

Assessing the Effects of Prognostic Factors in Recovery of Tuberculosis Patients in the Upper West Region

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Abstract

This study was conducted to assess the effect of prognostic factors in recovery of tuberculosis patients in the Upper West Region of Ghana. Four hundred patients who underwent treatment at the Wa General Hospital were used in this research. Product Limit function and Logistic Regression model were used to analyze the data obtained. It was observed that female patients had more chance of recovery than their male counterparts. Variables that significantly contributed to recovery were age, type of patents, duration of treatment, and HIV status of the patient. Patients who recovered were 73.75% with 26.25% treatment failure and a median recovery time of 25.43 weeks. The results revealed that for each one week increase in age after treatment initiation, the risk of relapse decreases by 7.1%. This indicates that increase in age, increases the risk of relapse and even death. Patients co-infested with HIV/AIDS had a high risk of treatment failure. People should be educated to avoid spitting in public places and cover their mouths when they cough or sneeze, patients should also be encouraged to visit the health centre regularly and also take drugs as prescribed, the Directly Observed Therapy Short-Course should be introduced for all patients, and especially the elderly and the immune compromised patients must be treated with care.

Keywords: Tuberculosis, Product-Limit Estimator, Binary Logistic Regression

1. Introduction

Tuberculosis (TB) is one of the most prevalent infections of human beings and contributes considerably to illness and death around the globe, and remains one of the most deadly diseases in the developing world (WHO, 2008). It is an infectious bacterial disease caused mainly by *Mycobacterium tuberculosis*. Basically there are two types of tuberculosis. Pulmonary tuberculosis results when the bacteria typically affect the lungs while extra pulmonary tuberculosis occurs when the bacteria affect any other part of the body except the lungs. Also TB cases are still rising as a result of alcoholism, drug abuse, exposure to dust and tar, smoking cigarettes and marijuana, people who inject illicit drugs (especially when needles are used), worker and residents in gold mining areas, consumption of milk and meat contaminated with the bacterial, overcrowding, insanitary condition in congested areas of large cities and prisons (Addo *et al.*, 2007). A patient on Tuberculosis treatment is likely to be cured within 24 – 28 weeks (CDC, 2005). Tuberculosis is transmitted through the air when a person with active pulmonary tuberculosis coughs, sneezes, spits or talks. In developing countries where population is dense and hygienic standards are poor, tuberculosis remains a major fatal disease; the high frequency of *Mycobacterium tuberculosis* in Sub-Sahara African countries which Ghana is not left out is as a result of poor nutrition, inadequate TB control measures, inadequate programme for the disease and rapid growth of the population (Kumar and Clark, 2002). In most settings, tuberculosis incidence rates are higher in males at all ages than in females (WHO, 2002). The incidence of TB cases for the years, 2009, 2010 and 2011 in Upper West Region were 145, 152 and 270 respectively, the recovery rate for the Region was the lowest recorded in the country (NTP, 2010). The main objective of the study is to model the recovery of TB patients in the Upper West Region of Ghana.

2. Materials and methods

This research was conducted in the Upper West Region and data were collected from the Wa Regional Hospital and TB centres in the region from July 2007 to July 2012 with a total of four hundred patients. The prognostic factors studied comprised of age, sex, type of patient, disease category, disease classification, date treatment started, date treatment ended, outcome of treatment, HIV status of the patient and the location of the patient. Duration of treatment was determined by finding the difference between the date treatment started and date treatment ended. The study did not involve direct patient interaction hence ethical clearance was not needed. The Kaplan-Meier estimator (1) was used to estimate the average recovery time of the patients in which the recovery probability after each week of treatment was studied (Paul, 2009).

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

Logistic Regression model was used to determine the prognostic factors that influence the recovery of the patients.

$$P = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k)}} \dots \dots \dots (2)$$

3. Results

Out of the 400 patients studied over the period, 256 (64%) were males while 144(36%) were females. Two hundred and forty eight (248) constituting 62% of the patients had pulmonary tuberculosis while 152 (38%) of the patients had extra pulmonary tuberculosis. Also, 340(62%) of the patients had TB for the first time whilst 60(38%) of the patients had treatment failure, default, and/or relapse. Category I recorded 300 (75%) of patients, category II had 50 (12.5%) of patients and category III had 50 (12.5%) of the patients. Two hundred and ninety five representing 73.75% of the patients were cured or completed their treatment while one hundred and five (26.25%) of the patients defaulted, died or had treatment failure. Out of the total number of patients, 115 (28.75%) of them were co-infested with HIV while 285(71.25%) were non-reactive to HIV.

3.1 The Kaplan-Meier Estimate Approach in Estimating the Median Recovery Time

The product-limit method was employed in estimating the median time of recovery of TB patients in the Upper West Region. The probability of recovery in 20 weeks was 0.9935 whilst the probability of treatment failure was found to be 0.0065. Also the probability of recovery in 24 weeks was 0.8006 and the estimated probability of treatment failure prior to 24 weeks was 0.1994. On the 28th week, the probability of recovery astronomically reduced to 0.071 and the probability of treatment failure rose to 0.929.

The 25th and 75th percentiles were found to be 24.29 weeks and 26.86 weeks respectively. The 50th percentile which is the median recovery time was 25.43 weeks with a 95% confidence interval of 25.14 and 25.71 weeks. The mean recovery time was 25.57 weeks with a standard error of 0.0999. Often the 50th percentile is considered the best measure of central tendency for survival data because the mean is affected by extreme values if present.

3.2 Results of Logistic Regression Model

The following parameters were significantly different from zero: age, type of patients, duration of treatment and HIV status as seen in table 1. This implies that there is an association between recovery and age, duration of treatment, type of patient and the HIV status of an individual infected with tuberculosis.

The odds ratios for the covariates in the model are significant since all odd ratios fall within the lower and upper limits of the confidence interval.

Hence the model for recovery is

$$P = \frac{1}{1 + e^{-(0.0738*age - 4.2191*type\ of\ patients + 0.4384*duration\ of\ treatment - 1.4419*HIV\ status)}} \dots \dots \dots (3)$$

4. Discussion

The results revealed that male patients were more than female patients. Out of the total patient population, 256 were males representing 64% and 144 were females representing 36%. 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 is because most males especially the youth and the elderly are exposed to activities like construction works, alcoholism, drug abuse, exposure to dust and tar, smoking cigarettes and marijuana, injecting illicit drug (especially when needles are used), working in gold mining areas among others which are all risk factors for tuberculosis infection.

It was also shown that 62% of the respondents had pulmonary TB while 38% of the respondents had extra pulmonary tuberculosis. Comparing the result with that of NTP annual report for 2010, proves that there are more Pulmonary tuberculosis than other classes of TB. It was discovered that 62% of the patients had new cases while 38% were relapse cases. Category I, II and III recorded 75%, 12.5% and 12.5% respectively. In this study, 73.75% recovered with 26.25% treatment failure. A treatment success rate of 73.75% achieved from the study was lower than the WHO target of 85% while treatment success rate in another study in the Upper West Region recorded a rate of 73.6% (NTP, 2010).

Patients who were co-infested with HIV was 28.75% and patients who were not reactive to HIV was 71.25%, similar to the findings of another research which showed that individuals with weak immune system have a higher risk of being affected with TB (WHO, 2005). This is a result of their weak immune system which cannot fight the *Mycobacterium tuberculosis* hence more of the HIV-AIDS patients are likely to be infected with TB. Because the weak nature of their immune system makes them more prone to all kinds of infectious disease including TB.

The 25th percentile was found to be 24.29 weeks which represents the smallest recovery time such that the probability of treatment failure is 0.25. The second quartile which is the median recovery time was 25.43 weeks indicating that a patient would be expected to recover within that period with a probability of 0.50. Frequently

the fiftieth percentile is considered the best measure of central tendency for survival data because the median is less sensitive to extreme values compared to the mean. Also, the median is often used instead of the mean when data contain outliers or are skewed. This research also revealed that when a patient starts treatment he/she is expected to be cured within 25.57weeks (179 days) holding the effect of all other variables constant. This is similar to findings of another research (CDC, 2005) which reported that it takes about 26 weeks for a patient to be cured from the disease.

The likelihood ratio, Score, and the Wald tests with p-values less than the 5% level of significance attested to the fact that all the coefficients of the predictors are non-zero. The variables that significantly contribute to recovery of patients are age, sex, type of patient, duration of treatment, disease classification, the category and HIV status of a patient. The odd ratio signifies the level of risk associated with a given variable holding the effect of all covariates constant. The results revealed that for each one week increase in age after treatment initiation, the risk of relapse decreases by 7.1%. This means that as time of treatment increases, the risk of relapse and even death decreases. Also, for each additional one week in duration after commencement of treatment, the risk of relapse decreases by 55%. Female patients have 36% risk of treatment failure as compared to their male counterparts. Patients diagnosed with pulmonary TB have 49.6% risk of treatment failure as compared to those with extra pulmonary TB. This is because it is very difficult to diagnose the extra pulmonary TB, patients have to go through series of laboratory test, ultra scan and take X-rays to detect the affected area. Patients who are newly diagnosed with TB have 98.5% chance of being cured than patients with relapse cases. Patients who are co-infected with HIV have 76.4% risk of treatment failure as compared to those who are not reactive to HIV. This is because patients co-infected with HIV have weak immune system and hence they have to eat highly nutritious food to boost their immune system for the anti-tuberculosis drugs to work effectively.

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Table 1: Test of Significance of Prognostic factors using Logistic Regression

| Covariates | D F | Standard Estimate | Chi- Square | Pr> ChiSq | Odds Ratio | 95% Confidence Intervals | |
|-----------------------------|--------|----------------------|----------------|--------------|---------------|-----------------------------|-------|
| | | | | | | Lower | Upper |
| Age | 1 | -0.0738 | 20.5103 | <.0001 | 0.929 | 0.900 | 0.959 |
| Sex | 1 | -0.4457 | 0.7857 | 0.3754 | 0.640 | 0.239 | 1.716 |
| Disease Classification | 1 | -0.7005 | 1.6626 | 0.1973 | 0.496 | 0.171 | 1.440 |
| Type of patients | 1 | -4.2191 | 18.7026 | <.0001 | 0.015 | 0.002 | 0.100 |
| Category | 1 | 0.6513 | 1.3700 | 0.2418 | 1.918 | 0.644 | 5.709 |
| Duration of Treatment | 1 | 0.4384 | 52.0788 | <.0001 | 1.550 | 1.376 | 1.746 |
| HIV Status | 1 | -1.4419 | 6.8054 | 0.0091 | 0.236 | 0.080 | 0.699 |

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