were HIV positive and over 10,000 HIV infected children died in 2007 alone [2].

In SNNPR, the 2007 HIV/AIDS estimate of the adult HIV prevalence is 1.4 [4]. Accordingly the urban prevalence surpasses the rural prevalence 10 times (7.5 Vs 0.8) and the prevalence among women is 1.5 times of the men (9.1% Vs 6.1%) [5]. Great variation in HIV prevalence has been reported across the urban antenatal surveillance sites in the region ranging from 3.1% in Hossaena hospital to 9.3% in Dilla hospital in 2005 [6].

Hawassa Health Centre has been serving as a sentinel surveillance site since 1998. The HIV prevalence among Hawassa Health Centre ANC attendees has been showing a declining trend, from 14.4% in 1998 to 9.2% in 2005 [7]. In 2006 alone 11,333 HIV positive pregnant women were living in the region and 2,205 HIV positive babies were delivered [8]. There are about 10,000 HIV positive children in the region and 1,774 of the infected children die of the virus each year. Despite the availability of PMTCT services the vast majorities of children are acquiring the virus and are dying [9].

2. Methods

The data for this study had obtained from Health Centre and Referral Hospital in Hawassa town. This study which review patients' intake forms and follow up charts of pregnant HIV patients taking ART in Hawassa Health Center and Referral PMTCT Department [10]. The patients chart include the patient intake forms and follow up cards, which are prepared by Federal Ministry of Health (FMOH) to be uniformly used by clinicians to early identify and document clinical and laboratory variables. Thus, in this study secondary data which is collected from patients follow up records have been used [11]. Based on this record of the patients, the variables which are important for the study such as the CD4 count of the patients are collected by using the patients identification number or the laboratory code without any direct contact with the patients, instead by communicating with the nurses and counselors to get the medical record and other information important for the study. The data are a mix of qualitative and quantitative. To sample those HIV/AIDS tested pregnant women from the population the list of pregnant obtained from clinical data by using their charts and then stratified the population (the whole HIV/AIDS tested pregnant women) in to year of tested in the health center and determine the sample size from each stratum [12]. Then, select pregnant women from each stratum by simple random sampling technique. Taking pregnant women counted at a time.

The statistical approach to be used in this study is Bayesian methods analysis. MCMC technique for carrying out the computation has been explored. For a binary response variable, the logistic transformation of success probability, P_i of the i^{th} individual can be modeled as a linear combination of k explanatory variables. Survival analysis is used for time-to-event data which are related with individual time elapse in certain situation or state [13].

3. Results

The results are summarized from Table 1 to Table 3. The Table 1 summarized the standard error and P value of the Cox proportional hazards model including the interaction terms for chronic HIV-1 children

Table 1. The parameter estimates, standard errors and P value of the Cox proportional hazards model including the interaction terms for chronic HIV-1 children interrupting their HAART at HH

Parameter	DF	Parameter Estimate	Standard Error	Sig.	HR	95.0% CI for HR	
						Lower	Upper
Age in year	1	.195	.102	.057	1.216	.995	1.486
Sex	1	.080	.381	.833	1.084	.513	2.287
Adress	1	.435	.321	.176	1.544	.823	2.899
Weight in kg	1	-.158	.065	.015	.854	.752	.969
CD4	1	-.022	.005	.000	.978	.968	.988
Age*Weight	1	-.004	.002	.058	.996	.962	1.002
CD4*Weight	1	-.003	.001	.000	.997	.996	.999
Age*CD4*Weight	1	.000	.000	.000	1.000	1.000	1.000

The fitted Cox's PH model using complete case analysis has found two main effects and two interactions that are statistically significantly associated with the hazard of having time death [15].

Table 2. Estimates for the final logistic regression model for mothers (Hawassa, August – September 2009)

Covariates	Sub-groups	$\hat{\beta}$	S.E $(\hat{\beta})$	Wald	D.F	Sig	$e^{\hat{\beta}}$
Age in year	≤19 (Ref)			7.052	3	.070	
	20-24	-.904	.506	3.188	1	.074	.405
	25-29	-.207	.442	.220	1	.639	.813
	≥30	.132	.446	.088	1	.767	1.141
Marital status	Married	2.142	.591	13.155	1	.000	8.516
Educational level	Illiterate(Ref)			4.627	3	.201	
	Able to read	-.471	.361	1.705	1	.192	.624
	Primary	-1.630	.827	3.885	1	.049	.196
	Secondary and above	-.285	.354	.649	1	.420	.752
Occupation	Elementary occupation(Ref)			98.848	3	.000	
	Merchant	21.411	3063.12	.000	1	.994	19.35
	Student	18.418	3063.09	.000	1	.995	18.52
	Professional	18.869	3063.12	.000	1	.995	15.12
Constants		-20.760	3063.0	.000	1	.995	.000

Table 3. Summary Statistics of Posterior distribution with alpha (Hawassa, August – September 2009)

Node	mean β	Sd	MC error	median	95% C.I.
Alpha	0.8587	0.8217	0.05423	0.838	(-0.699, 2.508)
b.A	0.04247	0.02612	0.00152	0.04325	(-0.007531, 0.008081)
b.EL	0.1924	0.1104	0.00241	0.1917	(-0.02403, 0.4125)
b.MS	-2.475	0.595	0.03457	-2.45	(-3.653, -1.383)
b.O	-1.521	0.1669	0.00397	-1.518	(-1.856, -1.201)
Or.A	1.044	0.02727	0.0016	1.044	(0.9925, 1.099)
Or.EL	1.22	0.1355	0.00295	1.211	(0.9763, 1.511)
Or.MS	0.09988	0.0609	0.00335	0.08632	(0.02591, 0.2509)
Or.O	0.2216	0.03684	8.85E-04	0.2192	(0.1563, 0.3008)

The parameters b.MS and b.O are significant at $\alpha = 5\%$ significance level, i.e. the confidence interval doesn't contain zero. The variables marital status and occupation expose mothers to HIV infection [14]. The models indicate significant negative association between the HIV Status of pregnant women and marital status as well as occupation, the corresponding approximate posterior odds for the other two models indicates decrease of 90% and 78%, respectively [15].

Infection rate is still high among the babies due to mothers, to avoid transmission of HIV, and raising level of awareness of MTCT/PMTCT on the part of the women to prevent their children from HIV/AIDS is crucial. Young women are especially vulnerable to HIV/AIDS. In order to address this problem, continuous awareness raising programs should be devised so as to bring about behavioral change that would in turn minimize the risk of being vulnerable to HIV/AIDS [16]. Capacity building of the health centre needs to be strengthened including training on PMTCT for all to staff involved in offering maternity care services, since they are working in rotation bases. It is urged to improve the quality of counseling through extensive training for PMTCT counselors, allocation of sufficient resources, continuous supervision and refresher training for the counselors to update with recent advances [17,18]. Since, the ARV drugs treatment cause adverse effects on some patients because of long duration of follow-up, it would be advisable for patient to interrupt their treatment according to the principle of structured treatment interruption (STI) with continuous assessment of clinical examination (CD4 and viral load count) [19]. ART often leads to an increase of weight and CD4 count at the start of the treatment [20,21]. Thus HIV positive mothers and babies should be misleaded by such results as the survival probability depends on other factors [19]. Rather they should be under strict follow-up to take the treatment for life long. Logistic regression does not take into account the uncertainty in the model selected and the uncertainty in its regression coefficients, Bayesian approach to logistic regression should be adopted to address this weakness [22].

4. Conclusions

The HIV related profile of PMTCT clients at the Hawassa Health center showed that most of positive pregnant women had good understanding about HIV disease and its transmission but very low understanding of the prophylaxis treatment (PMTCT) and ART medication adherence. From the total pregnant women, most of them were married and illiterate. The variables like married, elementary occupation are significant at $\alpha = 5\%$ level of significance exposing mothers to HIV infection. The Bayesian logistic regression modeling of mothers' infection was computed with high precision. It can be concluded for the analysis that the predictors age, marital status and occupation significantly related with the mothers' HIV infection. From the logit model, the odds of pregnant women who is married and in elementary occupation were higher for the HIV infection. The corresponding approximate a posteriori odds for a unit increase of age increases the odds of being HIV infection. Clinical/immunological factors play a primary role in the maintenance of HAART. This study highlighted the physiological and immunological factors influencing children's time to death. The Kaplan-Meier estimates and log rank test indicated that time to death for male and female children was the same, but was different among children groups coming from different residence areas. Baseline weight, CD4 count at the start of treatment, and the interactions between weight and CD4 count and baseline age, weight and CD4 count at the start of treatment were important factors related to time to death among the children.

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