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Characterization of Prognostic Factors for Recovery in Tuberculosis Patients In Northern Ghana

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ABSTRACT

This study was conducted in the three Northern Regions of Ghana. A total 1,199 patients who enrolled for treatment at various treatment centers across Northern Ghana were considered for the study. The study characterized the prognostic factors for recovery in tuberculosis patients in the study area. The Kaplan-Meier estimator and binary logistic regression was used for the analysis. It was revealed that relapse patients are at increased risk of treatment failure compared to those with new cases whiles male patients have about 53% high risk of treatment failure compared to their female counterparts. It was also realized that for each one week increase in time of treatment after treatment initiation, the chance of recovery increases by 50%. Also, treatment success was found to be related to age with elderly and infants more prone to treatment failure. It was found that HIV/AIDS patients have about 24% high risk of treatment failure compared to their counterparts who non reactive to HIV/AIDS. There is therefore a pressing need for enormous care for these vulnerable groups to stem the menace of the tuberculosis disease in Northern Ghana.

Keywords: Prognostic factors, recovery, logistic regression, treatment failure, Kaplan-Meier estimator

1.0 INTRODUCTION

Tuberculosis is an opportunistic infectious disease caused mainly by *Mycobacterium Tuberculosis* (Kumar et al., 2007). Tuberculosis burden is high in remote rural communities where much about the disease is unknown, resulting to herbal concoctions and led majorly by superstition (Jakperik and Ozoje, 2012). The government of Ghana on realizing the devastating effect of tuberculosis in 1994 instituted the National Tuberculosis Control Program to help combat this menace coupled with support from donor agencies and corporate organizations. Various tuberculosis centers were established across the country where patients were admitted and detained for treatment. The program though effective was discontinued for varying reasons (Jakperik and Aquaye, 2013). The success in tuberculosis treatment is an interplay of several factors ranging from the mean treatment time to identifying essential prognostic factors that contributes to recovery. Different average recovery times have been reported (Gavrilenko, 2001; Alice et al., 1909; Jakperik and Ozoje, 2012). HIV/AIDS patients and the elderly have an increased risk of treatment failure as their immune systems have been compromised.

Age has been reported as a major risk factor for recovery in tuberculosis patients (Jakperik and Ozoje, 2012; Pardeshi and Deshmukh, 2007). The incidence of tuberculosis is on the ascendency in Ghana (Jakperik and

Ozoje, 2012; NTP, 2007). Low education on the causes and treatment of the disease has led to increase cases of treatment failures and non-adherence (Sengupta *et al*., 2006). This therefore requires a corrective action for the combat of the tuberculosis disease in the less privilege part of the nation. The study therefore sought to characterize the essential prognostic factors in the treatment of tuberculosis.

2.0 METHODOLOGY

The data used for this study was collected from tuberculosis centers from the three Northern Regions of Ghana. It consists of 1,199 patients who underwent treatment at these centers from January, 2011 to December, 2012. A patient was considered cured only and only if s/he is negative to smear + test. The variables considered in the study include: age, sex, date treatment started, date treatment completed, disease classification, category of patient, outcome of treatment, HIV status of patient, and type of patient. The time of treatment was obtained by subtracting the date at which treatment started from the date treatment completed. The study did not have direct patient involvement; therefore, ethical clearance was not needed.

The Kaplan-Meier method was used in estimating the average recovery time of tuberculosis patients in northern Ghana given in equation (2).

$$\hat{S}(t)=\prod_{j:t_j\le t}\left[1-\frac{d_j}{n_j}\right], \text{for } t_1\le t\le t_k \quad \ldots\ldots(2.1)$$

The logistic model stated in (2.2) was used to assess the effect of each prognostic factor. For *k* explanatory variables and i = 1,..., *n* individuals, the model is

$$\log\left[\frac{P_i}{1-P_i}\right]=\alpha+\beta_1 X_{i1}+\beta_2 X_{i2}+\ldots+\beta_k X_{ik} \quad \ldots\ldots(2.2)$$

where P_i is the probability that $y_i=1$. The expression on the left-hand side is usually referred to as the *logit* or *log-odds.*

3.0 RESULTS

The study was conducted on patients who enrolled at tuberculosis centers in the three Northern Regions of Ghana for treatment. Out of a total of 1,199 patients, 801 patients representing 66.81% of the patients were males whilst 398 representing 33.19% were females. Nine hundred and twenty representing 76.73% had treatment success with 279 (23.27%) treatment failures. Nine hundred and thirty four representing 77.90% were HIV negative whiles 265 (22.10%) were HIV positive. Five hundred and eighty-eight patients representing 49.04% had pulmonary tuberculosis whiles six hundred and eleven, 611 (50.96%) had extra pulmonary tuberculosis. Nine thousand and seventy three representing 89.49% were patients who had the infections for the first time whiles 126% (10.51%) were relapse cases.

3.1 THE KAPLAN-MEIER ESTIMATOR

The median recovery time of tuberculosis patients in Northern Ghana was estimated using the Kaplan-Meier estimator. The probability of recovery in 22weeks was determined to be 0.9786 with the corresponding probability of failure of 0.0214. The probability of recovery in 24 weeks was 0.5658 whilst the probability of failure was found to be 0.4342. The probability of recovery tailed off rapidly to 0.0947 in 27 weeks while the probability failure experienced a major leap to 0.9053. The 50th percentile which is the median recovery time was determined to be 24.14 weeks. The 25th percentile which is the smallest recovery time such the probability of non-recovery is 0.25 was found to 24 weeks with a confidence interval of 23.86 to 24.00.

3.2 THE LOGISTIC REGRESSION MODEL

The logistic model had a 93.5% concordant and 6.3% disconcordant. The variables that are significantly different from zero are age, disease classification, and time of treatment. The details of the covariates can be seen in the table 3.1 below.

Table 3.1 Parameter Estimates Based on the Logistic Regression

Parameter	DF	Estimate	Standard Error	Chi-Square	Wald Pr > ChiSq
Intercept	1	-6.9195	0.8985	59.3050	<.0001
age	1	-0.0128	0.00635	4.0617	0.0439
sex	1	0.4251	0.2594	2.6851	0.1013
dc	1	-0.6861	0.2422	8.0239	0.0046
tp	1	0.4330	0.4070	1.1317	0.2874
cat	1	0.0332	0.2694	0.0152	0.9020
hs	1	-0.3348	0.2747	1.4847	0.2230
tf	1	0.4054	0.0304	177.6611	<.0001
Region	1	0.0344	0.1599	0.0462	0.8299

The odd ratio for age was 0.987 within a confidence interval of 0.975 and 1.00 inclusive. All the odd ratios are significantly different from 0 as they are within their confidence intervals. The highest odd ratio is associated with sex whiles disease classification has the least. Table 3.2 presents the odd ratios for all the covariates.

Table 3.2 Odd Ratio Estimates for the Covariates

Effect	Point Estimate	95% Wald Confidence Limits	
Age	0.987	0.975	1.000
Sex	1.530	0.920	2.543
Dc	0.504	0.313	0.809
Tp	1.542	0.694	3.424
Cat	1.034	0.610	1.753
hs	0.716	0.418	1.226
tf	1.500	1.413	1.592
Region	1.035	0.756	1.416

4.0 DISCUSSION

The study postulates that males seem to be more susceptible to tuberculosis than females. This may be due to the nature of activities both sexes engaged in. Whiles males are usually involved in manual works and other habits such as smoking and alcoholism that predispose them to the risk factors of tuberculosis; females seldom involve themselves in such acts. This is similar to a report by WHO (2002) which said in most settings, tuberculosis incidence rates are higher in males at all ages than in females. This was further supported by results from the Kaplan-Meier estimator indicating that there was significant differences among males and females (log rank=3.5921, p=0.0581).

Also, about fifty percent (49.04%) of the patients had pulmonary tuberculosis whilst 50.96% had extra-pulmonary tuberculosis. This findings is at variance with many researches (Jakperik and Ozoje, 2012; Jakperik and Acquaye, 2013; NTP, 2010) which reported high prevalence of pulmonary tuberculosis than extra pulmonary tuberculosis. Ninety-six patients representing 8.01% were infants diagnosed with tuberculosis, 125 (10.43%) had relapse cases, whiles 978 (81.57%) had tuberculosis for the first time.

The probability of recovery in 22weeks was evaluated to be 0.9786, probability of recovery in 24 weeks was 0.5658 whilst the probability of recovery rapidly declined to 0.0947 in 27 weeks. This is due to the fact patients who exceeds the median recovery time are mostly prone to treatment failure. Evidently, the probability of treatment failure rose astronomically to 0.9053 in the 27 weeks. Also, an average recovery time of 24 weeks was obtained in this study, slightly lower than that reported in another study in the Upper West Region of Ghana (Jakperik and Aquaye, 2013).

The Likelihood Ratio test, Wald, and Score were all significant indicating that at least one of the covariates is contributing to the significance of the model. The model fitted the data well classifying accurately 93.5% of the patients with a 6.5% error margin of not correctly classifying a patient.

Age is an important factor in the treatment of tuberculosis. The study reveal that for each one week increase in age after treatment initiation, the risk of relapse decreases by 1.3% holding the effect of all covariates constant.

This coincides with findings from other researchers (Jakperik and Ozoje, 2012; Pardeshi and Deshmukh, 2007) identified age as an influential covariate in tuberculosis treatment.

The study also revealed that female patients have about 53% chance of recovery more than their male counterparts. New patients have 54.2% chance of recovery higher than those with relapse cases. Patients who are HIV negative have 71.6% of the risk of relapse compared to those who are reactive to HIV. This may be due to the fact that HIV positive have an immuno-compromised system. Also, for each one week increase in time of treatment after treatment initiation, the chance of recovery increases by 50% holding the effects of other factors constant. This therefore means that, infants, HIV/AIDS patients, and the elderly needs to be handled with care to ensure increase in treatment success.

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